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EUROPE REPORT

SCIENCE AND TECHNOLOGY

WEST EUROPE

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WEST EUROPE/ADVANCED MATERIALS

BMFT OUTLINES 10-YEAR FRG ADVANCED MATERIALS R&D SUBSIDY PLAN

Bonn MATERIALFORSCHUNG in German 1985 pp 11-12, 19-23, 30, 34, 38, 42-43, 48-49, 51-52, 63-66

[FRG Ministry of Research and Technology publication: "Materials Research"]

[Excerpts] Program Summary

Materials are essential to every technical and economic activity; without them there is no commercial product, and new materials are often decisive for technical and industrial progress. New, strong and cost-efficient structural materials play a central role in achieving innovative concepts in engine, machine, equipment and systems engineering.

Innovative materials are not found by accident. They are based on successful basic research from which the new materials and the manufacturing processes for their realization can be developed. The program for material research therefore comprises incentives ranging from applications-oriented basic research and applied research to basic engineering development. Topics of the program are:

--Inorganic structural materials (materials for construction) (metals, nonmetals, ceramics, glasses);

--Organic-chemical structural and functional materials (polymers).

The main task of the program is to mobilize scientific and technological potential in institutes and centers of basic and applied research, together with the research potential of industry, to solve high-priority R&D tasks in material research. In doing so the program aims to boost the competitiveness of the West German industry, especially the manufacturers and users of materials. It is intended to help this industry, in the long term as well, to be productive and competitive by using highly developed know-how and modern technology. The subsidy program does not affect the original responsibility of the economy to conduct the research necessary to ensure its competitiveness.

The total length of the program is 10 years. After thorough consultation with numerous experts, five main areas have been selected which promise a high potential for innovation:

--ceramics,

--powder metallurgy,

--metallic high temperature and specialized materials,

--new polymers,

--composite materials.

Additionally, other projects in promising areas may also be subsidized in justified cases. The program outlines examples of projects but does not set them up in detail: establishing a program is primarily the task of the research partners in companies, universities and R&D institutions.

A model for the subsidy program is basically cooperative research, where research institutes and companies work together with divided tasks but a common aim. In this way the available R&D potential is used most efficiently, technology transfer is easier and problem-oriented R&D is guaranteed. Government subsidies should be used most efficiently by concentrating the program on major R&D efforts.

Stronger cooperation between institutional research and industrial partners is the basic goal. In addition, there are specific measures for increasing information and technology transfer, especially to the advantage of small- and medium-sized companies (reports, workshops, seminars etc.). Combining project subsidies with other national or corresponding Common Market (EEC) programs is not allowed.

Chart 1: Examples of R&D Tasks in the Priority Area of Ceramics

1.	New Powders:	a) further development of commercially promising methods for powder manufacture in view of: -- powder manufacture with limited particle size distribution below a critical particle size; -- fine production and defined composition of powders; -- manufacture of fine crystalline and amorphous powders; -- improvement of sintering capability through additives, such as Y_2O_3, SrO, Al_2O_3. b) -- development of alternative methods for the manufacture of ceramic powders, for example sol/gel processes, laser technique, spraying of reactive solutions.
2.	Application and structure standardization	Systematic Development of Ceramic Materials With Higher Mechanical and Thermal Stability, for Example: -- oxides with a reinforced transition [phase] (Al_2O_3 and Cr_2O_3) with additions of ZrO_2;

		-- Zirconia obtained through the influence of the transitory phase; -- high-temperature silicon-nitride alloys, for example SiAlONe, Si_3N_4-Y_2O_3; -- Non-oxide ceramics, for example silicon carbide, boron nitride, boron carbide, etc.
3.	Mass-production capability of ceramic components	a) further development of the processing steps within a production line aiming at commercial and dependable mass-production of large and complex components made of oxide and non-oxide ceramics in view of: -- restriction in the dispersion of material properties; -- reproducibility of material properties and component characteristics; -- Improvement of error detection through indestructible test methods. b) Further development of combination methods for ceramic/ceramic and ceramic/metallic composites.

Chart 2: Examples of R&D Tasks in the Priority Area of Powder Metallurgy.

1.	Powder manufacturing and processing	-- Development of procedures with ultra-fast quenching [Abschreckung] ($>10^5$ K/s); -- development of condensation methods for the preservation of powder materials properties.
2.	High temperature light metal alloys	-- Development of aluminum alloys with increased thermal stability over 450°C; -- development of titanium alloys with increased thermal stability over 650°C.
3.	Special structures	-- Development of macroscopic uniform special structures with homogeneous phase and property distribution; -- development of materials with local different properties (transition structure, graduated structures).
4.	Oxide dispersion-hardened super alloys	-- Basic research for hardness increase; -- development of new alloys.
5.	Alternative manufacturing methods	-- Development of micro-casting methods (direct construction of mouldings from atomized fusion).

Chart 3: Examples of R&D Tasks in the Priority Area of Metallic High-Temperature Materials and Special Materials

1.	Inter-metallic phases	-- Selection of phases and structures; -- production of model materials; -- research and definition of material properties; -- target-oriented influence of material properties for selected systems, which are important for commercial applications; -- development of manufacturing methods for components and semi-finished products; -- development of [procedures] for quality assurance.
2.	New super alloys	-- Selection and research of new alloys and structures for higher stability and corrosion resistance (new hardening phases or mechanisms); -- development of new manufacturing methods and further development of the existing ones (for example directional solidification, thermal spraying).
3.	High temperature functional laminates and tribology	-- Development of wear-resistant laminates in view of the higher corrosion resistance, capacity of resistance to wear and thermal shocks; -- development of procedures for testing and determination at high temperatures.
4.	Hot shape-able and wlldable ferritic materials	-- Further development of ferritic materials through a target-oriented influence of the alloy configuration and structure within [the framework] of the simultaneous increase of the use/cost ratio.
5.	New concept for determining break-down probability and for quality description	-- Determination of the relation between the quantifiable properties of materials and their breakdown behavior in complex activities [carried out] at high temperatures. A connection must be established among the probability distributions of those values characterizing the system of quality assurance, the error statistics, material identification and duration.

Chart 4: Examples of R&D Tasks in the Priority Area of Polymers

1.	Polymers with extreme load capacity	-- Development of polymers with extremely dispersed yet oriented molecule chains, identification and improvement of the relation among manufacture methods, orientation level and [relative] properties; -- new principles for the production, test and identification of polymer matrix materials for composite materials; -- development of high temperature-resistant polymers.
2.	Polymer alloys	-- Research and improvement of the interfacial liability; -- Production of polymer alloys and identification of their morphology.
3.	Orderly co-polymers	-- Improvement of their mechanical properties and reduction of their temperature dependence, deformation, and dimensional stability during a long period of time; -- Improvement of their behavior in fire and resistance to chemicals.
4.	Surface modification	-- New or improved methods for the modification of polymer surfaces; -- methods for the identification of polymer surfaces.
5.	Polymers with particular electric electronic, magnetic and optical properties	-- New development, particularly of temperature resistant insulating materials; -- development of polymer materials with conductivity which can be reversibly generated and eliminated, development of improved conductive rubber and polymer composites; -- development of polymers for light guide and [for the production of] components of integrated fiber optic circuits as well as other elements of optical communications systems; -- development of polymer ion conductors in the form of membranes and diaphragms; -- development of polymer materials with extraordinary piezo- and pyroelectric properties; -- development of polymer materials with ferro- or anti-ferromagnetic as well as ferro- or antiferroelectric properties.
6.	Polymers as information carriers	-- Development of polymer substrate materials with dimensional stability, isotropic thermal expansion, with particular reference to humidity influence, highest transparence, optical isotropy, possibility of double refraction, mechanical stability, easy manipulation; -- development of polymers as photopolymers and for olography; -- development of polymer materials with high sensitivity to electron irradiation; achievement of a good resolution;

good adherence power to base materials (such as SiO_2, Al); application in dry discharge methods (electron and ion discharge, discharge in fluoric and oxigenous plasmas);

-- development of polymer skeleton materials with precise local formation of special groups having donor or particularly acceptor properties to be used as shadow masks, network masks, optoelectronic components, channeltron multiplier arrays, matrixes for semiconductor image sensors, electronic circuit elements and memories;

-- development of polymer materials to be applied as molecular memories.

Chart 5: Examples of R&D Tasks in the Priority Area of Composite Materials

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1.	Reinforced plastics, reinforced carbon fibers	a) Improved reinforcing fibers -- Further development of high performance carbon fibers, CFC and protection against oxidation; -- development of methods for the production of an inexpensive and general-purpose carbon fiber; -- definition of technological prerequisites for carbon fiber processing; -- development of highly rigid fiber optics with high corrosion and media resistance; -- development of new organic reinforcing fibers. b) Matrix materials -- Development of materials with high media and thermal resistance as well as impact resistance; -- development of procedures for rational component processing. c) Inexpensive mass-production of complex components -- Development of methods for the production of semiconductors and components with short clock-times; -- development of processing procedures; -- on-line tests of semiconductors and components; -- development of methods for fiber recovery.
2.	Composite materials with a metallic matrix	-- New methods for the production of inexpensive high-performance fibers without carrier core (Traegerseele) based, for example, on SiC and Al_2O_3; -- development of new manufacture methods for components, for fusion infiltration, hot isostatic presses, extrusion, foil plating; -- development of test technology.

3.	Fiber reinforced ceramics, fiber reinforced glass-ceramics	-- Improvement of the behavior [against] brittle fracture, resistance to thermal shocks and impacts through intermediate layers of fibers and whiskers. The R&D activities regard in particular the following: -- Manufacture methods, for example pressing, sintering, glass technology; -- damage reaction in the boundary field of fiber/matrix, for example at high temperatures; -- identification of material properties.
4.	New structural concepts for composite materials	-- Development of new composites for components, bearing simultaneously different loads; -- development of adequate industrial processing methods; -- creation of computational methods for new structural concepts and determination of properties.
5.	Interfaces research	-- Identification of interfaces and their mechanical properties; -- generation of models of bonding mechanisms and strength transfer in composite materials; -- interface-related experimental research on real systems, for example, fiber composites, laminate composites; -- development of quantitative, possibly indestructible, operations for the test of liability properties of commercial material composites.

[Text] Research Policy, Goals

Overlapping Goals

The materials research program derives from overlapping research and technology goals of the federal government:

--safeguarding broadly-based basic research while simultaneously subsidizing leading-edge research;
--improvement of the operating conditions for industrial R&D;
--subsidizing R&D in a few selected key sectors of cross-sectional areas of technological development in order to safeguard the competitiveness of our industry in the long term.

Mobilization of National Scientific-Technical Potential

Within the context of this general outline of goals, the primary scope of these programs is to mobilize the scientific and technical potential of highly qualified research teams in the institutes of basic and applied research together with those of industry for solutions to selected R&D tasks. In doing so, the program is based on the principle that the responsibility for creating the basis for future competitiveness via R&D lies with the companies. The materials research program is designed to help applications-oriented basic research which can be quickly transferred to industrial technology and applications. It is mandatory to reinforce existing capabilities by combining scientific and technical potential. Concentration in more than one sense is required: On the one hand limitation to a restricted number of research priorities, on the other, inclusion of qualified research institutions in the program and finally, the organizational incorporation of working teams into cooperative programs. A large, still insufficiently developed potential lies in linking basic research and industrial development in a way which transcends disciplines. At the same time such linking makes possible the highly efficient use of the program's subsidies by including research done at institutes.

The selection of priority areas was made after discussion with numerous experts, taking into account the international state of the art in materials research. Selection criteria were the technical and economic development and applications potential which could be expected in view of the state of technology in the FRG and the technical and economic requirements. The selection of priorities, however, must not be seen in an absolute way. In justified cases, especially promising and far-reaching developments outside the priorities may be included in the subsidy program. Priorities and examples for important research tasks are given in Chapter V.

Inclusion of all the R&D capacities necessary for the success of the program should eliminate some existing weaknesses and enhance the efficiency of the program. A first step in this direction was the decision of the German Research ASsociation to subsidize materials research themselves, in a complementary manner. In addition, the knowledge and capabilities of university institutes, large-scale research facilities, the Max Planck Society, the Fraunhofer Society, the AIF institutes, the Federal Institute for Material Testing, and other research organizations are to be brought into the program on a large scale. In this way the transfer of knowledge and technology, especially in publicly subsidized institutions, should be easier and quicker. Cooperation between government-sponsored and industrial research should enhance mutual understanding, markedly accelerate technology transfer, and improve the willingness of industry, material manufacturers, and users to take risks. It should also eliminate existing problems of understanding between special disciplines of materials research.

Organizationally, cooperation of the kind described above is to be achieved through the concept of cooperative research as a preferred subsidy model: the research capabilities of the various project leaders (universities, companies, research institutions) are combined to work on functionally and thematically connected R&D problems together, sharing work and mutually exchanging know-how. Depending on the topic of a problem, the partners and the competitive situation, cooperative research will in practice be realized in various ways. Possible forms of cooperation may range from a fixed agreement for the exchange of R&D results to common research work in the laboratory.

Cooperative projects are characterized by binding agreements, for example with regard to planning, R&D team work, use of R&D results, and distribution of financing, etc., and by a responsible project coordinator for professional coordination and supervising partial projects. Special attention will have to be paid to reducing to a minimum--especially for complex larger projects--the internal bureacratic structures which are necessary for the organization in order to avoid loss of efficiency and additional costs. The program is open to all interested parties capable of a consistent R&D contribution.

Characterization and Testing of Materials

Even successful R&D remains patchwork when new materials or procedures are not utilized by expert engineers and technicians and applied industrially. A prerogative for fast utilization is primarily the availability of appropriate test procedures in order to characterize the technical data in a reliable and reproducible manner for subsequent acceptance of its use. Materials testing institutions and the appropriate research institutes play a role in this area. They have therefore already been heard early on during the planning stage of the program and will be involved in its execution as long as necessary.

Material-Specific Design, and Databases

It is, however, an equally important prerogative that the designer knows the new materials and handles them in a material-specific way in order to fully utilize superior properties in a component. Material-specific design--for example with new ceramic materials, polymers or composite materials--has long been a topic in the training of FRG engineers and designers. Inquiries at research organizations and specialists in universities and industry do not seem to reveal a special, additional requirement for training. It must be considered here that the materials research program will create considerable additional experience and know-how in the use of new materials through the contributions of numerous young scientists and engineers in research institutions as well as industry. In this connection it must be mentioned that in the especially active field of ceramics special attention is paid to material-specific design at several universities and through newly-established institutions. Furthermore the problem should be brought into focus by the modern instruments of computer-aided design (CAD) in connection with a materials database system also subsidized by the BMFT.

Appropriate databases-subsidized within the framework of the program for professional information centers--are available or are being built. They can be interconnected when necessary, for example, via EURONET. The data of new materials developed in the projects of these programs will be fed into this system of databases in order to permit comprehensive and fast access to the newest materials. Data which are not supposed to be generally available will be adequately protected.

Exchange of Personnel

In materials research, as in other areas of technology, technology transfer through personnel is an especially suitable means for creating intensive and durable interrelations between research and industry. This is especially true for the relations commercial companies have with governmental large-scale research institutions, whose more intense orientation toward the research requirements of industry is a central requirement of the FRG's research policy. In this context it seems to be important to mention a new BMFT research program which supports such a personnel exchange financially: junior scientists from commercial companies, in higher numbers than before, are to absorb new knowledge in research institutes while bringing a practical view of the problem to the area of research. New ideas and impulses in leading-edge technologies can then be transformed into industrial innovation much faster and more efficiently. Materials research must also be counted among those technologies which are subsidized by the BMFT and where junior scientists can be active. The work of scientists and technicians from research institutes and universities in industry laboratories has the same effect and should be applied practically more often.

Length and Character of the Program

The program is designed to run 10 years. This relatively long period of time takes into account the experience gained in the past with important, successful material developments: it was repeatedly evident that the path from basic research through applied R&D to industrial application is tedious and cannot be forced in the short term. This program concentrates on technically and commercially risky projects which are designed for the long term. After 3 years there will be an initial intermediate evaluation which can lead to a review of tasks, main efforts, instruments and financial requirements, and possibly to a modification of the program. The program ranges from basic research to all levels of applied research, but not to pre-manufacture or series production.

At this point it must again be emphasized that the federal g vernment, with this program, targets goals which go beyond the results which can be obtained immediately through program subsidies. These limited subsidies are supposed to trigger or amplify research activities in the FRG research world--both in the private sector and in the public domain--which in the long term lead to a stronger coordination of forces and to a new orientation toward main efforts of research which have been identified jointly as being important.

Financing, Subsidy Procedures

Funds totaling DM 1.1 billion have been allocated through 1994 to finance subsidy measures. The following amounts are planned up to 1988:

	1985	1986	1987	1988
in million DM	79	94	102	119

Progress of the program from 1989 to 1994 depends on the possibilities of the individual budgets. After 3 years, an intermediate evaluation is planned in which goals, main efforts, instruments and financial status will be scrutinized and the programs modified if necessary.

Model for Subsidy:

The preferred model for subsidy is cooperative research, where research institutes and companies work together with divided tasks but a common aim. The cost of planned cooperative research projects is carried jointly by industry and the BMFT [Federal Ministry for Research and Technology].

In order to promote efficient cooperation between industry and its research partners (institutes) as much as possible, companies must also share responsibility for financing the expenses of the institutes.

Cooperative projects within the materials research program are subsidized in the following manner:

1. The BMFT in general assumes 50 percent of the total cost of the cooperative project. The participating industry partners take care of the remaining 50 percent of the total cost; i.e., they are responsible for 50 percent of their own costs and 50 percent of the expenses of institutes.

2. The BMFT may increase its share in the expenses of institutes when the following trends emerge:

--obvious shift toward industry of the topic of the cooperative project and/or;

--necessity for the institutes to bear a higher than average portion of the total project in the case of inordinately high expenses for industry, and/or;

--a higher than average scientific-technical risk caused by the basic nature of the project, so that a industrial participation in the sense of point 1 can only be realized in a later phase of the project or in a follow-up project.

3. If application of the project is nearer, the BMFT contribution to the funds required by industry partners for their portion may be diminished to 30 percent regardless of point 2.

Subsidizing measures within the framework of this program are processed via the project leader KFA Juelich, PLR PO Box 1913, 5170 Juelich.

Existing R&D, Subsidy Programs

The Federal Government and states grant subsidies in the area of materials research, especially the federal minister for research and technology, the German Research Association and the Volkswagenwerk Endowment.

Many subsidy programs of the BMFT (e.g. energy research, air and space research, traffic technology, environmental research, ocean technology, health research) include considerable portions of materials research, albeit mainly oriented specifically to the program task. Often materials have a decisive significance for the realization of the program tasks:

for example, the high degree of safety in German nuclear plants was enhanced by the development of materials within the energy research program. Materials have made a major contribution in air and space research. Biomedical research resulted in biocompatible materials for extended use in tissue and in the development of bone and tissue substitutes. German experiments in the SPACELAB materials laboratory under the sponsorship of the DFVLR [German Research and Test Institute for Air and Space Flight] opened a new dimension of experimental possibilities with far-reaching significance; for example, for the research of metallurgical melting processes. It is not the possibility of manufacturing in space which primarily motivates this effort, but rather the chance to come to a thorough and commercially useable understanding of processes which occur during the formation of solid material in weightlessness.

Among the 13 large-scale research institutions, it is especially the primarily technology-oriented institutions DFVLR, GKSS, KFA and HMI which have major materials research activities. The expenses of these five centers for materials R&D in 1983 were estimated at DM 85 million by the working group of large-scale research. Within the framework of main R&D efforts of this program, this figure could rise by about 20 percent by 1988.

At KFA in Juelich, the main effort in the field of materials research is in the area of metallic high-temperature materials and in some areas of ceramics. In addition, the Institute for Solid State Research in Juelich conducts basic research with emphasis on metals. KfK in Karlsruhe works primarily in the area of ceramic and metallic materials behavior under corrosive and complex mechanical stress conditions as well as in the development of mechanically resistant materials. The DFVLR in Cologne is concerned with the development and characterization of lightweight, high-temperature materials. GKSS in Geesthacht mainly tests the mechanical breaking behavior of metallic materials.

Besides the BMFT it is primarily the Federal Ministry of Defense (BMVg) which conducts extensive materials research. Tasks for military materials research are derived from both the technological concepts of future generations of weapons and the experience gained with existing systems. R&D contracts are given to research institutes and industry. The identity of the grant recipients and the direct involvement of the BMVg in the selection of projects ensures that military materials research is widely used in the civil sector and that duplication of efforts is avoided. Other federal ministries and the federal states have no special materials research programs, but subsidize projects for the solution of existing materials problems within the framework of departmental research.

The success in the development of new materials, their manufacture and processing depends on reliable knowledge of their properties under predetermined conditions. This is a domain of materials testing. The Bundesanstalt fuer Materialpruefung [BAM--Federal Institute for Material Testing] and the 24 materials testing establishments of the states with 3,200 employees take care of this task in the FRG. These institutions enjoy international fame. The traditionally close partnership of the materials testing institutions with industry to find solutions to materials technology questions, and the resulting familiarity with the operational conditions in the companies in industry, make them especially suited for the desired technology transfer.

Some large comapnies in the FRG economy have important research institutes of their own and in addition give research contracts to institutes like the Fraunhofer Gesellschaft [Fraunhofer Society], the Max Planck Gesellschaft [Max Planck Society] or to universities. Small- and medium-sized companies, in contrast, pursue long-term projects generally in the form of cooperative research, for example within the framework of the Arbeitsgemeinschaft Industrieller Forschungsvereinigungen (AIF) [Cooperative of Industrial Research Associations]. The main effort of all this industrial activity is in product-oriented development and quality assurance and--with the exception of AIF--rather than applications-oriented basic research.

In the approximately 50 institutes of the Max Planck Society, materials research forms an important sector, with a yearly budget of about DM 60 million. The MPI for metal research in Stuttgart works mainly on questions concerning the physics of metals; for example, on plastic deformation under high energy radiation as well as in magnetism and supra-conductivity. Further main efforts in the material sector are made in the areas of power metallurgy, special ceramics and inner boundaries. In the MPI for solid state research in Stuttgart the optical, electrical and mechanical properties of non-metallic crystalline and glass-like solid states are researched. The MPI for ferrous research in Duesseldorf works in an interdisciplinary way with the departments of metallurgy, transformation technology, applied metal science, physical metal science and physical chemistry in the area of iron and steel and other metallic materials. The formation of the MPI for polymer research must be seen as a reaction to the requirement for additional interdisciplinary research in this field. The initiative for this came from industry, the panels of the German REsearch Association [DFG], as well as from the Science Council.

In the Fraunhofer Society several institutes are concerned with materials research. The spectrum reaches from non-destructive materials testing operational reliability, and material mechanics to applied material research. The Fraunhofer Society dedicates about DM 45 million to its available funds to material research.

BAM conducts the whole range of materials research, beginning with areas such as materials technology, metal protection, civil construction and building protection up to non-destructive test procedures, surface testing and biological material testing. For this it spends about DM 45 million of its budget.

The DFG spends about DM 30 million per year to subsidize a wide range of basic research in materials science in numerous university institutes, in priority programs and special areas of research. For example, it subsidizes work on solid state reactions both in volume and on the surface, on the physical basis of the creeping and deformation behavior of polymers, on resilience of ceramic materials and on the glassy state of metallic systems.

The Volkswagenwerk Endowment subsidizes as a priority unconventional materials and the behavior of mateirals in operational conditions.

The activities of publicly-financed research institutions working in the field of material research are listed in Annex 1; Annex 2 reflects the subsidizing activities of the DFG and the Volkswagenwerk Endowment.

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WEST EUROPE/BIOTECHNOLOGY

SWEDISH ASTRA TO CARRY OUT GENETIC R&D IN INDIA

Stockholm NY TEKNIK in Swedish 25 Sep 86 p 8

[Article by Staffan Dahllof]

[Text] High research standards and a low cost--this is why the pharmaceutical company Astra is establishing a basic research laboratory in India. The company's goal is to develop its own expertise in gene technology.

"This is purely basic work. As far as we are concerned, it may go in any direction," said Hans Hellstrom, project leader, who has the official title of senior vice-president of Astra.

The investment, which is barely 1 year old, has already yielded results. Astra has gained its own expertise on the production of restriction enzymes, the "chemical scissors" used to cut DNA strands during genetic manipulation.

Since even before this effort, Astra has had a plant for the production of pharmaceuticals in Bangalore in the state of Karnataka. The new laboratory will have 15 to 20 employees, about one third of whom will be researchers and the rest technicians.

Astra does not hide the fact that India offers high standards at a low cost.

"There is a surplus of good researchers who welcome us. We have even attracted outstanding Indians back home from the United States."

Five Times More Expensive

"Out investment, about $6 million over a 5-year period, may not be high, but it costs much less to work with Indian researchers than with Swedes. A similar program in Sweden would cost at least five times as much," Hans Hellstrom said.

He also stressed that this investment was totally in line with Indian investments in advanced technology.

Astra is not the only company that has discovered the possibilities of investing in inexpensive research and development in India. The same city of Bangalore has also attracted Texas Instruments and the Japanese company PSI Systems, which intend to develop software there.

Hans Hellstrom of Astra said that the investment was made in close cooperation with the Indian authorities, including the Indian Institute of Science.

The joy in India seems not to be without reservations, however. According to the magazine NATURE, Astra in Bangalore has skimmed the cream of Indian biochemistry and, among others, it has employed the biotechnology chief of the Indian Institute of Science.

The criticism raised by the Council for Scientific and Industrial Research is based on the opinion that the foreign research investments attract the leading Indian researchers in the competition with domestic companies. On the other hand, other authorities such as the Biotechnology Ministry, have welcomed the Astra investment as an "excellent model" for cooperation.

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WEST EUROPE/ BIOTECHNOLOGY

FEDERCHIMICA REPORT EXAMINES BIOTECHNOLOGY IN ITALY

Milan LE BIOTECNOLOGIE IN ITALIA: UN'OPPORTUNITA DI SVILUPPO INDUSTRIALE in Italian 1986 pp 135-163

[Article: Excerpts from 200-page report by the National Federation of Chemical Industries in Italy: "Marketing Biotechnologies in Italy Calls for Adequate Support"]

[Excerpts] While a significant effort has been made in Italy to market biotechnologies, as evidenced by several scientific and industrial projects, the overall position of the country is backward.

On the other hand, Italy could benefit considerably by an increase in the rate of development in the field of biotechnology, through government intervention and business-supported initiatives.

Italy Is Lagging Behind.

On the whole, Italy may be said to be lagging behind the other countries competing in the field of biotechnology. Indeed, our country did not score too well on any of the six success factors considered.

A more detailed analysis lends support to this assessment, even though it highlights some interesting aspects, which are most likely to be overlooked in an overall appraisal.

Government Funds Allocated to Research Are Insufficient and Are Not Being Properly Utilized.

While Italy seems to be making a considerable effort not to fall out of step with the more advanced countries, the resources allocated to research are still far less than those allocated by its direct competitors. The proportion of R&D expenditures in the PIL [Gross National Product], though rising over the 1981-1983 period, is roughly 1 percent, while proportionate investments by other countries are more than double; as a result, the gap is likely to widen. A suitable science policy must be developed in order to speed up and set specific targets for basic research, which is being carried out both by private and by public institutions, and to facilitate the transfer of scientific know-how between basic and applied research.

The development and implementation of such a policy is made all the more urgent by the very nature of biotechnologies, which cut across a wide range of different disciplines, and by the need to adapt the existing professional resources and equipment to the new frontiers of science.

Besides the inadequacy of its scientific hardware, which needs some thorough upgrading, our country lacks an effective software network interconnecting the various research centers and supplying the necessary multidisciplinary information through suitable supporting facilities, such as databases and bioinformatic lines.

It is readily apparent, therefore, that the development of biotechnologies in our country calls for significant additional financial support, and that these resources are to focus and to be effectively allocated on the basis of a select number of major targets, so as to define a set of critical masses interconnected by a functional network.

This would also lead to a more efficient targeting and scheduling of public expenditures, with considerable benefits in terms of cost effectiveness and results.

The Evolution of the Financial Markets Is Still Insufficient To Support the Marketing of Biotechnologies.

In the other competing countries, several highly innovative forms of funding have arisen enabling the scientist-entrepreneur to implement innovative ideas while encouraging investors to run certain financial risks. This means, on the one hand, that good ideas and promising business plans get the financial support they require, and on the other, for the single investor any amount contributed in the form of innovative investments is made tax-deductible, hence investment trusts (venture capitalists, merchant banks) are given the opportunity to diversify risks across a wide number of investment channels.

Also in Italy when there is definite growth on the financial markets, the risk factor is even less and the channels for innovative forms of financing are completely inadequate for the opportunities offered by biotechnologies.

Italy Is Behind Also in the Employment of Human Resources In the Field of Biotechnology--A Critical Factor for Success

Let us now see what is being done to improve the quality of biotechnology researchers in Italy.

These professional people who, numerically speaking, would be sufficient in an overall scheme of biotechnological development, are neither directly nor readily available for activities in the field of biotechnology, for they lack at present both a sound interdisciplinary basis and a sufficiently high degree of specialization. A number of educational projects are currently underway to fill the gap:

1. Establishment of special schools in biotechnology featuring post-graduate courses extending over several years.

2. Post-graduate specialization courses. These take less time than the former ones and, therefore, may be organized on a local basis by the universitites themselves.

Finally, there are substantial gaps in vocational training at the intermediate levels: it has been pointed out earlier that while in other countries the curricula include suitable training for laboratory technicians and people working in the intermediate professional tiers, no comparable effort has been made in Italy. (Footnote 1) (It must be noted, however, that some training courses for "experts in the biotechnological sciences" have been introduced by public institutions.)

The picture which emerges from this overview is one of a country that, on the whole, does not meet the human resource requirements for marketing biotechnologies--a problem which is made all the more apparent by Italy's brain drain, so conspicuous in this scientific area.

A National Targeting Policy For Biotechnology Has Yet To Be Defined.

1. So far Italy has not developed a national plan. This may be due to the fact that no industrial policy analysis for the development of biotechnologies has been carried out in our country to date; over the last few years (from 1982 up to the present) (Footnote 2) (This statement is based on a review of the following documents: "The Prospects for Genetic Engineering" by ENI, 1982; "Biotechnologies in Italy" by FAST, 1984; "The Biotechnological Revolution" by Parisi & Spalla, 1985.) the efforts made to sensitize public opinion to these matters have centered on scientific elucidation rather than on specific project development. In this perspective, the National Biotechnology Committee, which has been recently set up the Ministry of Scientific Research, is expected to play a major role in setting a number of nationwide targets.

2. The lack of a targeting policy does not mean, however, that nothing at all has been done to promote development in the field of biotechnology. Thus, the specific projects for biotechnologies developed by the CNR, and the inclusion of biotechnologies among the sectors to be financed by the renewable fund for technological innovation (Law 46), imply a real interest as well as a concrete intervention on the part of the Ministries of Scientific Research, Industry and Agriculture.

3. The lack of a definite targeting policy must be properly assessed through an analysis of the present situation. Successful experiments, such as the CNR finalized projects or the provisions made under Law 46, may indeed prove an effective way of supporting development in the field of biolotechnology, for this kind of intervention cuts right across the government structure and therefore involves all the relevant bureaucratic decisionmaking centers.

A survey ought to be carried out in order to ascertain whether or not the available funds are sufficient to cover the potential requirements, but the lack of an overall frame of reference as may be defined by a targeting policy need not be considered a drawback for our country. If, however, the negative aspects involved in the absence of a targeting policy prevail, i.e.:

--the failure to single out specific medium-term targets to be coordinated by the relevant decisionmaking bodies (the Ministry of Scientific Research, the Ministry of Industry, the Ministry of Agriculture, the CIPI),

--the refusal to establish specific priorities for government expenditure (especially in the health sector and in southern Italy),

--the failure to involve other decisionmaking centers, which are of critical importance for the development of biotechnologies (as noted earlier, a major role is played by human resources with the relevant vocational training and by financial resources with the necessary fiscal incentives)

then the lack of a targeting policy in the field of biotechnology must be considered a competitive handicap with respect to other countries. Undoubtedly, the marketing of biotechnologies calls for suitable forms of state intervention, as dramatically evidenced by the efforts made by the British and French governments to provide adequate support in all the stages of the process, including the entrepreneurial one (let us recall that these efforts led to the establishment of two extremely promising corporations--Celltech and Transgene, respectively).

The Integration Between University and Industry Is Less Successful Than in Other Countries.

New, advanced technologies can be developed only where a close link exists between scientific invention and research, on the one hand, and process/product innovation on the other.

This is particularly apparent in the field of biotechnology, which involves a large number of different disciplines and places considerable emphasis on industrial experimentation: these aspects lead to the conclusion that a high level of integration between industry and scientific institutions ought to be considered a critical factor for success in the field. For this purpose many projects aimed at marketing biotechnologies have been developed abroad, where suitable scientific and technological facilities have been introduced (Footnote 3) (A study on this phenomenon is being carried out by Federchimica. One such scientific/technological initiative is Germany's "Berlin Innovation Grundzentren," where the Deutsche Bank Berlin, Arthur D. Little, Berlin's City Council Authorities and the State Technical University are cooperating on a program designed to favor the development of start-up companies.)--areas specially equipped to facilitate the industrial development of scientific ideas.

The Role Played by the Industrial System in the Field of Biotechnology Is Still Insufficient.

This is best evidenced by the following observations:

1. If the chemical industry is considered the driving force behind the development of biotechnologies in Italy, an analysis of the country's industrial system indicates that while there is indeed an impetus toward innovation, it is still too weak competitively. Italy's chemical industry has always provided the thrust for the manufacturing system as a whole (see Table 79) [not shown]; this has been the case through the time of industrial reconstruction right up to the present day.

Our chemical industry, however, is rather fragmented as compared with other EEC countries, with large entreprises being smaller in size and a large number of small-size enterprises. (Table 80) [not shown]. A review of Italy's 60 leading chemical industries (Table 82) [not shown] readily shows that they are considerably smaller in size than the international chemical corporations; in addition, approximately 40 percent of their total sales volume is accounted for by companies belonging to large multinational corporation, their research and decision-making centers being located, for the greater part, at their head offices abroad.

As a last point, in the pending competitive struggle the chemical industries of other countries are showing large profits (see Table 82) [not shown] and, therefore, have the ability to invest heavily in R&D, whereas our chemical industry, having just accomplished its structural rationalization process, cannot as yet rely on any comparable investment capability.

2. In the light of these remarks, Italian industry cannot as yet be considered a success factor for biotechnological development.

There are, however, specific areas of industrial competence in this sector (Table 82),[not shown] and this initial "core" may provide a basis for development.

A review of the data shown in Table 83 readily indicates that:

--Biotechnologies play a more prominent role in the "health" sector than in the chemical and agricultural ones;

--Biotechnological resources are utilized mostly in such areas as "enzyme production and/or immobilization" and "fermentation and purifying of molecules produced by engineered organisms", for a substantial amount of technological knowhow already exists in these fields, and is to be found at all levels.

--the various cellular culture, cellular fusion, somaclonic and gametoclonic variation techniques, which provide the scientific and technological background for the modern enterprises operating in the agrobiological field, are virtually absent.

At this stage, a reduction of this initial core to its lowest critical mass seems to be imperative for effective competition; secondly, the business system as a whole must achieve a greater awareness of those entrepreneurial factors (innovation and change) which are essential in order to transform scientific innovations into business opportunities.

On the other hand, while small size is a real limitation in terms of R&D capability, it may nonetheless prove a success factor in terms of market adaptability and commercial flexibility, provided the relevant technology is established on a sound basis. (This, indeed, has been the case with small businesses in other industrial sectors).

3. The marketing of biotechnologies in Italy is seriously hampered by the failure to perceive existing opportunities on the part of enterprises other than chemical or pharmaceutical ones (it has already been noted that in other countries several groups engaged in the food, petrochemical and mining industries have taken a considerable interest

in the biotechnological field, due both to strategic diversification and to the inevitable interactions existing between adjacent market segments).

On the other hand, it must be emphasized that up to a short time ago Italy's chemical industries, too, had closer ties with a petrochemical culture and were, therefore, more committed to staple products than other international chemical groups. Table 84 [not shown] shows that the gradual shift away from the petrochemical culture and the relevant reduction in productive capacity, is taking place in Italy at a slower rate than in the other competing countries.

Looking at the matter in this perspective, there seems to be no doubt that, at least up to a few years ago, biotechnologies were not perceived in Italy as a strategic business, while other countries have been quicker at perceiving this.

Introduction of Biotechnologies May Create New Business Opportunities.

Italy is strongly conditioned in its development by the energy problem, and must rely heavily on other countries for the supply of raw materials. Its balance of trade is by now chronically in the red, owing to the weakness of some key sectors of the economy, such as the energy sector, the agricultural and food system and, at least in part, the chemical industry.

Recommendations to the Public Authorities.

Government intervention is indeed necessary, provided it is substantial and effectively coordinated.

Here are some possible options. The following steps should be taken before investing any financial resources:

--set specific targets for research and development in the field of biotechnology (health care, chemistry and agriculture) in the framework of a national plan or of a set of finalized projects;

--concentrate development in a limited number of qualified research centers, providing suitable incentives for the attainment of the required critical mass--an indispensable condition for playing a major role in the field;

--set up a suitable structure for coordinating the activities and the resources allocated and for checking results through the development of multiannual macro research projects. These objectives call for legislative action, such as:

1. Tax concessions--investments by companies or depositors in advanced biotechnological research and production should be made tax-deductible (these should also include shares in companies pursuing the same goals);

--tax exemption, for the first 10 years of activity, for any new business operating in the advanced biotechnology sector.

2. Financial facilities--adequate funding, in accordance with Act 46/82, for advanced biotechnological research;

--creation of suitable incentives to encourage the various regional investment trusts to allocate part of their assets to the financial support or acquisition of shares in research and manufacturing companies engaged in the field of advanced biotechnology;

--contributions towards the establishment of new enterprises operating in the field of biotechnology (taking the British Technology Group as a model); in particular, the national program referred to earlier should imply the creation of a special endowment fund for the establishment of biotechnological research firms;

--allocation of funds for the management of newly-established biotechnology businesses (research contracts, subsidies to cover personnel costs).

Promote the Development of Human Resources

--introduce specialized schools and specialization courses in the existing faculties;

--provide training for professional people at the intermediate levels (laboratory technicians, etc.) through secondary schools and institutes.

Improve University-Industry Relations in the Field of Biotechnology

--extend the mechanisms designed to establish effective cooperation between universities and enterprises (associations, conventions, etc.);

--identify new mechanisms for achieving a higher degree of mutual mobility between the academic institutions and industry, without interruptions in the individual's career;

--streamline the procedures through which research contracts are made.

Recommendations to Industry

Companies should intensify their efforts to step into the biotechnological field. Several approaches are available, notably:

--participating in the development of the business and in the exploitation of the relevant opportunities through investment in research and development;

--acting directly on the decisionmaking centers for industrial policy (as evidenced, for instance, by the steps taken by the Association of Japanese Industry within MITI), in order to promote the development and expansion of biotechnologies. In this connection, Federchimica may play an active role in:

1. drawing the attention of the government to a targeting policy or to a set of targeted projects (in the manner specified hereabove);

2. contributing to the development of a national biotechnology program and to its implementation and management;

3. promoting targeted "biotechnology projects," to be developed by the CNR [National Research Council] with substantial support from industry in the preparatory and implementational stages, to ensure closer links between scientific and industrial goals;

4. promoting the establishment of an association among the enterprises operating in the biotechnological sector (e.g., Assobiotec) in order to establish an effective link also with the CNR, universities and other public institutions;

5. promoting the creation of a fund, to be managed by a trusteeship, for the development of business initiatives in the field of biotechnology.

Conclusions

A rating of our country's performance, based on six success factors designed to assess the country's level of biotechnological development, showed that Italy is lagging behind its competitors in the field.

While the country does indeed possess specific scientific and industrial expertise, it lacks wholehearted support by the economic and institutional agents in the biotechnological sector.

On the other hand, the economic structure of the country, the gap between the north and the south, the beneficial impact of biotechnological applications on several segments of the health and food sectors, make it imperative to take some definite steps in the near future, as the rules of the game are being increasingly defined in terms of the ability to compete in the international market.

Two courses of action are available at present: either a national plan, or a wide range of targeted operations in the legislative, economic and human-resource programming areas.

Some options are clearly identifiable, and so are some of the steps that are to follow up any initial policy. Thus, a number of suggestions are made to the public authorities and to industry; these suggestions may be summarized as follows:

--As regards the public authorities, substantial financial aid is required in order to support basic research which is now being carried out by the R&D centers of large enterprises and to set up new biotechnology businesses. This effort must be paralleled by the introduction of legislative mechanisms designed to improve the transfer of biotechnological invention and innovation.

The development of human resources through professional training in the biotechnological sciences is the third option available to the public authorities.

The enterprises, on the other hand, should tackle the aspects connected with innovation and application. A greater involvement in the development of the biotechnological sector should be a prime objective for those businesses which are most likely to be affected by its results. In addition, companies should make an effort to identify new forms of organization, operation and financing in order to promote the growth of the biotechnological sector in Italy.

Table 83 - Italy's Leading Biotechnology Enterprises

Enterprises are subdivided according to the type of industry in which they operate and their respective areas of specialization in the Biotechnological field.

	1 SETTORI			2 COMPETENZE									
	3 SANITÀ	4 CHIMICA	5 AGRO-ALIMENTARE	6 Produzione, immobilizzazione ed impiego di enzimi	7 Clonaggio ed espressione dei geni	8 Fermentazione e purificazione di molecole prodotte da organismi ingegnerizzati	9 Produzione, analisi e selezione di ibridomi	10 Colture di cellule animali e produzione in scala di prodotti cellulari	11 Colture di cellule vegetali e produzione di metaboliti	12 Ingegneria genetica delle piante e loro simbionti	13 Sintesi di polinucleotidi	14 Chimica delle proteine	15 Ingegneria genetica degli animali superiori
• MONTEDISON •• FARMITALIA C. ERBA	■	■			●	●	●	●	●		●	●	
•• ISTITUTO DONEGANI		■	■	●		●			●		●		
• ENI •• ENI RICERCHE	■	■	■	●	●	●				●	●	●	
•• ENICHEM-SOLAVO	■		■	●	●	●	●	●			●	●	●
• FIAT •• SORIN BIOMEDICA	■			●		●	●	●					
• LEPETIT	■				●	●	●						
• MENARINI	■			●		●							
• RECORDATI	■						●						
• SERONO	■				●								
• SOCIETÀ PRODOTTI ANTIBIOTICI	■			●	●	●							
• IST. ZOOPROFILATTICO - Brescia	■						●	●					
• GRUPPO FERRUZZI			■			●							

Key:
1. Sectors
2. Areas of Specilization
3. Health
4. Chemistry
5. Agriculture & Food
6. Production, immobilization and utilization of enzymes
7. Cloning & expression of genes
8. Fermentation & purifying of molecules produced by engineered organisms
9. Production, analysis & selection of hybridones
10. Animal cell cultures & scale production of cullular products
11. Vegetable cell cultures & metabolite production
12. Genetic engineering of plants & their symbionts
13. Polynucleotide synthesis
14. Protein chemistry
15. Genetic engineering of higher animals

Source: Federchimica Working Group

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WEST EUROPE/COMPUTERS

FRENCH AI ACHIEVEMENTS REVIEWED

Amsterdam COMPUTABLE in Dutch 22 Aug 86 p 23

[Article by Dieter Murawski: "France Still Under the Spell of Prolog--French Stimulate AI"]

[Excerpts] The French have made a considerable contribution to artificial intelligence with their universal and user-friendly programming language Prolog. This language appeals not only to American scientists at the Stanfort Institute [sic], but also to the Japanese MITI [Ministry of International Trade and Industry], which is partly basing its fifth generation computer project on it. "The leap forward with Prolog is comparable to that of the introduction of the decimal numbering system, which put an end to the complications of Roman numerals," according to Jean Rohmer, head of Bull's AI research center.

The French government provides financial support to the research efforts of companies in certain key technologies and calls them national projects. Unlike a number of other areas within the electronics field, artificial intelligence has not been designated as such a national project. However, the so-called coordinating programs do provide support for public research.

It is quite obvious that the development of expert systems, programming languages, and hardware especially designed for AI is primarily concentrated in universities and in the interdisciplinary CNRS (National Center for Scientific Research) and that Bull and CGE [General Electric Company]--both state controlled-set the pace in industry. With its SPS-7 [Structured Programming System] model Bull offers a computer for technical and scientific applications which is expected to win about 7 or 8 percent of the European market in this category until 1988. Within the ESPRIT [European Strategic Program for R&D in Information Technologies] framework the French concern is involved in various projects. These include the "ACCORD" project, aimed at establishing comprehension of colloquial speech that goes beyond dialogue; the "KIMS" project on fifth generation software; the "ALPES" [Advanced Logical Programming Environments] project, an expansion of Prolog; and "Non-Von Neumann," research into the possibilities of parallel architecture.

On the international scene Bull is cooperating with Siemens and the British ICL [International Computers Limited] in the AI area at the Munich-based ECRC

(European Computer Research Center) headed by the French Professor Herve Gallaire. In France itself the Bull group has not only laboratories for each separate applications area but also a central laboratory.

Results in the AI area obtained by the institute headed by Jean Rohmer include the Prolog interpreter Xilog for the concern's PC series (Micral 30 and 60); Kool, a language for representing expert knowledge; and Schuss, a machine of which a few prototypes are already available, and which reduces the time needed to access data banks. A model has even been developed in VLSI [Very Large-Scale Integration] technology.

The DEA (Directorate of Advanced Studies), the research department of Bull's subsidiary Bull Transac, is also active in AI and serves as the secretariat of the ESPRIT IWS (intelligent workstations) project. In connection with this the Free University of Brussels developed the KRS language for representing knowledge. Furthermore, Transac developed the Planex system for planning, as well as a graphics- and formula-processing interface.

AI Computer

In the hardware area on French project deserves special mention: the industrial production of a special AI computer. The Marcoussis Laboratories (located south of Paris), part of the CGE, in cooperation with the CNET (National Center for Telecommunications Studies) is developing a machine intended for the use of artificial intelligence. The project is called MAIA (Machine for Artificial Intelligence Applications).

Software, however, is the French data processing industry's strongest branch. The development of expert systems is primarily concerned with further developing the practical experience of teams of specialists using computers to reach their findings. As opposed to the controversial expression "artificial intelligence," these systems merit their label of "expert system." Commercialization generally only follows successful in-house use. This is particularly helpful with different kinds of diagnoses. In the automobile industry, Renault uses a car repair system that was developed by the innovation department of Cap Sogeti. Likewise, INRA (National Institute for Agronomic Research) uses a tomato disease identification system called TOM which provides the point of departure from which new cultivation methods can be developed.

Other successes range from forecasting volcanic activity by the LRI [Data Processing Research Laboratory] at Orsay near Paris, to advising on capital investments (Credit Lyonnais' TECSI), to military applications (CISI [International Company for Data Processing Services], Matra [Mechanics, Aviation, and Traction Company], Syseca, Avions Marcel Dassault, and Electronique Serge Dassault), and to oil exploration (Schlumberger and Elf Aquitaine).

Medicine, however, benefits the most with an enormous supply of programs providing medical diagnostics.

To facilitate the search for documents, scientists at the CNRS designed the "Spirit" search system, which allows for much faster searches through the use of normal colloquial speech.

Spirit is a system equipped with a vocabulary of 450,000 word forms, including 2,500 idiomatic phrase structures divided into 170 grammatical categories; it uses the theory of probabilities when interpreting ambiguous expressions and 90 percent of the time it works.

In the exceptionally delicate field of atomic energy the CEA (Atomic Energy Commission) uses specialized expertise from various professional sectors to automate monitoring tasks. The extremely complex calculations are carried out by a vector unit (FPS 164 from Floating Point Systems). Through its subsidiary CISI and Informatique Internationale, the CEA has developed in its Cadarache development center near Aix-en-Provence simulation software and machines that improve safety and train operational staff.

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WEST EUROPE/COMPUTERS

ELSAG, CITEC DEVELOP NEW DATA STORAGE, PROCESSING SYSTEM

Genoa IL SECOLO XIX in Italian 11 Sep 86 p 17

[Article by Giorgio Meletti: "The Artificial Employee Has Arrived in the Government Workplace; A Machine Capable of Reading and Processing Forms Is Developed"]

[Excerpts] Genoa. The new machine presented yesterday at Elsag's headquarters is virtually unique in the world and is destined, if it is used properly, to radically transform bureaucratic work. The "SLAM" system, (as it has been called), is capable of reading, storing, and processing data contained in documents.

It is easy to imagine the implications of this change. Currently, data processing by computer is possible only if an operator (i.e. a human being) inputs the data into the machine's memory by typing the information on the keyboard. With "SLAM," it is only necessary to insert an entire package of documents inside the equipment, which will then do everything by itself. The machine leafs through the documents, reads the information, and stores the data in the memory. While a "human" operator can input about two data [due dati] per second, the machine can read and store up to 500 data per second.

Of course, the machine is able to read only forms: It knows that at a certain location on the page it has to read a given name and not a family name, a date of birth and not an amount of income. Therefore, with a supply of well organized forms, everything should work smoothly. The machine has no other problems, since it can read both typed and handwritten material. If a piece of handwriting is particularly confusing, and the artificial reader is totally incapable of deciphering it, the machine stops and requests human assistance.

This machine would be pointless if it were not paired with another technical masterpiece produced by the Citec company of Rome, a small but extremely prolific firm known for its ingenious inventions. Thanks to the industrial agreement drawn up between Elsag and Citec, the

"SLAM" system photographs the document while reading it and converts the picture into electronic signals, thus allowing memorization and "treatment" by the computer.

8615
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ITALIAN FMS MARKET PROSPECTS IN 1990 ANALYZED

Milan AUTOMAZIONE E STRUMENTAZIONE in Italian Nos 7-8, Jul-Aug 86 pp 115-119

[Article by A.M. Gaibisso & S. Rolfo, Dr. Anna Maria Gaibisso and Dr. Secondo Rolfo, CERIS-CNR (Research Institute for Enterprise and Development-National Research Council), Turin: "A Comprehensive Look at CERIS Research"]

[Excerpts] A Comprehensive Look at CERIS Research

This paper will furnish some background information to give us an idea of potential applications for flexible manufacturing systems (FMS) in Italian industry.

It would be useful to begin such an evaluation with an overall look at such systems in other countries. Then we will proceed to a comparison between these experiences and some of the situations peculiar to Italian industry (sales volume, employment, etc.).

Our observations stem principally from a rereading of the research study (1) carried out by CERIS in 1984 concerning some of the achievements of FMS in the most important industrialized countries (Japan, the United States, Great Britain, France, West Germany, the major eastern countries, and, of course, Italy).

This background survey, which allows us to draw a map of the major achievements worldwide in this area, shows that the rate of growth of the FMS phenomenon is rather steady. In fact, the research study counted more than 300 systems already operating or scheduled to be installed in the near future. More than one third of these are in Japan.* The study shows a definite trend in the industrialized countries to move towards forms of flexible automation, whether these be simple forms (cells) or complex ones (FMS) (See Table 1).

This development process, which already began in 1970-1980 in countries like Japan, the U.S., and West Germany, has taken off in the 1980's in a significant way in other countries such as France, Great Britain, the major eastern countries, and Italy. Table 1 shows the analytical data concerning each country individually. It also shows in absolute terms another interesting piece of information, namely the impact in each country of "in house" systems, whether they are entirely or partially constructed by the firm itself.

When these industries are in the machine tool or software engineering field, the significance of such an impact takes on strategic relevance in terms of market penetration of the automated factory.

An Estimate of the Italian FMS Market

An assesment of the potential of the FMS market in Italy presents considerable difficulties. In fact, flexible automation systems do not constitute a product with definite characteristics and a well-defined market; rather, they represent an operating philosophy applicable to various industrial sectors. In addition, this applicability is a function of many factors very different from each other, among which we could include factors that can be estimated in a quantitative sense such as the size of the firm (in terms of sales volume and employment) as well as other elements such as openness to new ideas, the technological background of management which cannot be generally deduced unless specific research is done.

In addition, the introduction of FMS, which involves substantial investment, is strictly connected with the economic situation of Italy, the cost of money, and, especially, with the current and future situation of individual companies on the Italian and foreign markets. For this reason, the use of statistical forecasting methods appears fairly risky in terms of the reliability of the results. As proof of this, we could cite the blatant errors committed by famous American research organizations in estimating the market for various automation products ranging from robots to computers.

Therefore, we decided to choose a more realistic approach aiming to use the available data bases constituted by the 1981 Italian census and the results of our survey concerning the extent to which FMS have taken hold in the principal industrialized countries. We did not perform a simple extrapolation to the Italian situation of the data shown in Table 5. Such an exercise would not take into account the peculiar situation of the Italian industrial scene with respect to the structural and market situations of other industrialized countries. Thus Table 5 was used as a reference base for: a) establishing a framework for the sectors and areas of use of FMS; b) evaluating the relative importance of the various sectors and areas.

The transposition of the data to the Italian situation was evaluated sector by sector both with respect to the specific characteristics which can be noted in Italy, and with regard to accumulated knowledge picked up in the course of the research study on foreign users.

From the point of view of size, we can state that recent American estimates (Footnote 1) (See D.S. Appleton, "The State of CIM." In Datamation, December 15, 1984) foresee a potential CIM market in companies with more than 500 employees (CIM can be applied to FMS since the latter is often identified with CIM and, in any case, constitutes one of the principal elements of CIM). The same source points to firms with more than 100 employees as the secondary market area. In the case of FMS, this secondary level corresponds more closely to the demand for modules and flexible cells than for true and proper FMS. Size limitations in terms of employees, however, can vary in relation to the activities carried out by the company and by its eventual place in larger industrial groupings. For this reason, an evaluation of total sales volume would be better, but unfortunately the Italian census does not refer to sales values. However, since on the basis of the research study carried out, the majority of FMS are installed in very large firms with thousands or tens of thousands of employees, we can consider that the Italian market for the potential use of these systems is situated in the largest class identified by ISTAT [Italian National Institute of Statistics], with more than 1,000 employees. We are dealing here with a little more than 150 local units (according to the 1981 census), belonging to various areas of the transport sector, the mechanical sector, the electromechanical arena, and the electronics sector which on a global scale use at least one flexible system.

Among the numerous exceptions which could theoretically be raised to this 1,000 employee limit, the most important concerns the machine tool sector. From our international analysis, it has become clear how companies in this sector have installed a considerale number of FMS on their own premises, precisely because they were interested in becoming suppliers of these systems. For the purposes of acquiring experience in this field or of being able to offer concrete FMS examples to potential clients, many companies--mostly Japanese, even with a few hundred employees--have pursued this strategy. Up until now, this strategy did not find followers in Italy. In fact, the very nature of manufacturing represented here (not very standardized, and often highly specialized according to the customers' requirements), as well as the frequent pattern of subcontracting are not favorable to the easy introduction of FMS.

However, the crisis of recent years, and increasing foreign competition especially from the Japanese could push Italian companies to invest in flexible automation to recover productivity and profitability. In this way, potential applications could extend to the 40 some local units with over 200 employees belonging to the machine tool sector.

On the other hand, a careful analysis of the production and market features of the various industrial sectors, as well as those of foreign FMS production leads us to limit further this area of about 150 units previously singled out. In fact, in some fields like naval construction, which is scarcely using FMS at the international level mostly because of the particular manufacturing structures involved (large-size parts, lack of assembly lines, etc.), does not constitute in Italy a realistic market for flexible automation in view of the crisis which has afflicted the construction sector for years, and which has only partially been alleviated by military production orders. Similar considerations also hold for railroad construction, which is now paying the price for the lack of investment in railroad transport in Italy. The aeronautics sector presents a different production picture, compared to that of other countries. FMS are in fact used in the production of aircraft motors, an activity which in Italy is limited to a very small number of companies for the most part working under American or British license. (Footnote 2) (In Italy, this sector is constituted mostly of firms producing cells.) Within the transportation sector, the potentially most interesting market will consist of the automobile and industrial vehicle sector, and, to a lesser extent, of the motorcycle and cycle sector. In both cases, a fairly large number of FMS have been enlisted for the production of motors, while other interesting examples of flexible automation concern the assembly and welding of automobile bodies. This last type of application will probably also include the home appliance sector in which Italian industry claims European Leadership.

It appears that the mechanical sector is less likely to invest in FMS. In fact, small size companies prevail in this sector in Italy, and the number of potential users will therefore tend to concentrate in those sectors in which the Italian presence on international markets is most extensive, and consequently most suceptible to stimulation by competitive rivalry.

This fact may be of particular interest to the agricultural and land moving equipment sector where all the major companies are turning towards the use of FMS following American Caterpillar's example (Footnote 3) (With 9 FMS in the U.S., and 9 in Europe, it is the major user of FMS in the world.)

However, even the sector of machine operators in the various industrial areas in which Italy occupies a strong international position will be able to demonstrate high demand for flexible automation. Indeed, as in the machine tool sector, we can predict a lowering of the threshold of suitability to companies with at least 500 employees.

In the case of companies producing motors, transmissions, turbines, etc., demand will be stimulated by sectors using these products, mainly the above-mentioned automobile and industrial vehicle sectors and the agriculture and land-moving sectors. However, considering that ISTAT does not include in this classification the manufacturers of motors for motor vehicles and aircraft, which are included instead in their respective finished products sectors, the weight of this classification in terms of local units is extremely modest.

Although in the other sectors of mechanics, electromechanics, and electronics, we foresee a growth in applications (especially in the area of assembly and testing), demand should remain modest. The causes for this vary and range from the difficulty of automating certain manufacturing processes, to the weakness of some sectors, and also the lack of adequate production volumes.

On the whole, therefore, one can reasonably estimate that the potential market for true and proper FMS in our country should be in the neighborhood of approximately 100 units between now and 1990.

There is, however, reason to consider that the lack of government subsidies to support demand and the managerial and financial difficulties felt by many companies will induce many managers to low profit choices which will favor flexible cells and modules around which the gradual integration of larger systems will take place over time. This choice will, in any case, be compulsory for many companies with fewer than 1,000 employees, which seem so far to have tended to introduce flexible automation systems for some sectors already mentioned.

*It is necessary to make a few remarks concerning the data compiled, in particular:

I) They do not include modules,

II) They are probably underestimated for the following three reasons.

a) The present state of such systems is undergoing rapid evolution, and there certainly exists more up-to-date versions which this study could not consider because of its methodological requirements,

b) The data reported are certainly lower than the true situation, especially the data concerning cells, because it is probable that the technical literature does not dwell, for various reasons, on small-size FMS,

III) It is particularly difficult to follow the phenomenon of in-house production, i.e. FMS produced within the very companies which are manufacturing these systems,

IV) With respect to Italian production, the figures do not include systems used for operations other than the removal shavings.

Table 5 Sectors Using Cells & Flexible Systems In 267 Examples

Sectors	Jap.	US	GB	Fr.	FRG	It.	Total	%
Automobiles & industrial vehicles	4	4	7	7	6	7	35	13
Motorcycles, cycles	-	-	-	2	-	2	4	1
Railroad construction	3	1	1	-	-	-	5	2
Naval construction	4	-	1	-	-	-	5	2
Aeronautical construction	-	12	6	4	2	1	25	9
Total Transportation Sector	11	17	15	13	8	10	74	27
Foundries	1	-	-	2	-	-	3	1
Framing	1	-	1	-	-	-	2	1
Agricultural & hand moving equipment	7	17	5	6	-	7	42	16
Machine and operating tools	23	9	8	1	5	6	52	19
Tools	-	1	-	-	1	-	2	1
Motors, transmissions, pumps	18	8	13	3	5	6	53	20
Heaters, reservoirs	-	-	-	-	-	-	-	-
Metal production	2	1	1	4	-	-	8	3
Precision tools & machines	-	-	-	-	1	-	1	-
Other mechanical equipment	-	-	-	3	-	-	3	1
Total Mechanical Sector	52	36	28	19	12	19	166	62
Energy: transport & production	2	1	-	4	-	1	8	3
Electro-industrial equipment	2	2	-	-	3	-	7	3
Electrical appliances	1	-	-	-	-	1	2	1
Miscellaneous	-	-	3	-	-	-	3	1
Total Electro-Mechanical Sector	5	3	3	4	3	2	20	8
Components	-	-	-	-	-	-	-	-
Civil electronics	-	-	-	-	-	-	-	-
Automated systems	-	-	-	2	-	-	2	1
Computer science	-	-	-	1	-	1	2	1

Telecommunications	-	-	-	-	-	-	-	-
Miscellaneous	2	-	1	-	-	-	3	1
Total Electronics Sector	2	-	1	3	-	1	7	3
Grand total	70	56	47	39	23	32	267	100

Source: CERIS

Table 6 Local Units, Italy 1981

	100-199	200-499	500-999	1000 >
Automobiles & Industrial vehicles	115	68	24	40
Motorcycles, cycles	21	14	5	3
Railroad construction	11	20	17	3
Naval construction	21	14	6	11
Aeronautical construction	11	10	7	10
Others	-	5	1	1
Total Transportation Sector	179	131	60	68
Carpentry	109	38	5	1
Agricultural & land moving equipment	120	64	23	7
Machine & operating tools	231 (86)*	95 (35)*	20 (5)*	9(4)*
Motors, transmissions, pumps	32	20	5	2
Metal production	138	51	13	1
Precision tools and machines	50	33	9	3
Other mechanical equipment	93	36	9	13
Total Mechanical Sector	773	337	84	36
Energy: transport & production	122	70	27	10
Home electrical appliances	40	42	14	10
Computer science	15	15	1	6
Other electric & electronic equipment	92	79	31	29
Total Electronic & Electro-mechanic sector	269	206	73	55

*Within parenthesis are indicated only local units of the machine tool sector.
Source: ISTAT, General Census, 1981.

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WEST EUROPE/MICROELECTRONICS

ITALIAN RESEARCHERS EXAMINE NEW APPLICATIONS OF GALLIUM ARSENIDE

Milan IL PROGETTISTA in Italian Nos 7-8, Jul-Aug 86 pp 19-22

[Article: "Gallium Arsenide in Italy"]

[Text] A meeting organized by the Telettra company, entitled "Discrete and Integrated Gallium Arsenide Components--Trends in Telecommunications," was held in Milan last February. In this meeting the current situation of Italy in this new technological sector was presented. It was noted that Italian initiatives in factories, universities, and research centers are numerous and extensive. The following is a summary of the many high-level reports presented:

Problems Relative to Materials for GaAs Devices: Growth and Epitaxy by S. Franchi, MASPEC CNR, Parma.

A large amount of scientific and technological work has been dedicated recently to the problems concerning the processing and transmission of information. In order to satisfy present and future requirements in this field, the existing devices have been pushed to their limits, while innovative equipment based on new concepts and new materials has been demonstrated and developed.

It is generally held that the physical properties of GaAs and III-V related compounds justify the growing use of such materials in the manufacturing of optoelectronics and microwave devices. In addition, the development of advanced epitaxy technologies such as Molecular Beam Epitaxy (MBE) makes possible the design of ad hoc structures for specific applications, which would be impossible with conventional structures and techniques.

Production of high quality GaAs monocrystals and of GaAs epitaxial structures requires a good understanding of the techniques of [crystal] growth and of the properties of materials; consequently materials technology will play a fundamental role in microelectronics.

This report briefly examines the main problems encountered in the processing of high quality GaAs [crystal] growth with the LEC method, and in the preparation of epitaxial structures with MBE. The most significant results obtained by the CNR's MASPEC Institute in the preparation of LEC GaAs crystals of the n and semiconductor type, with a low number of dislocations, and with high mobility MBE layers was presented and discussed. Finally the role played by the MASPEC Institute in national and international research projects is mentioned.

GaAs Characterization Techniques: Substrates and Heterostructures by P. Mazzoli, CISM Unit, Department of Physics, Padua University.

New analysis techniques have been developed in recent years and have been applied to the characterization of GaAs substrates and heterostructures. This report specifically discusses nuclear techniques (e.g. charged particle wide angle elastic diffusion and nuclear reactions), and secondary ion mass spectrometry. Specific examples are reported. In addition, the paper presents results of electric characterization of substrates and deterioration of MESFET in connection with specific metallization problems. The University of Padua's potential in the research field discussed in the meeting is outlined in relation to industrial research programs.

GaAs Mesfet Technology in a Telecommunications Industry, by G. Guarini, Telettra Inc.

The new generations of telecommunications systems, both with radio relays and with optical fiber transmission lines, increasingly require more extensive use of electronic components for analog applications at various GHz or tens of GHz and digitals for speeds greater than Gbit/sec. The reasons that may prompt a telecommunications industry to develop its own GaAs technology for high speed devices are of both a strategic and an economic nature. This report indicates the industrial choices made in relation to activities of research, development, and production of GaAs components for telecommunications:
--Power MESFET,
--Signal MESFET,
--Analog and digital integrated circuits.

The paper describes the most significant designs of power MESFET which were adopted, along with the CAD techniques used, and the main results which were obtained. The author also analyzes the most relevant technological aspects, such as GaAs crystal growth through vapor phase epitaxy, ion implantation, gate metallization, and MESFET and amplifier modules packages.

A Software Package of General Use for Analysis and Optimization of Non Linear Microwave Circuits by V. Rizzoli, Department of Electronics, Computer Technology, and System Study, Bologna University.

This report discusses the basic philosophy and the main characteristics of a general use program for analysis and design of microwave analog circuits. The programs are based on a nodal description of the frequencies of the circuit linear part, and on the harmonic balance technique for the nonlinear aspects. Emphasis is placed on two particular aspects of this package: (1) its capacity to proceed in fast mode to the optimization of nonlinear circuits and, (2) the availability of a vectorized version capable of optimizing the cost/performance ratio, if a supercomputer is being used. The author then discusses in detail applications for advanced problems such as generalized analysis and opitmization of mixers.

Computer Aided Design and Models for GaAs Analog Integrated Circuits by C. Naldi, Turin Polytechnic.

Computer Aided Design (CAD) is today an indispensable instrument for the development of monolithic microwave circuits. In fact, CAD allows such rapid design that costs are drastically reduced. Accurate models are necessary, both for passive (concentrated or distributed) elements, and for active elements which take into account as much as possible the manufacturing technology being used. On the other hand, models suitable for CAD techniques must allow simple and fast numerical implementation. With the aim of satisfying both requirements, the author proposes rigorous approaches, such as full-wave electromagnetic analysis for passive elements and physical models based on semiconductor equations, as well as CAD instruments to produce simple equivalent circuits capable of being incorporated in simulation and analysis programs. Models with equivalent waveguide are being used for passive circuits, in order to obtain a tool for flexible analysis. The model relative to active components is based on the solution of the equations of the transport of charges within the section of the device by means of digital techniques (finite differences of finite elements).

The models that have been developed will be included in a CAD library for GaAs monolithic analog circuits developed within the ESPRIT project of the European Community.

Design Criteria and Characterization Techniques for Monolithic Microwave Analog Circuits by F. Giannini, II University, Rome Tor Vergata.

MMIC circuits seem to adopt a general configuration which, starting from the simple reproduction of circuits with discrete components in extremely reduced scale, leads to the development of monolithic versions of absolutely new design.

The availability of "foundries" has solved the problem of circuit production, a problem caused by the high cost of investment required for manufacturing lines of GaAs components. Thus the system designer can consider the exciting potential of the monolithic approach.

The greater reproducibility and reliability and the possibility of wideband solutions and multifunction implementations constitute the most interesting characteristics stemming directly from the technology adopted in the design of the monolithic circuit manufacturing.

The production of an MMIC circuit goes through two stages: the design and the characterization, which must take into account the particular philosophy imposed by the constraints of the monolithic integration. The present paper deals with these last two aspects of the process. It describes the practical rules of design to be followed, and the characterization techniques which can be successfully applied to the development of analog MMIC. Finally, the author presents the design of an amplifier with three stages and low noise level, developed on the premises of Rome's Second University "Tor Vergata". The author also discusses each stage (electric design, sensitivity analysis, physical and topological design, etc.) necessary for the production of a set of masks for a foundry.

Some Solutions for the Production of Monolithic Microwave Integrated Circuits by E. Bastida, CISE Inc., Segrate Milan.

This paper describes a certain number of solutions for problems relating to the design of monolithic circuits developed and tested in recent years at CISE Inc.'s plant. Since non-reciprocal passive elements are not available in monolithic form, the only way to obtain decoupling in monolithic circuits is to use balanced configurations with an interstage coupler of 3 dB or 90. This may also allow improvement in the performance as a consequence of the great resemblance in electric behavior of two active devices built in very close proximity on the same GaAs substrate. For these reasons, monolithic microstrip Lange couplers have been widely used and studied, but they have shown excessively high losses and have occupied too large a total area. This report describes how the problem of the losses has been resolved by using a coupler with a coplanar topology. This coupler has been used to produce the first balanced monolithic amplifier ever built. This coplanar approach has also been used to design couplers with low coupling and reduced width, which have shown excellent band performance, and have been used as a basis for the development of slow wave coupling circuits of extremely small dimensions.

The report also discusses the practical use of the slow wave concept to resolve some well known problems in the design of monolithics, and describes the performance of a two-stage monolithic amplifier of medium power which uses a slow wave section of line in the interstage network.

Following this, the paper considers the coupling of a dielectric resonator through coplanar wave guide and demonstrates the feasibility of very selective circuits in which the resonator is placed under the other active and passive elements of the circuit.

There is a discussion of the design and operation of coplanar oscillators with high stability, and of the possibility of installing a monolithic chip over a high Q resonator, thus avoiding undesirable couplings in the entire circuit.

Finally, the author describes a new class of microwave integrated circuits. These circuits present some advantages with regard to hybrid or monolithic design. The technique thus developed can be used efficiently as a testing tool during the development of new monolithic circuits.

Applications of GaAs Devices in Telecommunications Systems Via Optical Fiber Radio Links by G. Marzocchi, Telettra Inc.

The report illustrates the applications of GaAs FET devices to microwave and optical fiber radio relay systems, and provides examples of manufacturing production in this area. It also discusses related problems concerning more advanced types of devices.

In radio relay systems, the GaAs FET devices are typically used in local oscillators with stabilized cavity and in low noise power amplifiers. The paper describes in particular the production of linear power amplifiers for 16/64 QAM at 140 Mb/s up to 8 GHz signals, and for 4 QAM up to 23 GHz signals. It also analyzes the influence of the power FET parameters and of the design criteria on the BER characteristics.

The manufacturing of the amplifiers utilizes a new advanced family of modular hybrid microwave circuits, with GaAs FET in the form of chips. This design achieves repeatable performance, easy handling, reduced dimension, and competitive cost. The author also describes a potential application of monolithic technology for analog microwave circuits at 70 MHz, and for high speed digital circuits and B.B. circuits. Following this, the author discusses applications with increasing relevance to the telecommunications field in the area of millimeter wave, and describes the role of new GaAs structures.

In optical fiber transmission systems, the GaAs FET are largely utilized in receivers, while their use in the pilot stage of the laser source is under study. PIN-FET and APD-FET receivers for 140 and 565 Mb/s systems are described with particular emphasis on the GaAs FET and homemade hybrid circuits.

Finally, the paper describes the design of circuits for the pilot stage of lasers and processors in B.B. in the Gb/s range, and demonstrates the strategic role of GaAs technology in the telecommunications sector in relation to cost considerations and to current and future volume.

Ultra Speed Logics: A Comparison Between Silicon and Gallium Arsenide by B. Ricco, Department of Electronics, Computer Technology, and Systems Study, Bologna University.

Because gallium arsenide presents high electron mobility and semiconductor properties, it is an almost ideal material for the production of ultra speed logics. In this field, however, it has a competitor in silicon. Although silicon presents inferior electric characteristics, it can count on a fully mature technology, capable of producing integrated circuits on large and very large scales.

To compare the characteristics and potential of these two materials, it is necessary to distinguish various areas of application and possible technological choices.

If one compares the MESFET with bipolar transistors and silicon MOS, one has to draw a distinction between two important cases. For circuits with low integration level (less than a few thousand gates), and with speed limitations which are due to the characteristics of active devices, GaAs presents clear advantages over silicon because it allows the production of logics with a speed two to four times higher. In this case, however, GaAs also has a considerable disadvantage because of its higher cost, particularly at low levels of integration. On the whole, therefore, GaAs seems of noteworthy interest only for applications in the higher performance band where silicon's slowness does not make it a true competitor.

In the case of large and very large scale integrated circuits, however, where speed limitations are essentially due to interconnections, silicon and GaAs show approximately the same performance.

Understandably, this consideration weakens the incentives and diminishes interest in the extremely expensive development of GaAs technology adapted to mass production of complex micrologics.

However, some very interesting prospects for GaAs stem from the exceptional performance which can be achieved with heterojunction devices. In fact, in research laboratories, high electron mobility field effect (HEMF) bipolar transistors have been produced. They can reach speeds considerably higher than those of conventional devices (either with Si or GaAs). In many ways, in fact, these devices are so fast that their limitations have not yet been well defined. We must also keep in mind that the construction of heterojunction transistors requires nonconventional technological processes (such as, in particular, Molecular Beam Epitaxy--MBE). And these processes are currently in the study and adjustment stage of development. The possibility of basing economically competitive production technologies on this type of processing is yet to be determined.

Problems of Reliability of GaAs Devices for a Manufacturer of Telecommunications Equipment by G. U. Mattana and F. Fantini, Telettra Inc.

Components based on III-V compounds semiconductors are becoming increasingly important for telecommunications. As a result of this growing importance, reliability studies on these components are being produced.

The application which is at the most advanced stage of research concerns gallium arsenide MESFET devices which by now are commonly used in receiver-transmitters in radio relays. Unfortunately, the quantity of data available in literature regarding GaAs reliability, and the knowledge of the breakdown mechanisms of these components are still far inferior to the documented results concerning silicon. For this reason, major efforts to improve this knowledge are under way, both by manufacturers and by the users of these devices. The Telettra company has been active in this field for a long time in both aspects.

This report examines the current state of knowledge, with regard to both reliability estimates and the study of breakdown mechanisms, on the basis of data published in the literature, and on that of direct experiments performed particularly in the field of power MESFET.

Many years of experience have permitted the singling out of the most significant quick testing mechanisms and the development of highly reliable testing systems which permit the tracking of the evolution of the parameters which characterize the degradation of these devices, thereby avoiding the well known problem of sudden burnout. Naturally, the tests mean different things according to the various manufacturing technologies used.

The information system based on this exercise has also allowed us to gather the first real data on reliability which confirm the trustworthiness of the forecasts made on the basis of quick testing results.

At the same time, the study of the physics of breakdown mechanisms is coming along. It is primarily centered on the stability of the Schottky contacts and of semiconductor surfaces. Through accurate measurements it has been possible to separate two types of effects and to link them to the burnout phenomena, which remain the main cause of breakdown during operation. The effect of thermic treatment at high temperatures on the degradation of the surfaces has been studied. This degradation turned out to be more evident in nonpassive devices. However, the excellent stability of ohmic contacts in all the tests that were performed must be noted, despite the criticism reported in the literature. Tests to evaluate the stability of Schottky contacts made with Al, Ti-Au, and Ti-W-Au were carried out, and the different degradation mechanisms identified, thanks in large part to Auger spectroscopy and to a technique of chemical attack from the rear which permitted the examination of the aspect of the gate at its interface with GaAs. Finally the effects of electromigration on Al gates have been brought to light thanks to the Electron Beam Induced Current (EBIC) technique.

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ITALIAN SGS EXECUTIVES VIEW RESEARCH, CORPORATION POLICIES

Milan ELETTRONICA DOMANI in Italian No 4, Jul-Aug pp 38-44

[Interview with Raimondo Paletto, SGS general manager, and Enrico Villa, director of the SGS Technological Coordination Department; date and place not given]

[Excerpt] ELETTRONICA DOMANI: During the most recent meeting of ANIE [National Association of Electrical and Electronic Companies], Mr Paletto, you emphasized the importance of the possibility of an ongoing dialogue between manufacturers of components and manufacturers of finished products--not to say the necessity of such a dialogue--if we are to be able to establish a system for the joint planning of production to replace our present approach of constant improvization and of living one day at a time, without making any short-term, medium-term or long-term plans. In our opinion, this is a basic requirement in the present world of electronics, because R&D in the end-user section is being transferred back to component manufacturers without adequate channels of communication. If your statement is not to be a mere declaration of intent but to move toward a concrete reality, how is this new strategy to be implemented? What practical measures should be taken? What bodies and organizations should be involved? What results can we expect and what are the relevant time frames?

Raimondo Paletto: I believe that in planning an initiative of this kind we have to take into account the characteristics of the country in which one is operating. Obviously, if we take the example of Japan and MITI we find outselves in an absolutely ideal situation. Japan is a very orderly country, with a government which runs like a Swiss clock and government bodies with a high level of technical expertise and capable of playing an active role--as, indeed, they already demonstrated--in the planning of products up to a specific level. What I mean by this is the idenitification of the product needed and of the application of that product, followed by interventions on the part of government, of industry and of universities. The convergence of different resources (government, industry, research) has been achieved by means of effective planning. It would be fantastic if we could try to achieve something of this type here in Italy.

What I have always dreamed of is to succeed, in one way or another, in getting an ideal place--which we will translate later in a more pragmatic way--where the component manufacturer and the systems manufacturer can sit down around the same table. The top priority would then be to try to create an exchange of fundamental information between these two parties. We, for example, would give an idea of the technologies which will be on the market in 1990, while the systems experts would describe to us the products they would like to have on the market in that year. By doing this, we would give ourselves a good 4 or 5 years in which we would have time to prepare, in a rational fashion, (I am not referring to the scientific aspect here) the basic technologies to be produced and the architectures needed.

The great malaise of the Italian market is that we continue to import a vast quantity of components because Italian indusry is incapable of making the right component available at the right time. And this is true not just in the case of active components but with regard to passive components also. If, for example, Olivetti were to say, "In 5 years time, we will be using only SMD [Surface Mounted Device]," all the manufacturers of passive components would adapt themselves to manufacture SMT [Surface Mounted Technology] condensers, SMT resistors and SMT support circuits. In this way, we would adapt ourselves to SMT. Again, if Olivetti were to say to us: "Five years from now we will need specific integration of 1 million transistors per square millimeter," then we would adapt ourselves to meet this requirement. What could then happen is that we would be forced to tell Olivetti that this is impossible in 5 years but that they can have them in 10 years time. In any case, though, this is the sort of dialogue which has to be created. And this is what I mean when I talk about production planning--production established by the component manufacturer working in conjunction with the end-user. Nor do I believe that this is an "impossible dream." All you need is the will to do it.

ELETTRONICA DOMANI: How can this be done? And when and where can it be done?

Paletto: There are already some initiatives of this kind in existence which come very close to this concept. For example, we at SGS [Societa Generale Semiconduttori] have established a design and manufacturing company for the production of "semi-customized" products. The name of this company, a totally new name, is Innovative Silicon Technology, and it will undoubtedly represent a meeting point between small and medium-size companies and a component manufacturer. Another initiative we are presently discussing with the company REL involves the creation of a joint design company in which all users of components will appear on the other side of the table. If this takes off, our objective is to plan the most advanced integrated circuits possible which will be needed by the Italian radio and television industry 4 or 5 years from now. We are totally confident that we can compete with the Japanese, who dominate this sector today, if we can manage to create a dialogue well in advance. This would mean that the Italian consumer industry could become one of the leading sectors, a sector of fundamental importance. To put it more simply, Italy could become the Japan of Europe.

Another agreement which is presently under discussion but which has not yet been finalized is an agreement with ISELQUI [not further identified] for the musical instruments sector. What we are trying to do is to establish a dialogue with all organ manufacturers so that we can plan the circuits which will be needed in the future. What I have been discussing up to now, however, are specific sectors, whereas I believe that this approach should be extended and made more general. I believe that organizations like ANIE and the industrial associations should be the ones to coordinate a system of planning, in order to make it easier to introduce and manage this dialogue between component manufacturers and systems manufacturers. And I also believe that at this point the state should step in and say: "We will make a specific figure available if this planning initiative is developed along certain lines, involving a specific segment of industry and with the participation of the basic research sectors of universities." More or less in line with the model established, in an embryonic form, with the national contract for microelectronics. I firmly believe that this is the most important development that we can promote in this country.

ELETTRONICA DOMANI: What weight will the price variations of the component have in this sort of partnership? In other words, will the price be controlled, or will price variations be the determining factor?

Paletto: The price factor will not represent a major variable. The only case in which price becomes important is when you have high volume production of standard products.

On the contrary, when a product is planned, the innovative content plays such an important role that the question of cost becomes only secondary. When the product is highly innovative, the added value which can be obtained on the final product is so great that nobody worries about price at all. Moreover, when we are talking about electronic components, the weight that these components have as part of the final product is never more than 8 to 10 percent of the final cost of the product. In other words, it is minimal. The most important thing about planning is to be able to guarantee this innovative advantage.

ELETTRONICA DOMANI: And what about the ups and downs of the market?

Paletto: If the Italian semiconductor can increase its penetration of the Italian market, then it will be the Italian semiconductor, rather than ones produced abroad, that will dictate the rules of the game.

ELETTRONICA DOMANI: I think that Italian manufacturers probably feel that having a partner like SGS close by is one of the advantages which are implicit in creating a more effective dialogue of this kind. This new form of dialogue with the end-user that you are proposing implies the need for a change in the mentality of the designer since, rather than consulting your catalog, the designer will be the one to suggest possible products...

Paletto: This is an aspect which does not concern just designer but CEOs also. What is essential, though, is that a company be in a position to compete, because today competition is the only way to survive.

It is necessary for technologies to be born as part of a system, and that this system understand them perfectly. Today the problem is no longer one of horizontal knowledge but of vertical knowledge. You have to have in-depth knowledge of every technological step which is taken.

Design Networks

ELETTRONICA DOMANI: An interesting initiative of SGS is the design network for integrated circuits for third parties, a program which the company announced a short while ago and which you yourself referred to earlier. This will basically take the form of a new national structure, on a level with the national road network and the telephone network. Imagine that I am a small company; I need a design. I go to this new structure or infrastructure--a national network. At what stage are you now in implementing this program?

Paletto: We are working in collaboration with all the local authorities in order to open the design centers. The first of these centers will be the one in Milan, which will have the participation of the regional authorities, the Milan Polytechnic and the CNR [National Research Council].

ELETTRONICA DOMANI: But do you think that all these names, Regional Authorities, Milan Polytechnic, CNR, might not frighten off the customer, in terms of the approach, the rapid decisionmaking and the short completion times which are typical of small companies?

Paletto: The role of these centers obviously has to be that of providing a service for small and medium-size companies and, in a certain way, of establishing links with universities, for example. This is necessary if young people are to be properly trained for design work. And this is the reason why the Polytechnic and the CNR are involved in this program. If you want to have young, fully qualified engineers, you have to train them and create them.

In effect, these design centers will act as a focal point, receiving financing from both the regional authorities and the CNR. We are absolutely determined to continue with this initiative, and this means that these centers will certainly become a reality.

ELETTRONICA DOMANI: How will you solve the problem of testing for the customer?

Paletto: When you are talking about integrated circuits for third parties, one of the basic problems lies in the very fact that the circuit does not work, the reason for this often being that the initial specifications were not sufficiently detailed. What we aim to achieve, therefore, is implementation of a test program running in parallel with the design process of the circuit. It is absolutely vital, though, that these two activities be fully parallel. In other words, we want to avoid the system sequence used up until now which has the design stage followed by the test stage, a method which is totally wrong. What has to be done to implement the new system is to set up "testability" programs on the computers which are capable of simulating the final conditions right down to the last detail. This is no easy thing to do, and will require an immense amount of work. Therefore, one of the major functions of the design centers will be not so much the design of the circuit itself, something for which accepted standards already exist, as the ability to predict the final results.

STET and Government Support

ELETTRONICA DOMANI: Now I would like to turn to the subject of the recent STET shareholders' meeting. In his speech on the year-end results, the CEO of STET, Mr Giuliano Graziosi, stated that the two main factors outside their control had been the fall of the dollar and the situation with SGS. As far as you at SGS are concerned, was this due to external causes or is it structural?

Paletto: Since SGS is a multinational company, it quotes its prices in dollars. Now, if we have a drop in the dollar of around 25 percent, this almost completely wipes out our margin on semiconductors. You also have to remember that here in Italy we have the added problem of the cost of labor, which is higher than in the United States, and is 10 times higher than in Singapore and 12 times higher than in Malaysia. What this has meant for SGS is that the substantial profit levels we achieved in the 1984 operating year are now followed by very negative results for 1985.

ELETTRONICA DOMANI: And what about 1986?

Paletto: Today, 1986 still represents a critical period for us because if an upswing in the markets occurs, it will probably start in the second half of the year. When, some time ago, I said that I believed that the recovery would start in the second half of 1986, I was branded a pessimist. Now it appears, from the most recent meetings of Dataquest, that the recovery will not start in 1986 at all, but in 1987...

In addition to this, we greatly overproduced, because 1984 was the year in which production plants flourished everywhere. This enabled us to expand all over the world, and it also meant that we improved our production efficiency. From all this it is evident that the present situation in SGS is the result of market conditions, not of the structure of the company.

ELETTRONICA DOMANI: Mr Graziosi also voiced the opinion at the meeting that "an agreement between STET and other manufacturers who are in the same situation, or with the big boys in the sectors, would be advantageous." Do you have any specific information that any agreements to this effect may be in the pipeline?

Paletto: As far as we know, STET has not yet created any contacts with other semiconductor manufacturers. Obviously, we at SGS have made attempts, both now and in past years, to see whether there was any possibility of reaching agreements with major companies which would contribute to our activity in terms of technology and markets, as well as finance. As yet, however, nothing concrete has emerged, one of the reasons for this being our desire to maintain a certain level of independence and to avoid losing control of our company, thus ensuring that SGS retains its status as an autonomous company.

ELETTRONICA DOMANI: Going back again to the STET shareholders' meeting, Mr Michele Principe, president of the corporation, maintained that SGS requires state sector financing...

Paletto: We at SGS have always refused outright any form of handout or, in other words, to be supported by the state. What I would like to see is for the necessary conditions to be created so that we could operate in the same way as other countries operate. You see what they do in France and Germany, and you look at the business American corporations get through government orders, and then you take a look around you and see what a company like SGS manages to obtain. The ratio is 1 to 10, if you think about it.

ELETTRONICA DOMANI: Not all state financing necessarily gets channelled in the right directions, though. Take the fact that EFIM [not further identified] is organizing an optoelectronics laboratory in Florence, for example. It is obvious that the reason behind it is to get state financing. What we are talking about here is tens of billions of lire which are invested in areas which are not areas of strictly strategic importance...

Paletto: I think that you have hit on one of the most important points in this respect. There is absolutely no doubt that our sector is capital intensive. Unfortunately, dispersion occurs. Not that I want to be accused of being a parasite. As I said earlier, that is a concept I hate. Nonetheless, we have to channel our investments better, which is what the Japanese have done, the Americans, the Germans, the French... We have to be able to compete on an equal footing.

ELETTRONICA DOMANI: This is an extremely important subject. It would be interesting to know whether anybody has done any reliable research on the amount the German government, for example, invests in the electronics industry, or how much the French government...

Enrico Villa: Precise figures are hard to come by. And even if you do manage to get your hands on this sort of information, it is usually broken down into a mass of minor investments programs. Rather than focusing on only government investments programs, we should really consider government orders. In France, for example, state aid does not stop at the provisions of the "Plan Composant" but, far more importantly, also extends to the "research market." A government or an administration that requires a specific product pays to have that product developed. What this means in real terms is the component manufacturer is placed in a position in which he can develop the product, and perhaps the technology too, at zero cost.

ELETTRONICA DOMANI: Without harping on the subject, could I just ask you what you think the ratio might be between, say, French or U.S. investments and Italian investments?

Villa: As Mr Paletto stated earlier, the ratio is on the order of 10 to 1.

ELETTRONICA DOMANI: To put it another way, what level of government investment is needed to improve the situation of a company like SGS?

Paletto: Although I am aware that opinions differ on this point, I am in favor of a much larger state contribution than the one we have today. The general opinion is that government financing of 100 billion lire a year is adequate. In my opinion, however, if we are to come out on top in a battle of this kind, this figure is not enough. We need at least 150 to 200 billion lire a year. Moreover, it is nothing for a government to invest a figure of 1000 trillion lire over 5 years in a basic activity such as ours. This is just peanuts when you consider the sums that are spent, and are often thrown away, unfortunately, an old technologies like the steel industry.

Development Plans in Europe and Italy

ELETTRONICA DOMANI: The problem is to make the people who make the decisions aware of this. I do not know whether you have had a chance to read the latest report of the Science and Technology Committee appointed by the cabinet? One can see only too clearly that these reports are manipulated. What I am saying is that there are massive interests at work here, and the one who pulls the most weight is the one who, indirectly, derives the most benefit. The interests of the large industrial groups must be put to one side and investment must be rationalized, not on the number of employees and negotiating power of these groups, but on the basis of programmed strategies... In this context, what is your opinion of the Esprit program?

Paletto: Our feelings on the Esprit program are extremely positive. The levels of financing were not high, but what this program has succeeded in doing is to make universities, countries, companies work together...

ELETTRONICA DOMANI: In its role as an Italian semiconductor industry, has SGS benefited at all from the program?

Paletto: Obviously, within the European Community, the lion's share always goes to the Germans and the French, because they are well-organized. However, something more than usual was done for the Esprit program, and this certainly benefited us in terms of knowhow, since it enabled us to work on joint programs both in the CAD [Computer Aided Design] sector and in the technological sector. This definitely is a positive sign. Things are starting to change...

ELETTRONICA DOMANI: Still on the subject of government financing structures, do you feel that the existing laws (675 or 46) are positive in this respect and that their scope should be broadened, or do you believe that a new system should be devised?

Paletto: I have always maintained that the revolving fund for technological innovation managed by the Ministry of Industry, and the fund for applied research, managed by IMI [not further identified] are working very well. Moreover, the mechanisms of the national contract for microelectronics is also working very well. The national microelectronics contract, which is based on a new law which has only just been passed, took longer to be finalized. Law 46, on the other hand, is a law which has already been fully tried and tested, and this means that things move along much more smoothly and, in fact, quite fast. The mechanisms exist, therefore, and they work. The crux of the matter is that there is no money... The funds to be distributed must be there every year, at the beginning of the year and in the right amounts. We cannot launch new programs, for example, without knowing what funds are going to be provided. Nor is it feasible that we only know this in July. It is a question of budgetary planning. I know only too well that in a country like Italy this is no easy thing. On the other hand, the only problem is money...

ELETTRONICA DOMANI: As part of the STET Strategic Plan, SGS drew up a series of plans which took into account, as far back as 1981-82, the range of possible variables which could come into play today, 1986. Again, in the 1985-1990 5-year plan, rather than presenting just one plan you have presented a whole set of plans to cover the range of technological and market variables. How is this plan progressing? Are there different scenarios (i.e., low, high)? Could you say a few words on the subject?

Paletto: When we prepare our operating plans we prepare them in dollars. Let us just take a look at the 5-year plan. The picture which emerges is that, if we consider the matter using the lira as our base currency, we have not met our objectives. If, on the other hand, we translate this into dollars, we are well within the limits established. In either case, our results for the 5-year period as a whole will certainly be positive. The critical years are 1985 and 1986, but 1987-1990 will be in the black.

ELETTRONICA DOMANI: But in terms of returns, can these be quantified, i.e. jobs, return on investment, production...?

Paletto: On the job front we will see a considerable change in the mix. We are not an industry which takes in blue-collar workers, but we will increasingly require high-level workers, i.e. engineers. The need for a manufacturing science is becoming more and more evident, and this also means that our machinery will be worked by graduate statisticians, highly qualified engineers, and so forth. This will lead to a substantial shift in the mix from a direct unskilled labor force to a direct, highly qualified labor force. In terms of numbers, on the other hand, I believe that our payroll will probably contract to some extent.

ELETTRONICA DOMANI: And production?

Paletto: Production will essentially be judged on the basis of the added values which emerge in the systems industry. Our company will never make earth-shattering profits. It is totally impossible, since the fact that the innovative content is so great, we require equally large injections of support capital.

Villa: But let us just take a number--the famous 1 to 100. In other words every lira in research generates 100 lire between components and production. It is easy to add this up; if we take the amounts spent on research in this industry (a minimum of 10 percent) in relation to total sales volume, one lira will generate 10 lire of sales. Then, to make a very rough estimate, semiconductors generally account for 10 percent of the final system (as we said earlier). This gives us a figure of 1 to 100.

"We Want to Plan our Activity"

ELETTRONICA DOMANI: What I mean by "production" also includes the development of new companies. One way of fighting unemployment is to create new jobs...

Paletto: Obviously. But when we say "we want to plan," what do we really mean? We mean that we want to prepare ourselves; we want to put outselves in a position in which our company is one of the leading systems companies in Europe, whatever sector that may involve, from the consumer industry of high-definition television to the robotics sector or the sector of software working on artificial intelligence. And the name of the game is to plan the production of components so that we are fully competitive. As I see it, this is the bottom line.

The end-user cannot simply come along and ask me for a component when he needs it. Why? Because at that point the learning curve of the competition in this sector has already reached a point at which I can no longer manufacture economically. In our business, the time factor is an absolute.

Then what are we really talking about? We come back to what I said at the beginning of this interview, which is that we all have to sit down together around a table and plan the future. If there is one sector which is totally predictable, it is ours. We know for certain that we will progress from 1.5 micron to 1.2, 0.8, 0.6 micron. We also know what basic units we will use in this process, what types of memory, what types of microprocessors.

We are able to make projections; the problems start when it comes to the other party. Innovation is a problem which has to be confronted at all costs, and it must be confronted working in conjunction with the systems sector.

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WEST EUROPE/MICROELECTRONICS

EUREKA MEGABIT PHOTOLITHOGRAPHY PROJECT ADVANCING

Zellik TECHNIVISIE in Dutch 20 Aug 86 p 6

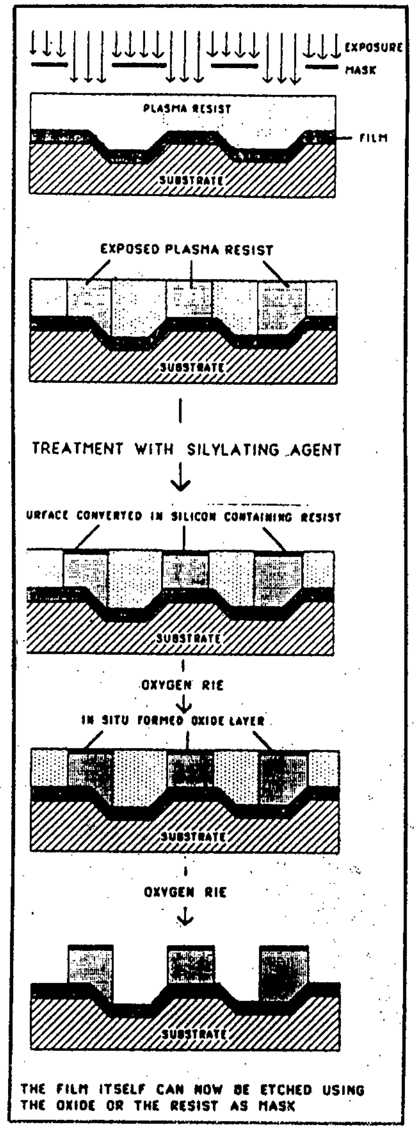
[Article by A. Vrancken: "UCB Project leader of European Megabit Chip"; first paragraph is TECHNIVISIE introduction]

[Excerpts] UCB [Belgian Chemical Union] is the project leader of the DESIRE project, one of the few EUREKA programs under Belgian leadership. DESIRE stands for "Diffusion Enhanced Silylating Resist," a new photolithographic process making it possible to produce the new generation of integrated circuits, the megabit chips.

The DESIRE project is a spin-off from a research program initiated in 1983 by UCB and IMEC [Interuniversity Microelectronics Center]. Since 1985 the program has been supported by the IWONL [Institute for Scientific Research in Industry and Agriculture]; this year it was included in EUREKA to carry out the industrial development of this new process of the 'plasmask' protective layer used in it, and of the applied dry development technique. Project leader UCB works together with IMEC and two British partners: Plasma Technology and the Royal Signals and Radar Establishment. Research is conducted by the Chemical Specialties Department with headquarters in Drogenbos. This department produces radiation-sensitive resins which cure under ultraviolet light or electron radiation. UCB is already cooperating with JSR (Japan Synthetic Rubber, a leading producer of microresists in Japan) in the field of photoresists (light-sensitive resins) and electron-beam and x-ray resists.

DESIRE Process

The DESIRE process aims specifically at obtaining the same resolution as that reached in the multilayer technique while avoiding its disadvantages. This was achieved through the process represented in the drawing.



The 'plasmask' developed by UCB is applied as a single-layer resist, pre-baked, and exposed by current exposure equipment. Subsequently, the exposed surface is brought into contact with a substance containing silicon-containing molecules. This substance is conducted in its gaseous phase over the wafer's surface. This causes selective absorption and reaction to take place in the exposed wafer parts. Thus, a silylated pattern is formed. The silylated wafer is then treated with a reactive oxygen ion plasma to etch away the nonsilylated parts. Post-baking is no longer necessary; thermic stability is far greater than that of existing conventional resists. Thus the process requires as many steps as with a normal photoresist, the post-baking stage is eliminated, but an additional gaseous-agent silylating process is required. Since silylating occurs in a depth ranging between 1,500 and 2,000 Angstrom, the pattern is extremely sharp and lacking the normal optical interference phenomena. The results of this research have aroused great interest in the electronics industries in Europe, the United States, and Japan.

Automation

This type of research has been made possible by intensive collaboration between the chemical manufacturer UCB and the IMEC electronics research center, which has the necessary equipment as well as motivated researchers. The contribution of the English partners consists in developing silylation, anisotropic plasma etching techniques, and equipment which is not only completely anisotropic, but which also allows high etching speeds and can be used in superclean production environments. The equipment developed thus far can be used in class-10 production rooms and will later be adapted to class 1. The construction lines currently developed for megabit chip production are being fully automated and built inside hermetically closed units to prevent possible contamination. The subsequent steps are carried out with the cassette-to-cassette method, which treats every wafer separately. Further decreasing the line width and increasing the number of elements per chip increases the cleanliness requirements--expressed in maximum concentration of metal ions and dust particles in the air. The current standard requires 0.2-micron filtering and a maximum metal-ion concentration of 1 ppm [as published]. However, industry is developing toward 1-ppm concentration, and 0.1-micron or probably even 0.05-micron filtering. UCB will thus have to invest in clean rooms for production and packaging and in appropriate purification techniques to reach this standard. IMEC tests the equipment developed and the processes used in the DESIRE project to make sure that they meet submicron production requirements for output and quality. There are plans to build a pilot line to demonstrate the process to potential users.

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EEC'S FRAMEWORK R&D PROGRAM FOR 1987-1991 OUTLINED

EEC Brussels INFORMATION MEMO in English Jul 86 p 62

[Text] The Commission has selected eight projects concerning research and technological development, mainly at the pre-competition and pre-standardization stages for the Community's new R&TD Framework Programme (1987-91) (1).

Drafted after extensive consultations with the institutions, industrialists and scientists concerned, the Commission's proposal is consistent with the provisions of the European Single Act.

It will shortly be transmitted to the Council, Parliament and the Economic and Social Committee.

Presenting the proposal, the Vice President, Mr Narjes, Member of the Commission responsible for science and technology emphasized that the new framework programme was decisive step towards the achievement of the 'Science and Technology Community,' a concept endorsed by the European Council in Milan.

This joint effort to develop the sciences and new technologies was of crucial importance, he said, if Europe was to remain competitive and continue to hold its place on the world stage.

The Framework Programme is thus the selective instrument of Community intervention in the R&TD field, which is particularly valid when:

--it serves to affirm and defend the European model in which dialogue between the two sides of industry, living and working conditions and environmental concern are of special importance. Accordingly, the Commission also proposes that R&TD be exploited to enhance social development through the pursuit of ad hoc objectives (health, nuclear safety, working conditions, training and, more generally the environment);

--it is directly linked with the establishment of a broader economic continuum geared more to competition. Since the R&TD component has a determining effect on both the size of our markets and the performance of our firms, it is important to expand the common basis of technology, as it were, the humus of technology, that will enable European firms to thrive in order to make the vital qualitative leap and develop new and lasting markets;

--it contributes to the harmonious development of the Member States and the regions by being based, to the advantage of all concerned, on the scientific and technical quality characteristic of each one of them;

--it provides the opportunity for building on the skills and knowledge that the Community is acknowledged to have accumulated already. In fact, in programmes such as Esprit and Brite and the thermonuclear fusion programmes, the Community has shown that it can:

(a) organize the synergy of human and material resources, effort, skills and disciplines;

(b) create the critical mass required to perform certain types of research;

(c) initiate cross-frontier consultation between the individual protagonists and between them and the users of research.

The eight projects that the Commission proposes to include in the Framework Programme have been selected in the light of these four major concerns.

Eight Projects

1. As regards the quality of life, the Commission proposes to concentrate on health (the development of preventive medicine and early diagnosis, the aging process and research into cancer and AIDS) and the environment (with a view to working out preventive policies, reconciling economic development, protection of the material environment and the safety of installations and of the public).

2. With regard to information technologies (upon which the competitiveness of two thirds of the economy and 55% of jobs depend), the Commission wants to speed up the development of microelectronics, peripheral technologies, data-processing and application systems, together with the standardization they require.

3. The large-scale market depends on a nerve system constituted by advanced telecommunications, the new services that they spawn and transport. The Commission therefore proposes the rapid introduction of broadbank networks in the 1990s and the integration of telecommunication technologies with information and audio-visual technologies in new services (in education, health, etc).

4. The application of new technologies to modernize traditional industrial sectors--upon which a large part of the GDP depends--is geared to giving a 'technology transfusion' to those industries whose modernization has so far lagged behind (textiles, shoes, building, motor vehicles, mechanical engineering). The Commission places particular emphasis on advanced design and manufacturing techniques, an extension of the Brite programme, advanced materials, techniques for exploiting raw materials and standards.

5. In the continuation and updating of the energy programme, the emphasis will be on fission (reactor safety, management of radioactive wastes, monitoring of fissile materials), thermonuclear fusion (JET, NET) and on the non-nuclear energy sources and the rational use of energy.

6. As regards biotechnology, the new focus in technology, the Commission hopes to use its potential to promote agro-industrial development (agricultural products used other than as food) and process and product innovations in the fields of chemistry, pharmaceuticals and food. The Commission will be concerned with the social and ethical implications of these developments and with their repercussions for society as a whole.

7. Exploitation of the seabed and upgrading of marine resources are of specific importance to a great many Community regions. This is a completely new project, the aim of which is to pull together all the efforts being made to develop the basis of science and technology needed to exploit, manage and protect marine resources (minerals or fish).

8. To help achieve the objective of the 'Researchers' Europe' more quickly, specific activities are proposed with a view to promoting the mobility of research workers, increasing cross-frontier and interdisciplinary cooperation and enabling more use to be made of large-scale equipment.

The choice of projects takes account of the development of technological cooperation in other contexts, particularly Eureka, with which there are vital complementary links, and intergovernmental bodies such as CERN and the European Space Agency. It is in this multifaceted environment, where the general aim is to seek a better distribution of financial and human resources whilst building up sufficient critical masses, that the Community policy must find its place, its whole place and nothing but its place.

Seen from this standpoint, the possibilities of progress depend, in the first place, on the achievement of the large frontier-free market. However, it is clear from, amongst other things, the opening-up of public-sector purchasing, that such a market cannot evolve unless there is a common technological base, particularly in the field of standards. At the same time, the decompartmentalization of the public-sector markets can provide more promising industrialization prospects for all those who invest in research. Community R&TD must, therefore, contribute directly or indirectly to the attainment of all the objectives defined in the Single Act.

Nevertheless, Community action must continue to be selective, firstly, because of the plurality of the fields and institutional frameworks already mentioned, but also because Member States pursue national policies which they believe, rightly or wrongly, must remain cornerstones of their actions. It is the task of Community cooperation to demonstrate its vitality because of the synergy it generates, the knowhow it accumulates, the optimum allocation of resources it makes possible and the coordination of national policies that it involves.

Implementing Procedures

This activity will mainly take the form of specific programmes. There may also be supplementary programmes involving only those Member States concerned or forms of participation whereby the Community is associated with projects or programmes conducted by individual Member States or by other European or international bodies. Some specific programmes could, for example, involve joint ventures (as in the case of the JET project under the Fusion Programme) or agencies.

The Community aims through its Framework Programme to achieve efficiency, transparency and compatibility with national policies and with other projects performed at international level. It thus intends to implement its policy on a simple, flexible basis by means of:

--direct action receiving 100% financing from the Community budget and performed under the auspices of the Joint Research Centre;

--shared-cost projects, financed partly by the Community and partly by the institutions or firms themselves;

--concerted projects, whereby the Commission coordinates national research projects.

The system will operate for the benefit of its users with whom the Commission intends to maintain excellent relations. It is designed to give industrialists and research workers a clearer idea of what the Community framework is in relation to other forms of cooperation and to serve as a guarantee for medium-term planning. Clarity and simplicy are needs shared by businessmen and scientists alike.

Bearing this in mind and eager to make its projects more effective, the Commission has already adopted measures allowing for a revision of its administrative, regulatory and financial system, aiming for simplification, speed and transparency in programme management. Two important aspects are the reduction in the number of contractual obligations as regards the frequency of reports, for example, and the speeding-up of payments to contractors.

Participation of SMEs

The Commission's proposal places a very special emphasis on the benefit that SMEs should derive from the R&TD programmes. Such firms are already playing a significant part in programmes such as Brite (where they represent 30% of the participants) and Esprit (where half the projects involve at least one small business). The Commission plans in various ways to promote even greater participation by such firms whose dynamism and adaptability have not yet been exploited sufficiently in Europe.

A Technology Community Open to Others

The Community intends to forge greater links with others involved in European technology, most significantly with Eureka, but also intergovernmental bodies such as the ESA, CERN, the European Science Foundation and the Council of Europe. At international level, the Community must also expand its cooperation with its industrialized partners, particularly within the EFTA and with the developing countries.

Financing

The Commission estimates that a total amount of 7 735 million ECU will be required to implement the new Framework Programme during the period 1987-1991. It proposes that there be a mid-term review, however, to take account of R&D requirements and changes in the financial situation. To complement financing from the Community budget, the Commission intends to implement new financing formulas, Eurotech Capital (funds derived purely from private sources) and Eurotech Insur (a guarantee mechanism involving a Community contribution).

Lastly, in view of industry's growing awareness of the advantages of cooperation and given the limited budget resources available to the Community, the Commission may consider re-examining and extending the existing financing procedures for shared-cost projects:

--by making provision for the payment of reimbursable advances to supplement the financial contributions;

--by determining the amount of financial contributions and advance payments, e.g. from 20% to 80% of the total cost of a project, on the basis of criteria such as the size of the institution or firm, the type of expenditure involved or the degree to which a project is "pre-competitive" or the research advanced.

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WEST EUROPE/SCIENTIFIC AND INDUSTRIAL POLICY

FRG RESEARCH INSTITUTE ASSOCIATION SETS LONG-RANGE GOALS

Bonn AGF in German 1985 pp 5-11, 29-32

[Editorial Report] Thirteen FRG institutes representing a wide range of scientific disciplines have formed an Association for Large-Scale Research [AGF] to coordinate their efforts in key technological areas for the remainder of the century. A December 1985 AGF publication entitled "The Thematic Orientation of Large-Scale Research in the 1980s and 1990s" identifies biotechnology, information and communications, and materials science as the primary "new technologies" objectives of AGF member institutes. The following excerpts from the AGF booklet describe the functions of selected institutes and the primary "new technologies" fields under development"

Technology-Oriented Large-Scale Research Institutions

Leading the technological sector is the first large-scale research institute founded in Germany, the German Research and Experimental Institute for Aeronautics and Astronautics (DFVLR). The DFVLR is the largest engineering and scientific research institute in the FRG, with research centers in Braunschweig, Goettingen, Koeln-Porz, Stutrgart, and Oberpfaffenhofen, near Munich. The DFVLR conducts research in the air and space sector, cooperates in project planning and development, and builds and operates large-scale research facilities.

In addition, it has made a priority of "new technologies" in related areas, such as energy. As an applied research institute, DFVLR is mainly problem-oriented.

For its research, development and service tasks, the DFVLR operates the German Satellite Control Center, a mobile launch base for high altitude research rockets, the German Long Distance Reconnaissance Data Center, large experimental and numerical simulation installations (wind tunnels, earth and airborne flight simulators, the Space Lab Simulator), testbeds for rocket engines, jet propulsion, sun and wind energy systems and instrumentation platforms (research aircraft), and data reception and processing installations.

At present, DFVLR employs about 3,700 people; its total budget for 1985 is approximately DM 415 million.

The Research Association for the Use of Atomic Energy in Ship Construction and Propulsion (GDSS) concentrates on research in underwater technology, environmental research/environmental technology, and reactor safety. The GKSS center has at its disposal large-scale installations such as the GUSI underwater simulation installation and the FRG I and II research reactors.

At present, GKSS employs approximately 700 people and has a 1985 budget of about DM 90 million.

The Society for Mathematics and Data Processing (GMD) performs R&D work in information and communications technology and makes the results of this research available to users in industry, science, and [public] administration. The GMD's R&D program includes methodology fundamentals, systems technology, applications technology, infrastructures for technological information and transfer of information technology. The main themes of this research are applied mathematics, especially multi-grid methods, network theory (Petri nets), the design of integrated circuits, innovative computer structures (fifth generation) as well as knowledge based information systems, especially for the office [automation], and expert systems. For this task, GMD has several large high performance computers and decentralized data processing networks at its disposal. The GMD has entered joint ventures to form research centers in Berlin (computer structures) and Karlsruhe (program structures) in cooperation with universities, and has brought about a better exchange of information through its offices in the U.S. and Japan.

GMD current employs about 800 people and has a 1985 budget of approximately DM 80 million.

The Karlsruhe Nuclear Research Center (KFK) has undertaken tasks in the field of future energy supplies since its founding in 1956, in close cooperation with industry and universities.

The KFK's main efforts for the 1980s and 1990s involve nuclear technology, nuclear fusion material and solid state research, nuclear and particle physics, production technology and handling as well as environment, climate, and biology.

Among other installations, the KFK makes use of the following large-scale factilities: The compact sodium cooled reactor in Karksruhe (KNK) and the processing installation in Karlsruhe (WAK), which are already in use today to provide commercial users with experience in connection with future commercial installations.

The KFK has about 4,000 employees and a 1985 budget of roughly DM 590 million.

The main research efforts of the Juelich Nuclear Research Center (KFA) for the 1980s and 1990s are neutron source for nuclear spallation material properties and material research, basic nuclear research, health and environment, high temperature energy technology, future fossil fuels, and nuclear fusion.

The KFA operates the following large-scale installations: the DIDO research reactor with hot cells and a pebble-bed reactor, a long distance energy test installation, and the TEXTOR fusion installation. Since the end of 1983 theuultra-high performance CRAY X-MP computer has been installed in the KFA.

The KFA has about 4,500 employees and a 1985 budget of approximately DM 450 million.

Physics-Oriented Large-Scale Research Installations

The German-Electron Syncrotron Facility (DESY) in Hamburg concentrates on research in elementary particle physics which explores the smallest building blocks of matter and the forces acting on them. The research work is carried out by DESY and foreign scientists on the DORIS and PETRA large electron positron storage rings. Of steadily increasing importance are the experiments with synchrotron radiation on the DORIS storage ring. These experiments range from molecular and solid state physics, biophysics, and nuclear physics to crystallography, and also include applications-oriented problems.

At present, the new HERA storage ring installation is being constructed at DESY with international participation. In the HERA, electrons and protons will collide with high energy. After completion in 1990, the installation will be available to physicists worldwide.

DESY employs about 1,100 people and in 1985 has a budget of approximately DM 240 million.

The Max Planck Institute for Plasma Physics (IPP) is active in fusion research, with an emphasis on plasma physics. The objective of present and future programs is the further development of the Tokamak and Stellarator line. The long term scope of this activity includes the development of a nuclear fusion reactor.

The IPP has constructed and operates the ASDEX Tomakak and the WENDELSTEIN VII-A Stellarator. The high performance followup installations to these facilities, ASDEX-UPGRADE and WENDELSTEIN VII-AS, are under construction. In addition, IPP makes a considerable contribution to the Joint European Torus (JET) and also to the planning for the followup system, Next European Torus (NET).

The IPP has an annual budget of DM 85 million and employs approximately 1,000 people.

Biology-Oriented Large-Scale Research Institutions

The Society for Biotechnology Research (GBF) in Brunswich conducts multi-disciplinary research in the use of biological systems for materials processing on an industrial scale. The range of research includes microbiology, cell biology and genetics, enzyme technology and chemistry of natural substances, as well as bioprocessing technology. There is a close tie between basic research and applications projects.

The GBF employs about 350 people and has a 1985 budget of DM 36 million.

The following tables list the 1985 financial R&D budget (in millions of DM) in the various disciplines:

New Technologies

Three fields, in particular, can be regarded as key areas of technology: materials, information and communications, and commercial exploitation of biological processes. The pioneering role of these three areas in terms of technological innovations will certainly last until the end of the century.

The size of activities in large-scale research centers obviously must be increased for all key technologies. This is equally true for biotechnology, information and communications technology, and materials research. The contribution to international development can only be maintained when these research areas are worked on with appropriate intensity.

In biotechnology the joint projects of large-scale research facilities and universities take on growing importance. They supplement the existing copperation with industrial firms to form an efficient team. In information and communications technology, cooperation with industry certainly is still to be completed. An important step in a new field of cooperation should be the recently-started collaboration in the jointly financed project group for research on special semiconductor materials. After all, considerable problems can be expected in the expansion of large-scale research activities in information and communications technology, primarily due to the personnel structure within the centers. This will be explained in more detail in the "Information and Communications" section.

The situation in the third field is somewhat different. Materials research is basically a traditional theme of large-scale research. Within the framework of nuclear development and aerospace research on the one hand, and solid state research on the other, both project-related research and basic materials research have been conducted continuously. There will be large-scale projects with their own materials problems and a corresponding need for development in the future as well. This is especially true in fusion reactor technology, where the problem of materials is a primary, if not the central problem. Besides such materials R&D which is incidental to given projects, large-scale research must also perform materials research specifically as an innovative task.

Biotechnology

The most important themes in biotechnology, where the issue is the methodical definition of problems and the development of production-oriented processes, are:

--microbiology and cell biology,

--molecular biology,

--enzyme technology,

--biological processing techniques and processing techniques.

It is true that biotechnology, especially in the sector of foodstuffs, belongs to the oldest technologies used by man. The progress made in various stages in recent decades in its fundamental principles and applications, however, has conferred new a quality and dynamism to the term. The most important phases of technological development are characterized by the mass cultivation of micro-organisms in technical reactors, the mastering of commercial-scale enzyme catalysis, and the knowledge of genetic engineering. Today biotechnology must have at its disposal a wide spectrum of new methods based on biology, chemistry, and processing technology in order to be successful. It is unavoidably multidisciplinary.

As a key technology, biotechnology is going to change the character of a variety of industrial and nonindustrial areas. It will lead to completely new products which, in turn, will open the way to new possibilities for medical diagnostics and therapy (monoclonal antibodies, human proteins), will show energy-saving and environmentally protective ways to make known products [derived from] intermediate organic products, and make available new sources of raw materials (recycling raw materials). Biotechnology is highly efficient in eliminating environmental load (liquid waste, exhaust air), to alter constructively the structure and the function of biological molecules "on the drawing board", and to ensure the production of these new biological molecules (molecule arrangement). It establishes cross-connections with ostensibly dissimilar technologies, such as microelectronics, and may create revolutionary areas of technology (biocomputers). It makes new strategies possible in sensor technology and provides important impulses for new developments in the manufacture of equipment and instruments as well as in materials technology.

The biology of micro-organisms and higher cells (plant, animal, human cells) provides in any case the basis for a biological reaction. The basically unlimited potential of reaction methods and of the products created (primary and secondary metabolites) is far from being fully exploited and requires long term, even risky experiments. The methods of research need considerable improvement. The primary target is the search for highly functional and specific agents. The molecular biological modification of cells also creates new possibilities for obtaining conventional basic chemicals economically.

The methods of molecular biology would be unthinkable without biotechnology. The development of new host vector systems for the expression of genes in higher cells, possibly resulting in a final product, represents a special challenge for our national economy in the fact of internationl competition. Methodical innovation is the priority in this field.

Enzyme technology has advanced on an international scale mainly by a considerable participation in large-scale research. In the future as well the high standard for the discovery of new enzymes, for the development of purification methods, and for the concepts of commercial enzyme catalysis must be maintained. This will also require special efforts in the area of enzyme (arrangement) in order to improve the efficiency of enzymes and to expand their applications. The problem of cofactor regeneration on the one hand and of biocatalysis with entire cells--especially immobilized cells--on the other need intensified attention.

The technologies of bioprocesses and process engineering include reaction technology, measurement technology, control engineering and downstream processing. Also in this regard large-scale research has special international assets which should be enhanced. The keywords in this context are membrane reactors, adaptive control, and the liquid/liquid extraction of proteins. The existing areas of technology need considerable investments to solve these tasks, i.e. they act as an intermediate step in the materials industry and in the manufacture of equipment and instruments.

The resolution of a process related or product-specific problem will only be possible with targeted integration and interaction of the individual areas mentioned above. System-oriented thinking which, for example, integrates processing problems into selecting the product line must be worked out qualitatively and quantitatively.

Typical areas of technology whose materials can profit from biotechnology are the foodstuffs industry, the chemical industry--including pharmaceuticals and additives--and environmental technology, as well as from a commercial point of view, measurement instruments and equipment industry, and equipment and factory engineering. In the end, we are talking about applications which are useful to mankind for health, nutrition and a healthier environment.

Information and Communications

The intensifcation of research andddevelopment activities in information and communications technology ranges from digitization and microelectronics, and data and communications integration, to knowledge-based systems and knowledte engineering. The technical design of future information systems must also take into account, besides efficiency and effectiveness in practical applications, secondary factors like simplicity, security and manageability.

Information and communications technology is used by the large-scale research centers both as a tool in the infrastructure of large-scale research itself and as a separate area of technology which in the coming years will be exposed to the tough competition of international R&D and design of marketable products. In this area technology transfer is also of great importance through the continuing education of young scientists and promotion of their transfer to industry. The contributions of large-scale research can be classified in four levels of R&D tasks: fundamental principles, basic technology, systems technology, and applications technology.

These levels are tied together by information technology and form the foundation of this key industry and technology through the close interaction of their disciplines.

Fundamentals: Important themes of basic research in information and communications technology are:

—Physical and chemical fundamentals of basic technologies;

--Mathematical and information methods for information systems;

--Knowledge manipulation (cognition theory);

--Computer principles.

These are research activities which answer fundamental questions in mathematics, natural science, technology and especially methodology which arise in other fields of information technology; research into connections with social sciences also has a place here. This level includes, in particular, the physical, chemical and, the future biochemical fundamentals for the conception and the development of basic technologies for which the existing know-how in the large-scale research centers is effective. Special reference is made to the fields of solid state-physics, materials science, plasma technology, super-conductor technology, radiation and photochemistry as well as biotechnology. Mathematical and data processing methods for planning and using technology-based information systems and for the simulation of complex experiments are to be developed. Knowledge manipulation in various applications requires that the fundamental principles of cognition theory be available. The conception and the methodology of future-oriented computer architecture and associated hardware and software systems as well as new communications systems are based on these principles.

Basic technologies: The basic technologies for the engineering of information processing and transmission are widely influenced by the results obtained in the basic activities and are undergoing rapid development. In the foreground are the themes of very Large-Scale Integration (VLSI) and fast mass memories.

For further miniaturization of switching elements in submicron silicon-based technology, the development of faster highly integrated circuits based on the new materials (gallium arsenide), exploitation of the capabilities of integrated optoelectronics (III/V compounds), and the increased development of memory media (semiconductors, amorphous silicon, magneto-optical materials, optical memories), the areas of material preparation and material characterization are of decisive importance.

The combination of individual components into an integrated system (for example, fifth generation computers) requires the establishment of adequate production and design techniques.

VLSI conception and design is done in large scale-research. Work in solid state physics and solid state chemistry to develop components has only been attempted to this point. But there is a significant potential of experience in the preparation and characterization of a broad spectrum of materials, especially in microscopic analysis and the interpretation of structural defects and transport processes. Possible future activities are in the area of magnetic and magneto-optic memories, interfaces of ceramic-metal semiconductors, amorphous silicon, and ion implantation.

Systems technology: Systems technology deals with information and communications technology concepts and structures, and produces hardware components, software systems, and network components as well as methods and processes for the planning of systems with these components. The design and evaluation of complete systems and the search for innovation require a concerted methodology of information technology. This need is amplified by the growing amount of space created by miniaturization, digitiation, and intellectualization of information technology components.

In the area of large-scale research the following themes are important:

--innovative computer architectures,

--inclusion of high rate data transmission in the data processing system.

In the future, the solution to complex problems will force the developmnet of innovative computer architectures along with adequate software. These computer systems are "hybrid" aggregates of processors (multiple fast scalar processors, parallel processors for maximally parallel algorithms, vector pipelines, database processors, inference engines, data stream machines, reduction machines: which work together through a global control system via broadband bus structures and interconnecting networks. Since the simulation of complex circumstances and artificial intelligence systems--especially expert and computer systems for the support of logic programming-are seen today as a secondary market after office communications, the development of new forms of computers will accelerate quickly.

In this sense the concept of a combined project for the development of PROLOG/inference engine and also of a computer structure for superfast numerical methods, as they are now in the preparatory phase, is an important step. However it seems to be equally necessary to start long-term R&D products whose scope, results and time frame go well beyond this planned project and the other activities in the FRG in the area of computer architectures and methods development (parallel algorithms). Here lies a possible future task for large-scale research. The institutions of large-scale research could be project pioneers for the development of innovative supercomputer architectures in the second half of the 1990's.

In the area of high data transmission rates there is, first of all, the integration of diverse services on the basis of digital transmission systems and multifunctional terminals, as well as the creation and operation of networks, the interfaces between them and subscribers, and adaptation to the new transmission media. Important keywords are local area networks (LAN), wide area networks (WAN), operating components for support of fast computer terminals, satellite networks, and the connection of satellite networks with ground networks.

Applications technology: In applications technology the support systems for man are most important. These can be oriented to manufacturing processes or decision and evaluation procedures.

Important themes in the future work of large scale research are:

--Intelligent management systems;

--Mobile radios;

--Video transmission;

--New generations of office and decision-making systems;

--Open access to knowledge and information bases;

--Expert systems.

Intelligent management systems will be developed by using knowledge based data-processing components and algorithms easy to learn. Important key-words in this context are process and manufacturing control, automation, and robotic systems for application under extreme conditions. The work on video transmission is mostly concerned with teleconferencing and the video telephone in connection with satellite networks.

New generations of office and decisionmaking systems should be developed utilizing knowledge-based tools and systems in order to obtain an enhanced quality of support to the man-machine interface, in office procedures (cooperative and distributed problem solving), and in the operation of systems. Examples of the desired integration of knowledge into tools are data knowledge in databases, knowledge of methods in method banks, design processes in text and graphics systems. Also in this field are the methods of software engineering and programming as well as their transformation into the environment of the specific work area (office, management, production, R&D).

In the area of expert systems the large-scale research organizations have very good qualifications through their basic scientific-technical knowledge together with the existing data processing technical know-how. This is evident from experiments in the fields of biology and medicine or in the area of oil exploration and deposit research.

This presentation of information and communications technology in four levels shows the vast spectrum of know-how that is necessary for this central area of research. In large-scale research institutions, established knowledge as well as practical experience is available for many of these topics. Multidisciplinary cooperation and an integrated technical infrastructure also exist. However, the personnel prerequisite for a substantial extension of the research spectrum is not favorable.

Shifts in priorities have for years only been possible by exploiting internal mobility. A short-term extension of this idea in the area of large-scale research appears to be possible only when staffing and the funding for investment and operation are complemented for a sufficiently long period of time by unconventional solutions in organizational and personnel policy. If this is not possible, then a substantial amplification of this research theme in large-scale research is only possible in the long term within normal boundaries of flexibility by a slow thematic shift of priorities.

However, in order to be able at the present time to exploit all available AGF forces in a concerted manner, the concerned centers are in the process of drafting an overall R&D program for information and communications technology beyond the thematic areas already put into action within the framework of the new cooperation projects. The target is to treat this set of problems as a cross-sectional task within large-scale research.

In connection with considerations to intensify R&D work, the question of the possible creation of a center for basic computer science technologies will have to be dealt with. Such a concept must be called an unsolved problem when evaluating current incidental constraints and the operating environment affecting its development. The first attempts must still be worked out.

Materials Research

The ability to function and the economical operation of commercial equipment, installations and systems is greatly determined by the existence of appropriate materials and their behavior during operation. Therefore, technical progress is closely connected to the development, adaptation, and testing of materials. This is especially true in energy technology, particularly in nuclear energy technology, as well as in aerospace technology, areas which are among the traditional priorities of large-scale research. For this reason several large-scale research organizations have a large number of personnel and equipment at their disposal for materials research. This is to be ideally complemented within the sphere of basic research by research capability in the area of condensed matter as well as boundary and surface research. The special strength of large-scale research facilities in materials research is the fact that the spectrum of basic materials research, including the use of technical materials, is covered in their large projects. This contributes to bridging the often-criticized gap between basic research and practical use of materials.

The mission of large-scale research institutions in materials research can be characterized as follows:

--Basic research on structure, properties, and behavior of materials;

--Development and optimization of materials for selected uses;

--Fundamentals for new groups of materials;

--Innovative manufacturing processes and material-specific design.

In this framework the large-scale research institutions participate in the "materials research program" of the FRG Government.

The importance of basic research for the development of materials is undisputed, especially since we are far from a general theoretical understanding of the connection between the structure and behavior of materials, most of which consist of many components, are astructured in several phases, and do not exist in thermodynamic equilibrium. A more profound understanding of the structure and the processes within the material will enhance the possibility of targeted materials development and optimization.

Targeted materials research and development within the framework of technological projects will also be the main future activity in the area of materials research in large-scale research organizations. In some areas where materials are essential--for example, in the development of fission reactors--the R&D activities of large-scale research institutes will decline. Extensive and, in part, expensive materials development and testing is required especially for projects in the areas of 1) nuclear fuel cycle (matrix material for the solidification of radioactive waste); 2) fusion reactor technology (structural material for the so-called first wall of the fusion reactor, which is exposed to extreme neutron flux); 3) non-nuclear energy technology (materials for high efficiency photovoltaic cells); 4) sea technology (materials suitable for underwater welding); 5) traffic technology (ceramic materials for automobile engines); and 6) information technology (materials for fast mass memories). The stress analysis will in this case have breater importance than it used to have in large-scale research facilities.

Besides the targets of materials research which are oriented toward the technological projects of large-scale research facilities, the development of completely new groups of materials which, in turn, stimulate technical innovation or open up new areas of application, becomes more and more important. Materials with special properties or specific combinations of properties, like high-performance ceramics, metallic glasses, composite materials, intermetallic bonds, and certain polymers are examples of this group. Also belonging to this group are those developments which do not result from the requirement for certain properties of the material, but result from other requirements, such as the replacement of expensive or strategically important alloy components, reduction of the energy demands during manufacture, or easy recycling.

An important section of materials research also performed in the large-scale research institutions is the development both of new manufacturing and processing methods, and of material-specific designs. Special highly developed materials often cannot or can only be manufactured with defects using traditional methods, and require special manufacturing processes. Powder metallurgy, ion implantation, deposition from the gaseous phase, and superfast cooling are some examples of a type of process with a wide range of applications, on which large-scale research institutions are working at the present time. Among the unconventional manufacturing processes, laser techniques have special importance. The potential of this technology is far from exhausted, and large-scale research, which already is active in this area, certainly continues to be required at a growing pace.

Material-specific design for the optimal use of materials is equally important as the manufacturing processes are for the production of materials. Even if this is primarily a task for manufacturers of equipment and plants, the large-scale research facilities will also work on questions of material-specific design in connection with activities in CAD/CAM (computer aided design/computer aided manufacturing).

[Table on following page.]

1985 RESEARCH AND DEVELOPMENT EXPENDITURES IN MILLION DM, DIVIDED INTO ORGANIZATIONS AND RESEARCH FIELDS

Orientation / Large scale research inst. / Research field	Technological					Physical				Biological				
	DFVLR	GKSS	GMD	KfK	KFA	DESY	GSI	HMI	IPP	DKFZ	GBF	GSF	AWI	Summe
Fast breeding reactors	-	-	-	94,7	-	-	-	-	-	-	-	-	-	94,7
High temperature reactors	-	-	-	-	72,0	-	-	-	-	-	-	-	-	72,0
Uranium enrichment	-	-	-	16,8	-	-	-	-	-	-	-	-	-	16,8
Reprocessing, ultimate waste disposal	-	-	-	79,7	11,2	-	-	4,9	-	-	-	15,0	-	110,8
Safety of nuclear plants	-	24,0	-	24,1	11,0	-	-	-	-	-	-	-	-	59,1
Nuclear fusion, plasma physics and technology	-	-	-	-	32,0	-	2,0	-	121,4	-	-	-	-	155,4
Fusion technology	-	-	-	50,9	10,7	-	-	1,9	-	-	-	-	-	63,5
Non-nuclear energy system	40,9	-	-	-	10,3	-	-	4,8	-	-	-	-	-	56,0
Total (amount) for energy research and technology	40,9	24,0	-	266,2	147,2	-	2,0	11,6	121,4	-	-	15,0	-	628,3
Regional traffic and transport systems	5,9	-	-	-	-	-	-	-	-	-	-	-	-	5,9
Air traffic technology	148,0	-	-	-	-	-	-	-	-	-	-	-	-	148,0
Total for transport and traffic systems	153,9	-	-	-	-	-	-	-	-	-	-	-	-	153,9
Space research	63,6	-	-	-	-	-	-	-	-	-	-	-	-	63,6
Aerospace technology	44,5	-	-	-	-	-	-	-	-	-	-	-	-	44,5
Total for aerospace reserach and technology	108,1	-	-	-	-	-	-	-	-	-	-	-	-	108,1
Technologies for sea exploitation	2,2	22,0	-	-	-	-	-	-	-	-	-	-	-	24,2
Polar exploration	-	-	-	-	-	-	-	-	-	-	-	-	43,0	43,0
Total for sea research and technology, polar research	2,2	22,0	-	-	-	-	-	-	-	-	-	-	43,0	67,2
Oncological research	-	-	-	-	-	-	-	-	-	73,9	-	14,0	-	87,9
Medical research and policy	2,5	-	-	-	9,5	-	-	4,2	-	-	-	35,9	-	52,1
Environmental influence on biological systems	-	-	-	7,0	3,3	-	2,0	-	-	-	-	25,7	-	38,0
Biotechnology	-	-	-	-	10,3	-	-	-	-	-	31,1	-	-	41,4
Environment exploration and climate research	8,6	21,0	-	9,1	17,6	-	-	-	-	-	-	21,2	-	77,5
Environmental technology	15,3	4,0	-	9,4	4,6	-	-	-	-	-	-	1,1	-	34,4
Total for health, environment, biotechnology	26,4	25,0	-	25,5	45,3	-	2,0	4,2	-	73,9	31,1	97,9	-	331,3
Fundamentals of info. technology engineering	9,4	-	15,2	-	1,0	-	-	-	-	-	-	-	-	25,6
Technologies for information engineering	-	-	3,9	-	-	-	-	-	-	-	-	-	-	3,9
Systems engineering	8,4	-	35,7	-	0,2	-	-	1,7	-	-	-	-	-	46,0
Utilization of information engineering	2,4	-	29,4	-	3,0	-	2,0	4,4	-	-	-	-	-	41,2
Total for information and communications technologies	20,2	-	84,2	-	4,2	-	2,0	6,1	-	-	-	-	-	116,7
Low temperature and superconductor technologies	-	-	-	-	-	13,0	-	-	-	-	-	-	-	13,0
Policies for the safety of raw materials	-	-	-	-	5,7	-	-	3,7	-	-	-	-	-	9,4
Material and surface research	10,6	12,0	-	-	20,3	-	-	-	-	-	-	-	-	42,9
Measurement and process technology, robotics	3,0	-	-	7,2	22,7	-	-	-	-	-	-	-	-	32,9
Total for basic technologies	13,6	12,0	-	7,2	48,7	13,0	-	3,7	-	-	-	-	-	98,2
Nuclear chemistry, radiation-photoelectrochemistry	-	-	-	-	4,0	-	-	7,1	-	-	-	-	-	11,1
Physics of elementary particles, rsch w/mesons	-	-	-	11,5	-	214,0	-	-	-	-	-	-	-	225,5
Nuclear phisics and heavy ions research	-	-	-	6,7	35,9	-	72,2	25,5	-	-	-	-	-	140,3
Solid - state research	-	-	-	30,6	96,0	14,0	2,0	29,1	-	-	-	-	-	171,7
Total for research on matter elements	-	-	-	48,8	135,9	228,0	74,2	61,7	-	-	-	-	-	548,6
Global total of AGF allowances	365,3	83,0	84,2	347,7	381,3	241,0	80,2	87,3	121,4	73,9	31,1	112,9	43,0	2052,3

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WEST EUROPE/SCIENTIFIC AND INDUSTRIAL POLICY

ITALIAN S&T COMMITTEE ISSUES REPORT ON R&D GOALS

Rome RAPPORTO AL PRESIDENTE DEL CONSIGLIO in Italian Sep 86 pp 1-13

["Report to the Prime Minister on the Situation and Prospects of Science and Technology in Italy" issued by the Committee of the Prime Minister for Science and Technology; date not given]

[Excerpts] Introduction

The objective of the proposals set out in this article is to achieve a "quantum leap" in our country's research and technological innovation capabilities in order to place Italy on an equal footing with the situation in the leading industrialized nations and make the country capable of facing the long-term challenges created by advances in science and technology.

These proposals, however, will only be effective if the stage of analysis and planning is completed rapidly, enabling us to implement what has been decided as quickly as possible. Even the most effective therapy is less effective if applied late--and this is something to be avoided at all costs. Today Italy risks losing its status as one of the most highly developed nations in the world. It is the responsibility of government and parliament to take the necessary action, and they have to move quickly if they want to prevent the weaknesses of the Italian research sectors from becoming even more pronounced. The necessary remedies exist and there is widespread agreement on these remedies. They can be postponed no longer; on the contrary, they must be applied immediately.

Summary of the Proposals

It is felt that there are three main objectives to which top priority must be given. These are:

1. To upgrade the quality and quantity of the human resources essential to research. This would be achieved by introducing at least 50,000 new young researchers (on a full-time basis) into the research sector over the next 5 years;

2. To increase research expenditures, bringing them to a level of about 3 percent of GNP over a 5 year period, thus making up lost ground in a short time. These financial resources would esscentially be concentrated on a limited number of leading edge sectors and "centers of excellence;"

3. To increase the amount of research carried out by industry and private organizations through the upgrading of existing incentives and the introduction of automatic fiscal concessions.

For these measures to be effective and lasting, it is absolutely essential that the following conditions be met:

a) Creation of a "Research Governing Countil" with a structure capable of guananteeing effective coordination and control of the country's research activity, and correlating the allocation of resources to the results achieved;

b) Implementing improvements in the structure of Italian universities by formulating a set of standards aimed at upgrading the quality of teaching and research to be applied at a national level, and by guaranteeing universities a greater degree of autonomy which would produce more effective management;

c) Strengthening the role played by the research bodies (particularly the National Research Council (CNR) and ENEA) as "producers" of scientific and technical knowledge.

d) Work toward achieving a gradual process of internationalization of Italian research. This would be done, first, by creating the necessary basis for increasing research activity at a national level, which would make it possible to create synergies within the within the European Community with regard to the utilization of resources and a fair technological return on investments. Second, Italy would have to interact with the developing nations in such a way that these nations become the natural setting for the transfer of know-how.

Recommendations of the Committee for Science and Technology

In conformity with the terms of the mandate conferred upon the Committee in the inaugural meeting held on 7 May 1984, and of the subsequent decree of the prime minister, the following sections of this article will develop a number of different themes. The aim of this is to illustrate, first Italy's existing capabilities in science and technology; second, the present relationship between the scientific resources available and the development models of the Italian economy and, finally, what a greater commitment to science and technology could mean for the future of Italy in terms of production and employment.

What the committee would like to do in this introductory section of the article is to summarize a series of "recommendations" concerning various "basic" aspects which will affect the development of the country's scientific knowledge and technological performance. These cover such diverse areas as education and labor policies, industrial policy, international cooperation and, finally, the organizations responsible for research.

In doing this, the committee does not intend to usurp the role of the bodies responsible for this task, that is, government and parliament, but rather sets itself the objective of stimulating and orienting the discussion in progress on these subjects by setting forth considerations which are intended to place greater emphasis on the role of "science and technology" in the context of the prospects for development of the Italian economy, as well as to demonstrate both the potential and the "centers of excellence" which certainly exist today in the Italian scientific and technological spheres.

On the basis of what has been said above, certain premises are evident:

a) The first premise concerns the "cultural attitude" and the "external economies," as these affect the development of scientific potential and the achievement of specific milestones in terms of technological progress.

   Technological innovation is a complex process, and one which requires the participation and firm commitment of the entire social system--from the school system to the family nucleus, from public services to private companies and the government bodies responsible for research and the economy.

   In particular, there must be a widespread conviction that unless scientific activity has basic foundations of broad-spectrum research which is properly distributed and fully effective, it is extremely unlikely that the necessary premises will be created for the internal development of innovation and for modernization of the country as a whole.

   However, the development of scientific knowledge and the spread of the new technologies in society and in the production process are related to external factors and, more precisely, to the overall efficienty of the country. In this context, aspects of particular importance are the presence and the functional levels of infrastructures such as transportation and telecommunications and data transmission networks. It is self-evident that the mobility of human resources, ideas and information is an essential premise for the spread of scientific knowledge and technological know-how.

b) The second premise concerns the fact that it is essential for certain measures to be implemented URGENTLY if our country is to improve its standing in international scientific and technological spheres.

From what has been said above and the information given in the second and third sections of this report, it is clear that Italy's commitment to R&D is lower than that of other industrialized nations. This is a gap which apparently can be bridged, however, since there are a number of areas and sectors "of excellence" in which Italian research is state of the art and in which Italian technologies are fully competitive. Moreover, over the last 3 years a trend has emerged of increasing our efforts in this country to bring ourselves into line with other European nations. Given this growing interest in increasing Italy's commitment in the scientific and technological spheres, it is essenital that certain measures which have been under discussion for some time now (measures such as reforms to secondary education and the reform of the CNR) should be rapidly introduced. We must also ensure that laws of major importance (such as law No. 382, dealing with reform of the university system, and law no. 46, concerning the Fund for Applied Research and the Fund for Technological Innovation) are correctly applied and modified as and where necessary.

c) The third premise concerns the extent of the human and financial resources that the country allocates to R&D activity. In Italy, the scientific world suffers from the fact that it receives inadequate financing. In 1985, for example, the overall sum allocated to both public and private organizations in this sphere was 9.245 trillion lire, equal to 1.3 percent of GNP. This sum compares unfavorably with the amount allocated to this sector in the same year by the FRG (2.8 percent of GNP) and by the United States (2.4 percent of GNP).

The fact that, once again, the increase in the allocation made to scientific research last year was so modest (+3.7 percent in real terms in 1985 compared to 1984) means that, as things stand, it will be impossible for the government to achieve the objective it had set reaching in the early 1990's a ratio of research expenditure to GNP comparable with that of our foreign competitors.

If we turn now to the question of the total number of human resources employed in research activities--both in the public sector and in industry--we can see only too clearly that these resources are totally inadequate to satisfy the requirements of a highly industrialized nation. This affirmation is borne out by a few figures: the total number of researchers in Italy is just over 60,000; this figure is one-tenth of the researchers in the United States, one-seventh of those in Japan and one-half of those in West Germany.

The shortfall in the size of research staff is greater in the field of applied research and development than in that of pure research.

Given the serious situation in which Italy finds itself today concerning the level of unemployment among young people, and in view of the need for more importance to be placed on science and technology not only by society as a whole but also from the point of view of the manufacturing capabilities of this country as a whole, it seems logical that we should set ourselves an ambitious goal, that of substantially increasing the number of people involved in research in this country over a very short period of time.

On the basis of these preliminary comments, the committee is of the opinion that, if the scientific and technological potential of this country is to be upgraded to meet the challenge of modernization, specific measures must be implemented in the following areas:

- secondary and technical schools;
- universities;
- research personnel;
- financial resources;
- incentives for companies to innovate;
- participation in international research programs;
- introduction of a "governing council" for scientific and technological activity.

The recommendations to the prime minister which are now given by the committee within the limits of its competence and the mandate received concern the aspects listed above.

Financial Resources

The increase in the number of researchers will have to be accompanied by an increase in the total financial resources allocated to R&D activity in order to bring Italy more into line with the country's foreign competitors. These financial resources include both the allocations made in various forms by the public sector and the sums allocated independently by industry.

While on the subject, it should be pointed out that, in Italy, R&D expenditure by industry accounts for 0.7 percent of the added value compared to more than 2 percent in Germany, the United States and Great Britain.

Because of the extent of public sector spending in Italy (almost 60 percent of GNP) and because of the specific characteristics of the product mix in Italian industry, any strengthening of the overall commitment to R&D must be regarded both as a public sector support tool and, at the same time, as a means of making Italian products more competitive on international markets.

There is an additional problem to be confronted: The problem of the attitudes and objectives in the allocation of expenditures on research. The situation today is that, in the government research sphere, priority is given to academic and pure research objectives in the broad sense, resulting in the fragmentation of resources over an excessive number of different sectors and projects. At the same time, an inadequate amount of money is spent on activity aimed at solving concrete problems and the identification of scientific hypotheses in response to the real needs of the nation. When it comes to the private sector, on the other hand, research expenditures are focused on a fairly limited number of sectors (chemicals and pharmaceuticals, electronics and informatics, transportation and space activity account for more than 70 percent of research spending). This is at odds with the pervasive, horizontal, multisector nature of the present stage in the evolution of technologies.

Given this situation, it is felt that the following measures should be implemented:

-Government programs should make clear provisions for reaching the objective of increasing the country's overall expenditure on R&D (both public and private) from 1.5 percent of GNP to 3 percent of GNP over a 5 year period;

-A minimum of 30 percent of public resources should be allocated to pure research, the most logical setting for this being universities;

-Expenditure of public resources should be channeled toward a more limited number of technological objectives, allocating these resources to priority initiatives, including initiatives created as a result of European collaborative programs;

- Every effort should be made to speed up and support commitment to R&D, both in industry and in the service sector. This would be achieved both through the introduction of automatic incentives and through the creation of consortiums or forms of cooperation for the transfer of technology toward traditional sectors of the economy and toward small and medium-size companies.

With regard to the channeling of public and private resources toward high-priority objectives for the development of the country, the committee wishes to emphasize the strategic importance of the following sectors:

- biotechnology (genetic and biomolecular engineering) and fine chemicals;

- microelectronics and molecular electronics;

- third-generation robotics, CAD-CAM and factory automation;

- artificial intelligence;

- new materials (for example, superconductors, ceramics);

- broadband telecommunications;

- nuclear fusion;

- optics and lasers;

- new-generation transport systems;

- satellites and space vehicles;

- biomedical instruments;

- use of new technologies in teaching and training.

Provision of Incentives to Industry for Technological Research and Innovation

Today there is a growing tendency for the governments of the major industrialized nations to provide support for research and innovation in production, in the form of a vast and varied range of measures and the provision of substantial financial resources. In this sense, the "policy of innovation" represents a fundamental aspect of government policy.

In Italy, the continued delays in the formulation and implementation of adequate support measures for research and innovation have led to a progressive weakening of the competitiveness of Italian industry. What therefore has to be done--and done rapidly--is to upgrade and strengthen public sector intervention, both in terms of the financial resources available and through the implementation of flexible and efficient procedures for the management of such intervention.

One of the main weaknesses from the point of view of implementation of a system of this kind concerns government research contracts. In all industrialized nations these contracts constitute an effective method of promoting research in areas of state of the art technology and of encouraging the spin-off of know-how acquired throughout the entire production system.

It must also be emphasized that the development of new technologies is increasingly coming to depend not only on a country's ability to carry out research but also on that country's ability to create new companies, encouraging (particularly by providing adequate risk capital) managerial capabilities and the potential for entrepreneurship in the technical and scientific spheres. In this respect, venture capital represents a tool of absolutely vital importance. Up until today very little use has been made of this tool in Italy, one of the reasons for this being the innumerable obstacles to the development of this financial instrument.

Therefore, on the basis of these general objectives of an industrial policy which provides support for technology, the committee recommends that the following measures be implemented:

- The allocation of more resources to the Fund for Applied Research and the Revolving Fund for Technological Innovation, and upgrading of the management of these funds. In theory, these funds represent effective support instruments for medium-size and large companies. Today, the situation in Italy is that the percentage of R&D expenditure in industry which is funded by government (8.8 percent in 1981)is in fact 30 percent lower than the levels allocated in the major European countries and in the United States. The funds referred to above must therefore receive adequate financing on a long-term basis. Therefore, if we are to meet the objective mentioned earlier in this report of increasing overall research expenditure to 3 percent of GNP over the next 5 years, starting in 1987 it will be necessary to double the allocations made on the basis of the Financial Law for refinancing of the Fund for Applied Research and the Fund for Technological Innovation. In addition to this, it will also be necessary to simplify the procedures for applying law No. 46 (the law governing the creation of funds), dispensing with constraints and reserve funds, which in practice simply prevent these funds from being utilized rapidly;

-The introduction of fiscal concessions and incentives which will promote research activity in companies, in the same way as the provisions are applied in this respect in other industralized nations. The committee also considers it important for new measures to be introduced granting tax relief on the profits made by new companies operating in the sector of advanced technology;

-Specialized provisions to support technological innovation in small companies, giving priority both to automatic interventions as well as to the supplying of specialized technological services and, at a more general level, of real services. On the basis of what has been done in this respect in other countries, it can be seen that this type of incentive (for example, the supplying of "real services") is particularly appreciated by smaller companies because it was conceived to meet the specific ways in which these companies implement their innovation processes;

-In order to promote the creation of new and extremely innovative companies, fiscal and financial legislation is needed which will make it possible for the use of appropriate forms of venture capital to become normal practice all over Italy in a short space of time. This would mean that banks would have to become more receptive to the concept of financing projects in which there is a risk factor, both technological and commercial, breaking with traditional banking practice which requires real quarantees and/or coverage by state funds;

-The measures contained in the provisions of law No. 46 (the law governing government research contracts forming part of the National Research Program) must be implemented rapidly. In addition to this, specific allocations for research must be established as part of the major infrastructure programs formulated by the ministries concerned (transportation, energy, telecommunications, health). These allocations must be accompanied by a description of the procedures to be applied for awarding contracts;

-With regard to other areas of public demand, on the other hand, (for example, agriculture and education), bid procedures must be defined which specify the innovative technical requirements involved and, as such, favor those companies which have high levels of research and innovation;

-There must be greater selectivity when it comes to allocating resources set aside for promoting research and innovation, giving priority to those activities where the technological and competitive risk factor is high. We feel that we must also emphasize the fact that there must be a close correlation between funds allocated and results obtained.

Finally, priroity will be given to those technologies in which Italy intends to develop a strong position in the medium and long term, assuming a position of leadership in international collaborative programs.

Management of Research

Present developments in research and the need for this research to be programmed and properly directed and managed means that we are confronted with one fundamental requirement. This is the necessity to create an appropriate "control panel," in the sense of a central body responsible for programming, coordinating and controlling the national system of public research and the measures for creating research incentives within industry.

With regard to actual implemention of public research, therefore, the committee believes that certain institutional and managerial changes should be made to the main bodies responsible for this sector. To be more precise, the committee feels that, in the case of the National Research Council, the first step which has to be taken if the operation and efficiency of this authority are to be improved is to upgrade and create a clearer distinction between, on the one hand, the authority's planning and funding activities (through the mediation of the consultative committees and, on the other hand, the authority's role as a "producer" of knowledge and technologies.

For this purpose, the committee has the following proposals to make:

-Reform of the consultative committees: This would cover both the method of appointment of the members of these committees (implementing a system whereby half the members would be elected, while the other half would be experts appointed by the government on the basis of recognized scientific merit), as well as the composition of the committees, in order to ensure not only that the sectors of public and private research are properly represented but also that the final users of the research carried out have a say in the matter.

The committees will be responsible for implementation of the Annual Research Program, establishing "executive programs" which will result in the stipulation of contracts, agreements and specific projects to be assigned both to public research organizations and to private companies or organizations.

Priority must be given to those programs which will make it possible for a number of different sectors (industry, university staff and departments, research organizations) to work in collaboration under the leadership of organizations with high-level scientific status and unquestionable managerial and administrative capabilities.

If the structure of these committees is based on the problems to be solved rather than on the area of expertise involved, we will create a situation in which it will be possible, first, to promote interdisciplinary research activity between a variety of different research organizations; second, to transfer the results of this research activity to the end user; and finally, to participate in international programs.

In addition to this, the committees will be able to identify, program and provide scientific services of general interest, services which frequently require large-scale, extremely expensive equipment (for example, documentation, informatics networks, super-computers).

The members of the committees will have to receive payment for their services.

-Reorganization of research activity: The various organizations of the CNR active today are "producers" of research. The first stage of this reorganization will consist of an in-depth analysis of their scientific and technological capabilities. After this, units found to be inadequate and any superfluous structures will be eliminated and the organizations will be arranged into various departments. Finally, they will be assimilated within a management structure which will be independent of the committees.

The structure of the CNR research departments must be flexible so that existing areas of competence can be maximized, and so that the scientific strategies which will be identified and defined can be expanded and explored.

It is essential that the process of reorganization of the CNR's research structures take into account the new specializations, assigning these to the existing areas of research on the basis of the information provided by the Central Coordination Department.

The management structure, on the other hand, will be responsible for the organization of the various services required by the different departments. It will also be responsible for coordinating the research programs established on an autonomous basis by the departments, both in response to the research programs of the committees and the requirements of the "research market" or, in other words, the overall demand within Italy.

The statutes of this new CNR will be of the type used in private industry. It will be assigned funds of its own, in addition to which financing will be provided for specific projects which the government research body considers to be valid.

-ENEA: The committee feels that the institutional objectives and the areas of intervention of this organization must be more clearly defined in order to delimit its functions to some extent and differentiate it from other public research authorities.

At the present time, the main institutional responsibilities of ENEA are the following:

-research into sources of energy;

-promotion at an industrial level in energy-related sectors;

-supervision of the siting and safety of nuclear installations.

The part played by ENEA in the overall sector of "industrial promotion" and in the transfer of technology must be coordinated and brought into alignment with a global national framework. This would avoid the fragmentation of resources and interventions, and would also put an end to the overlapping of ENEA's role and activity with that of other authorities, particularly at the regional and local levels.

The committee therefore feels that ENEA's activity as a "producer" of knowledge and technologies in areas related to the utilization and exploitation of energy resources should be consolidated.

Similarly, the activities and roles of all the other public research organizations (for example, INFIN, the Public Health Authority, the Agriculture Board and hospital institutes involved in scientific activity) should be made more specialized. Moreover, more stringent procedures should be implemented at a national level for verifying and controlling the scientific output of these organizations, a function which would be performed by the competent central government body.

International Scientific Collaboration

Over recent years, the Italian economy has become increasingly dependent on the international situation. Because of this, it would be extremely restrictive, not to say totally mistaken, if we were to base industrial policy and, consequently, technological policy, on domestic considerations alone.

At an international level, the technological scenario clearly demonstrates that the leading areas of the world (for example, the United States, Japan and Europe) are initiating highly ambitious research programs, setting themselves the objective of what is, in effect, the establishment of totally new technological bases for industrial and social systems. They feel this to be necessary if the strategic development objectives of the various countries are to be achieved.

These structural objectives and characteristics of the era of technological transition in which we live today, in conjunction with the complex nature of the problems to be solved and the financial and human resources required, all means that, in Europe at least, many sectors of technology are finding that a purely national approach to the matter is wholly inadequate. The failure of our country to participate in research programs based both on European and extra-European collaborative approaches could result in the definitive exclusion of Italian science and technology from the "club" of the most highly industrialized nations, a position which, once lost, would be difficult to recover.

We have various options open to us if we wish to make international technical and scientific collaboration a reality. Of these options, we believe that preference should be given to collaboration at a European level, since this would be consistent with the present trend for closer political and economic integration of the nations of Europe.

Today, a number of European research programs are already either developed or planned (for example Esprit, Brite, Race) which establish channels of collaboration between industrial groups and/or research centers in different countries.

We therefore recommend that a concerted action should be defined and undertaken with the aim of supporting active, wholehearted participation of Italian research (and we mean all areas of Italian research) in these programs, and of broadening the frontiers of this type of collaboration.

More specifically, the committee has the following recommendations to make:

- New funds should be created for European research projects in order to place Italian technology and industry on an equal footing with other European nations;

-Guarantees must be provided that Italian participation will be integrated into domestic programs which are already underway;

-An in-depth analysis must be made, and appropriate measures must be provided to ensure that participation in these programs produces spin-off both in terms of industrial production and as a means of extending the spheres of science and technology in Italy.

The internationalization of research cannot be divorced from an extensive process of interaction with developing nations. We cannot limit the concrete aid that we must give these nations to contributions at an emotional level--however understandable this may be. On the contrary, this aid must take the form of a transfer, as and where necessary, of scientific and technological know-how. Italy has already made significant contributions in this sense to the developing nations, and must continue along the path it has chosen in the following ways:

-Organizing training programs in Italy for researchers from developing nations and training programs for young Italians who want to work in developing nations;

-Establishing research structures in developing countries in which Italy's role would be that of cooperation; upgrading the research structures in Italy in which the scientific and technological probelms of the developing nations are studied.

These initiatives should lead to the development of intense cultural, scientific and economic activity in developing nations, with the additional advantage of creating spin-offs for Italy as well.

8616
CSO: 3698/M017

NORWAY TO INVEST 7.5 BILLION ANNUALLY IN INFORMATION R&D

Stockholm NY TEKNIK in Swedish 25 Sep 86 p 6

[Article by Christer Kallstrom]

[Text] Oslo--Research investments totaling 1 billion kroner will stimulate Norwegian industry. Norway will dramatically increase investments for research and development in the field of information technology. This will provide 75,000 new jobs by the end of the century, Norwegian Industry Minister Finn Kristensen hopes.

Many people believe that, in the past, Norwegians have been too one-sided in their industrial policy and have made major investments only in oil. The drop in oil prices now shows clearly how dangerous such a policy can be.

In order to diversify Norwegian industry, the Norwegian government is now making a major investment in information technology--a field that is now becoming the world's largest branch of industry.

"The information technology industry has formidable growth possibilities in Norway," Industry Minister Finn Kristensen said. During the next few years, it will grow more than any other industry. The prerequisite for this is that private companies and public authorities take strong joint action.

"Today high technology imports are increasing faster than the value of our own production. The Norwegian electronics industry is losing its share of the market both at home and abroad. If we manage to change this trend, it could mean 23,000 new jobs by 1990 and more than 75,000 by the end of the century," Finn Kristensen said.

The government will soon present a plan of action for information technology. The government hopes this will strengthen both training and research in data technology and electronics. Norway now has a great shortage of trained personnel, expertise, and equipment.

Major investments will also be made in fields such as product development, the dissemination of technology, and research activities of the Telecommunications Service.

Norway now spends 7.5 billion kroner on research and development in information technology. The goal is to increase annual spending to 9.5 billion kroner during the next 4 years.

The Norwegian Scientific and Technical Research Council (NTNF) has understood the situation in information technology for a long time now.

Director Reidar Kuvas of the NERA section of the Electric Bureau led an NTNF study on this topic.

Long Expected

"We in the industry have waited for the government's decision for a long time," Reidar Kuvas said. "Here in Norway we have an annual growth rate of 10 percent in information technology. If this trend continues at the same rate, the industry will soon be as large as the oil sector."

"The problem is that we import far more than we produce when it comes to goods and services in the area of data and electronics. By increasing our training capacity, I believe we can improve domestic production in this field," Reidar Kuvas said.

Helge Kristensen, chairman of the Electronics Industry Association, agrees that the availability of workers is a bottleneck.

Hunted Like Animals

"The higher up in the educational pyramid you go, the more difficult it is to find people. Doctors in this field are hunted down like animals and we cannot get enough of them," Helge Kristensen said.

"It is absolutely necessary that the state improve and increase training in data and electronics. At present, the industry must utilize much money and time to retrain people who have not received the proper training."

If the situation does not improve, Helge Kristensen believes that by the year 2000 Norway will have to import high technology worth 100 billion kroner each year. That is twice the amount that oil exports bring in today.

The Labor Market Administration of Norway believes that a goal of 75,000 new jobs in information technology by the year 2000 is wholly within the realm of possibility.

"There will be no shortage of workers by the end of the century," manager Hans Kure said. "The question is simply whether or not there will be enough people who have been trained for jobs in information technology."

"I have not yet seen specific plans for training, but if a reasonable effort is made, then it will be possible to create 75,000 new jobs within this sector," Hans Kure said.

9336
CSO: 3698/27

LASER SATELLITE MEASUREMENT SEMINAR HELD IN BULGARIA

East Berlin VERMESSUNGSTECHNIK in German No 9, Sep 86 p 317

[Article by H. Fischer: "International Scientific Seminar on Laser Telemetry to Earth's Artificial Satellites"]

[Text] An international scientific seminar entitled "Laser Satellite Telemeters of the Second and Third Generation and their Uses in Inter-Space Programs" took place in Sofia from May 26 - 30, 1986. The seminar was arranged jointly by Coordinating Commission 4 (laser/radar) within the scope of inter-space cooperation among the socialist nations, the Bulgarian Academy of Sciences (Central Laboratories for Space Research and Higher Geodesy) and the Bulgarian Society for Geodesy and Land-Based Equipment. The approximately 25 participants included representatives of Bulgaria, the Soviet Union, Hungary, the CSSR, Yugoslavia, Poland and the GDR. At the opening ceremony the participants were welcomed by academy member Dakov, Prof Massevic and academy member Serafimov, representing the sponsoring groups.

Questions and problems concerning the current state of the art of existing second generation (accuracy within dm) and third generation (accuracy within cm) laser/radar systems and those to be enhanced or expanded in the future were dealt with within the inter-space framework in the lectures and discussions. At the same time the great importance of third-generation systems in terms of obtaining geodetic and geodynamic earth-related parameters was underscored and the international cooperation needed to accomplish this in terms of coordinating and carrying out global testing programs was emphasized. Of particular importance, particularly in terms of realizing the Ideal and Wegener testing programs for studying movement of the earth's crust and seismic activity in central Europe and Eurasia, is the Plana Station near Sofia which is equipped with a new ULIS-630 laser/radar system. The total 18 presentations made can be grouped into three main subject areas:

1. The importance of second- and third-generation laser/radar systems for obtaining geodetic and geodynamic parameters and a precise time comparison.
2. Descriptions or detailed studies of existing inter-space laser/radar systems.
3. Structure and operation of the ULIS-630 universal laser measurement system.

Among other things, the Polish delegation presented interesting reports on problems of time-interval measurement techniques adapted to real-time test conditions. Close attention was paid to the presentations of the GDR delegation concerning theoretical considerations and experiments performed regarding the use of p/s pulses in third-generation equipment, the results of analyses using the Potsdam-5 railroad model within the scope of the Merit project, and the second-generation laser/radar system built by the GDR in Santiago, Cuba.

A relatively large number of the presentations dealt with the new ULIS-630 laser/radar system. This system was introduced as a third-generation group of equipment. The ULIS-630 is a joint development between the Soviet Union and Bulgaria. The optical system was developed and manufactured in Riga. the mechanical and electronic section in Stara Sagora (Bulgaria) and Sofia. The Cassegrain-Coude system design, with a 60 cm opening and a multiprocessor configuration in the instrumentation and control section, permits the use of a stationary laser and completely automatic sighting and measuring operations. The seminar participants were also able to learn about the ULIS-630 system in detail during a tour of the Plana Station. Since no test measurements with the main components which will ultimately be used (such as the laser and the receiving electronics) have as yet been made under actual conditions, no statement can yet be made concerning the actual level of accuracy achievable.

In summary, it can be said that the seminar provided valuable suggestions for realizing third-generation systems. Numerous contacts with Bulgarian specialists were made which will likely be further solidified in the future. We would also like to take this opportunity to thank our Bulgarian hosts for the warm reception and friendly service. Participation in this seminar served to further strengthen the close ties between the engineering organizations, the NTS and the KDT.

12552
CSO: 2302/6

EAST EUROPE/MICROELECTRONICS

CSSR'S TESLA PLANT FACES DEMAND FOR ELECTRONIC COMPONENTS

Prague TECHNICKY TYDENIK in Czech 16 Sep 86 pp 1, 2

[Article by Eng Jan Stach, technical director, Tesla Electronic Components Concern: "Component Base for the Eighth 5-Year Plan"]

[Text] We are placing extra emphasis on the use of electronics in the national economy. By this we mean the broad application of electronic equipment in practically all areas of production and nonproduction activities, but especially the use of electronics in the production process. Electronically automated facilities make it possible to increase greatly the national productivity of labor with savings in manpower and to raise the quality indicators of production. In addition, there is the use of electronics in management activities. Computer technology can improve both information and decision making processes. Finally, there is the development of cultural and educational activities. The use of electronic facilities, especially audio-visual technology, can improve the educational process and further extend cultural influences to broad sections of the population.

By means of electronics a broad spectrum of different electronic devices is oriented for application to various fields. A basic premise for the existence and development of these finished devices is an adequate component base. This is determined to a great extent by the available technical level of finished equipment and thus, in principle, influences the overall process of electronic application.

Under our conditions the economic production unit Tesla-Electronic Components, Roznov concern, practically monopolizes the production of our electronic component base. This is a grouping of organizations which are oriented toward individual types and a selective range of electronic components encompassing the whole spectrum of components from passive ones, like resisters and condensers, to active ones, like transistors and integrated circuits. Also included are vacuum components, especially television picture tubes, ceramic-based components, design components, various kinds of filters, etc., in short, basically all that is necessary to build finished equipment. This concern, which originated in 1980, is comparatively young. However, it continues the good traditions of its concern organizations and in the Seventh 5-Year Plan achieved considerable successes in the development of components. The volume of production in the sector of key components more than doubled in the course of the 5-year plan and research and development laboratories produced many new kinds of components, especially integrated circuits in response to specific consumer demand.

Immense Increase in Demand

The beginning of the Eighth 5-Year Plan posed great problems for our components base. The use of electronics in the national economy has elicited greatly increased demand for the number of component products already available and new components. Consequently, it appeared necessary to modernize our existing production capacity to a large degree and to invest in new construction of projects specifically for the expansion of electronic component production, especially integrated circuits. The consumers' demand for new components presents the concern with the problem of further expanding its product range. There is still a need for practically all components already on the market and new components cannot be produced at the expense of part of existing production. The selection of electronic components in the economic production unit is already so extensive that it is difficult to find any other component producers of comparable size. The problems resulting from this are, however, being resolved. Nevertheless, it is obvious that the only producer of electronic components cannot, in Czechoslovakia's circumstances, cover all consumer demands, especially in view of the range of products. This emphasizes the necessity of international cooperation and the division of programs in the field of electronic components among CEMA member countries. The concern has already experienced good results with this international cooperation. Several long-term agreements have been concluded on specialized production. The division of programs is based on pre-production stages and a considerable volume of components is exchanged along commercial lines. The results, however, still do not meet demand and the international division of labor is the subject of systematic work.

The Comprehensive Program of Research and Development of CEMA Member Countries to the Year 2000 will bring qualitative changes since a significant portion is devoted to key electronic components. The CSSR has an important role in this program which also gives it responsibility for providing a challenging selection of groups of integrated circuits for our partner countries in exchange for other selected groups produced by these countries.

What Is Being Prepared

The broad public, however, is interested in the specific situation, especially in the field of new components related to the goals of the Eighth 5-Year Plan. The program formulated so far, which is based on the successes of past years and incorporates developmental concepts already adopted, is included in the document on future series of electronic components. At present this program is in its fourth edition. It contains key component groupings in this number of basic types:

- 405 types of passive components (especially resisters and condensers)
- 248 types of discrete semiconductor components
- 789 types of integrated circuits
- 337 types of structural components (especially connecters and switching elements)

That is a solid basis for resolving the various problems of finished electronics. It is necessary to proceed very carefully in further expanding this grouping, especially in connection with the variety of the assortment and the building of the production base. In fact, all requisitions cannot continue to be accepted. Many of them do not even meet basic economic criteria. At present it is essential to concentrate our forces on those programs for new components which are most important to the national economy and where high technical standards and good economic production can be attained. Consequently, the concern is directing its technical policies from this point of view, an essential aspect of which is the international division of labor. Integrated circuits, which are unquestionably the key areas of the component base, will in the future be developed first. To keep things in balance the remaining component branches will also be developed commensurately as necessary to produce key finished units.

One of the most important areas in the application of electronic components is computer and automation technology. Certain technological innovations were created for this branch of integrated circuits. The present TTL and TTLS logic series are succeeded by the ALS series, which combined reduced power consumption and a higher speed of operation. We anticipate further development of single-ship microcomputers, microprocessors and especially digital-to-analog signal converters. There will be an important role for custom-made and semi-custom integrated circuits which can resolve many problems of computer and automation technology on a high technical level. The economic production unit is preparing the ground for this important branch. Cooperation with certain consumers is already under way, especially in the area of gate fields.

Another important branch is the telecommunications field. A series of integrated circuits is in preparation for a new generation of automatic electronic exchanges and for fully electronic telephones.

In consumer electronics further development is anticipated in integrated circuits for color television receivers and other audiovisual technology.

This is just a brief enumeration of some of the directions in which the new component base will be oriented. In all these plans it is, of course, expected that the use of components from our partner countries in CEMA will complete the necessary range of products.

For Surface Mounting

An important technical innovation which will affect the whole field of electronic components is that designed for so-called surface mounting. In this concept of components the producer achieves significant savings in materials by means of further miniaturization. For the user there is the possibility of considerable automation of assembly operations and at greater reliability of the finished units. Consequently, our economic production unit is also devoting full attention to this technology, which has already been designed, in the plans for the Eighth 5-Year Plan.

As can be seen from the above, the building of the Czechoslovak component base in the Eighth 5-Year Plan will not be simple. It will be necessary to take into account the steadily growing consumer demand which means modernization including new construction. At the same time we will have to develop and put into production a number of new challenging components to take care of key finished programs. This is, therefore, a very difficult job which, however, can be done by concentrating our forces on solving critical problems and by intensifying international cooperation among CEMA member countries in accordance with the goals of the Comprehensive Program.

8491/12851
CSO: 2402/4

EAST EUROPE/SCIENTIFIC AND INDUSTRIAL POLICY

SZEKESFEHERVAR DEBATE ON TECHNOLOGICAL DEVELOPMENT

Budapest HETIVILAGGAZDASAG in Hungarian 21 Jun 86 pp 52-54

[Text] Can technological development be planned? How and by whom should research and development (R and D) costs be paid in Hungary? These were among the questions debated by the participants in the conference on technological development held at Szekesfehervar last week. In the following paragraphs we describe a few of the papers on the system of economic conditions necessary for technological development that were delivered at the conference organized by the MSZMP, the National Technological Development Commission (OMFB), and the Federation of Technological and Scientific Associations (MTESZ).

Everyone at the two-day Szekesfehervar conference agreed on one point: faster technological development is one of the most important conditions for making the Hungarian economy more competitive internationally. On the other hand, there was disagreement among the speakers and commenting listeners with regard to how technological development in Hungary could be accelerated, and they disagreed especially on the question of how and by whom the costs of research and development (R and D) should be paid.

Jozsef Thuma, Main Division Director at the National Planning Office, also referred to these debates in his paper. As a starting point, he declared that in research and development Hungary has fallen behind the most developed countries and that this fact is evident in the quality and international competitiveness of Hungarian products. Thus, he said, the most important goal is to make sure that we do not fall farther behind the international front-runners. The only question now is whether national economic planning can help in attaining this goal. He said that opinions differ on this subject. According to one view, the national economic plan should not only specify the main lines of R and D but also contain, in as much detail as possible, the tasks involved and the method for financing them; he called this the plan-centered view. The other view--which the speaker called market-centered--holds that research and development cannot be planned and that the market must decide what should be developed in what areas. In Jozsef Thuma's opinion, however, neither of these paths should be followed. The first has already been tried for decades in Hungary but proved unsuccessful. The second, on the other hand, is not being followed anywhere, not even in the most fully developed market economies.

Everywhere in the world, the state--in most cases by means of financial support--prescribes certain directions for development. Thus, said Jozsef Thuma, the answer to the question, "Plan or market?" is, "Plan and market." The task of the national economic plan is to find an orientation, he said, and that of the market is to monitor the rightness or wrongness of the decision. It appears that the national economic plan, at any rate, has been shaped in this spirit, for the seventh 5-year plan contains only the main lines for research and development and the conditions for financing. The present 5-year plan allocates more than 3 percent of the national income available for domestic use to research and development (about 152-164 billion forints). This, he said, is a respectable figure even by international standards; he added, however, that in the light of the unfavorable economic events of 1985-1986 it is conceivable that not enough national income will be generated, so that it may become necessary to modify the above-mentioned R and D plan.

Table 1. Financial sources of domestic R and D allocations in 1984

	Billions of forints	Percent
Allocations made by enterprises	14,44	55,6
State budget	5,50	21,2
Central technological development fund	5,59	21,5
Other state monetary funds	0,36	1,4
Foreign sources of money	0,09	0,3
Total	25,98	100,0

Table 2. Principal ratios in the national economy which relate to domestic R and D (percent)

	1980	1983	1984
Percentage of domestic R and D workers among active earners	1,68	1,58	1,60
R and D allocations as a percentage of national income	3,75	3,19	3,23
R and D allocations as a percentage of domestic utilization	3,65	3,27	3,36
R and D investments as a percentage of total investment	1,61	1,41	1,66

Table 3. Principal data on domestic research and development installations

	1980	1983	1984
Number of scientific research and development workers (in thousands)	38,7	36,7	36,8
R and D allocations (billions of forints)	19,0	21,2	23,3
Portion representing investment	3,1	2,7	3,1

"I must begin by destroying some illusions," said Deputy Finance Minister Gyula Csaky in introducing his paper. He said that arguments had been heard both at the general assembly of the Hungarian Academy of Sciences and at the Szekesfehervar conference to the effect that a prerequisite for technological progress was the modification of the system of economic regulators, and of the regulation of R and D as a part of this. In his opinion, however, acceleration of technological development cannot wait until an opportunity is found for changing the regulators. He said that regulators had been brought up to date in past years as well--for example, the compulsory formation of the technological fund introduced in 1959 had been discontinued in 1983 except in the machine and chemical industries--but rapid changes could not be expected. The reason was, he said, that today the foremost goal is to increase the export capacity of the Hungarian economy and to maintain the anti-inflationary policy. Everything else must come after these.

One of the disputed questions of R and D financing concerned the central technological development fund [sic] (5.6 billion forints in 1984), which is built up from contributions made by enterprises--more precisely, from contributions made only by certain enterprises, since those engaged in agriculture and commerce do not make any contributions. But even within industry, the burden of payment to this fund is not uniform: in proportion to price income from other-than-product sales it is transportation and communication that pay the least (0.2 percent) into the central fund, while information technology and vacuum technology pay the most (4 percent). This is unfair, said the deputy minister, since the central technological development fund is used for financing programs--primarily the development of the R and D infrastructure--that benefit the economy as a whole. For this reason, the Finance Ministry feels that the range of those who make contributions should be expanded. According to the deputy minister, thought should also be given to the idea that this fund should not be handled separately at the OMFB and that instead, enterprises should pay their contributions directly into the budget and the money for research and development should be returned directly through the budget. However, said Gyula Csaky, there are many that oppose this idea.

One objection could be heard at once by the audience when, immediately after the deputy minister, the microphone was taken by Istvan Goldperger, Main Section Director in the OMFB. In his opinion, if the contributions were paid into the budget--for example, through an increase in the profits tax--this would not only reduce the profit incentive of the enterprises but also make it necessary later to beg for the money to be allocated from the budget.

According to Istvan Goldperger, a favorable change in research and development can be achieved by further updating of the regulators. The essential point is that organizations engaged in R and D should be given further preferences in comparison with productive enterprises. He justified this with the argument that research and development work is very expensive and involves high risks and that the time required to recoup the money spent on R and D is also longer than average. In his paper, the main section director of the OMFB pointed out a few preferences that had had a beneficial effect on Hungarian research and development during the past years. He said that research institutes operating under the enterprise system enjoy complete exemption from taxes on fortune, while the other research organizations--those operating under the budget--are exempt from only half of the tax on fortune. (In 1985 the total amount of such preferences was about 340-350 million forints.) Research and development organizations enjoy a 75 percent exemption in profits tax on the price income from their activities carried out in response to orders, research institutes can obtain import goods duty-free, and R and D organizations have also been authorized to accelerate their depreciation writeoffs. Among the special regulations relating to R and D, he mentioned the so-called profit-sharing scheme. Under this arrangement, research and development organizations may also share in the economic results of the commissioned research. Part of the money thus received by the R and D organizations may be used to pay honoraria to researchers in addition to their regulation salaries. (In 1984 about 15 million forints was paid on the basis of this scheme.)

The ultimate lesson gathered by the participants in the two-day conference--at which enterprise managers also spoke--was that in the long term, regulators must be modified in such a way as to be more favorable than the present ones to research and development. Although no concrete recommendations were made, the participants emphasized that this is the only possible way to accelerate Hungarian technological development.

R and D Figures

In 1984--this is the year for which the most recent detailed data are available--a total of about 26 billion forints was spent on research and development in Hungary, 2.5 billion forints more than in 1983. Within this figure, there was a slight decrease--from 22.2 percent to 21.2 percent--in the proportion represented by money obtained from the state budget. In 1984 there were altogether 1,279 research institutes and research installations in the country, but of their 78,400 workers only

36,800 were scientific researchers. Of the total amount allocated to research and development installations, 74 percent was spent on research and development in technological science and 11.9 percent on research and development in natural science.

Comparisons at the international level reveal that Hungary's per capita R and D allocations are higher than the world average but lower than the European average. When the comparison is made with the socialist countries, it is found that Hungary holds a position in the middle of the field. On the basis of allocations in proportion to national income, in 1980 only the Soviet Union, the GDR, and Czechoslovakia were ahead of Hungary; however, in the number of scientists and engineers per 10,000 inhabitants, Hungary was outdistanced not only by the above three but also by Bulgaria and Poland.

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EAST EUROPE/SCIENTIFIC AND INDUSTRIAL POLICY

TOP GDR SCIENTIST DEBUNKS NUCLEAR PLANT DANGERS

Jena GLAUBE UND HEIMAT in German No 38, 21 Sep 86 p 2

[Interview with Dr Manfred von Ardenne by chief editor Gottfried Mueller, date and place not given]

[Text] In an interview with GLAUBE UND HEIMAT the famous Dresden scientist, Dr Manfred von Ardenne, addressed the problems of the peaceful uses of nuclear energy. At the same time he warned of the dangers arising out of the nuclear arms race. Dr Gottfried Mueller asked the questions.

[Question] The reactor accident in Chernobyl has shown that the peaceful use of nuclear power also involves risks. In addition, the GDR is a densely populated country and such a catastrophe in one of our nuclear power plants could have very serious consequences. Shouldn't we decide now to forego nuclear power sooner or later?

[Answer] In my speech to the People's Chamber (at the People's Chamber Conference on 17 June--the Editor), I spoke out against foregoing nuclear energy. I am convinced that following this very serious accident at Chernobyl substantial additional improvements in terms of safety measures will still be made which we--and it is important to know this--have already implemented here to a large extent. I believe that foregoing nuclear energy would be a step which would have a very negative effect on future energy availability in the world. I am also thinking about nuclear fusion in which energy from water, from the oceans, can be used. An age of energy abundance will dawn when nuclear fusion is mastered both technologically and physically. In my opinion, mankind should not close itself off from this development.

[Question] If in the future we continue to live with nuclear power plants, is adequate safety ensured in view of experiences to date?

[Answer] The various accidents which have occurred in nuclear power plants in the past will lead to measures which, though they may not exclude accidents of this type in the future, will limit their consequences to insignificant occurrences. The accident at Chernobyl is certainly a sequence of an entirely abnormal number of individual failures, numerous human failures in particular. More systems, safety mechanisms in particular, will now be introduced which will exclude human error, i.e. totally automatic systems.

[Question] But the human factor cannot be entirely excluded, can it?

[Answer] Yes, if the system is automatic. That is the objective of automatic systems--to eliminate human error which must always be taken into account.

[Question] Safety problems exist not only with regard to nuclear power plants but also with regard to the nuclear arms race. You already referred to this matter earlier. How do you view this problem?

[Answer] The events at Chernobyl have shown that even high technology is subject to limits in terms of safety if the automatic systems we already discussed are not taken into account. However, it is also true that safety mechanisms are in place before the launch of a nuclear missile--very refined mechanisms. But we must also figure that with the tens of thousands of missiles standing ready for launch, at some time or other the safety mechanisms in one of these nuclear missiles will fail. In all probability this would start the nuclear inferno--particularly now because with the short distances involved the hot-line is no longer effective. It is simply a matter of luck that up to now no such safety mechanism involving a nuclear missile has failed. I say luck because the danger of each individual nuclear missile is far greater than that of a single nuclear power plant.

[Question] To come back to the question of the peaceful uses of the atom. Could not the so-called "soft" alternative energy sources, following a certain transition period, be in a position to replace nuclear power? Cannot these sources be expanded?

[Answer] Of course they can be expanded. And we should expand them as much as possible, for example by building more hydroelectric power plants wherever we can. In particular, I am thinking about solar energy, where the effectiveness of solar cells is always being further improved. Today entire roofs are being built out of solar cells and the electrical energy which they supply helps to heat the building. I am also thinking above all about energy conservation. Energy for heating purposes is saved by constructing buildings with walls and windows which provide thermal insulation. Wind power can also be better utilized today than with the old windmills. Therefore, in terms of the energy balance sheet, it is a safe bet to try to increase availability using "soft" methods and to reduce energy consumption. But there will still be a large energy gap due to the high demand for energy in the modern industrial society so that in the long run, in my opinion, we will not be able to do without nuclear power plants and later mammoth nuclear fusion power plants.

[Question] Would this gap not perhaps already have been closed if in the past there had not been a one-sided orientation in the entire world toward the development of nuclear energy? And could not a concentrated effort still lead to alternative energy sources which will make nuclear power superfluous?

[Answer] From the point of view of physics, which I am intimately involved in, I do not believe that. The task of further developing solar energy, hydroelectric power, etc., has also been in existence for decades. We have realized that these ways have limits. I simply do not believe that they will provide enough energy economically that we would be able to forego nuclear energy.

[Question] You spoke before of the high energy demands of the modern industrial society. Could not a willingness to make fewer material demands also produce a kind of reserve which would counteract increasing energy consumption? There are--also within our churches--above all young people who say, "We do not even want all the comforts of a modern industrial society." In view of the crass differences in living standards between the industrialized nations and the developing countries we must in any case learn to share, to sacrifice, to live more modestly. Do you think that this is a concept worth considering?

[Answer] We must give it a great deal of consideration. The transition to a more modest way of life in industrial societies is absolutely necessary in my opinion. A similar matter is of very great importance and that is that the development of ethics must be greatly accelerated. It is related to the development of science, the immense overall development of science and technology. When the latter develops more rapidly than ethics, impossible international political conditions arise such as those we are experiencing now. It is crazy to spend unbelievable amounts of money just to increase the nuclear weapons arsenals of both sides, i.e. to endanger the entire culture and lives of all the people on this planet. It is difficult to imagine how such nonsense can ever develop. And I find that the only conclusion that can be drawn from the accidents of which we spoke initially and from the known limits of high technology--specifically on the basis of the development of good modern ethics--is that the nuclear potential of both sides must be reduced step by step to zero. Only when nuclear tensions no longer exist will we no longer need to count on "luck" that nothing happens. Only then will the risk to mankind be eliminated. Such a development would correspond completely with the theoretical basis of Christianity. If the resources which would become available in the event of total nuclear disarmament would be used to improve our cultural circumstances and to improve the living standard in the underdeveloped nations, this would be a turning point--an extremely happy turning point in the history of mankind. Imagine what would happen in the area of health, in terms of battling the illnesses, suffering and ailments of mankind, in the area of education, and regarding questions of environmental pollution which costs so very much to clean up. Just think of the good that could be done!

[Question] One final question concerning the problem of the expert versus the layman in the area of peaceful uses of nuclear energy. Up to now the experts have given us the impression that the use of nuclear power was one hundred percent safe. It appears that after the experiences with various accidents and near-accidents, and in particular after Chernobyl, a kind of lack of trust has developed between the experts and the lay people. What should be done to alleviate this situation?

[Answer] I do not think that the lack of trust is justified. I suspect that the politics of the moment also play a significant role in this situation. What characterized Chernobyl was human error which contributed in many different ways. Perhaps the experts made the mistake of not taking human error sufficiently into account. But now that they have the experience they will direct all their energies toward designing safety mechanisms such that human failings can no longer have such critical consequences, i.e. they will favor automatic systems. And it is my opinion that then nothing really serious can happen.

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