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Airbus: Ribbed Aerodynamic Skin Testing

90AN0087 Rijswijk PT/AKTUEEL in Dutch 25 Oct 89 p 10

[Article: "Airplane With Ribbed Skin Increases Mileage by One Percent"]

[Text] Apparently, a smooth skin does not always offer the least resistance. The fastest fish and sea mammals, for instance, often have a very rough skin surface. This has not escaped the attention of experts in the field of aerodynamics. In the meantime, Airbus has begun experiments with an airplane covered with a ribbed foil. Eventually, this should result in fuel savings of up to two percent.

This month Airbus will carry out an experiment with an airplane equipped with a special ribbed skin. The ribs are 0.06 mm deep and 0.12 mm wide.

Late last year, a wind-tunnel test was performed on a model covered with such a skin. This month, a full-scale test will be carried out on an A320. Judging from previous experiments, it is generally assumed that the airplane—80 percent of whose surface has been covered with a plastic foil—will get between one and two percent more mileage.

The project is supported not only by the Airbus partners—France's Aerospatiale, West Germany's Messerschmitt Boelkow Blohm (MBB), British Aerospace, and Spain's CASA)—but also by the U.S. company 3M, which developed the ribbed foil. During the test program's first phase, the feasibility of the rib concept was checked in a wind tunnel. In fact, two test programs were run almost simultaneously: the first by Aerospatiale and the National Office for Aerospace Studies and Research (ONERA) in the S1 wind tunnel near Modane, and the other by British Aerospace and the Royal Aircraft Establishment of Farnborough. The researchers were interested in results from both wind tunnels because of the different calculation methods used. The results were most encouraging: a fuel economy of 1 percent seemed possible with 70 percent of the airplane's body covered with the foil.

But the question was whether the delicate foil would resist wear due to weather conditions and air pollution. So the second part of the program focused on the foil's durability. This project is still in progress. To this end, the body of a Lufthansa A300-600 was covered with 12 ribbed foil sheets in crucial areas. The test began in July 1988, and so far the foil's condition is quite satisfactory. Apparently, the material on the airplane, which is used on the African and Asian routes, is not adversely affected by 1 year of exposure to extreme conditions, and, even more important, appears to be resistant to de-icing agents, cleaning agents, and dust. The foil is expected to last about 5 years, which corresponds to the interval between two paint jobs.

Airbus is now beginning the third phase with an Airbus A320, in order to check the actual energy savings. The foil is applied to 65-80 percent of the airplane, which is then allowed to perform four 2-hour flights. Each strip is approximately 80 centimeters wide and is applied like an adhesive tape. The airplane's hard-to-reach parts (including flaps and tail) remain uncovered. According to Airbus, four test flights should be sufficient to ascertain whether the ribbed foil actually results in a fuel savings of 1 percent or more. The final results will be known by the end of this year.

Savings

One percent may not seem like much, but Aerospatiale has calculated that such a savings does have huge consequences. The foil's price and its application bear no relationship to the advantages offered, says Airbus.

For an airplane such as the A320, which is used on 925-kilometer hauls, the annual fuel savings amounts to as much as 70 tons. This means that a company with 20 such airplanes flying on similar routes would save 1,400 tons of fuel a year. Considering the fleet's projected service life (15 years), this amounts to 21,000 tons, which corresponds to a savings of $3.5 to $8 million (depending on fuel prices).

A long-haul plane such as the A340, which covers distances of 11,000 kilometers, would save 320 tons a year; 10 such airplanes would save 46,500 tons within 15 years. Depending on fuel prices, a company would save between $7.6 and $15 million a year. The average European airline (about 100 planes) has a fuel consumption of about 2.5 million tons a year (Source: Aerospatiale).

Matra, GEC To Form 'Matra Marconi Space'

90AN0117 Brussels EUROPE in English 16 Dec 89 p 18

[Text] The French group Matra and the British group GEC signed a memorandum of understanding for the creation of Matra Marconi Space, which will bring together the aerospace activities of Matra Espace and Marconi Space Systems (GEC group). The agreement, which remains to be approved by the British and French defense ministers, is expected to be officially signed before 31 March 1990.

The new company will be the European leader in the area of communications and observation satellites. Its turnover will amount to Fr 3 billion (Fr 2.2 billion for Matra and Fr 800 million for Marconi) and will employ 2,700 people (1,600 from Matra and 1,100 from Marconi). Management expects a turnover of some Fr 3.6 billion for next year.

This financial integration is the end result of a technological cooperation initiated several years ago. In the near future, Matra would like to strengthen its cooperation with the German group Daimler-Benz, whose subsidiary Deutsche Aerospace might acquire a stake in Matra Defense Espace.

AUTOMOTIVE INDUSTRY

Siemens, CNRS To Create Joint Laboratory

90AN0072 Paris ELECTRONIQUE HEBDO in French 19 Oct 89 p 8

[Article by Marina Anger: "Siemens and CNRS Set Up Joint Laboratory"]

[Text] Siemens Bendix Automotive Electronics (soon to be renamed Siemens Automotive) has confirmed decisions made previously—when it was still part of the U.S. group Allied Signal—to strengthen its research and testing facility at Toulouse-Le Mirail. It was at this center that new generations of electronic systems for ignition, fuel injection, and antilocking wheel brakes were developed. The group's management has begun collaborating with the Laboratory for Automatization and Systems Analysis (LAAS) of the National Center for Scientific Research (CNRS) at Toulouse, which should culminate in the creation of a joint laboratory by early 1990. This project is in line with CNRS's new goals in the area of research implementation.

First Year Operating Budget of Fr 2 million

For the industrial group, this is an opportunity to acquire a structure that surpasses previous contracts with research laboratories. "Each time we sign this type of contract," explains Jean-Marc Nozeran, R&D director at Siemens-Bendix, "we easily need 2 to 3 months to come to an agreement on the terms of the contract. The industrial research center and the laboratory do not speak the same language. Therefore, we have to set up a new type of collaboration, to agree to a long-term rationale, to establish the foundations of a structure that will allow research to be fully implemented through the total immersion of researchers in the industrial environment." In fact, this laboratory will be installed on the company's premises, at the Toulouse-Le Mirail facility, where it will employ about 20 researchers (one-third LAAS, one-third Siemens-Bendix, and one-third doctoral candidates) with an operating budget of Fr 2 million for the first year. The premises and heavy calculation instruments will be paid for by the company; salaries will be paid by the two participating parties; and the laboratory will receive financial assistance from the Regional Council of Midi-Pyrenees, by virtue of a subsidy destined to support the creation of joint laboratories in the region.

Improving Electronic Control

A major research goal of this new laboratory will be to improve electronic control through the development of command functions based on advanced concepts of automatization and the simulation of behavioral models. Two other goals will involve the development of mechatronic concepts and the design of sensitive subsystems that will lead to greater sensor integration and advanced signal processing. The main point of these projects is, of course, to enable the company to complement its development program with new products, such as a controlled acceleration system (drive by wire) integrating sensors in the accelerator and mechatronics in the engine (specifically, the carburetor) with, among others, an electric butterfly valve; and an adaptive suspension integrating an electrovalve within shock absorbers.

Regarding the question of industrial ownership of the work conducted by the joint laboratory, the most recent negotiations have leaned toward giving Siemens-Bendix exclusive ownership of automotive applications, with LAAS reserving rights to other industrial applications.

BIOTECHNOLOGY

Dim Prospects Seen for French Industry

90AN0076 Paris LE MARCHE DE L'INNOVATION in French 13 Oct 89 p 6

[Text] There is a degree of satisfaction in the world of research, but manufacturers are worried. The biomaterials sector in France is another victim of the gulf separating research and industry. Whereas the former consider themselves "among the best in the world," the latter coldly assess the difficulties of a market where a world presence is indispensable.

As Jean-Michel Bonabosch, CEO of Laboratoires Domilens, says: "French research results may indeed be good, but this is not reflected in our market share. More than half of biomaterials applications are found in the United States, and this is a very costly market. A specific structure is required for FDA approval. For the past 3 years, we have invested $2 million per year trying to get a foothold in the United States. If we are not successful soon, the company will be bought out."

Christian Pusineri, an engineer with Rhone-Poulenc Silicones, is also aware of the difficulties in store and the runaway costs of R&D. "The next generation of biomaterials will without a doubt be hybrid and will possess biological capabilities. Therefore, joint teams of biologists and specialists in the physical and chemical properties of surfaces will have to be formed. The bioreactive materials obtained by biotechnologies are also an attractive direction. But, given the fragmentation of applications, we cannot talk in terms of volume and thus of profitability. Therefore, there must be a very strong collaboration between materials manufacturers and specialists in biomedical engineering. The two do not have to merge, but the biomedical engineering companies ought to reallocate a part of their profits to materials manufacturers." It is obvious that, despite a potentially promising market, the rare French industrial companies active in this sector are far from having won the race. "Research is our priority. Yet it is practically impossible to find engineers in our sector. We are in the process of developing a machine capable of manufacturing a hundredth of a micron—something that is not available on the market—and we cannot find a micromechanic," Bonabosch laments.

Dutch Coal Processing Technology Upgraded

90AN0086 Rijswijk PT/AKTUEEL in Dutch 25 Oct 89 p 1

[Article by Gerard van Nifterik: "TUD Research: Desulfurization by Means of Bacteria Becomes Realistic Option"]

[Text] A method developed at Delft for removing inorganic sulfur from coal using a microbiological process seems to offer good prospects. At the end of this year, a partial study will be concluded showing that the method is technologically and economically feasible. In early 1990, construction of a pilot plant will begin in the Italian town of Porto Torres [Sassari,Sardinia].

The study has shown that microbiological desulfurization may have a very promising future. It concludes that the method is technologically practicable and possibly economically profitable. This would certainly be true if the method were combined with the process for the production of coal dust/water slurry. The latter product, which serves as fuel for smaller installations, is being developed in Italy by ENI-Chem (a semisubsidiary of the Italian state-owned company ENI) [National Hydrocarbons Agency]. For this reason, a pilot plant for microbiological desulfurization will be built on the grounds of ENI-Chem (Sardinia). Construction will probably begin next summer and last 1 year.

The method could also become extremely valuable for the upgrading of very sulfurous quantities of coal and scrap coal. According to researcher P. Bos from the Technical University (TU) of Delft, coal will become increasingly important in the future, thus increasing the method's value.

Combination

The process, which has been under development at TU Delft since 1982, focuses on inorganic sulfur, which is generally found in coal in the form of sulfuric sulfide (pyrite). The method does not involve removal of organic sulfur. Roughly, what happens is that sulfur is extracted from coal dust in a watery, acid environment by microorganisms. The idea is not new, but it had never been shown to be a realistic option. Initially, the Dutch Government subsidized the research within the framework of the National Research Program on Coal. In 1986, the research was adopted by the EC, which contributed 50 percent of its funding. At the same time, three foreign institutions joined the research project: Bergbau Forschung (West Germany), Warren Springs Laboratory (Great Britain), and the University of Cagliari (Sardinia).

The research has resulted in the development of a (provisional) microbiological desulfurization system that will be tested in the pilot plant at the Italian town of Porto Torres. As far as use in combination with ENI-Chem's product is concerned, the products complement each other very well. The method uses coal dust in an acid, watery environment. ENI-Chem's product contains 70 percent coal dust and 30 percent water.

EC Council Decision on BRIDGE Program

90AN0109 Luxembourg OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES in English No L360, 9 Dec 89 pp 32-40

[EC Document: "Council Decision of 27 November 1989 on a Specific Research and Technological Development Programme in the Field of Biotechnology (BRIDGE) from 1990 to 1994"]

[Text] The Council of the European Communities,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 130q (2) thereof,

Having regard to the proposal from the Commission,

In cooperation with the European Parliament,

Having regard to the opinion of the Economic and Social Committee,

Whereas Article 130k of the Treaty stipulates that the framework programme shall be implemented through specific programmes developed within each activity;

Whereas, by Decision 87/516/Euratom, EEC, as amended by Decision 88/193/EEC, Euratom, the Council has adopted a framework programme for Community activities in the field of research and technological development (1987 to 1991), providing *inter alia* for activities ensuring the exploitation and optimum use of biological resources;

Whereas that Decision provides that a particular aim of Community research must be to strengthen the scientific and technological basis of European industry, particularly in strategic sectors of advanced technology, and to encourage it to become more competitive at the international level, and that Community action is justified where research contributes, *inter alia,* to the strengthening of the economic and social cohesion of the Community and the promotion of its overall harmonious development, while being consistent with the pursuit of scientific and technical excellence; whereas the Biotechnology Research for Innovation, Development and Growth in Europe (BRIDGE) programme should contribute to the achievement of these objectives;

Whereas the activities provided for in the framework programme include, in particular:

- The establishment of Community research and development (R&D) for contributing a transnational dimension to national efforts and for facilitating technology transfer towards industry and agriculture in the areas of infrastructure, basic biotechnology and risk analysis,

- The continuous evaluation of the strategic significance of new developments in biotechnology and promotion of the essential coherence between the different areas of Community policy concerned with biotechnology;

Whereas Decision 81/1032/EEC adopting the multiannual research and training programme for the European Economic Community in the field of biomolecular engineering and Decision 85/195/EEC adopting, and Decision 88/420/EEC revising, the multiannual research action programme for the European Economic Community in the field of biotechnology (1985 to 1989) have clearly demonstrated the utility of Community actions in biotechnology and the need for their expansion;

Whereas particular attention should be paid to ethical and social matters which may be associated with this programme;

Whereas the participation of European non-member States wholly or partially with projects in this programme is desirable;

Whereas it is desirable to involve small and medium-sized enterprises to the maximum extent possible in the biotechnology research and development programme;

Whereas the implementation of research and training actions in the COST (European Cooperation in Scientific and Technological Research) framework is an essential element to complement R&D projects in the field of biotechnology;

Whereas the Scientific and Technical Research Committee (CREST) has given its opinion,

Has adopted this decision:

Article 1

A specific research and technological development programme (BRIDGE) for the European Economic Community in the field of biotechnology, as defined in Annex I, is hereby adopted for a period of four years from 1 January 1990.

Article 2

The funds estimated as necessary for the execution of the programme amount to ECU 100 million, including expenditure on a staff of 28.

An indicative allocation of funds is set out in Annex II.

Article 3

Detailed rules for the implementation of the programme and the rate of the Community's financial participation are set out in Annex I.

Article 4

1. In the 3d year of implementation of the programme, the Commission shall review it and send a report on the results of its review to the European Parliament and the Council. This report shall be accompanied, where necessary, by proposals for amendment or extension of the programme.

2. At the end of the programme, an evaluation of the results achieved shall be conducted by the Commission, which shall report thereon to the European Parliament and the Council.

3. The abovementioned reports shall be established having regard to the objectives and criteria set out in Annex III to this Decision and in accordance with Article 2 (2) of Decision 87/516/Euratom, EEC.

Article 5

The Commission shall be responsible for the execution of the programme.

The Commission shall be assisted by a committee of an advisory nature, hereinafter referred to as "the committee," composed of the representatives of the Member States and chaired by the representative of the Commission.

Contracts concluded by the Commission shall govern the rights and obligations of each party, in particular the arrangements for the dissemination, protection and exploitation of research results.

Article 6

1. The representative of the Commission shall submit to the committee a draft of the measures to be taken. The committee shall deliver its opinion within a time limit which the chairman may lay down according to the urgency of the matter, if necessary by taking a vote.

2. The opinion shall be recorded in the minutes of the committee; in addition, each Member State shall have the right to have its position recorded in the minutes.

3. The Commission shall take the utmost account of the opinion delivered by the committee. It shall inform the committee of the manner in which its opinion has been taken into account.

Article 7

The procedures laid down in Article 6 shall apply in particular to:

- the contents of the calls for proposals,
- the assessment of the proposed projects and the estimated amount of the Community's contribution to them,
- departures from the general rules governing Community participation set out in Annex I,
- the participation in any project by non-Community organizations and enterprises referred to in Article 8 (2),

- any adaptation of the indicative allocation of funds set out in Annex II,
- the measures to be undertaken to evaluate the programme,
- arrangements for the dissemination, protection and exploitation of the results of research and carried out under the programme.

Article 8

1. The Commission is authorized to negotiate, in accordance with Article 130n of the Treaty, agreements with international organizations, those non-member States participating in COST and those European countries having concluded framework agreements in scientific and technical cooperation with the Community, with a view to associating them wholly or partly with the programme.

2. Where framework agreements for scientific and technical cooperation between European non-member States and the European Communities have been concluded, organizations and enterprises established in those countries may, on the basis of the criterion of mutual benefit, become partners in a project undertaken within the programme.

No contracting party based outside the Community and participating as a partner in a project undertaken under the programme may benefit the Community financing for this programme. Such contracting party shall contribute to the general administrative costs.

Article 9

This Decision is addressed to the Member States.

Done at Brussels, 27 November 1989.

For the Council The President R. Dumas

ANNEX I

Programme Contents and Implementation and the Rate of the Community's Financial Participation

Action I: Research and Training

CONTENT

1. Information Infrastructure

1.1. Culture collections

Development of a communication system for easy and rapid access to the most important service culture collections within the Community is to be achieved through support of:

- a promotion center for culture collections, specifically designed for providing to European users (distribution of catalogues, patent regulations, printed and visual material) adequate information on expertise and services available in different European culture collections,
- a centralized European data bank, primarily on microorganisms and subsequently extended to other biotic materials (animal and plant cells, viruses, plasmids). The first phase towards this objective is to involve the harmonization of formats and data in the main service culture collections of the European Community.

1.2. Processing and analyses of biotechnological data

- Applications of information technology (specialized software and equipment) such as required for the implementation of the activities in protein engineering and gene sequencing (see also 2.1 and 2.3).
- Updating and design of knowledge bases for storing and classifying biotechnological data such as sequences, genetic maps, protein and biopolymer structures, risk assessment data.
- Exploitation of existing or newly developed information technology for rapid access to European knowledge bases and closed sequencing networks via an electronic network, including electronic input, on-line catalogues, electronic ordering, etc.

2. Enabling Technologies

2.1. Protein design/molecular modelling

- Multidisciplinary approaches including genetic engineering and advanced structural methods aiming at improving the properties (such as stability, pH optimum, substrate specificity) of interesting proteins and their complexes (including glycoproteins).
- Development of methods to understand and predict structure/function relationships of proteins, such as those involved in folding, stability, crystallization, including theoretical methods for simulation of these properties, and their interactions with other related molecules.

2.2. Biotransformation

- Development of biological reactions using new strains of cells or novel enzymes for synthesis of key intermediates needed for the production of high added value substances (particular attention to be given to the bioconversion of agricultural surpluses) and for converting pollutants to innocuous compounds.
- Research addressing the problem of genetic and physiological stability of the free or immobilized genetically modified microbes or cells under biotransformation conditions.
- Research addressing the problem of enzymatic activity under extreme environments (organic solvents, pHs, temperatures, immobilization).
- Development of methods for the isolation and purification of biotransformation products (upstream and downstream processing).

- Development of specialized software and mathematical modelling for the control and analysis of biotechnological processes.

2.3. Gene mapping, genome sequencing, novel cloning methods

- Sequencing the genome of yeast (*Saccharomyces cerevisiae*) or parts thereof and of *Bacillus subtilis.*
- Development of molecular genetic techniques to identify new meaningful plant genes, using the *Arabidopsis* genome as a resource; characterization of the identified genes.
- Development of advanced sequencing procedures and technology (see 1.2) and integration of these procedures and technology in the sequencing projects.

3. Cellular Biology

3.1. Physiology and molecular genetics of industrial microorganisms

Gene stability and expression, post-translational processes, genetic and metabolic regulation of overproduction, transport and secretion. These studies, adapted in each case to the current state of the art, will concentrate on some industrially interesting microorganisms, such as the genera lactic acid bacteria, *Streptomyces Pseudonomas, Bacillus, Clostridium, Corynebacterium,* and including the larger groups of lactic acid bacteria, extremophiles, yeasts and filamentous fungi.

3.2. Basic biology of plants and associated organisms

- Core processes for sexual breeding: mechanisms of flower initiation and evocation, differentiation of sex cells; molecular bases of gamete recognition and selection systems.
- Fundamentals of plant cell regeneration: genetics and molecular biology of somatic and zygotic embryogenesis; perception and transduction of growth-promoting signals.
- Molecular interfaces of plants and associated organisms: molecular bases of host-range and virulence; characterization of plant defence reactions; development of genetic techniques for phathogenic fungi or mycorrhizae; regulation from plant/microbial signals of the expression of microbial/plant genes; structural and functional identification of genes involved in N_2-fixing symbioses.
- Physiological attributes of crops: storage processes; stress physiology; nitrogen use efficiency.

3.3. Biotechnology of animal cells

- Animal cell engineering and culture technology leading to new or improved productions of important substances for industrial and zootechnical purposes.
- Animal genetics: mapping and sequencing of important genes; methods of gene transfer; and study of gene expression and regulation on cell cultures.
- Animal husbandry: improved immunity through genetically engineered vaccines of second generation.

4. Prenormative Research

Prenormative research in biotechnology places itself at both ends of the research-development-exploitation chain.

4.1. Safety assessments associated with the release of genetically engineered organisms

- Monitoring and control techniques: sampling and probes for engineered organisms and introduced segments of DNA; methods and instrumentation for high-resolution automated microbial identification and the establishment of adequate data bases; creation of a bank of specific probes and chemical signatures for a large number of specific microorganisms; eradication methods.
- Assessment techniques: biological containment; gene stability and gene transfer; development of microcosms and simulating methods for impact analysis.
- Acquisition of fundamental knowledge on gene behaviour (horizontal transfer between species, rearrangement of introduced genes in the host organism) and on the survival and adaptation of released organisms, in particular soil bacteria, and including modification of host range and tissue range for engineered viruses.
- Novel constructions: biologically contained organisms; suicide vectors or constructions which cannot develop outside the host organism; engineered organisms which can be destroyed in the environment by known and specific techniques.

4.2. *In vitro* evaluation of the toxicity and pharmacological activity of molecules

- Development of cellular and multicellular systems as surrogates for *in vivo* tissues and organs.
- Research addressing the problems of preparation, storage maintenance and growth of human cell cultures.
- Development of cell lines in which functional properties are better preserved.

<u>Implementation</u>

This part of the programme shall be implemented by means of training activities, research activities, research activities carried out on the basis of shared-cost research contracts, and participation in certain COST (Category A) activities.

Training actions shall be implemented through training contracts and courses for any of the themes defined above. The cost of these actions shall be borne by the Community.

Participants in a project conducted as a shared-cost action may be industrial enterprises, including small and medium-sized enterprises, research institutions, universities, or combinations of them, established in the Community or in those European third countries which have concluded framework agreements in scientific and technical cooperation with the Community. Pending the implementation of the provisions of a possible Council Directive on deliberate release into the environment of genetically modified organisms, proposals selected will have to conform, in the country where the release experiment is to take place, to relevant safety regulations or guidelines; in those countries where no such regulations or guidelines have been developed, the project proposers planning to initiate release experiments will obtain the written consent from the competent authorities concerned.

Shared-cost research projects involving research centers (and/or universities) and industry are strongly encouraged. Industrial participation should constitute an important criterion of selection in the programme.

For shared-cost contracts, the Community participation will be up to 50 percent of the total expenditure. Alternatively, in respect of universities and research institutes carrying out projects under this programme, the Community may bear up to 100 percent of the additional expenditure involved.

Two types of transnational research projects, which will normally be carried out by participants from more than one Member State (irrespective of participants from third countries), are foreseen:

- N projects, for the integration in adapted Community structures (European Laboratories Without Walls: ELWW) of research efforts in areas where the main bottlenecks result from gaps in basic knowledge. The contribution of the Community in such projects shall not exceed ECU 400,000 per year per project.
- T projects, for the removal, through a significant investment of skills and resources, of important bottlenecks resulting from structural and scale constraints; the contribution of the Community in such projects may vary from ECU 1 to 3 million per year per project.

Shared-cost research contracts shall be awarded following a selection procedure based on calls for proposals published in the *Official Journal of the European Communities.*

Special attention will be paid to the dissemination of the programme results in accordance with Community rules and taking into account contractual arrangements in order to maximize the effects of this work and to allow all enterprises, particularly small and medium-sized enterprises, in all regions of the Community, including the less-favoured ones, to benefit.

COST Activities (Category A) Associated With Action I

Content

- Marine primary biomass;
- *In vitro* cultures for the purification and propagation of plants;
- Methods for early detection and identification of plant diseases;
- Vesicular-arbuscular (VA) mycorrhizae;
- Development of vaccines against coccidiosis.

Implementation

Implementation shall take place through the organization of meetings, consultation of experts, publications, exchange of research workers between laboratories, coordination contracts.

Action II: Concertation

Content

In conjunction with the relevant Commission services and the Member States, the following tasks will be executed:

- Monitoring developments in biotechnology, particularly in the field of R&D, assessing their implications, and hence informing services of the Commission and interested public authorities having related responsibilities;
- Identifying possible ways in which the contextual conditions for the beneficial development of biotechnology in Europe may be improved, and the effectiveness and coherence of Member State and Community biotechnology programmes and related policies enhanced, including those involving international collaboration;
- Disseminating knowledge and helping to increase public awareness and understanding of the nature, potential, and possible risks associated with biotechnology;
- Identifying the need for and helping to promote greater activity in the biotechnology small-firm sector in the Community.

Implementation

The action will continue to develop the work (begun under the Biotechnology Action Program, BAP) of *ad hoc* collaboration between groups and individuals with interests and capabilities in the life sciences and biotechnology, so creating networks, as informal and flexible as possible, adapted to the needs of encouraging coordination through the exchange of information between the participants, and assisting the broader diffusion of information required by the above tasks.

Specifically, the work will involve inhouse analysis, the setting-up and the exploitation of an organized information base, and missions. It will also include as necessary the commissioning of study reports, the organization of workshops and meetings, and support for the production of reports and dissemination of information.

An appropriate part of the resource of Action II, Concertation, will be devoted to actions concerning the wider implications of research and development in the areas of biotechnology—e.g. for consumers, society, environment, and development—featuring in Action I.

Annex II

Indicative Allocation of Funds

	millions of ECU	
Action I: Research and Training		
Contract Research		76.5
(To be divided equally between N projects (ECU 38.25 million) and T projects (ECU 38.25 million))		
—pre-normative research	15.5	
—cell biology	27.0	
—enabling technologies	27.0	
—information infrastructure	7.0	
Training activities		12.0
COST activities		2.0
Action II: Concertation		9.5
Total		100.0

Annex III

Programme Objectives and Evaluation Criteria

The Commission's communication to the Council concerning a Community plan of action relating to the evaluation of Community research and development activities for the years 1987 to 1991 (COM (86) 660 final) states that the objectives and milestones of each research programme have to be set out in a testable form. The objectives and milestones of the programme are set out below.

Action I: Research and Training

1. The long-term objective is to contribute to the exploitation and the optimum use of biological resources in the Community, thus improving the research capabilities and infrastructure necessary for the competitiveness of the European agriculture and biotechnology industry, and for the protection of the environment. This aim is to be pursued through the removal of scientific and technical bottlenecks resulting either from gaps in knowledge or from scale and structural constraints. Research projects will be executed in the interactive way, making full use of integration between disciplines, bringing needs and opportunities in different Member States together, combining different expertises from basic and applied fields.

2. The primary short-term objectives are, therefore, to elicit proposals for research and for training activities on a scale commensurate with the Community resources proposed and, thereafter, to implement these activities ('N' projects, 'T' projects, training, and cooperation with third countries) in such a way that multidisciplinary transnational cooperation and scientific mobility are vigorously promoted. These objectives are to be testable in 1992 to 1993.

3. Particular objectives, testable in 1995, to be attained through 'N' projects including the following:

3.1. Constitution of networks for transnational cooperation in each of the four areas (information infrastructure; enabling technologies; cellular biology; prenormative research) of the programme;

3.2. Transnational cooperation as demonstrated through the analysis of scientific publications (each specific network or ELWW to produce at least one paper, either with transnational authorship or with acknowledgement of materials/methods supplied by other contract partners);

3.3. High quality of scientific achievements, as demonstrated through consultations of scientific experts and through analysis of citation records of scientific articles summarizing the results of the research;

3.4. Expression of industrial interest as underlined, at least in 20 percent of the projects, by industrial involvement during the implementation phase or, outside the BRIDGE legal framework, at the time of exploiting the results of the research.

4. Particular objectives, to be attained through the constitution and implementation of 'T' projects, include the following:

4.1. Setting out a description, in terms of research efforts and expected benefits, of specific targets, such as the sequencing of the yeast genome, high-resolution automated microbical identification or molecular identification of new plant genes;

4.2. Accomplishment, two years after initiation of a 'T' organization project, of progress towards the specified targets (namely through having made the right provisions and commitments securing that scientific goals are attainable by the time the programme is completed);

4.3. Significant contributions indicating that the specified targets have been reached and that the specific interest of industry, agriculture or environmental control has been met.

5. For the training programme, the aim is to provide fellowships in research laboratories of a high scientific level for approximately two years for junior scientists,

and one to two years for senior scientists. Particular objectives are the following:

5.1. Accomplishment of a marketing effort in all Community Member States;

5.2. Return of most fellows, after their training period, to any other Community Member States, if not their own country of origin, to work in biotechnology;

5.3. Organization of training courses, summer schools and workshops, with support from the programme, and including participants from industry whenever possible. Where appropriate, representatives of other disciplines may also be invited to participate in these activities.

The above criteria can be partially tested in 1993, but a further examination should be made in 1998.

Action II: Concertation

The evaluation of the concertation action will consider whether the programme has in fact implemented the tasks specified in the Decision, and whether their implementation has effectively contributed to the stated objectives. More specific evaluation criteria are as follows:

1. Concertation with Member States: The concertation action should have assisted those responsible for biotechnology in Member States' administrations:

1.1. To be aware of current and planned Commission initiatives in areas relevant to biotechnology;

1.2. To be aware of biotechnology activities and plans in other Member States;

1.3. Consequently, to have taken into account, in their national plans or initiatives for biotechnology, activities at Community level or in other Member States.

2. Impact on the conditions for biotechnology in Europe: The concertation action should be examined to establish whether and to what extent it has contributed to improving the contextual conditions in Europe for the safe development and beneficial application of biotechnology; with particular reference to international competitiveness; to the formation and growth of small companies and to the climate of public opinion about biotechnology.

3. Impact on the development of international collaboration in biotechnology, particularly in the field of R&D, and including developing countries.

4. Taking account of the results of Community, national or private sector research activities in biotechnology, it shall be considered whether the BRIDGE progamme has:

4.1. Contributed to the application of the results of the said research activities in the regions of the Community other than those in which research was conducted;

4.2. Given adequate consideration to all the selection criteria set out in Annex III to Decision 87/516/Euratom, EEC which includes that of contributing to the strengthening of the economic and social cohesion of the Community, while being consistent with the pursuit of scientific and technical excellence.

COMPUTERS

Survey of Finnish AI Research

90AN0140 Amsterdam AI COMMUNICATIONS in English Sep-Dec 89 pp 152-158

[Article by Seppo Linnainmaa of the Technical Research Center of Finland (VTT), Helsinki: "Artificial Intelligence in Finland at the End of the 1980's"]

[Text]

Introduction

The interest towards AI increased rapidly in the early 1980's in Finland as well as elsewhere. A similar national programme as the ESPRIT research programme of the European Community was launched in Finland in 1984. The size of FINPRIT (Finnish Programme for R&D in Information Technology) was diminutive when compared with ESPRIT, but in Finnish scale the several hundreds of man-years of research devoted to information technology were very significant. The largest of the five subprogrammes of FINPRIT was focused on Artificial Intelligence. At the same time, also several other AI-related activities were initiated. Their common goal was to raise the Finnish competence in applications of AI, being almost nonexistent ten years ago, to international level. This article is focused especially on the results of the AI subprogramme of FINPRIT that was completed in spring 1989, but also a more general overview to the current status of AI in Finland is presented.

AI Subprogrammme of FINPRIT

The Goal and Organization of the Subprogramme

The FINPRIT programme, completed in spring 1989, was mainly funded by TEKES, the Technology Development Center, operating under the auspices of the Finnish Ministry of Trade and Industry. The goal of its AI subprogramme was to transfer the international knowhow in AI, especially in knowledge engineering, to Finland. As an evidence of a successful transfer, several operative prototypes of knowledge-based systems, in which the Finnish industry takes an interest, were to exist at the end of the subprogramme.

The subprogramme was started in 1985 by a one-year initial phase, with goals to learn to use existing software tools and to build simple prototypes of expert systems.

The main phase of the AI subprogramme lasted three years and was finished in spring 1989. The responsible director of this subprogramme was Niilo Saranummi and the subprogramme manager was Seppo Linnainmaa, both respresenting VTT, the Technical Research Center of Finland.

The main phase consisted of seven projects, each described briefly below. Its total budget was about ECU 5 million, that was used mainly to finance the 80 man-years of research and to equip the research groups with up-to-date computing facilities. TEKES provided 56 percent of the total financing. Each project was supported by at least two companies. Strong support for the subprogramme was provided especially by Nokia, Kone, IVO and DEC. Most of the research work was done at several laboratories of VTT, that has 2,700 employees altogether, and at Helsinki University of Technology (HUT).

Intelligent Interfaces

The goal of this project of the Laboratory for Information Processing of VTT was to develop methods and software for creating intelligent interfaces that enable easier and more effective use of existing complex software and data resources. General guidelines and some tools were created for developing this type of knowledge-based software.

The most elaborated of the prototypes produced by this project, developed together with the Information Service of VTT, was an intelligent intermediary system for information retrieval. Another prototype allows the designer of a chip to concentrate on the actual design task without bothering the implementation details of the underlying mathematical software, and a third prototype gives advice on how to optimally select transportation via public road, railway and air traffic networks to travel from one city to another in Finland with given time constraints.

Embedded Expert Systems

This project of HUT aimed at creating software that supports building of real-time embedded expert systems. A programming environment was developed for this purpose.

Two prototypes were created for fault diagnosis and maintenance of digital telephone exchanges. Also an elevator group simulator was built to support the development of a knowledge-based system that controls the movements of an elevator group to optimize the traffic flow.

Also a prototype expert system called Filex was created that supports in selecting files that should not occupy disk space.

Expert Systems for Fault Diagnosis

The Finnish part of a Nordic cooperative project KUSIN-ROTA (Fault Diagnosis for Large Rotating Machinery) was simultaneously one of the projects of FINPRIT. The research in Finland was done mainly at the Machine Automation Laboratory and the Laboratory for Information Processing of VTT.

ROTA created a general model-based framework for developing expert systems that diagnose faults in any type of large rotating machinery. For each single application, application-dependent knowledge about the components and their relations are inserted in the knowledge-based system, together with fault and repair descriptions, the available sensors, etc. A prototype expert system for diagnosing the faults of an ethylene gas compressor was developed, running currently in a simulated environment.

Expert Systems for Production Management

The general goal of this project of HUT was to investigate the possibilities of knowledge engineering in production management where stiff results produced by conventional algorithmic software must in most cases be modified on the basis of experience to fit dynamic changes.

An operative system was created to monitor the workload in coil production and to provide support in balancing the peaks, using rule-based reasoning. Also a prototype was built that aims at formalizing controllability of engineering expertise.

A general model for distributed scheduling was created in this project in cooperation with Carnegie Mellon University. It is based on a hierarchically decentralized set of subsystems that communicate with each other. A sample Implementation prototype was developed for scheduling of a medium-sized production line for multilayer printed boards for professional electronics.

Expert Systems for Medicine

Three knowledge-based prototypes for medical purposes were created in this project of the Medical Engineering Laboratory of VTT, that was simultaneously the Finnish subproject of the Nordic cooperative project KUSIN-MED.

One of the systems diagnoses operational disorders in thyroid function and is based on clinical measurements of hormones received from the connected analyzer. Also many kinds of background information is included in the reasoning. The system has been used in analyzing 1,000 real patients, and it is found to function properly.

Another prototype supports the doctor in determining what antibiotic substances to prescribe in cases of common but serious bacterial infections. The system is connected to existing information systems and is also able to provide general knowledge about microbes, available drugs, etc.

The third prototype concerns treatment of disorders in fluid and electrolytic balances in an intensive care environment.

Expert Systems for Product Specification

The goal of this project of the Computer Technology Laboratory of VTT was to study and develop tools that support structured specification and design and reuse of existing designs, using knowledge engineering approach. The project focused especially on embedded products where hardware and software must be designed simultaneously.

A prototype supporting design and reuse was built, consisting of a set of tools that can be used to create and modify RT-SA/SD models. While the design is produced, the system creates an internal description of it. A rule base contains knowledge about the design process and the product to be designed. The user interface supports both diagram development and different kinds of analyses, both controlled by the rule base.

The prototype was used for demonstrating the reuse possibilities by a concise example connected to the design of control software for elevators.

Applying AI to Power Plant Control

IVO (Imatran Voima, the main Finnish electric power supplier), supported by the Laboratory of Electrical and Automation Engineering of VTT, studied the usefulness of AI techniques in the real-time monitoring of process behavior by the control room operators of power plants. The problem in current information systems is that, in case of a disturbance or even during a normal shut-down run, many needless alarms are presented as consequences of certain natural events.

A prototype was built that concentrates on the main flow system of a nuclear power plant's secondary circuit. It was connected to a training simulator where different kinds of test transients were selected to cover the area of modelling, involving, e.g., leakages in various locations.

Associative Projects

Almost twenty AI-related projects that were not included in the actual FINPRIT programme were organized as *associative projects* of the programme. The aim of this was to provide means for mutual communication, for spreading information of gained experiences and for paving the way for possible cooperative efforts. The associative projects included most of the major AI-related activities in Finland.

The actual activities included several seminars where the projects presented their achievements to each other. Some AI-related topics of mutual interest were treated in forms of talks and discussions.

Evaluation of the Subprogramme

The AI subprogramme of FINPRIT did not produce great breakthroughs or commercial successes. But that was not even expected, and as a whole the subprogramme can be considered very successful, especially when reflecting its results to the nonexistence of AI expertise at the beginning of the subprogramme. Tens of interesting prototypes were created, about two hundred articles and reports were published, almost half of them internationally, and a dozen researchers gained new academic degrees. Through the research that was done in the subprogramme, tens of Finnish researchers are capable to accept even the most challenging tasks in creating modern knowledge-based systems and to participate effectively in international cooperation in this field.

Many of the prototypes have been used as the basis for further developments and the ideas created during the projects have led to a large set of new projects, with both research-oriented and commercial goals. The subprogramme also increased faith in the applicability of AI and its sole existence provided mental support to numerous other AI-related activities in Finland.

Other Educational and Research Activities

Educational Activities

Currently most Finnish universities have at least a few AI-related courses in their curricula, and even many lower-level educational institutes offer such courses to their students. Half a dozen of Finns have written Ph.D theses on AI-related topics.

AI-related education is most systematic at the Information Processing Laboratory of Helsinki University of Technology, where Prof Markku Syrjaenen is the first Finn to hold a professorship officially devoted to knowledge engineering, since 1988.

At the University of Helsinki, since 1988 students have been able to enroll themselves to be specialized in Cognitive Science. But there are not yet any permanent faculty positions for this subject, currently supervised by Prof Fred Karlsson from the Department of General Linguistics.

VTT's Research Programme on AI Applications

Simultaneously with FINPRIT, VTT ran its own research programme, *Applications of Artificial Intelligence*, that was finished at the end of 1988. The main goal of this internal research programme was to create expertise among the researchers of VTT in applied AI, especially in knowledge engineering. Prof Niilo Saranummi was also the responsible director of this programme, coordinated by Lic Tech Rauno Heinonen. The size of this research programme was roughly half of the size of the AI subprogramme of FINPRIT. The two programmes were started at the same time, and their projects overlapped during the first year.

Also in VTT's own research programme several prototypes of expert systems were developed, including, e.g., systems for safety analysis of industrial processes, for the construction industry and for cancer treatment. Information about available methods and tools was collected and analyzed systematically during the whole programme, and the expert system projects of the programme itself served also as test benches in measuring the applicability of different approaches.

Research in Natural Language Processing

Two distinct research groups are focusing their efforts in solving the problems concerning natural language processing. The Research Unit for Computer Linguistics, headed by Prof Fred Karlsson and funded by the University of Helsinki and the Academy of Finland, is aiming to develop independent analyzing methods for natural languages. The work is strongly based on the two-level morphological model created by Dr Kimmo Koskenniemi. The group has developed, e.g., a general parsing formalism based on finite automata, that makes it possible to process languages with very different structures. About 30 universities abroad use programs developed at the research unit.

The other research group called Kielikone (Language Machine) is headed by Dr Harri Jaeppinen and funded mainly by the SITRA Foundation. Its original goals were in office automation and intelligent user interfaces. Main achievements concern proof-reading of Finnish text, but prototypes have been built also for, e.g., performing database queries using natural language. Recently, cooperative efforts have been started for machine translation and for transforming spoken Finnish into text.

Both research groups have created commercially successful proofreading products, and both of them have established spin-off companies to distribute the results of their efforts.

Other Research Activities at Universities and Research Institutes

Quite many research activities in addition to those mentioned above have been started during the 1980's. At VTT, almost ten laboratories have their own research groups in knowledge engineering. Prototypes of expert systems have been created, e.g., for interpreting different kinds of regulations on building area, for controlling energy distribution, etc.

At HUT (Helsinki University of Technology), the research group of Prof Teuvo Kohonen has been very successful since the 1970's in areas closely related to AI, like pattern recognition, self-adapting systems, and neural networks, where Kohonen is one of the most distinguished pioneers in the world. A speech recognition system created by the group has been sold to Japan for commercialization. Also another research group headed by Prof Matti Karjalainen, at the Acoustics Laboratory of HUT, is focusing its efforts on speech recognition.

In addition to the activities described above, most Finnish universities and research institutes have research groups specializing in some subtopics of AI. For example, a research group at the Department of Computer Science of the University of Helsinki, headed by Prof Esko Ukkonen, has designed and implemented a Prolog development environment; another group at the Computer Technology Laboratory of the University of Oulu, headed by Prof Matti Pietikaeinen, has created an intelligent system for visual inspection of, e.g., printed boards for electronics and blades of turbines. A third group at the Finnish Forest Research Institute, headed by Dr Hannu Saarenmaa, has created a knowledge-based system that simulates moose behavior in a forest area.

New Research Programmes

The Academy of Finland, the main financier of basic research in Finland, has supported several AI-related projects during this decade. Its new research programme on Cognitive Science is being initiated at the change of the decade. The proposals for projects to be included in it were to be submitted in the middle of autumn 1989.

Also another AI-related research programme is being launched. The projects that will be accepted to the research programme focused on the knowledge-based systems for production and delivery of energy will be started in spring 1990.

International Cooperation in AI Research

Several of the Finnish AI projects have had more or less permanent international connections, especially to Scandinavian countries, but also, e.g., to the United States. For example, two of the FINPRIT projects were also included in the Nordic KUSIN programme. Every year several Finnish AI researchers are contributing personally to international cooperation by working for longer periods, from a few months to a few years, in European, American or Japanese universities, research centers or companies.

As a European Free Trade Association (EFTA) country, Finland has recently received permission to participate in research programmes of the European Community, provided that this participation is financed by Finland itself rather than by the Commission of the EC. TEKES has adopted the respective role in Finland, and some Finnish AI research groups have already been accepted to participate in AI-related projects of, e.g., ESPRIT (European Research Programme for R&D in Information Technology) and AIM (Advanced Informatics in Medicine).

Commercial AI in Finland

Most large Finnish industrial and financial companies either have internal activities in knowledge engineering or they are cooperating with firms that are specializing in AI applications. Several such small firms have been established during the 1980's in Finland.

The currently largest single research group for knowledge engineering in Finland is headed by Dr Pertti Lounamaa at Nokia Research Center. The group consists of about 40 people. It has created several knowledge-based tools and products, both for internal use and for commercial purposes, partly by orders of other companies. For example, it has created a commercial tool called RFT for designing analog circuits, and an expert system for analyzing the prerequisites of Finnish farms for receiving financial support.

A large knowledge-based system called Scala is targeted for Computer-Aided Design, especially for designing complicated systems consisting of containers and pipes filling a 3-D space. It was created by a group of Nokia Data employees who later established a company around their product, and has been successfully used in designing large industrial installations.

Intellitech, a small Finnish company, has developed a Common Lisp compiler and development environment for computers using the 386 processor. The performance of *Entity Lisp* is comparable to the best available systems worldwide.

Also Finnish research units are creating commercial products. For example, the Graphics Arts Laboratory has created an expert system for supporting the layout of the yellow pages of phone books, and the Laboratory for Information Processing has developed, in cooperation with Waertsilae Diesel, an expert system for fault diagnosis of ship engines using hypermedia approach. This system will be taken into routine use in 1990.

Currently most Finnish banks have knowledge-based systems, e.g., for checking prerequisites in loan granting and for advising their customers in investments. The variety of routinely used expert systems in Finnish industry, in addition to the systems mentioned above, ranges from controlling the quality of cardboard machines to controlling the biological purification process of industrial waste waters. Most of these systems have been developed using PC shells. The existence of an increasing number of knowledge-based systems is kept as confidential information.

All the systems described in this article are of pure Finnish origin, even if most of the commercial tools being used in developing them have been bought abroad. In addition, several multinational companies, especially in the computing industry, use also in Finland their AI products developed elsewhere.

Statistics on Finnish AI

In spring 1989, the general situation concerning AI in Finland was clarified by means of a questionnaire. It was sent to 250 Finnish organizations that were considered to be potentially interested in knowledge engineering. Roughly every second of these organizations replied. The figures below are based on their answers.

Since the mid 1980's, around 20 new organizations annually have adopted AI techniques. In 1989 the situation is getting steady with more than 100 Finnish organizations having AI-related activities.

The total annual amount of man-years of AI-related work in Finland is currently more than 300. One-third of this amount is targeted to research activities, another third to development and programming, the rest being divided between knowledge acquisition, selling, education, etc. About 220 persons have full-day positions in AI-related jobs, while 210 other persons have part-time duties around AI. The educational level of these practitioners is very high. More than 40 of them have received doctor's and another 40 licentiate's degrees (the latter being an intermediate degree between master's and doctor's degrees in Finland). More than 170 of the rest have other academic degrees. In research-related tasks, the amount of people having academic degrees was 75 percent.

The largest organization, when measured in total annual work on AI, was VTT with 64 man-years; the second was Nokia with its subsidiaries in Finland as a whole with 27 man-years. The University of Helsinki reached 24 man-years and Helsinki University of Technology 21 man-years. Another ten universities and six research institutions totalled 77 man-years. Among commercial companies, small units with less than 20 employees were very active in AI. There were 17 such companies, with altogether 32 man-years of their work specialized in AI. Among large organizations only a few were truly active. These included especially VTT and Nokia.

In spring 1989, about 80 knowledge-based systems developed in Finland were in production use. Several examples of these systems were given above. Most of them are small systems built using rule-based shells on PCs, among which the most popular ones were XiPlus and Guru. Also programming languages, especially Lisp, Prolog, and C, are used in many of the systems. Two of these systems are built on KEE, that is used more extensively in prototyping. Several tens of new knowledge-based systems were expected to be taken into production use in 1989, and work was started to produce still several tens of other systems for such use.

Finnish AI Society

The Finnish Artificial Intelligence Society (FAIS) was founded in 1986. The current more than 400 members of the society represent versatilely AI-related disciplines such as computer science, philosophy, linguistics, phonetics, and psychology. Universities and research institutions as well as industry and business are strongly represented among the members. The society has also about a dozen of Finnish companies as its business members. Since its foundation, the president of FAIS has been Prof Seppo Linnainmaa.

FAIS is a member of ECCAI (European Coordinating Committee for Artificial Intelligence). In addition to distributing the AI Communications magazine of ECCAI to its members, FAIS publishes its own quarterly membership magazine called "Arpakannus." Its editor-in-chief, Jouko Seppanen, has also taken care of the public relations of FAIS. The society has also its own publications series.

National AI symposiums called STeP (Suomen Tekoaely Paeivaet, Finnish AI Days) have been organized every second year since 1984. The concept of AI is interpreted very liberally in these popular events, where people representing a very wide range of disciplines inform each other of their innovative work. For instance STeP-88, the last of these symposia so far, attracted more than 350 Finns, and had such famous names as Daniel Bobrow and Teuvo Kohonen as invited speakers.

FAIS participated also in organizing the First Scandinavian AI Conference SCAI'88 in Troms, Norway. It hosted, together with Tampere University of Technology, the Second Scandinavian AI Conference SCAI'89 in Tampere, with Donald Michie as its main invited speaker.

The conferences as well as numerous seminars hosted by FAIS are typically organized in cooperation with other organizations, ranging from societies to commercial companies. This kind of cooperation has proven to be very fruitful. Some of the seminars coorganized by FAIS have been completely on a national basis, but also many well-known persons, e.g., Edward Feigenbaum and Ted Nelson, the father of hypertext, have had their own seminars.

FAIS has also initiated ten Special Interest Groups that cover most of the central topics inside AI. These groups organize meetings and internal seminars to strengthen the Finnish know-how in their own special areas.

Conclusions

A dramatic increase in interest and achievements concerning AI has occurred in Finland in the 1980's. The focus has been strongly on AI applications, especially on using knowledge engineering in developing advanced systems that would have been too difficult to create using conventional approaches. In applied AI, Finland has reached its goal to raise its know-how to an international level in a rather short period of time. The advances in education and basic research have not been as strong, but there are clear indications that also this side of AI is gradually improving in Finland.

Philips Chromatography Expert Systems Described

90AN0085 Rijswijk PT/AKTUEEL in Dutch 18 Oct 89 p 7

[Article by Gerard van Nifterik: "Philips Expert System Marks End of Lab Guru Era"]

[Excerpts] Philips has marketed three expert systems for use in liquid chromatography. All three should make an important contribution to the rapid optimization of separation techniques for complex samples in high-performance liquid chromatography (HPLC).

The philosophy behind the three Philips software packages is fairly simple. Liquid chromatography is limited in extent, but has important applications and relatively inaccessible knowledge.

Developing an expert system is a costly affair requiring a great deal of expertise. According to Philips, it would have been virtually impossible to develop the package commercially without Europe's financial support, which was provided through ESPRIT's Expert Systems for Chemical Analysis (ESCA) program.

ESCA was launched in March 1987. The partners involved—Philips Cambridge (in collaboration with the Philips Research Laboratories in Hamburg and Eindhoven), Organon from Oss, the Free University of Brussels, and the Catholic University of Nijmegen—were allocated an ECU 3.6 million budget (about 9 million Dutch guilders) to show it was actually possible to use expert systems in practice. After several years of investment in the development of expert systems, the EC finally wanted to see some practical results.

The first applications of a chemical expert system are mainly intended for structural clarification. Dendral, a system deriving the structure of chemical compounds from mass spectrometric data, is one of the best known examples of an expert system.

Chromatography is a typical example of an analytical method in which expert systems can be of great value, due to the technique's numerous potential applications and the lack of reliable expertise. Says Dr. L. Buydens from the University of Nijmegen: "There is a disparity between knowledge and applications, especially with regard to the optimization and validation of methods and knowledge areas covered by the new expert systems."

Philips has developed and marketed three expert systems: a system that supports chemical optimization, a package that can be useful in existing methods requiring further optimization (physical optimization), and a system that gives an insight into the method's reliability (validation and reporting). The latter two systems result directly from the collaboration with ESCA.

Chemical System

Apart from ESCA, but in conjunction with Philips Scientific (Cambridge) and the Philips Research Laboratories in Hamburg and Eindhoven, the Philips Analytical Techniques department has developed an expert system intended for the chemical optimization of liquid chromatography. According to the manufacturer, this package—which will probably be commercialized under the name Solvent Optimization—is by far the most advanced system available in this field.

In chromatographic analysis, a sample's components are separated by spreading them very selectively over two phases, a flowing (mobile) phase and a stagnant (stationary) phase.

Without carrying out any experiments, it is impossible to determine the most appropriate mobile phase. The new system ensures that the number of experiments required can be reduced to a bare minimum. The system can help set up experiments, interpret data, and forecast the optimal result.

Physical System

Once both chromatographic phases have been defined, it is still possible to optimize the method's physical aspects. To this end, Philips has developed the System Optimization package. It deals with the dimensions of the chromatographic column, particle size in the stationary phase, flow rate, etc. Theoretical models can be used to optimize these parameters, thus eliminating the need for further experiments. One of the systems helps the user improve an already developed but not optimized method. This results in shorter analysis time and higher sensitivity. Moreover, this system can also be useful in optimizing the instrument's configuration in accordance with the chromatographic analysis. According to Philips, the equipment is often used inefficiently or even completely incorrectly. The expert system advises the user on the most suitable components and measuring conditions.

Validation

Another expert system was developed in association with the University of Nijmegen. This system—the Method Validation package—makes it possible to test the reliability of newly developed analytical methods. The computer helps the user set up the test procedure and evaluate the results. According to Philips, this is particularly convenient when introducing new methods. Not many chemists are fully aware of the requirements of the new liquid chromatographic methods. The same is true for the test methods and the statistics needed to interpret the results. Philips' system has been specifically developed for the validation of analytical methods. But the program is also a useful tool for reporting purposes. The manufacturer is primarily targeting the pharmaceutical industry, but Philips says the program could also be used in other types of laboratories.

DEFENSE INDUSTRIES

Dornier Installs Antenna, Radar Test Range

36980017 Friedrichshafen DORNIER POST in English Vol 3, 1989 pp 16-20

[Article by Joachim Flacke, Dr Joachim Boukamp and Dr Wulf Koschel: "Antenna and Radar Signature Technology at Dornier"]

[Text] The manifold Dornier activities in the fields of antenna and radome technology, and in imaging radar systems for space and defence applications, have received a new impulse with the installation of an antenna and radar test range in the company's new electronics facilities. Based on many years of experience in the development of radar antennas, radomes, and pulsed radar systems, Dornier has become increasingly active in the field of radar signature technology. This sector is of growing importance for the European and U.S. aerospace industries because present-day military specifications for aircraft and missiles nearly always include the demand for stealth characteristics, or low radar detectability.

The detection range of a radar system essentially depends on the object's radar cross-section (RCS) which can be significantly influenced by the shapes and materials selected during the development phase. These development programmes, therefore, require a radar test system in the simulated far field with high dynamics and a good resolution of the backscatter centres.

Of course, such a test range with its highly precise amplitudes, phases, and angle resolutions can also be used advantageously in antenna and radome technology. Applications include antenna integration of airborne radars, optimization of antenna and radome systems, development of new radomes, and integration of phase-controlled array antennas.

RCS Measurement Chamber

In late 1987, Dornier decided, after thorough studies in Europe and the U.S.A., to set up its own antenna and radar cross-section test range. The timing was good, as it was still possible to integrate the test range in the new electronics centre where it can be supported by the electronics and high-frequency experts. The primary goal of this investment was to maintain Dornier's international competitiveness in highly specialized fields of antenna and radar technology. The technical planning of the facility was based on the following criteria:

- "Compact-range" setup to generate simulated radar far field with excellent amplitude and phase homogeneity; use of two parabolic reflectors

High dynamics by a careful design of the anechoic measurement chamber and the radar instrumentation

High resolution in "radar imaging" as a consequence of the two above-mentioned requirements by means of a mature imaging software the ISAR (Inverse Synthetic Aperture Radar) process.

Instrumentation and software are already operational whereas the measurement chamber will be fully operational by the end of 1989. Preparatory studies are carried out in cooperation with Eindhoven University and Arizona State University. Intense contacts have been established with expert companies in the USA. When finished in late 1989, the Dornier facility will meet the standards identified in the U.S. aerospace industry.

The measurement chamber will be used to determine the radiation behaviour of antennas and the radar cross-section of backscattering objects. The field radiated by the feed system will be bundled by two reflectors so as to generate a plane wave with nearly homogeneous amplitude and phase distribution in the limited test zone (quiet zone). The reflectors will concentrate the echo signal back into the feed system. Test objects are placed on a turntable inserted in the floor of the measuring chamber and rotated within the quiet zone. Direction-dependent backscatter and/or radiation behavious can be studied under different aspect angles. Absorbers in the measurement chamber prevent multiple reflection and interference signals which could distort the teset results.

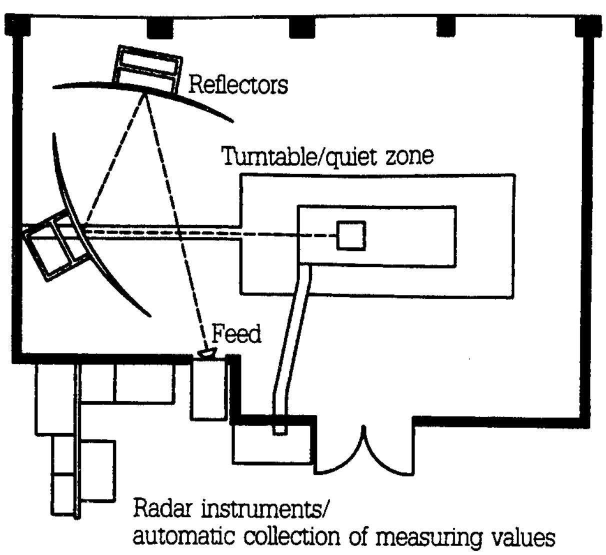
The instruments of the antenna and RCS test range are based on a network analyzer system for measuring amplitude and phase of high-frequency signals. These signals are either reflected by a test object (for example a drone, model aircraft or structural parts) when RCS is to be measured, or they are emitted by an antenna in case of antenna tests. The measuring results are processed by a computer which also controls the test sequence. Peripheral equipment for storing and displaying the measurement results is connected. The basic version of the instrumentation comprises the frequency range of 2 GHz to 18 GHz. Suitable additional instruments will permit measurements in the 93 to 95 GHz range. An extension to other frequency bands is planned.

The test range can be used for the following tasks (2 to 18 GHz, step-by-step extension to 94 GHz):

- Measuring radiation diagrams, for example reflector antennas, passive arrays (DOSAR), sub-panels of active arrays, and integrated motor vehicle antennas for mobile radio use via geostationary satellite

Radome measuring, for example missile radomes, ERWE Tornado radome, nose radomes for military aviation

Antenna radome system testing, such as ESM units and scanning airborne radars



Top View of Radar Test Hall

Radar cross-section determination, such as global RCS vs. aspect angle/frequency/range; RCS of small drones (1:1), structural components (1:1), and aircraft models (scale 1:10)

2D-Radar imaging with ISAR, that is identification of backscatter centres, control measures to reduce RCS, collection of target data for the simulation of target tracking algorithms and for studying the efficiency of electronic countermeasures (ECM).

The radar test range was designed to the example of existing systems in the U.S. industry and corresponds to the latest state of the art. A user board was set up, which includes expert and program departments of the aviation, space, defence electronics, and research sectors. In the meantime, a growing project and program scenario is developing which will use the radar system in close interaction with the corresponding Dornier business fields, that is:

- Aviation

—Radomes for aircraft, missiles (ERWE Tornado, nose radomes)

—Reduced radar signature designs (such as EFA structural parts, technological developments for the Federal Procurement Office and the Federal Defence Ministry; stealth technologies)

Space Systems

—Next-generation active array antennas for SAR earth remote sensing

Defence Technology

—Stealth designs for drones and missiles

—Integration of radar search-head systems and/or reconnaissance radar systems

Electronics

—Subsystems of radar and antenna technology such as sub-panels of active phased arrays

—Imaging radar systems (SAR, ISAR), radar signature technology

Applied Research

—Research contract work for new developments, such as radar-absorbing structures and radar-relevant materials.

RCS Measuring Technology/Radar Imaging

In the Dornier "Compact Range," the Inverse Synthetic Aperture Radar (ISAR) process is used for two-dimensional radar imaging. Other than in SAR, it is not the radar source that is moving but the test object, which is placed on an ultra-precise turntable. The radar image is synthesized with similar methods as in SAR by means of range and Doppler information in accordance with the angular rotation of the test object.

Measurement in the millimeter wavelength range with the conventional ISAR procedure make demands on the positioning precision of the turntable that are not easily met. Therefore, a special evaluation procedure will be used that has been designed by Dornier for high-resolution backscatter centre measurements of ships at sea. Images are generated without the use of phase data which makes sure that the requirements on the motion definition of the test object can be more easily met.

When the test object is turned around its vertical axis, the resolution is in the direction of its horizontal outline coordinates, called down-range and cross-range. Resolution quality depends on the measuring bandwidth and the evaluated aspect angle range which should both be as large as possible. The bandwidth is artificially generated by a computer-controlled synthesizer and by storing the corresponding amplitude and phase values for evaluation by the imaging software. Resolution is restricted by the frequency ranges of the synthesizer and the antenna system. Bandwidths of several GHz, corresponding to a resolution of several centimeters, are easily obtained. The distance of the individual measuring frequencies and, correspondingly, the number of measuring points is determined by the requirement for an unambiguous range.

These boundary conditions can be taken into account more easily by a menu controlled system. The parameters which can be selected by the user and the values derived therefrom both with regard to the resulting resolution and unambiguous range and to the settings of the measuring instruments are clearly displayed. Thus the effect of any change can immediately be seen. Program control guides the user through the calibration procedures and ensures that only admitted calibration data sets are used in the measurement process.

Besides measurement evaluation by the most generally used contour plot displays, there are the following possibilities:

- Perspective display of RCS amplitude across the downrange and cross-range (cascade, isometric or dimetric)

Display as a false-colour image

Combined contour plot and false-colour display

Contour plot and simultaneous presentation of the maximum RCS amplitude along down-range and cross-range.

Raw data can, of course, also be displayed in various forms:

- RCS amplitude versus aspect angle

RCS amplitude versus frequency

RCS amplitude versus range

RCS amplitude versus frequency and aspect angle as perspective presentation of contour plot

RCS amplitude over range and aspect angle.

Parts of the objects can be masked by "time gating" in accordance with the propagation time of the radar signal.

Precise reading and fast determination of the relative and absolute minimum and maximum values and the definition of relative values are facilitated by market functions. The horizontal outline of the test object can be superimposed on the contour plot for orientation. Simulation results can be shown in the same format, allowing direct comparison with the measured values.

Antenna Test Technology

The instruments of the new test range can also be used for measuring antenna directional patterns. Compared with open-air far-field measuring ranges, the compact antenna test range offers the following advantages:

It is independent of the weather, has shorter detour signals and shorter distances.

Interference reflections in wideband antenna structures can be localized due to the range resolution. Measuring and calibration processes are menu-controlled and can be carried out as comfortably as in RCS measurement.

Antenna structural reflections, diagrams, again, and adaptation can be measured simultaneously with the RCS process. To do this, the scattering cross-section of the antenna is measured with different terminal impedances and evaluated in a computer. It is not necessary to separate the emitter and the receiver as is normally required for coherent evaluation at high frequencies.

Antenna and RCS Calculation Methods

Complementary to the measuring technology, Dornier provides antenna and RCS calculation methods, which are an indispensable help in innovative antenna developments or in the difficult task of reducing the radar signature of complete configuration or structural parts. Numerical simulation helps in the reliable interpretation of the measured results.

In conclusion, it can be said that, with the sum of these capabilities, Dornier is a valuable partner for multiple tasks in antenna, radome, and radar signature technologies. All these capabilities are concentrated at Friedrichshafen, and it is planned to use them to a wider extent in new programmes and projects.

Technical Data of the Antenna and RCS Test Range

Reflector array and test zone (quiet zone)		
Type	Compact range with 2 cylindrical parabolic antennas	
	Subreflector:	3.2 m wide by 3.8 m high
	Main reflector:	4.8 wide by 3.8 m high
Frequency range	2-100 GHz	
Test zone	Diameter	1.6 m-2.4 m
	Depth	1.6 m-2.4 m
Amplitude ripple	less than 0.4 dB	(6-40 GHz)
Phase ripple	less than 4 degrees	(6-40 GHz)
Cross-polars	less than -33 dB	
Instrumentation		
Frequency range	2-18 GHz	93-95 GHz
(Extensions planned)		
CW test receiver	HP 8510 B	HP 8510 B
(Pulse instrumetation planned)		(extended by fundamental-wave mixers)
Test emitter	HP synthesizer	mm-wave synthesizer
Computer	HP 350 (with Unix operating system, hard disk, graphic terminal, plotter, printer)	
Emitted power	+23 dBm	0 dBm
Detectable cross section (RCS)		
(min)	-75 dBsm...	-27 dBsm
	-56 dBsm	
Dynamics	>90 dB	>75 dB
Measurement Chamber		
Dimensions	14by7by6 m (LxWxH)	
Reflection damping of absorber system	2 GHz:>35 dB	
	5GHz:>50 dB	
	10GHz:>50 dB	
	18 GHz:>55 dB	
Turntable		
Configuration	Elevation over azimuth turntable with mobile tower and polarization positioning	
Angular precision	plus or minus 0.03°	
Maximum load	100 kg (depending on the kind of assembly and on the position of the centre of gravity, heavier loads may be carried)	

The new antenna and RCS test range is also capable to improve Germany's international competitiveness in the framework of the new Deutsche Aerospace (DASA) Group. It is an excellent support to the existing activities at Dornier and in other companies of the group, thus reinforcing the innovative force of DASA.

Thomson Buys Half of Philips Military Projects

90AN0141 Brussels EUROPE in English 8-9 Jan 90 p 18

[Text] The French group Thomson-CSF and the Dutch group Philips have signed a definitive agreement concerning the sale of half of Philips' military activities to the French group, in compliance with the agreement in principle reached last summer. Thomson-CSF is notably acquiring 80 percent of the capital of Hollandse Signaalapparaten BV (HSA), which produces radar equipment, predictors, military telecommunication equipment, and command systems for use by marine, land, and air forces. It employs 5,300 persons. The nationalized French group is also acquiring 49 percent of the defence activities (military telecommunications) of MBL (Brussels), a Belgian subsidiary of Philips. The latter firm has 250 employees. Finally, Thomson-CSF is acquiring 99 percent of the defence activities of TRT (Paris), a French subsidiary of Philips. This firm's telecommunications activities are separate and will remain under Philips' control. According to the two firms, this transaction meets the merger needs of the defence industry, with a view to European integration.

Philips still owns three subsidiaries specialized in defence, the American firm Magiec, the British company MEC, and the German firm PST. The Dutch group is negotiating or seeking a buyer for these three companies, a spokesman for Philips specified.

LASERS, SENSORS, OPTICS

FRG, France Enter YAG Laser Market

German Firms

90AN0075 Paris LE MARCHE DE L'INNOVATION in French 13 Oct 89 p 6

[Article: "Disturbances in the YAG"]

[Text] The West German manufacturer Rofin-Sinar (a subsidiary of Siemens) has entered the industrial yttrium-aluminum-garnet (YAG) laser producers club, something that might disturb the current balance of power.

The two major companies in the sector today are Canada's Lumonics and Japan's Nippon Electric Company (NEC). They are in the lead with a 1,200-W system each.

Rofin-Sinar has a more modest power source: The RSY 500 P has 500 W in average power, 10 kW in peak power, with a pulse energy reaching 80 J. It will be presented at the Europalaser Symposium, to be held during the week of 20 October at Le Creusot. However, Jean-Marc Decaux, managing director of Rofin-Sinar France, has already announced a 1,000-W source. If it is successful, Rofin-Sinar will give Siemens (which already has the CO_2 sources of the industrial division of Spectra-Physics) a virtually impregnable position in the European market.

Other competitors are lining up. Adron Sources, a subsidiary of Lectra Systemes, founded in April 1988, is also working in CO_2 and water jets and has entered the YAG market with 100-, 200-, and 400-W sources. Herve Coutard, head of R&D, has stated that five YAG sources will be delivered in 1989, most of them in Italy.

Perhaps this bubbling activity will soon spread to BM Industrie, a medium-sized business of 35 employees which, until now, has concentrated on the scientific YAG laser market. It has nevertheless entered the industrial market with beam transmission components and today is focusing on the industrial YAG source market.

One of the proposals being studied concerns the founding of a new company, owned 50-50 by BM Industrie and a machine manufacturer that could build machines to use the sources. To this must be added the recent acquisition of a NEC 1,200-W YAG laser by Framatome, followed by a second delivered recently to Le Creusot's University Institute of Technology (IUT) (price Fr 3 million). Both are intended for R&D, evidence of the impetus currently pushing French industry toward the YAG laser. The first industrial contract won by Le Creusot's IUT, the result of a ministerial request for proposals, concerns welding by YAG laser of automobile sheet metal for Peugeot. Having failed to keep its options open in the area of CO_2, where the battle is virtually over, France might still be able to jump on the YAG bandwagon and keep a foothold in the industrial laser field.

French Firms

90AN0075 Paris LE MARCHE DE L'INNNOVATION in French 27 Oct 89 p 5

[Article: "The Battle of the YAG"]

[Text] First Rofin Sinar and Adron Sources; now it is Mecachrome's turn to enter the battle of the industrial YAG laser. The company has just hired the former director of Laser Application, Didier Pretot, who will be responsible for developing industrial machines. An R&D laboratory will soon be set up for this purpose in the "breeding ground" next to Le Creusot's University Institute of Technology (IUT). Lasers Industriels SA (LISA) has the same objectives: It was initially intended to develop CO_2 sources using the German technology Held. The company, which is controlled by Aerospatiale (through Unilaser), now plans to industrialize Quantel products, which, to date, have been limited to scientific applications. In addition, LISA will continue to benefit from the expertise of the other two members of the Unilaser group: Cilas and Laserdot (optronics division of the Laboratoires de Marcoussis). Another competitor is also about to appear, with the same ambitions: BM Industrie.

MICROELECTRONICS

Thomson-CSF Neural Network Activities Described

90AN0070 Le Chesnay BULLETIN DE LIAISON DE LA RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE in French No 124, 1989 pp 9-10

[Article by Dominique Potier of Thomson-CSF's Central Research Laboratory, and Bernard Angeniol of the Electronic Systems Division: "Neural Network Activities at Thomson-CSF"]

[Text]

Introduction

For almost 2 years, Thomson-CSF has been involved in an ambitious study in the field of neural networks. The work is justified by its potential major significance and the performances expected from neural methods for numerous types of data processing (signals, images, etc.) that are specific to equipment (radar, sonar, optoelectronic devices, etc.) developed by the group. As indicated in other articles in this bulletin, the significance of the neural method lies chiefly in the fact that it combines the following three characteristics:

- A relatively simple mathematical model (of the nonlinear parametric type) that can be considered in several cases as an extension of existing models (models used in data analysis, mathematical statistics, etc.);
- The possibility of learning by example, which allows the parameters of the neural model to be identified from examples of the objects (signals or images) to be processed;
- The model's computational structure, which is intrinsically massively parallel and allows the development of high-performance hardware.

Studies underway at Thomson-CSF aim at a better understanding of these various points and their implementation and experimentation on the basis of real signals. They are outlined briefly below relevant to the following three categories:

- Thomson-CSF application fields;
- The ESPRIT II Pygmalion project;
- Studies by the Central Research Laboratory (LCR).

Application Fields

The data given below do not cover all ongoing application studies. They are meant to illustrate typical Thomson-CSF application fields.

Acoustic Signals

In the field of underwater acoustics, over the last few years Thomson Sintra ASM [antisubmarine warfare] has developed several applications involving neural techniques. This work has been conducted as part of contracts with GERDSM or in self-financed studies, some of which emanate from Research, Studies, and Technologies Directorate [of the Defense Ministry] (DRET) studies. The neural networks used are: the Rosenblatt perceptron (P), the Adaptive Learning Network (ALN), and the multilayer perceptron (MLP) with Widrow-Hoff learning by back propagation.

The main activities carried out so far concern:

- Classification of acoustic signals (seven applications completed, including five on real signals);
- Qualitative description of low-frequency analysis and recording (LOFAR) pictures;
- Multipath telemetry;
- Various exploratory works in nonlinear prediction of time-division signals and in utilization of the simulated annealing technique.

Thomson Sintra ASM is also participating in the ESPRIT II Pygmalion project (on the classification of biological noise in antisubmarine warfare) and in a Research Ministry project on a numeric/symbolic conversion device involving two coupled neural networks.

Radar Signal Processing

An ongoing study at the Radar, Countermeasures, Missiles Division (RCM) aims to evaluate the cost/performance ratio of the neural method in the framework of:

- Reconnaissance of countermeasure radar emitters,
- Radar identification of airborne targets.

This research in the radar field will continue and, if results are positive, an in-depth study on countermeasure equipment will follow to define its operational limits and its possible insertion in equipment.

Studies undertaken by the Defense and Control Systems Division (SDC) concern the application of neural networks to three successive stages of radar echo analysis to distinguish different echoes: airplane/helicopter, single/multiple target, useful target/parasitic echo, etc.

Image Processing

Work undertaken by the Optronic Applications Division (DAO) concerns problems linked to automatic target acquisition and neural network technology. A preliminary study has been carried out on the classification of the contents of windows extracted from infrared pictures using the backscatter algorithm. Results are promising.

The General Avionics Division (AVG) is studying position updating of flight paths trajectories (long-distance mission) using a condensed cartographic database. Data provided by an active (radar) or passive (visible-light or infrared camera) sensor is linked to a cartographic database via a process that can extract correlative data.

ESPRIT II Pygmalion Project

On the basis of some university results, the Electronic Systems Division (DSE), in collaboration with various teams, began developing neural networks in early 1987 to meet its in-house data processing requirements. An overall approach was adopted that was to produce operational applications in the fields of image processing, detection, reconnaissance, and tracking of airborne targets.

The development program centers on three main points:

- Algorithm research (in particular, problems of learning, optimization, and self-organization);

- Development of software tools for handling neural networks;
- Search for appropriate architectures.

These objectives are part of the ESPRIT II Pygmalion project for which DSE is the prime contractor. The goal of this project is the development of a complete environment for the development of neural networks, including the hardware and software tools appropriate for the particular aspects of these networks.

An initial 2-year phase, which began on 1 January 1989, will result mainly in the development of an integrated software environment comprising a high-level specification language, compilers for sequential or parallel machines (transputers), a library of basic algorithms, and a set of interactive graphic tools for display and control during simulation. Hardware-related work during this phase will be limited to a study of wafer-scale integration (WSI) of networks. The entire approach will be evaluated by a number of applications, in particular for image processing and speech recognition.

Neural Network Research at LCR

Thomson-CSF's LCR has launched a research program covering the major aspects of the field of neural networks, from components and specific architectures design to the analysis of neural algorithms and their application to various problems of signal processing and interpreting (acoustic signals, images, radar signals, etc.).

The program is being conducted in the form of a horizontal project linking the following LCR-developed technologies: physics, optoelectronic devices, electronics, optical signal processing, and expert systems.

Research is being conducted in close cooperation with Thomson-CSF's operational divisions.

The projects and results are presented briefly below.

Algorithms and Applications

The performance of Hebb's law in learning and generalization were established analytically for the classification of Boolean functions that can be separated linearly. These results, which were confirmed by digital simulations, are important for interpreting the experiments and deriving more general models.

New classification techniques, based on neural methods, were studied and evaluated by experimental data (acoustic signals) in collaboration with Thomson Sintra ASM. The results obtained are distinctly superior to those obtained through conventional methods.

A computer-aided design (CAD) study was conducted on the classification of miniwindows extracted from an infrared picture. It was shown that a two-layer network with learning by backscattering permits complete learning with a high generalization rate.

Another planned field of application is shape recognition by correlation techniques on 10^6-pixel images at video speed (with a required computational power on the order of giga operations per second (Gops). One approach studied by the LCR is that of optical holographic devices, with the calculation of filters (i.e., optical interconnections) from examples as a first design phase. Various neural models are being studied to this end.

Components and Architectures

In the field of specialized components, the LCR is studying the development of a technology that allows the integration of a programmable network of 1,000 fully connected neurons on one chip. The technology consists of a thin ferro-electric film between two orthogonal sets of electrodes with analog neural operation (scalar product) by pyroelectric charge transfer. The anticipated performance rate is $50x10^9$ interconnections per second.

In the field of specialized neural network simulation machines, the LCR has built a programmable analog neural network (RNAP) in discrete components. This machine, called IRENE, allows the simulation of a fully connected 1,024 x 1,024 RNAP operating in a hybrid serial-parallel mode with a vector output of 1,024 bits in 0.5 ms. A set of resistors and a comparator make it possible to conduct the basic neural operation in a single cycle.

AEG, Siemens Collaborate in Power Semiconductors

90AN0073 Paris ELECTRONIQUE HEBDO in French 26 Oct 89 p 40

[Article signed J.P.-D.M.: "AEG and Siemens Unite for Power Semiconductors"]

[Text] The German Cartel Board having given its assent, AEG and Siemens will form a 50-50 association in the area of high-power semiconductors (gate-turnoff or GTO) on 1 January, as expected. The new company will be called the European Power Semiconductor Company (EUPEC) and will have a capital of DM 50 million (Fr 170 million). It will employ 700 people and will take over production from the two shareholders (Fr 289 million in sales for AEG in 1989 and Fr 238 million for Siemens). It should be noted that this union's goal is primarily to achieve economies of scale in R&D in response to the resources brought into play in Japan by Toshiba, Mitsubishi, and, to a lesser extent, Fuji. Will the new German union be able to rise to the challenge? Unfortunately, this is doubtful, because the Japanese lead is so great in this sector—unless the recent contacts between Siemens and the General Electric Company (GEC) also result in collaboration between the German company and GEC/MEDL in high-power semiconductors. However, it is conceivable that the recent agreements between GEC and Alsthom will lead to a rapprochement among the GEC subsidiary MEDL, the Mitsubishi subsidiary Powerex, Westinghouse, and Alsthom. This is, then, a story to follow.

Belgian Quantum Component Research Described

90AN0083 Kalmthout INDUSTRIE in Dutch Nov 89 pp 89, 93

[Article by Jan van Dijck: "Resonant Tunnel Structures: Electronic Building Blocks for the Future"]

[Excerpts] Quantum components will gradually replace conventional transistors on integrated circuits.

At the Interuniversity Microelectronics Center (IMEC) in Louvain, scientists are conducting research on the next generation of semiconductor structures.

"The performance of conventional components could still benefit from a better knowledge of the IV materials (Si, Ge), just like GaAs-based III-V components," notes Chris Van Hoof, one of the scientists at IMEC. He adds: "But, with the exception of memory components, which are not limited to 0.2 microns, the cost aspect seems to impose certain restrictions on ever-increasing component density. My personal opinion is that the saturation point will be reached somewhere around the middle of the next decade. Before actually designing that technology, we should first access its technological feasibility."

Van Hoof is a member of one of the teams doing basic research for IMEC, the Compound Semiconductor Epitaxy team; it consists of three physicists and four engineers-researchers.

Resonant Tunnel Structures

Line widths of less than 0.25 microns result in parasitic, quantum-mechanical effects. This phenomenon gradually brings us closer to the fundamental integration limits inherent in conventional metal-oxide semiconductor (MOS) and bipolar transistors. But these disturbing quantum-mechanical effects are already being successfully exploited in tunnel diodes and transistors. Indeed, it is certainly preferable to use these negative side-effects as a technological weapon in order to develop entirely new functional concepts.

The next generation of semiconductors might be based on resonant tunnel structures, because such structures allow better performance while reducing costs.

Quantum components are based on the principle of the behavior of electrons in ultra-small dimensions, where electrons tend to take on the properties of a wave. A barrier (for instance, an insulator between two conductors) that cannot be penetrated by these electron waves in conventional electromechanics can be easily "tunneled through" if the barrier has the same dimensions as the wave. When two barriers follow each other closely, for instance at a rate of 10 nanometers (one millionth of a cm), only the electron waves that resonate with this geometrical structure are transmitted. This is exactly what happens in an optical interferometer. Hence the name "resonant tunneling." This specific geometry makes it possible to select the transmitted electron wave's energy. Unlike common diode layers, in which doping substances allow for an extensive depletion region, in this case the dimensions are limited by atomic distances.

However, a fully finished integrated circuit composed of these quantum components will not be available for some time. This is all the more so since the chip's design, and therefore its architecture as well, is based on the behavior of conventional transistors, which differs fundamentally from the behavior of quantum components. While physicists deal with "separate components," engineers are responsible for the "design," and close cooperation between them is absolutely necessary. The components' unique behavior makes them not only interesting, but also very useful. It has already been proved that a single component can perform several functions, thus allowing for a higher functional density or multiple logic.

What Kinds of Applications?

In the meantime, IMEC and others have developed a number of smaller circuits, such as analog-to-digital converters, parity bit checkers, memories, and frequency doublers. Due to their special characteristics, the number of quantum components required for their production is only a fraction of the quantity required with conventional means.

The manufacturing process for such resonant tunnel structures is not cheap. As Mr Denoyelle, an engineer, explains: "The growing of extremely thin semiconductor layers on a gallium arsenide substrate using molecular beam epitaxy is a rather expensive process which is likely to remain the privilege of the laboratories for some time. The metallo-organic chemical vapor deposition process, on the other hand, allows a much faster c-growth of the layers and lends itself to semi-industrial use."

The experiments performed are related to several subareas. These include the extension of existing tunnel structures toward multiple logic and the development of A/D-converters and tunnel transistors. Tunnel structures' optical characteristics are also being looked at. For this purpose, IMEC is collaborating with Prof Vounkx's infrared lab at the Free University of Brussels. However, the university labs do not have the appropriate infrastructure to make such new materials. As for the electronics, IMEC has recently teamed up with the University of Antwerp to design, among other things, optical modulators based on tunnel structures. In optical communication techniques, the biggest problem results from the power absorbed by existing circuits. Although no advanced research has been done in this field so far, possible improvements should not be ruled out. As for the prospects for sensitivity to electromagnetic, nuclear, and other interference fields, they seem very promising.

Quantum components are probably less sensitive to radiation due to the use of GaAs. Very little is known about the phenomenon yet, but experiments performed over the years have shown that classical tunnel diodes are radiation-resistant.

Research on transistors, however, is still in an experimental phase. It is difficult to tell which structures will gain the upper hand. The problem might just come down to a choice of materials. The research carried out by IMEC concentrates on GaAs- and AlGaAs-structures, which have proved to be superior to GaAsIn-types. But today other materials are available, such as gallium antimonides and indium antimonides. Further research should elucidate this matter.

The circuits developed also include an A/D-converter (2 bits—4 conditions; two tunnel diodes grown one on top of the other, adjusted to one another in such a way that four conditions can be obtained). However, what matters most is not the number of bits converted, but rather the availability of a 5 x 5-micron device replacing the 12 transistors that are normally required. This suggests that a scale reduction by 10 should be within reach.

But even though it is theoretically possible to "grow" an unlimited number of tunnel diodes on top of each other, designing the necessary metal conductors remains a technological problem. "This is extremely difficult. Today we have the masks required for four-layer structures," explains Chris Van Hoof. Multiple logic as a "profitable" element has been a well-known concept for a long time, but the structures required for their actual production are lacking.

No Appropriate Production Technology Yet

The techniques required for the technology of resonant tunnel structures are still nonexistent. And even if they did exist, they would in any case not be considered sufficient. Even existing production tools, such as masking and lithography, are inadequate. The 1-micron lithography process is not satisfactory. Electron beam (EB) lithography, a rather slow technology still based on a pattern-by-pattern input method, is limited to 0.065-micron lines. About 3 years ago, IMEC purchased two very expensive EC installations (1 micron and 0.3 micron). But IMEC definitely prefers the Desire process, an optical lithography process intended for submicron applications. Resonant tunnel transistors have limited vertical dimensions (nm layers), but the devices' size can easily reach 10 microns. Of course, the number of components to be integrated is a decisive factor: Resonant structures allow five-way logic, thus yielding a savings of four components in comparison with conventional technology. Another contact-making method will probably have to be developed to replace the simple masks. Obviously, this will also affect dimensions. For the time being, no equally advanced alternative seems to exist. Within the group of quantum-like devices, optical structures might be the most eligible. Future developments might also benefit from molecular electronics. The end is definitely not in sight.

SCIENCE & TECHNOLOGY POLICY

EC Countries Reduce R&D Framework Budget

Commission Proposal Rejected

90AN0119 Brussels EUROPE in English 18-19 Dec 89 p 6

[Report: "Research Council: The Twelve Adopt the Political Principle of a Third Framework Programme for ECU 5.7 billion (Against 7.7 Billion Proposed by the Commission)"]

[Text] Last Friday [15 December] it took the [EC] Research Council over 15 hours to reach a minimalist political agreement on the scientific research and development framework programme for 1990-1994, for which funding is estimated at ECU 5.7 billion. The initial proposal by the European Commission provided funding of ECU 7.7 billion. Seven delegations were prepared to approve the ECU 7.7 billion figure, but the Spanish, British, and Dutch delegations (which recommended figures significantly lower than the one finally decided upon) did not want to give up any more ground.

At the end of the debates, the EC vice president, Mr Pandolfi, specified that an additional ECU 3.125 billion would be added to the ECU 5.7 billion for actions coming under the second framework programme, which would bring the total to some ECU 8.8 billion available for research over the next five years. At the request of the Commission, it was also written into the minutes of the Council meeting that "the Commission feels that following the revision for 1992, the amount for actions to be carried out in 1993 and 1994 would have to be estimated at at least ECU 2 billion." This possibility is rather uncertain for the time being, because it depends on the next interinstitutional agreement and will necessitate a new unanimous decision by the Research Council.

The sum of ECU 5.7 billion over the next five years is also vastly different from the amount decided on by the European Parliament in its opinion and, consequently, it is probable that the Assembly will ask for a consultation with the Council. A formal decision on a common position will, therefore, probably not be adopted until next February under the Irish Presidency.

The compromise approved by the Council provides a third framework programme with total funding of ECU 5.7 billion, of which 2.5 billion cover the period from 1990 to 1992 and ECU 3.2 billion for 1993 to 1994. Therefore, the ministers abandoned the idea put forth by the French Presidency to cut the amount in half, with the first part going to ensure continuity in the actions begun between 1990 and 1992, and the second to support and redirect these actions or to meet newly arisen needs. In point of fact, legal considerations were against the setting up of such a "reserve".

The breakdown of the framework programme between the various headings is rather close to the distribution initially planned on the basis of the overall figure of ECU 7.7 billion. The greatest portion of expenses—ECU 2,221 million over 5 years—will go to information technologies and communication, followed by industrial technology and materials (ECU 888 million), energy (ECU 814 million), life sciences and technology (ECU 741 million), the environment and human capital and mobility (ECU 518 million for these two headings).

At the initiative of the German delegation, the Council also approved a statement on cooperation with third countries in light of current changes in Central and Eastern Europe. The draft Council Decision already underscored the Community's willingness to cooperate with third countries, to their mutual benefit, particularly with those which have concluded agreements with the Community.

The current text indicates that the Research Council is willing to study the terms of close cooperation with the countries of Central and Eastern Europe in the area of research, especially in areas having a direct impact on the population, such as the environment and health, as well as in initiatives to promote exchanges and the free movement of scientists.

In the Communication that it will present to the Council on cooperation with third countries in the area of research, the Commission will take these factors into account.

Appropriations Defined

90AN0119 Brussels EUROPE in English 20 Dec 89 p 12

[Report: "Research: Allocation of Appropriations Forecast by the Council for the Third 1990-1994 Framework Programme"]

[Text] As a complement to the information concerning the political agreement reached by the Council concerning the third framework programme of scientific and technical R&D for 1990-1994, here is the allocation of appropriations (total of ECU 5.7 billion) between the different "lines" and "sublines" of actions (in ECU millions):

Allocation of Appropriations

	1990-1992		1993-1994	Total
I. Diffusing Technologies				
1. Information and communications technologies	974		1,247	2,221
—Information technologies		1,352		
—Communications technologies		489		
—Development of telematics systems of general interest				
2. Industrial and materials technologies	390		498	888
—Industrial and materials technologies		748		
—Measurements and tests		140		
II. Management of Natural Resources				
3. Environment	227		291	518
—Environment		414		
—Marine sciences and technologies		104		
4. Sciences and technologies of living organisms	325		416	741
—Biotechnology		164		
—Agricultural and agri-industrial research (see footnote 1)		333		
—Biomedical and health research		133		
—Sciences and technologies of living organisms for developing countries		111		
5. Energy	357		457	814
—Non-nuclear energies		157		
—Safety of nuclear fission		199		
—Controlled thermonuclear fission		458		
III. Valorisation of Intellectual Resources				
6. Human resources and mobility	227		291	518
—Human resources and mobility		518		
Total	2,500		3,200	5,700
		(5,700) (see footnotes 2-3)		

Footnotes

1. Including fisheries

2. Including ECU 57 million for the centralised action of dissemination and valorisation provided for under Article 4, collected proportionately from each action.

3. Including ECU 180 million for 1990-92 and ECU 370 million for 1993-94 earmarked for the Joint Research Center.

Standard Groups Cooperate in OSI Promotion

90AN0082 Amsterdam COMPUTABLE in Dutch 20 Oct 89 p 31

[Article: "Cooperation Between Eurosinet and SPAG in OSI Tests"]

[Text] Brussels—The Standards Promotion and Application Group (SPAG) and Eurosinet will collaborate in the field of Open Systems Interconnection (OSI) tests and demonstrations. The cooperation is intended to create greater uniformity in testing and evaluating product performance, thus allowing their concurrent operation using the OSI model.

The cooperation is also associated with the agreement recently reached among five OSI promotion organizations (Eurosinet for Europe, Osicom for Australia, Osinet for North America, Instapnet for Japan, and Osnet for Singapore), aimed at jointly achieving, through the OsiOne organization, uniform use of international standards and better worldwide standardization with respect to the further development of test technologies. In practice, the agreement between SPAG and Eurosinet means that both organizations will combine and optimize available resources, their technical knowledge, and their experience. Initially, this refers to the testing of systems and products in multivendor environments. In the long run, however, the agreement will lead to a coordinated approach to the testing of technological developments. Eventually, they will also jointly publish test results.

Philips Director on JESSI, Microelectronics Prospects

90CW0090Duesseldorf VDI NACHRICHTEN in German 22 Dec 89 p 14

[Text]**Due to the EC research project Jessi, the Federal German infrastructure in the area of microelectronics has decisively improved within one year. Dr. Eng. Hans Weinerth, long-term observer of the semiconductor industry, propounds this thesis. Director at Philips, Hamburg, and chair of several boards, he is, among other things, Curator of the VDI (Association of German Engineers), but he emphasizes that still further efforts are necessary to compete internationally with this key technology.**

VDI Reports: By 1996, that is distributed over a time of eight years, a total of 7.874 billion DM are supposed to flow into the microelectronics research project Jessi from means of the EC Commission, national, European, and participating enterprises. What regional effects will this have? For example, in the industrially weak North German area?

Weinerth: The consciousness that microelectronics will be eminently important for the future of our national economy has drastically grown among the public and in the political area during the last few months. But we are still far removed from a general basic consensus about the necessary efforts.

Positively, two specific national initiatives to support the Jessi project should be pointed out: the Isit and the Sican GmbH.

An Institute for Silicon Technology, Isit, with an ultraclean room laboratory is being constructed in Itzehoe. The federal government and the land will each participate with 200 million DM. The Sican GmbH, Silicon Applications and CAD/CAT, Lower Saxony, is being founded as a central unit in Hannover. The financial arrangements are similar as for Isit.

Sican will collaborate closely with the Institute for Applied Microelectronics, IAM, which is resident in Braunschweig. This institute is concerned with spreading microelectronics among small and medium businesses in the area of Lower Saxony. The Laboratory for Information Technology at Hannover University will act as cooperating partner. It emphasizes the area of telecommunications.

VDI Reports: And industry is collaborating?

Weinerth: Sican is supposed to begin with a portion of 60 percent of public funds, while industry will contribute 40 percent - in the form of corporate shares. This ratio is supposed to reverse in the course of time. In the final effect, Sican will be an industrially controlled facility both as regards the corporate shares and as regards its allotment of projects. Siemens, Phillips, and Daimler-Benz also participate in Isit as "core partners"; other companies will follow in the course of time.

VDI Reports: But other federal lands likewise have not been inactive. In Bavaria, Baden-Wuerttemberg North Rhine Westphalia, and Hamburg there are similar initiatives. Is competition between regions again preprogrammed?

Weinerth: I hope not. To begin with North Rhine Westphalia: The CAD lab in Paderborn emphasizes research on CAD software. It works on a different aspect than Sican as regards silicon applications. But it will surely cooperate closely with the latter. In any case, Sican will strive for such cooperation. In the case of Hamburg, a microelectronics user central (MAZ) is planned with initial investments of 80 million DM. Here, the idea at the very beginning in any case was that the center should perform its activities within the Sican framework.

I greatly welcome this step of the Hamburg Senate. The planning work that is now in progress is evidently moving ahead quite well.

VDI Reports: And how are the South German Jessi activities related to overall development?

Weinerth: Although the public has not yet been shown any results, I nevertheless see clear possibilities for cooperation, e.g. with the Fraunhofer Institutes in Erlangen, Munich, and Stuttgart, in the technology area, and with other south German facilities in the system- and CAD-area. In any case, there is no reason for polarization between north and south.

VDI Reports: You have indicated again and again that reinforcement of the interface between industrial and non-industrial research is an important point. Are the already initiated developments, such as Isit and Sican, sufficient to achieve this goal?

Weinerth: Jessi - at least the federal German contribution to this - represents the maximum consensual contribution towards the development of microelectronics that is currently possible in our coun- try. However, when viewed over longer periods of time and by way of international comparison, this is not sufficient. We really need a series of concomitant measures in order to be able to persist inter- nationally beyond these Jessi activities. Isit and Sican are the two high-priority infrastructural measures.

VDI Reports: But Jessi is often described as Europe's high road from dependence on Japan and the USA...

Weinerth: As a research and development program, Jessi is far from being a guarantee that, by the mid-90's, a bright star will rise over the European microelectronics landscape. This requires still further measures.

VDI Reports: On the part of industry or of the state?

Weinerth: Of both, but certainly the state is also challenged in a special way. What is decisive is the broad coordination, and in certain areas also the stimulation of non- industrial research activities inasmuch as they have reference to microelectronics. The landscape is indeed quite motley, but also very fragmented.

VDI Reports: And the middle class will just be run over here?

Weinerth: In terms of the national economy, Jessi makes sense only in the broad effect of its applications, and the middle class plays a central role here.

VDI Reports: You are chair of the board of the working group Jessi/Microelectronics of the Central Association of the Electrical Engineering and Electronics Industry. Is a contribution to the middle class to be expected here?

Weinerth: Beyond doubt! Both the ZVEI (Central Association of the Electrical Engineering and Electronics Industry), as well as the Association of German Machine and Systems Construction, have built up structures to support their middle class firms in this area. It is also to be expected that both associations will collaborate here even more closely in the future.

It will have to be seen how the structure will develop around Jessi. But I think that coordination beyond the boundaries of industrial and non-industrial research would be more than the Fraunhofer Society could accomplish now with its present structure.

VDI Reports: Stimulation of non-industrial research activity also means more and more money from public sources...

Weinerth: That's right, it also means more and more money. But support of far-reaching research classically belongs to the archetypal tasks of the state. What is involved here is the creation of suitable infrastructures and the creation of stimulating ambient conditions which are reflected in the site criteria for the semiconductor industry. And one should also take a look at those from whose shadow one wishes to emerge. Japan pumps money into microelectronics in quite different orders of magnitude. That country does not afford subsidy of anthracite and no agrarian subsidies. Japan invests in the future, and there is a broad social consensus for such a policy....

VDI Reports: Would the creation of large conglomerates be a proper path?

Weinerth: At least it would be an alternative to the ever recurring requirement for the electronic branch to balance this out internally. The market economy knows no possibilities for creating financial equalization within the respective branch by way of industrial associations - or in whatever way.

VDI Reports: And this brings us back to the state....

Weinerth: As a key technology, microelectronics today has a dimension for the national economy which other key industries in the past did not have in such a scope. It is more complicated and has a previously unknown growth rate. The state just has to adjust itself to this. The Federal Republic of Germany has no other chance than to adjust rapidly to these new contingencies.

COMPUTERS

GDR: U84C00 Microprocessor System Described

90CW0069A East Berlin
MIKROPROZESSORTECHNIK in German
No 10, Oct 89 pp 296-298

[Article by Michael Ritter of VEB Microelectronics "Karl-Marx," Erfurt, Research Center: "U84C00 Eight-Bit CMOS Microprocessor System"]

[Text] Foreword

A survey of the international eight-bit microprocessor market indicates a trend whereby numerous systems using CMOS technology have been introduced in recent years. Several basic common features have become apparent here. First of all, families—meaning processors and applicable peripheral circuits—are always produced in the new technology. Secondly, all manufacturers attempt to offer CMOS processors that are compatible with the existing NMOS options. Thirdly, one discernible common feature is that advances in classical eight-bit processors are being offered with improved architecture. For example, the 80C85 (Intel) came from the 8080 and the HD64180 (Hitachi) came from the Z80. There are various advanced designs in CMOS technology based on the internationally dominant Z80 eight-bit processor system. Among others, Zilog, Toshiba, Sharp, and Hitachi offer such systems.

At VEB Microelectronics "Karl-Marx," Erfurt (MME), the U84C00 family, using CMOS technology, is being offered as a further advance of the U880 family. These circuits are especially suitable for applications in mobile measuring equipment and hand-held computers. However, they can also perform the current tasks of the U880 family of circuits.

The U84C00 Family of Circuits

Introduction

The U84C00 family of circuits is a powerful eight-bit microprocessor system using CMOS technology, which in addition to the CPU comprises a series of peripheral components. The circuits are available in the frequency classes 2.5 MHz and 4.0 MHz. For some models, there are incidental components called U84Cxx DC02-1. These differ from the standard models in that they cannot go into power-down mode. All other parameters are in keeping with those of the standard components. Table 1 shows an overview of the models offered by MME.

Table 1 Overview of models offered by MME

Model	2.5 MHz		4.0 MHz
	Standard model	Incidental model	Standard model
Central processing unit	U84C00 DC02	U84C00 DC02-1	U84C00 DC04
Parallel input/output	U84C20 DC02	U84C20 DC02-1	U84C20 DC04

Table 1 Overview of models offered by MME (Continued)

Model	2.5 MHz		4.0 MHz
Counter/time clock	U84C30 DC02	U84C30 DC02-1	U84C30 DC04
Serial input/output	U84C40 DC02	—	U84C40 DC04
Asynchronous serial input/output unit	U84C70 DC02	U84C70 DC02-1	U84C70 DC04
Clock generator/controller	U84C97 DC02	—	U84C97 DC04

Comparison of the U84C00 and U880 Families

In principle, the circuits of the U84C00 family are compatible to the circuits of the U880 family. This is true of all commands as well as all hardware parameters, including the TTL incompatibility of the clock input (see also Fig. 1 and 2). Since the family of circuits is produced using CMOS technology, it has the important advantage of low power consumption compared to the circuits of the U880 family. For the user, this means that applications are possible that are characterized by low self-heating, smaller power supply units, and smaller packages. In addition, it is also possible to use batteries for the power supply, at a reasonable cost.

Table 2 shows a comparison of the power consumption of the circuits of the U84C00 family with those of the U880 family.

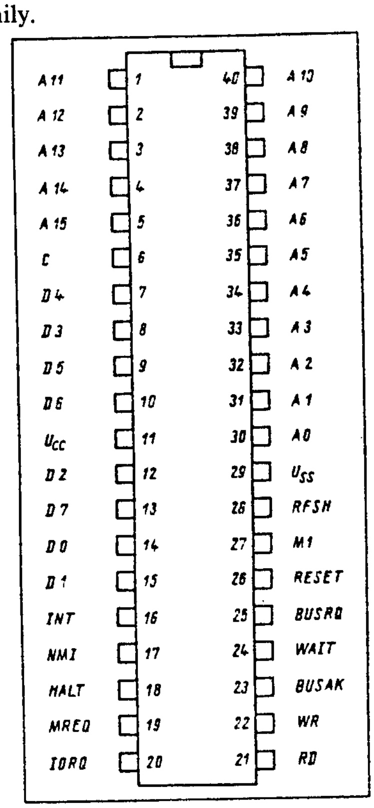


Figure 1. Pin assignments of the U84C00

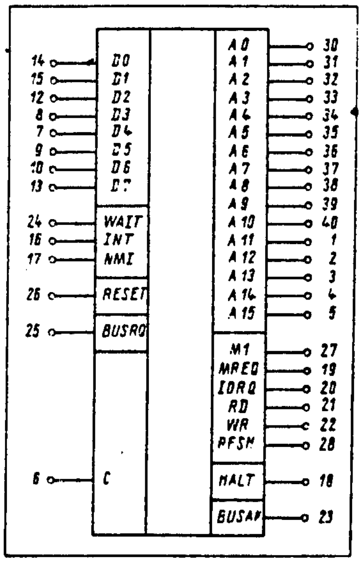


Figure 2. Circuit diagram of the U84C00

Table 2 Comparison of power consumption (4 MHz)

Model	U84C00 family	U880 family
Central processing unit	25 mA	200 mA
Parallel input/output	5 mA	100 mA
Serial input/output	15 mA	130 mA
Counter/time clock	7 mA	120 mA
Clock generator/controller	4 mA	-

A CMOS component consists of basic modules that are constructed from complementary field effect transistors. In static operation, it is always the case that only one of the two transistors is conducting. Power dissipation is basically determined by leakage currents. During a switching procedure, the gate capacities must be recharged, and both transistors are conducting for a short time. This means that the power dissipation of the CMOS microprocessor circuits is extremely small in static operation, and increases with a rise in frequency.

Unlike the circuits of the U880 family, the circuits of the U84C00 family have a static internal structure. This means that there is no lower frequency cut-off. If they are operated at clock rate zero (system clock is stopped), all internal information is retained. When the clock is restarted, the system continues working at the spot where processing had been interrupted. This fact is utilized for so-called power-down mode. Besides a very favorable power balance in operation, this mode offers the option of even further minimizing power consumption by the circuits. If no activity is required by the computer, the circuits can be put into power-down mode. After execution of the HALT command, the system clock is stopped through a fixed regime. Proper assumption of power-down mode is controlled by the clock generator/controller (CGC). The power consumption of any circuit in power-down mode is smaller than 10 microamperes.

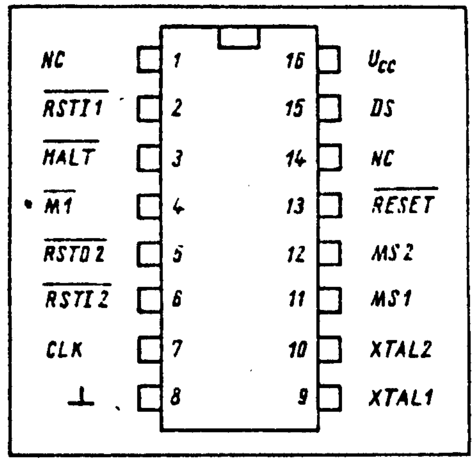


Figure 3. Pin assignments of the U84C97 CGC

Assumption of Power-Down Mode by CPU

The system clock can be stopped at any time during operation. However, it is guaranteed that the operating current of the CPU in power-down mode will correspond to the standby current of less than 10 microamperes only if the clock is stopped in the exact proper order. In order to properly go into power-down mode, the clock must be stopped on the low level of the fourth clock cycle of the machine cycle that follows the HALT command. Fig. 3 shows the proper transition to power-down mode controlled by the CGC.

By applying the system clock to the CPU, the latter returns from power-down mode. This transition is controlled by the CGC as well. The HALT state is eliminated in a known manner, either through RESET, INT, or NMI.

Description of the U84C97

General

The U84C97 circuit is a clock generator/controller for the U84C00 CPU and for the relevant peripheral circuits. It is produced using CMOS technology and is housed in a 16-pin DIL package (Fig. 3 and 4).

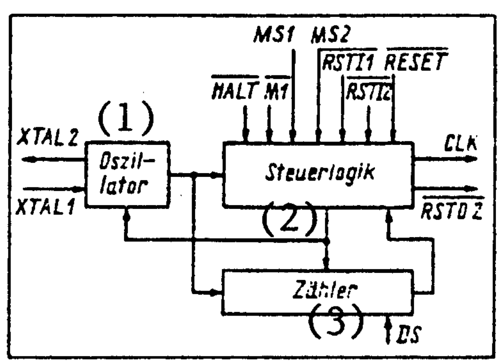


Figure 4. Circuit diagram of the U84C97

Key: 1. Oscillator 2. Control logic 3. Counter

The CGC has two tasks in an application of the U84C00 family:

- Providing the system clock
- Organizing the transition to power-down mode.

The terminal pins for the circuit are explained in Table 3.

Table 3 Pin assignments for the U84C97 circuit

Pin number	Name	Description
1	NC	Not assigned
2	RSTI1	Input for restoring clock, level-triggered
3	HALT	Input for HALT signal by CPU
4	M1	Input for M1 signal from CPU
5	RSTO2	Output corresponding to the RSTI2, normally connected to NMI of the CPU
6	RSTI2	Latched input for restoring the clock, edge-triggered, standard for NMI requests
7	CLK	Clock output
8	U_{SS}	Ground
9	STAL1	Quartz terminal (X_{in})
10	XTAL2	Quartz terminal (X_{out})
11	MS1	Input for mode select
12	MS2	Input for mode select
13	RESET	Input for restoring the clock, standard for RESET signal
14	NC	Not assigned
15	DS	Input for selecting warm-up time in STOP mode
16	U_{CC}	Operating voltage

Modes of the U84C97 Circuit

The U84C97 circuit can operate in three modes: RUN MODE, IDLE MODE, STOP MODE.

The modes are chosen through pins MS1 and MS2. The assignments are shown in Table 4.

Table 4 Modes of the U84C97 circuit (HALT operation in every mode; x = any value)

MS1	MS2	MODE	Description
1	1	RUN	System clock is always available.
0	x	IDLE	System clock is stopped, but internal oscillator keeps running.
1	0	STOP	All internal operations are stopped.

RUN MODE is set when the existing circuit should never go into power-down mode. After reading the HALT command, the CPU goes into HALT state. The CGC continues to execute NOP commands during the HALT state. In this mode, the clock controller has a power consumption level of around 4 mA. Fig. 5 shows the clock diagram for this mode.

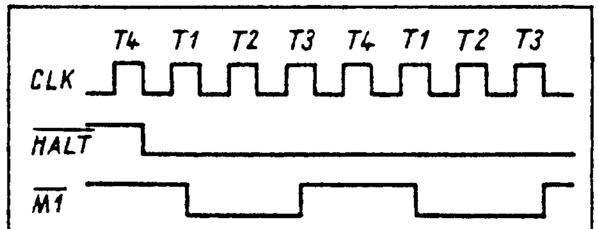


Figure 5. Clock diagram in RUN MODE

In Fig. 6, the timing is shown for the case where the CPU reads a HALT command (76H) and the clock controller is set for IDLE MODE. The activation of the HALT signal by the CPU is synchronized by the falling clock pulse edge of T4. The rising edge of signal M1 makes the CGC keep the clock output after the falling edge of T4 on low. Stopping the clock puts the CPU into power-down mode. The internal oscillator of the CGC continues to run in this mode. In this mode, the circuit has a power consumption level of approximately 500 microamperes.

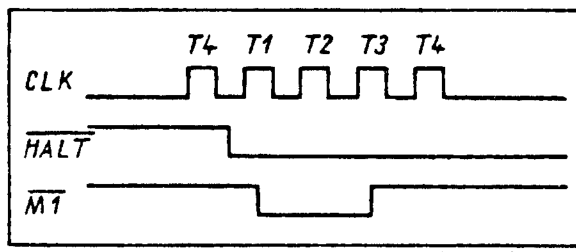


Figure 6. Clock diagram in IDLE/STOP MODE

In STOP MODE, the same operation as in IDLE MODE is performed after the HALT command of the CPU. The difference is that in STOP MODE, the CGC adjusts all actions. This means that the internal oscillator is switched off as well. In the off position, the CGC in this mode has a power consumption level of less than 10 microamperes.

Restoring the Clock

There are three inputs that can be used to end power-down mode: RESET, RSTI1 and RSTI2. Fig. 7 shows the order for restoring the clock in IDLE MODE. A request is made, and the clock is provided after a slight delay.

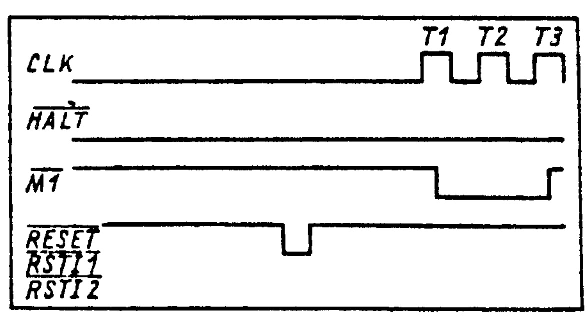


Figure 7. Restoration of the clock in IDLE MODE

Fig. 8 shows the order for restoring the clock in STOP MODE. Since the internal oscillator is turned off in STOP MODE, a warm-up time is needed to ensure proper oscillation startup. Two different values can be set for the oscillation startup time. The DS pin is used for this. If DS is set on high, then a warm-up time of 2^{15} clock pulse periods is set. If DS is on low, a warm-up time of 2^{18} clock pulse periods is set. If the RESET input is used to restart the CGC, then no warm-up period is generated. Thus, if the RESET inputs of the CPU and CGC are connected, it must be externally guaranteed that the RESET signal is kept on low long enough to ensure a proper resetting of the CPU.

Fig. 9 shows the standard wiring for the CPU and CGC. When using the system, it is important to be absolutely certain that no inputs are unwired. Otherwise, there will be interference during operation, due to the high input impedances of the CMOS circuits. They can be closed with high-impedance resistors up to around 500 kOhm.

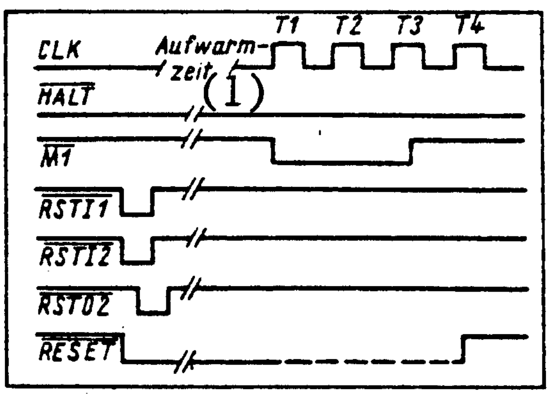


Figure 8. Restoration of the clock in STOP MODE

Key:—1. Warm-up time

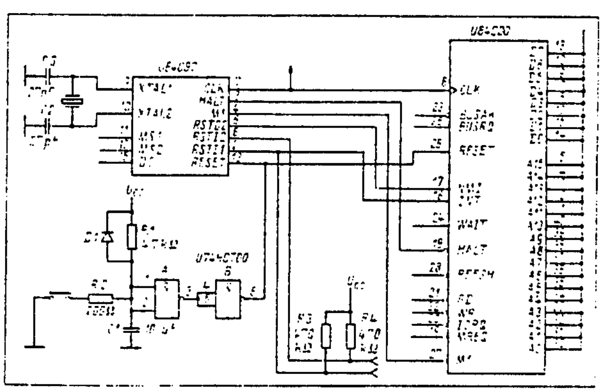


Figure 9. Wiring of CPU and CGC

GDR's Indigenous IBM-Compatible PC Described

90CW0074 East Berlin RADIO FERNSEHEN ELEKTRONIK in German No 11, Nov 89 pp 690-695

[Article by Eckhard Schiller: "Indigenous PC with MS-DOS Capability"]

[Text] This article will discuss the successful cloning of an XT-class personal computer. Because this is a very complicated process, only the main points can be given here. The goal of the article is to inspire the reader to become involved in this field.

In the early days of microprocessor technology, the amateur would put together a small computer, write an executive routine, and then look for software. Today, the process is reversed. We look around, find the software we want to use, and put together a computer that will run it.

To date, clones of the ZX-spectrum and CP/M-capable computers have been introduced in the GDR. However, from the international perspective, these computers are already being phased out, and new programs are scarcely being offered for them any more. Currently available are computers using the 68000 processor (ST, Macintosh, Amiga), as well as other MS-DOS capable XT-class personal computers using the 8088 processor and its successors. Only the latter are considered for cloning.

The IBM PC

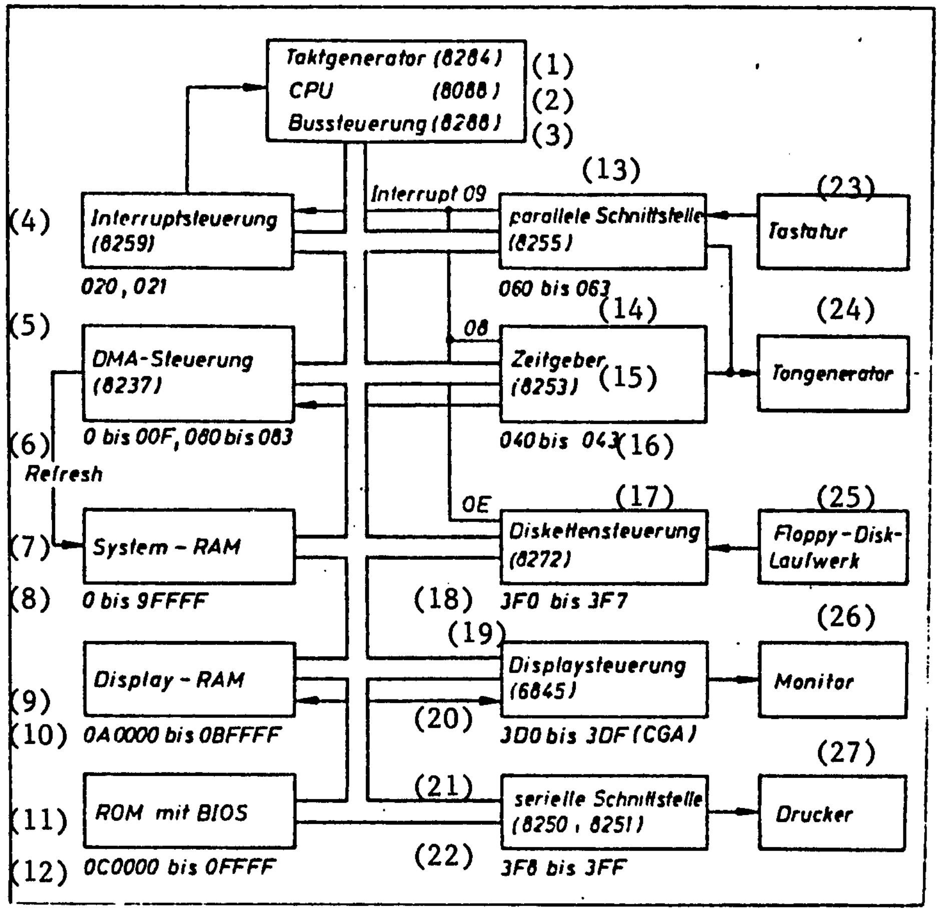
The American firm IBM marketed a personal computer in 1981 that became the industry standard in the following years. In 1983, it was followed up with the XT-class (XT = extended) of personal computers with the MS-DOS 2.0 (Fig. 1) operating system, which consists of the basic device, the monitor, and the keyboard.

The basic device contains the main plate with the CPU and plug-in type optional cards, e.g., for expanded memory or screen and diskette control. The disk drives have 40 grooves and are two-sided (360 Kbyte), although one-sided diskettes can be processed. Various screen controls can be attached, of which the most important are: MDA (characters out of 9 x 14 pixel, monochrome, no graphics), CGA (characters out of 8 x 8 pixel, color graphics with 640 x 200 picture elements), and Hercules (characters out of 9 x 14 pixel, graphics with 720 x 348 picture elements, monochrome). The keyboard has 83 keys.

In addition, a sound generator and several parallel and serial interfaces are available.

Compatibility

The MS-DOS operating system uses the BIOS Interrupt in Table 1 (BIOS = Basic Input and Output System) to interface with user-specific hardware, so that every computer that uses these precisely described BIOS interfaces correctly is MS-DOS-compatible.



Block Diagram of the PC-XT

Key:—1. Clock generator—2. CPU—3. Bus control—4. Interrupt control—5. DMA control—6. 0 to 00F, 080 to 083—7. System RAM—8. 0 to 9FFFF—9. Display RAM—10. 0A0000 to 0BFFFF—11. ROM with BIOS—12. 0C0000 to 0FFFFF—13. Parallel interface—14. 060 to 063—15. Timer—16. 040 to 043—17. Diskette control—18. 3F0 to 3F7—19. Display control—20. 3D0 to 3DF (CGA)—21. Serial interface—22. 3F8 to 3FF—23. Keyboard—24. Sound generator—25. Floppy-disk drive—26. Monitor—27. Printer.

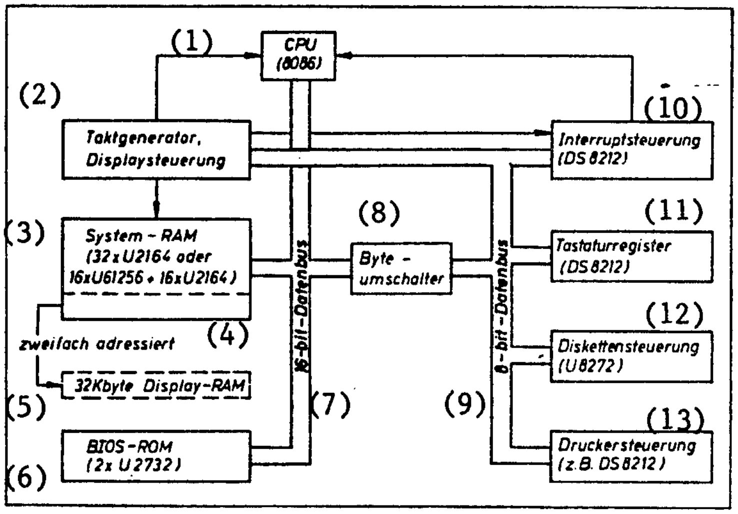
Table 1: BIOS Interrupt of the PC-SE (All further Interrupts will be overlaid with IRET during cold starts)

Number	Name
07	Batch Interrupt of the PC-SE (every 5 mins)
08	Timer Interrupt of the 8253, Channel 0
09	Keyboard Interrupt
10	Screen output
11	Equipment test
12	Memory size
13	Input and output diskettes
16	Keyboard input
19	Diskette loading system (cold start)
1A	Clock time
1C	Timer cycle (every 55 mins)
1E	Diskette parameters

Unfortunately, most programs ignore the BIOS Interrupt for screen and keyboard and access the hardware directly. Thus, it is accurate to say that a personal computer is only IBM-compatible if the same addresses and circuits are used as in the original.

Basic concept of the PC-SE

In conceiving the amateur computer PC-SE, the goal was to use generally accessible components to develop a simple computer, with which most of the MS-DOS programs could be run. Large-scale integrated circuits form the core of all important components in the PC-XT and, because the only LSI produced in the GDR is the IS U 8272, they should be replaced with TTL-circuits (Fig. 3). Aside from the K 1810 BM 86 (8086) microprocessor, only GDR-circuits are required. Of course, limitations in compatibility could not be avoided. The PC-SE has a RAM capacity of 224 or 608 Kbyte, supports CGA



Block diagram of the PC-SE

Key:—1. CPU—2. Clock generator, display control—3. System RAM (32xU2164 or 16xU61256 + 16xU2164)—4. Double address—5. 32 Kbyte display RAM—6. BIOS ROM—7. 16-Bit data bus—8. Byte converter—9. 8-Bit data bus—10. Interrupt control—11. Keyboard register—12. Diskette control—13. Printer control.

graphics, and is almost as fast with the 8086 as the PC-XT is with the 8088. All MS-DOS programs that run on the A 7150 and work with the existing diskettes and RAM size are usable.

To build the PC-SE, in addition to the components contained in the following circuits we also need a power pack (5 V, 5 A; 12 V, 3 A), a reliable keyboard with at least 80 keys, a monitor, and one or two 1.2 or preferably 1.6 type disk drives. The total cost for material is not much higher than that expended for a ready-made small computer.

Circuit description

Cycle generation

Contrary to the U 880, the 8086 does not provide refresh cycles for dRAM memories. This task is assumed by the 8237 DMA controller in the PC-XT.

In the PC-SE, the display RAM is part of the system RAM. The cyclical reading of the display RAM during image building ensures that all RAM cells are refreshed as necessary. The CPU and the display control access the RAM alternately, which requires the CPU to wait for a few cycles. The clock generator provides the CPU cycle (mark-space ratio 2:1), the shift register cycles DOTCLK and DOTS, the display RAM addresses B1 through B13, and the synchronizing signal SYN for the monitor (Fig. 5).

A 12 MHz quartz was intended as the frequency-determining component, but LC-oscillators can also be used. All other cycles are derived from this frequency. Table 2 shows the relationship between various variants.

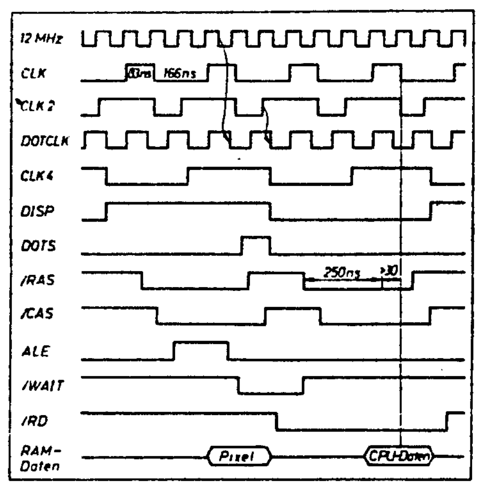


Figure 5.

Table 2: Effects of various clock frequencies

Clock frequency in MHz	CPU cycle in MHz	dRAM access time in ns	Line frequency in kHz	Image frequency in Hz
10.7	3.57	300	14.9	59.6
12.0	4.0	260	16.7	66.8
13.5	4.5	230	18.7	74.8
15.0	5.0	200	20.8	83.2

With R1, the shift register cycle is set in such a way that it results in a mark-space ratio of 1:1. The DISP and CPU signals indicate whether we are dealing with a RAM cycle of the CPU or of the display control.

The display RAM consists of two 8 Kbyte areas, which are reversed with B13 after each line.

On the screen, 640 bits are displayed for each line. There are 40 cycles per line, thus 16 bits can be read in one cycle. At the beginning of each line is the horizontal blanking signal HAUS on L-level, and D_8 to D_{10} count forwards. After 40 DISP cycles, the HAUS signal moves to H-level, and D_8 to D_{10} count backwards twice as quickly. After another 20 cycles, the signal HAUS becomes L again and the count goes forwards. B13 now has the H-level and prevents counting backwards, so in the third line the next 640 bits are shown to the first area. A total of 204.8 lines are displayed. Then the image pulse is triggered and, at the end of the 256th line, a new image begins.

The horizontal position of the image on the screen can be set with R2.

CPU component

The 8086 is an efficient 16-bit processor with an address space of 1 Mbyte. It is usually operated in maximum mode, together with the 8284 clock generator and the 8288 bus controller. In can also be used in minimum mode, in which case the bus controller is unnecessary. Table 3 shows the time response in minimum mode.

Table 3: Time response in ns of the 8086 in minimum mode according to [7]

symbol	5-MHz type		8-MHz type	
	min	max	min	max
TCLCL	200	500	125	500
TCLCH	(2/3 TCLCL)-15		(2/3 TCLCL)-15	
TCHCL	(1/3 TCLCL)+2	(1/3 TCLCL)+2		
TCHV'				
TCLV	10	110	10	70
TCHX'				
TCLX	10		10	
TCLA	80		50	
TCHA	85		55	
TDVCL	30		20	
TCLRL	10	165	10	100
TCLRH	10	150	10	80

Reset and NMI can be activated with keys S_1 and S_2. D_{16} to D_{18} store the addresses and are loaded with the ALE signal. With D_{21}, 8 memory areas of 128 Kbytes each are selected. The ROMs are activated in the uppermost area (0E0000H to 0FFFFFH). They contain the load routine after resetting and the BIOS. The smallest size is (2 x 4) Kbytes (2732). However, all other ROM types up to the 27512 can also be used. The free space can be used as an ROM floppy.

The setting of S_3 depends on the type of RAM used. In the setting shown, the U 61256 are selected through R0. The top setting applies to the U 2164 at R0 and R1.

D_{31} and D_{32} switch the 16-bit data bus of the CPU over to the 8-bit data bus of the input and output components. This allows the CPU to access odd addresses as well. Word input and output is not possible.

D_{30} provides the Interrupt vector 07H. With B8, an Interrupt is triggered every 5 ms.

D_{28} is an output register with the address 3D8H and controls the screen display. D_{29} is an input register with the address 3DAH. Some programs, which access the display RAM directly, utilize the HAUS signal and only access the image memory in the blanking break in order to avoid disturbing the image.

RAM control

The IS U 61256 or the U 2164 can be used as the RAM.

A total of 32 chips are envisioned. Of course, with the 80 IS U 2164 the 640 bits possible with MS-DOS can be accessed. In that case it is recommended that the memory be built in two parts, each with its own multiplexers and drives. A parity-check similar to that in the PC-XT was dispensed with.

The RAM area is separated into two banks. The lower bank is selected with A0 = L, and the upper one with /BHE = L. Both banks are always accessed in DISP cycles. D_{12} controls the /WAIT and /RAS cycles. With a clock frequency of 12 MHz, the dRAM's RAS access time of 250 ns is just enough to allow the use of U 2164 S 1-type RAMs as well.

The most rapid circuits possible should be used to produce RAM signals. LS-output can sometimes cause problems with 32 MOS input.

The data exchange with the CPU (when DISP = L) takes place via D_{75} and D_{76}.

D_{77} to D_{80} are shift registers for the screen display. The 640 signal is used to switch between two-color display (640 pixel/line) and four-color display (320 pixel/line).

Screen control operating modes

The PC-SE simulates the CGA screen control (CGA = Color Graphic Adapter). Its four operating modes are set by means of the BIOS Interrupt 10H, register AH = 0:

- AL = 2: 16-color text display 40 characters x 25 lines
- AL = 3: 16-color text display 80 characters x 25 lines
- AL = 5: 4-color graphics 320 pixel x 200 pixel
- AL = 6: 2-color graphics 640 pixel by 200 pixel

All characters are displayed by 8 by 8 pixel. With text displays, the character code (even address) and an attribute character (odd address), which contains the color for the fore- and background, are written in the display RAM.

Thus, 4 Kbytes of RAM are required for 80 x 25 characters. The image of the character is produced through the hardware (ROM). For graphics, the characters are formed by the software and are located in the RAM as pixel designs. A memory of 16 Kbytes is required.

Only the graphics display in the PC-SE is achieved by means of the hardware. Text display is simulated using the software. The last 32 Kbytes of the system RAM are used as the display RAM. They have a double address and can also be accessed by means of the addresses 0B8000H to 0BFFFFH. This area of the system RAM is closed to the operating system.

The CGA mode uses the area 0B8000H to 0B8F9FH for text display and the area 0B8000H to 0BBE7FH for graphics. In the graphics mode, the PC-SE displays the area 0B8000H to 0BBFFFH on the screen. In the text mode, the signal GRA is used to switch to area 0BC00H to 0BFFFH.

As with the CGA mode, the characters are located in the area 0B8000H to 0B8F9FH. All the characters are also stored in the comparison areas 0BA000H to 0BAF9FH. D_{81} is set each time the display RAM is accessed. This signal is interrogated in the Interrupt routine. A comparative run is initiated if this signal is set and if more than 400 ms have passed since the last comparison. This process compares all the cells of the character area with the cells of the comparison area. If a discrepancy is noted, the comparison area is corrected and the character is displayed on the graphics area. Once this has been accomplished, D_{81} is reset. This process burdens the CPU only when changes are made on the screen. There is no noticeable hesitation with the output of individual characters. The complete reconstruction of the image takes approximately 0.3 secs.

The graphic mode (640 x 200 pixel) does not allow for a color display. Thus, only the monochrome attributes Inverse and Intensive could be achieved by means of the software. There is a second character set for Intensive, in which all vertical lines are displayed with two pixel apiece.

Monitor

The monitor must be able to display three brightness levels as well as black and must be adapted to the image and line frequency of the computer. The band width of the video final stage should be around 20 MHz, so that the characters have sharp edges. Normal color television receivers with a pitch width of over 0.8 mm have too little resolution to display 640 pixel/line. They can only be used for 320 pixel graphics, i.e., for games.

Keyboard

The keyboard of the PC-XT is software-controlled. This means that the keys can be overlaid with any character. When a key is pressed it provides its position code, and when it is released it provides the same code again with a set bit 7. In this way, any number of keys can be pressed simultaneously. Figure 2 showed the key arrangement of the IBM PC. This should be adhered to as closely as possible, because some programs would otherwise be difficult to use.

Assigning the ASCII code to the position code is not imperative, since the position code of the programs is only utilized if there is no ASCII code. The umlauts can thus be accommodated without problem.

Utilization of the keyboard can, on the one hand, be taken over by the 8086. This, however, requires 20 percent of the computer's CPU during the interrogation of an (8 x 12)-matrix typewriter keyboard. On the other hand, utilization of the keyboard could be undertaken with the help of a one-chip microprocessor. This variant is currently in preparation.

Figure 9 shows the original circuit [1]. A position code from the keyboard triggers an Interrupt 09. The code is read by the address 060H. Subsequently, the shift register 74LS322 is cleared by means of an output to 061H.

Figure 10 shows an equivalent circuit for timer and keyboard registers. D_5 and D_6 constitute the keyboard register. When the BIOS has recognized a key, its code is written to 060H and INTO9 is triggered. This register is necessary because many programs circumvent BIOS and interrogate 60H directly.

D_7 and D_{10} reproduce the 0 timer channel of the 8253. D_7 and D_8 are inscribed by the BIOS with the numerical value 0FFH via 40H. This value is reloaded when the counters D_9 and D_{10} are nulled. In addition, the BIOS triggers an Interrupt 08. Many game programs will not run without this circuit.

Diskettes

Since the diskettes are only accessed via the BIOS, any kind of diskette control can be used [3] [4]. It must be taken into consideration, however, that the data transmission in the PC-XT is Interrupt-controlled and takes place via the DMA operation. The address of the motor starting register is 3F2H and that of the IS 8272 is 3F4H.

All diskette formats are processed off the operating system variant MS-DOS 3.0 and are defined with DRIVER.SYS. CP/M diskettes can also be processed with the SCOPY program.

BIOS Adjustment

In the PC-XT, the BIOS is 8 Kbytes long, including the character generator. It contains a hardware test, which runs after the reset process, and Interrupt routines to control the screen, keyboard, diskettes, printer, clock, and serial interfaces (Table 1). The original BIOS could not be used because of changes to the hardware. Aside from the programs for the screen and keyboard, which were largely taken over for the PC-SE, everything else was reprogrammed. Also new are a second character generator and an Interrupt routine, which interrogates the keyboard matrix and, if necessary, activates the text

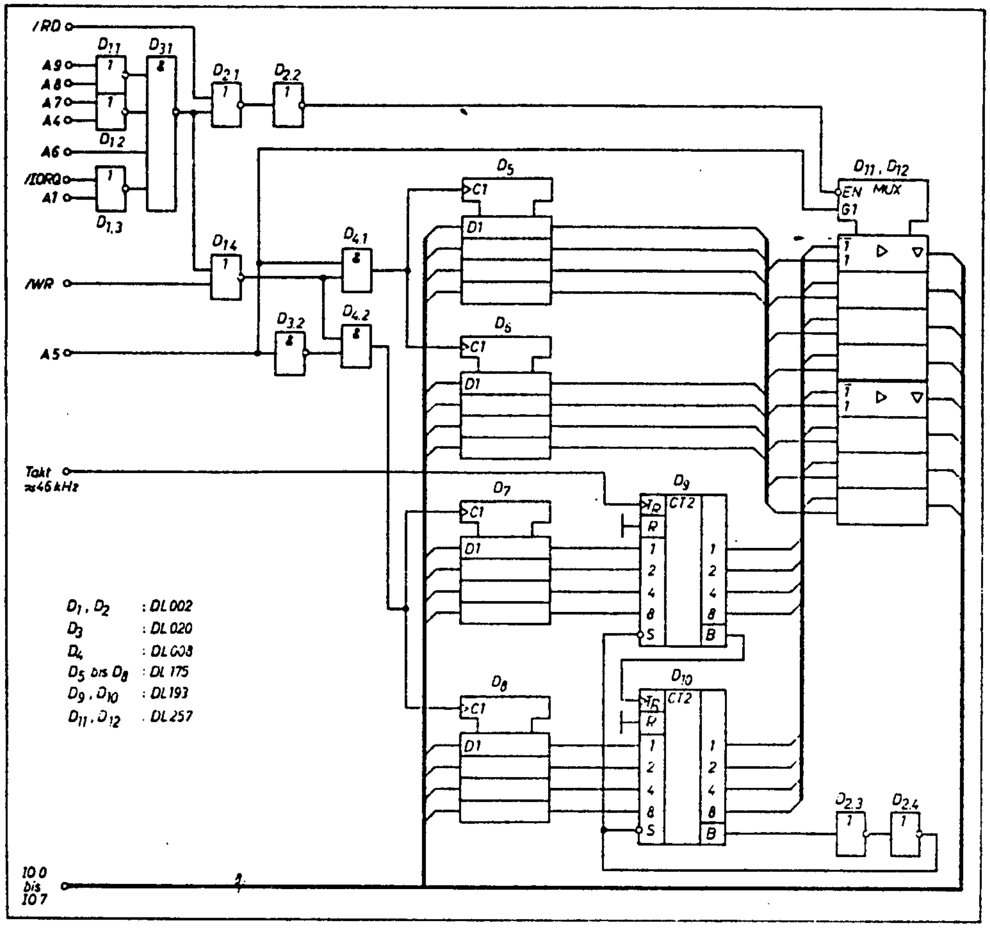


Figure 10.

output and triggers the timer Interrupt. This BIOS is over 1,300 sourcelines long. As adjustments are still necessary for later use, it does not make sense to publish anything in the hexadecimal format. Those interested can write the author at Fr.-Ebert-Str. 39, Naumburg, 4800.

Conclusion

The preceding text shows that it is possible to build an IBM-compatible personal computer that, except for the 8086 CPU, contains only GDR-manufactured integrated circuits. The PC-SE can process almost all MS-DOS programs that are available in the GDR. The following have been tested, among others: MS-DOS 2.11 to MS-DOS 3.30, WS, SC4, dBASE, NC, NU, TURBO, GWBASIC, DIGGER and CAT. As no program copyright laws currently exist in the GDR, these programs may also be used privately.

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MICROELECTRONICS

GDR: VEB Carl Zeiss Jena Facility Profiled

90CW0066 East Berlin FEINGERAETETECHNIK (bx;1No 10, Oct 89 pp 434-437

[Article by Wolfgang Nordwig, physicist, representative of the director-general of optical precision instrument production, Carl Zeiss JENA Combine (VEB): "High Technology and Optical Precision Instrument Production in Carl Zeiss JENA Combine (VEB)"]

[Text] In recent years, the Carl Zeiss JENA Combine (VEB) has gradually taken on a new responsibility for the development of our society.

Implementation of the economic strategy decided upon at the Ninth Party Conference of the Socialist Unity Party of Germany, with a view to the year 2000, will accomplish the development into a center of high technologies which increasingly define the dynamics and continuity of the productivity increase in our national economy.

On the basis of a goal-oriented concentration and specialization of forces and means, of a productive Combine strategy—where science and technique are the pivots of prospective development—and, beyond these, on the basis of comprehensive economic-organizational measures (especially the incorporation of significant potentials of microelectronics as well as of vacuum and high-vacuum techniques into the Combine's area of responsibility), a new Zeiss profile has developed along four strategic lines:

- Microelectronics

of a complexity ranging from the design of most highly integrated circuits, through the development of basic production technologies, all the way to the development and production of the most precise electronic machines;

- High Technologies,

such as laser technique, high vacuum technique, high performance optics, information transfer by light conduction, space technology, among others;

- Production of Optical Precision Instruments

with the traditional product lines: microscopic instrument-technique, analytical measurement technique, fine measurement technique, optical medical technique, measuring instrument technique, photographic measuring instrument technique, astronomical observation and projection techniques, among others;

- Consumer goods

with the product lines of phototechnique, eye glass lenses and frames, spy-glasses and telescopes as well as household glass.

These basic lines are in a close, interactive relationship, linked with outstanding possibilities for the development of productivity. Thus, in recent years, entirely new product lines were adopted by the Combine's development and manufacturing programs.

Currently, nearly 1,000 principal products are manufactured in 30 production areas which find use in almost all areas of research and study, as production instruments in industrial laboratories, in industrial manufacturing processes, in the construction industry, in agriculture and forestry, in geodesy and cartography, and are steadily gaining new domestic and foreign users also in nonindustrial areas such as the health system, popular education, environmental protection and, increasingly, also as consumer products of high value in recreation.

For the manufacture of optical precision instruments, the development and application of microelectronics and the other high technologies are of outstanding importance, because

- scientific instruments are the prerequisites for and the means of new knowledge in science and technology and form the basis for their technical-technological utilization in production and
- scientific instruments themselves are the objects of research and the application of high technologies.

The fundamental place of scientific instruments in the acquisition of knowledge is derived from the fact that, in the field of science and technology, obtaining and processing quantified data is a pre-eminent problem. Because of limited methodological possibilities, scientific-technological problems were often temporarily insoluble and became soluble only after the expansion of these possibilities through new observational procedures, experimental methods and measuring instruments based on new principles.

With outstanding instruments, new investigative methods in research became possible—for example, our Combine's laser impulse spectrofluorometer, LIS 201, the first automatic compact instrument in the world for laser-based ultra-rapid spectroscopy. The instrument makes it possible to study atomic systems where not only the energy states can be measured but also statements can be made concerning the time constants of the decay of excited energy states and the interactive processes which cause decay. The investigation of such processes with attained time resolutions under 10^{-9}s has far reaching significance because, within these time intervals, processes occur which are of decisive importance. Development of the instrument in close interaction with the analytic method to be applied—a characteristic of high technologies in order to secure highest effectiveness—was done jointly with the AdW [Academy of Sciences]. in contrast with the flash lamp instruments prevalent on the market, considerably higher excitation intensities can be achieved with the LIS 201 through the addition of a nitrogen-impulse laser. With the help of an additional distributed feedback dye laser, tuned ultrashort light impulses can be produced in a broad spectral range, the technological requirements being extraordinarily high.

With the LIS, fundamental work in the field of ultrafast spectroscopy, acknowledged worldwide, became instrumentally feasible.

The use of new scientific knowledge in production requires instruments and equipment which fulfill the following conditions, among others:

—very sensitive and accurate acquisition of geometric magnitudes—comprehension of temporally defined processes—measurement of material properties—production of microstructures—mastering increasingly complex arrangements and systems, especially the control of extreme conditions—securing and overseeing special production conditions and—comprehensive use of new communication techniques and of information processing.

As an example of an instrument which fulfills such industrial demands, let us mention the new two-coordinate measuring instrument ZKM 01-250 CM, the most efficient variant so far of the well-known ZKM series. This instrument encompasses in itself the experiences derived from the use of more than 600 of our two-coordinate measuring instruments the world over.

The measurement of geometric magnitudes remains the main component of manufacturing measurement technique also when installed in automated manufacturing systems with little operator involvement where higher measurement and evaluation rates and smaller measurement uncertainties are required in order to be able to make rapid decisions concerning the optimal formulation of the process step or a correction of process parameters.

With the ZKM 01-250CM, a guided precision instrument for use in the measuring laboratory, which employs for guidance and evaluation the workplace computer A 7150 of the ROBOTRON Combine, Dresden, various handling procedures are being used on the objects to be measured. The optoelectronic, direction-independent measurement installation Kreis-Kreisring objectifies the optical handling and thereby provides for the requirement for automatization of the optical measurement procedure.

A comfortable and universal software package serves as the processor of measurement data. The device permits programming in a learning mode as well as automatically repeated operation. The ZKM 01-250 CM is our most up-to-date coordinate measuring instrument with the highest precision and productivity and it embodies a further step in the direction of integrating the measuring process into the manufacturing process.

Characteristic for development and progress in the building of optical precision instruments is the unification of precision optics and precision mechanics, the increasing integration of microelectronics and computer technology, steadily more complex peripherals and the rapid growth in software.

The productivity of the modern instruments is mainly based on an optimal combination of different operational principles into an organic, closed, total conception.

Two examples from the instrument program of the Combine may clarify how, through the use of microelectronics, the introduction of new operational principles and their combination, new solutions arise which satisfy the highest user demands:

With the ZEISS-UNIVERSARIUM, a new type of planetarium was opened to the public at "Heureka," the Finnish science center in Vantaa, in April of this year.

With the addition of fiber optics, fixed star projection occurs, for the first time in the world, on the basis of a new operational principle. Using only 10 percent of the power of the fixed star light source, compared with the previous solution, 10-times more light will be transferred to the dome which is decisive for use in modern show planetaria.

The previous, mechanical coupling of projectors is replaced by the software guidance of various optical-mechanical drive- and brightness-regulating systems. Modular microcomputer guidances with a multibus and real time operational system are used to achieve astronomically correct function.

The principle of projection, together with software guidance, overcomes the principle-based limitations of the classical planetarium (geocentric presentation of all celestial phenomena in time frames close to the present, possibility of use exclusively in flat domes, necessary time for darkness adaptation of the viewer, loss of contrast when using light intensive projection media such as film, slide and video).

Compared with the great planetarium "Cosmorama," the number of individual parts could be reduced to about 70 percent and, through the use of modern software development tools (emulators) and higher programming languages, the cost of software development has not increased in spite of a massive increase in productivity.

Or—in aerial photographic technique, a considerable jump in performance was achieved in 1982 with the picture taking system of the Combine's aerial camera, LMK, characterized by the fact that the quality of pictures obtained under flight conditions approaches that of pictures taken in the laboratory. Through new operational principles and constructive solutions, it became possible to compensate for picture drift during exposure—a function of the speed and altitude of the flight and of the exposure time and the resulting blurring,—and thus to exploit fully the high performance of the high-performance objective, improved by new computational and production methods and also new optical glasses (in connection with high-resolution photo material). The film is moved during exposure translationally with the projected picture. The corresponding compensation velocity is determined by a microprocessor. Thereby new possibilities of aerial picture taking technology were opened for various national economic tasks.

Additionally, the new aerial camera, LMK 2000, eliminates the effect of rotational oscillations of the airplane which occur in the case of air turbulence. For this, a gyro-stabilized suspension for the camera was developed. Dynamic position changes are measured and are compensated for through an electronic regulating amplifier and hydraulic positioning elements.

Both solutions, compensation for picture drift and dynamic stabilization, are novelties the world over for commercial aerial photographic instruments.

The examples make it clear that, by mastering high technology, a new quality is being achieved through the synthesis of optics, mechanics, microelectronics and software.

This development is illustrated in Figure 4 with selected technical parameters which characterize a multitude of instrument-technical functions of precision optics, microelectronics and precision mechanics, and determine the utility level of the instruments.

The data represent currently achieved and prospectively achievable international peak values which are consistently realized in the products of the combine.

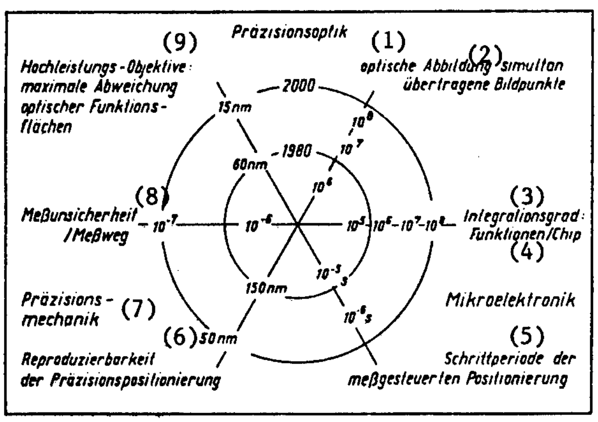

Figure 4. Currently achieved and prospectively achievable technical parameters for a multitude of instrument-technical functions of precision optics, microelectronics and precision mechanics, which determine the utility level in instrument production (from: "Carl Zeiss JENA—Roads Into the Future")

Key:—1. Precision optics—2. Optical image of simultaneously transmitted picture dots—3. Degree of integration: functions/chip—4. Microelectronics—5. Step period of measurement-guided positioning—6. Reproducibility of precision positioning—7. Precision mechanics—8. Measuring uncertainty/measuring path—9. high-performance objectives: maximal deviation of optically functional surfaces

High technologies are the essential foundation for principally new products and also their fields of introduction and cases of utilization, mainly new needs and markets. Their deployment ensures that, in the production of optical precision instruments, the trends of scientific-technical development,

- rapidly growing information volume
- rising degree of automation
- usage-dependently increasing interweaving of measurement technology and production technology

will be realized.

New operational and work principles and new materials provide the conditions for a closer approach to the limits of physical possibilities and offer the user greater effectiveness for his process.

Microelectronics assumes a key position in all this. Within a few decades, it has broken through internationally faster and more comprehensively than all of the fundamental innovations coming before. The information technology that emerged on the basis of microelectronics makes it increasingly possible that complex functions, which until now had been carried out by people, are transferred to technical systems. In the building of optical precision instruments, microelectronics opened up qualitatively new possibilities for rational information processing. Thereby it became a determining component of the productivity of optical precision instruments.

The products are increasingly being conceived and implemented from the point of view of information processing, that is, service, internal construction, and application are largely determined by it.

The achievable increases in utilization value, through modern microelectronics, have their effect in the following directions:

—additional increases in the degree of automation, interactive capability, and "intelligence"—increase in the rate of work and productivity—broadening the range of application, especially through appropriate software—further energy saving, mass and volume reduction.

The structuring of the Combine for increasingly demanding tasks in microelectronic production also opened up completely new possibilities for its use in the products of the manufacture of optical precision instruments. The availability of highly integrated circuit families, user-specific electronic components, hybrid- and optoelectronic components, microcomputer systems and additional material-technical components—all of them developed and produced by us—makes it possible to incorporate tailor-made microelectronic components. That is of decisive importance because in part, extremely specialized electronics is typical for optical precision instruments. The electronics which can be produced in this manner is characterized by increasing functionality and complexity, and also by high reliability. With further miniaturization, energy and mass reduction, the possibility is increasingly there to integrate the electronics into the products. The mastery of the highest integration of microelectronics will thus become the decisive problem in transferring the scientific-technical progress into instrument building. Thereby microelectronics itself will be effectively promoted in its entire further development through the making of optical precision instruments—through the highly advanced special technological equipment for the development and production of functional microelectronic elements.

The enormous advances made in microelectronics during the past few years did not push optics aside, as it had been variously predicted, rather—quite to the contrary—they created outstanding conditions for new developments in optical fields and gave impulses to principally new optical developments. Examples are: the laser, the modern optical radiation receivers, color-capable picture sensors, low-loss glass fibers for optical information transfer, optical high-performance imaging systems developed on the basis of efficient computers, among others.

As a source of precision, optics remains a "supporting column" of optical precision instrument production.

Based on its ability to transfer, nearly simultaneously, very large amounts of information, optical imaging will retain its eminent place among the optical methods also in the future. The necessary performance increase of optical systems will be possible through an expansion of the useful spectral range especially toward shorter wave lengths and through aperture increases. The imaging faults associated with it must be suppressed by splitting the imaging systems into multilens systems (a high performance objective for transmitting structures in the submicrometer range contains over 20 lenses). Therefore, the picture quality which can be achieved in practice will be largely determined by extremely narrowed tolerances in the production of optical components and their assembly. For the manufacture of high-performance optics, special high technologies were developed in the Combine, including the required machine technique and precision testing instruments. Examples are computer-guided polishing refinement, the interferometric precision measurement of surfaces, an automatic centering technique, the optical precision measurement of thicknesses, lens distances and excentricities, without contact with the object, the computer-supported assembly and the wave surface analysis.

A peak achievement of the tradition-rich ZEISS measuring-machine manufacture, for incorporation into the Combine's own production, is the digital interferometer for precision measurements on modern, high-performance optics, without contact with the object, where the precision achievable with conventional interferometric methods is no longer sufficient.The digital interferometer measures with an uncertainty of less than lambda/50 in quasi-real time.

The Combine VEB Carl Zeiss JENA carries on in a goal-oriented manner with the proven, progressive traditions of more than 140 years of making optical precision instruments. Throughout its history, optical precision instruments have always served as a catalyst for scientific-technical progress. Through the making of the products responsive to the demands of research and industry, especially of high technologies, and also through the use of high technologies, this catalytic function becomes further pronounced, on the one hand, and, on the other hand, new, higher demands on the dynamics and flexibility of the development and production of optical precision instruments arise. Optical precision instrument manufacture and high technologies form an inseparable unity.

GDR: Hybrid Circuits from VEB Ceramic Works Hermsdorf Described

90CW0070A East Berlin MIKROPROZESSORTECHNIK in German No 10, Oct 89 pp 298-299

[Article by Dr. Bernd Racurow of the Combine VEB Ceramic Works Hermsdorf, Microelectronics Enterprise: "Hybrid Circuits From Hermsdorf"]

[Text] The Combine VEB Ceramic Works Hermsdorf is the central producer of hybrid circuits in the GDR. This means that it is faced with the task of producing hybrid circuits for primarily multivalent use and of fulfilling customer-specific requirements with highly productive technologies. In contrast to the international trend, thin-film technology has been preferred over thick-film technology at Ceramic Works Hermsdorf. It has been demonstrated that highly effective mass production of high-precision resistance networks is possible with a resistance tolerance of 0.1 percent in a value spectrum from 0.1 KΩ to 1 MΩ and a relative tolerance of 0.01 percent at a TK_R of greater than or equal to 10 ppm/K and a relative TK_R of 1 ppm/K. Structuring and resistance compensation are performed with the electron beam at a very high level of productivity. For a resistance network on glass with 10 resistors, 2.5 s is needed. At present, eight million resistance networks are produced each year in thin-film technology on glass using evaporation technology.

It was only consistent with this that this leading position in thin-film technology would promote the development of hybrid circuits with high standards in terms of precision and the stability of the electrical parameters.

In 1981, work was begun on producing a digital-analog converter with resolution of 15 bits and a linearity of 0.1 percent for use in CNC controllers. Because of a new type of circuit technology for the power source, an extraordinary degree of circuit stability was achieved, so that a linearity of 0.1 without functional compensation was guaranteed only by mounting precompensated resistance chips on glass with the semiconductor chips on a thick-film baseplate.

In 1983, this was followed by a 12-bit D/A converter according to the same principle, for standard applications. The DAC 32 model requires only minimal functional compensation, which takes an average of 3 minutes. In 1984, an instrumentation amplifier was developed that meets the highest standards in terms of the temperature dependency of the electrical parameters with MAA 725 (μA 725) chips. In the same year, in order to round out this line of precision circuits for analog peripherals of microcomputers, a 12-bit A/D converter and an isolating amplifier in the 0.1 percent precision class were included in the production program for an insulation voltage of 1 kV according to the principle of flyback modulation, with a printed transformer.

Since 1980, the limits of thin-film technology on glass with evaporated layers have become increasingly clear. Glass is a relatively poor conductor of heat, so that increasing the degree of integration of the resistance network and of applications with higher power conversion even further in thin-film technology has required the use of new substrate materials, such as passivated silicon and ceramics. Thus, in 1984, high-rate sputter technology was introduced. The "Manfred von Ardenne" Institute, with which our enterprise has had successful cooperative ties for many years now, provided the computer-controlled system for this. Resistance chips on passivated silicon are used with a temperature coefficient of less than or equal to 5 ppm/K and a relative coefficient of less than or equal to 0.2 ppm/K in a D/A converter with precision of up to 16 bits. In 1986, the DAC 4071, a model compatible with the internationally known DAC 71, with a resolution of 16 bits and a linearity of 14 bits, was included in the production program. At present, a genuine 16-bit converter is being developed. By using the principle of digital correction, the 16-bit linearity can be compensated at any time using an additional memory in which the correction values are stored digitally. Sputter technology on unglazed and glazed thick-film ceramics opens up completely new potential applications. It is possible to produce resistance networks that in the past were possible only with noble-metal pastes, and networks for thermal printing technology are being produced on glazed ceramic. In this technology, ultra-fine structures with eight picture elements per mm are the goal of developing networks for thermal printing heads. It should only be mentioned that the necessary abrasion protection layers (SiO_2 and $CrSiO_x$), which prevent premature wear and tear on the heads, are also sputtered.

Naturally, there are also applications under the conditions of thin-film technology, which is more productive than the international standard, that can be practically produced only with thick-film technology or a combination, meaning thin-film R chips. While internationally the ratio of thick-film to thin-film applications is around 80 to 20, we diverge from the norm at 60 to 40.

On the basis of thick-film technology in keeping with the international state of the art, products have been developed that take advantage of the benefits of thick-film technology in a special way, including controlling higher power dissipation, high impedance, and multilayer technology, to name only a few. Compared to SMD (surface mounted device) technology on printed circuit boards, the possibility of function compensation (active trimming) is also a significant advantage. Key products in thick-film technology are produced primarily with SMD-based components, especially transistors in SOT 23 and SOT 89 packages, and with ICs in SO packages and in chip carriers.

Our enterprise has distinguished itself in applying thick-film technology in the areas of medical electronics and automotive technology in particular.

After first- and second-generation hybrid circuits for heart pacemakers, production was begun in 1988 on two third-generation hybrid circuits (single- and dual-chamber variants). In the 1990s, there will be fourth-generation hybrid circuits that will make it possible to adjust heart frequency using sensors.

Hybrid circuits for automotive alternators can be produced advantageously with thick-film technology. Through functional compensation, the nominal voltages can be adjusted to 14 V or 28 V. Control components for electronic four-stroke ignitions were put into production.

The productivity and reliability of microelectronic technologies, and naturally of hybrid technology as well, were significantly influenced by automated assembly processes. In cooperation with VEB Elektromat Dresden (enterprise in Combine Carl Zeiss Jena), the fully automated VADB 60 wire bonder was developed. It uses the teach-in process to make it possible not only to assemble a chip under fully automated conditions, but also to bond all chips in a hybrid circuit while maintaining the given mounting tolerances. A maximum of 400 bond bridges can be contacted in a hybrid circuit, with an average productivity of 3,000 bond bridges an hour.

It seems reasonable to think that automated assembly technologies for SMD components and for chips could be used to produce highly integrated wiring carriers, which have greater structural density (less than 50 μm) as thick-film multilayer circuits and thin-film single-layer circuits. The transition to wiring carriers on the basis of thick-film copper pastes and to thin-film multilayer technology is in keeping with international developments. One application of wiring carriers is that of hybrid memory with very high integration. In 1985, production of static CMOS RAMs with a memory capacity of 32 Kbit began. In 1989, several thousand dynamic 1-Mbit memories will be produced on the basis of 64-Kbit chips. At the 1989 Leipzig Spring Fair, samples of 4-Mbit memory units on hybrid circuit carriers were presented that consist of 16 256-Kbit chips or four 1-Mbit chips. They demonstrate the potential for hybrid technology in terms of very high component density and integration.

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