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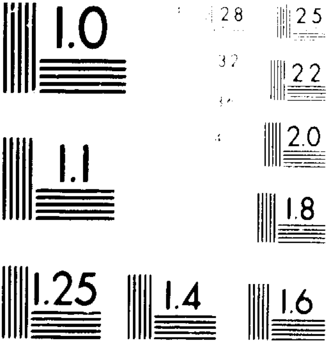

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MICROELECTRONICS MONITOR

No. 10/11 14568 April-September 1984

Dear Reader,

Whatever our good intentions were to produce a summer issue of the Microelectronics Monitor, this proved to be impossible in view of concentrated efforts towards holding the Fourth General Conference of UNIDO which took place at Vienna from 2 to 19 August 1984. You will find a report on items of interest to our readers that came up during the conference deliberations in these pages.

UNIDO's efforts to promote regional co-operation in the field of microelectronics are continuing. A plan for joint action has been elaborated by the Economic Commission for Western Asia (ECWA) and UNIDO following the expert meeting on microelectronics in the ECWA region held in March 1984, on which we have reported in the previous issue. ECWA will be the focal point for activities in the region such as arabization and CAD/CAM training programmes while UNIDO will concentrate on programmes on industrial controls as well as the establishment of a silicon foundry and design centres. Also, UNIDO will assist ECWA in launching a regional awareness bulletin on microelectronics.

Efforts for the establishment of a regional network for microelectronics in Latin America are proceeding. A meeting is planned for spring next year, to be hosted by Venezuela, establishing the network and the provisional modalities of its operation and identifying the work programme of the network.

At the invitation of the Government of Kenya, a national meeting will be organized by UNIDO in February 1985 to help draw up a programme of action for microelectronics development in Kenya. Representatives of some other East African countries will also participate. Some of the organizations which participated in the Discussion Meeting on Information Technology for Development organized by UNIDO in March 1984 will also participate and exhibit some illustrative products developed by them.

A state-of-the-art series on microelectronics in selected developing countries has been initiated by UNIDO and the first five volumes in this series are available (vid. section on recent publications).

The UNIDO international roster or referral system of scientists and technologists is under preparation. Four areas have initially been chosen, i.e. genetic engineering/biotechnology; microelectronics; biomass-industrial conversion; and photovoltaics. Suggestions of names of outstanding scientists in any of these areas who may be able to assist developing countries through visits, training, fellowships etc. are welcome.

G.S. Gouri
Director
Division for Industrial Studies

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NEWS AND EVENTS

Fourth General Conference of UNIDO, Vienna, 2-18 August 1984

The Fourth General Conference of the United Nations Industrial Development Organization (UNIDO) was held in Vienna, Austria from 2 to 18 August 1984. It had been preceded by high-level expert group meetings on major topics of the Conference, one of them being the International Forum on Technological Advances and Development, held at Tbilisi, USSR in April 1983, which had also looked at the developments of microelectronics as one of the technological advances most likely to have implications on every walk of life. The consensus there had been that the importance and relevance of microelectronics was such that the question was not whether microelectronics should be introduced in the developing countries but how. It was also agreed that the technology was complex in regard to manufacture of chips but relatively simple as regarded applications. In this connection, the meeting was of the view that a major factor was the direct impact of microelectronics on the quality of life through applications which could improve, for example, public health and educational levels in a country. A concept of "technologies for humanity" was formulated at the International Forum proposing a new form of international co-operation in selecting a limited number of advanced technologies - microelectronics to be one them - and developing and disseminating these technologies to meet needs of a clear urgency to mankind.

The agenda of the Fourth General Conference of UNIDO (UNIDO IV) included, *inter alia*, the subject of strengthening the scientific and technological capabilities for industrial development in developing countries. When this item was discussed the UNIDO secretariat drew attention to the changing technological world scene and the consequent need for the developing countries to rectify past deficiencies and to come to grips with the new situation. As technological advances were expected to affect a wide range of industrial sectors, it was necessary for each country to reduce to a minimum the adverse consequences of these advances and to maximise their benefits through a selective and differentiated policy adapted to its own requirements.

In the ensuing discussion UNIDO's programme in microelectronics was commended and support was expressed for promoting the establishment of regional and international centres for selected advanced technologies as well as the networking of existing institutions in the respective regions. Developing countries may identify gaps in existing arrangements with a view to considering setting up national, regional and interregional centres and networking existing facilities including research and development institutions.

The Conference recognized that the new technologies will have a wide-ranging impact on industrial development and endorsed the importance of strengthening scientific and technological capabilities for industrial development in developing countries; it urged UNIDO to assist developing countries in building their technological capabilities in different fields of technology including the setting up of national groups to monitor and assess technological trends and the changing international market and promote the building of core groups or institutions in selected technological advances. The present information explosion was also noted; in this connection UNIDO's Industrial and Technological Information Bank (INTIB) was requested to help developing countries in handling and processing technological information and also make its own information available to developing countries.

The concept of "technologies for humanity" as presented to the Conference was generally supported in regard to its objectives and there was agreement that appropriate technologies including advanced ones should be promoted and developed to meet particular needs of clear urgency to mankind.

UNIDO "marriage broker" turns to microcomputers for productivity

Our readers were introduced to the Computer Feasibility Analysis and Reporting System (COMFAR), which supports the preparation of industrial feasibility studies, in issue No. 7. Now UNIDO has an additional microcomputer-based tool to facilitate investment promotion. The Project Profile Screening and Pre-Appraisal Information System (PROPSPIN) will help speed the flow of industrial investment to developing countries on equitable terms.

The UNIDO Investment Co-operative Programme and its global network of Investment Promotion Services handle hundreds of industrial investment opportunities every year, often with gratifying results. The Investment Co-operative Programme distributes a brief project profile for each investment opportunity to inform and stimulate interest among potential investors and to match them with project sponsors. These project profiles are the main stock in trade of the Programme, and their quality largely determines the results of promotional efforts. Over the years the Investment Co-operative Programme has revised the content of its project profile several times, in agreement with financial institutions such as the International Finance Corporation, in an effort to standardize project preparation and satisfy the increasingly discriminating needs of promoters, investors and financial institutions. Finally, in mid-1983, a new format was issued which permits collection of enough project data (about 50 numerical entries) to support preliminary examination of the projects. When the necessary information is provided the project can be screened to ensure that it is at least prima facie bankable. This greatly increases a project's promotability.

But it would be impossible for the Programme staff to handle this additional analytical work-load - even selectively - without increasing its already substantial reliance on computers. For some time the Investment Co-operative Programme has been using computers to operate its Investment Promotion Information Service, which now comprises four separate data banks covering active project opportunities; prospective investors and the resources they offer; a classified directory of investment-related institutions; and industrial financial institutions. A fifth roster is under preparation: the storage of public and private partners (sponsors) within developing countries. A computer is also used for dynamic scheduling of individual meetings between project sponsors and investors during the major investment promotion meetings, which are held several times each year.

In October last year, an in-house team began development of PROPSPIN. The system has been in use on a production prototype basis with complete documentation since mid-January 1984. A sampling of investment projects, from pesticides and fruit processing to special steels and hollow glass, have served as test cases. The results were used to negotiate improved offers from equipment suppliers, and several portfolios have been prepared for examination by a prominent development bank. PROPSPIN is a simple yet powerful project analysis tool. It is based on widely used electronic spreadsheet software, operating on a variety of inexpensive portable and desk-top microcomputers. The system can help project sponsors and promoters to organize and speed the preparation of a credible and verifiable profile for a proposed industrial investment project. The data required, in addition to investment figures and other financial estimates, are physical quantities such as material and energy consumption, process yields and employment figures. The key design feature of PROPSPIN (besides flexibility and low cost) is its integrated structure: both the physical inputs and financial consequences are displayed on the same report schedules. Thus a PROPSPIN report is a self-contained quantitative profile on the project, within the limits of its capacity. (The project may be for a new manufacturing unit or for modernizing, rehabilitating or diversifying an existing enterprise). The system requires only minimum input (about 50 numerical entries) and thus lends itself to quickly screening a number of project project proposals to select those worthy of serious attention. In the process, it also highlights cost elements, inefficiencies and assumptions that may endanger successful project completion if undetected. Thus PROPSPIN encourages early identification of necessary design changes and supports effective negotiations with suppliers and prospective investors.

The system accepts both "hard" data and the results of rough estimates or assumptions. The operator can use built-in formulae and rules (depreciation rates, inventory levels etc.) for the analysis or can substitute others to better suit the project being developed.

For effective use PROPSPIN requires:

- Basic physical and financial data on the proposed investment project, with or without detailed studies;
- A portable or desk-top microcomputer equipped with one of the widely available electronic spreadsheet (financial planning) programmes, normal floppy disk storage and a printer, with a gross total weight of about 15 kilograms (light enough to be carried as baggage on aircraft) and costing $2,000 to $3,000 or more;
- A copy or customized version of the PROPSPIN analysis tables, suitable for the selected computer system;
- A user familiar with project analysis;
- An operator familiar with the microcomputer and spreadsheet programme being used. A junior non-professional can be easily trained.

The system's outputs are presented in the form of a series of reports that can be viewed on the screen of the microcomputer or printed. At present, PROPSPIN can produce the following (in English or French versions):

- An investment table and a period-by-period analysis of depreciation and amortization, with separate tabulations of the proposed capital structure and debt service arrangements, including grace periods, dividend obligations etc.;
- An operations analysis presenting unit sales and capacity utilization figures as well as clearly displaying the calculation of operating costs, energy consumption, physical process yield etc. for ease of checking and eventual changing (varying);
- A proforma income statement summarizing major operating cost items; a balance sheet; and a cash-flow table for whatever operating conditions are specified;

- A ratio analysis schedule presenting a wide variety of standard project analysis measures: e.g., debt service coverage, internal rate of return, break-even point, capital intensity and investment per job created;
- Quick answers to any number of "what if" questions (sensitivity analysis) reflecting possible variations in prices, capacity utilization, choice of equipment, interest rates, maturities, labour rates, taxes, scrap rates etc.;
- Special summary sheets, subsidiary analyses and institutional labels, as defined by the user.

As always, the quality of the reports will reflect the quality of the data and assumptions and judgements entered or imputed. The system can just as easily display the results of bad inputs as of good ones. Furthermore, in order to preserve ease of use, some simplifying assumptions have been employed in constructing PROPSPIN. Thus, there is no substitute for seasoned judgement and specific industry experience in interpreting the results. Finally, PROPSPIN complements - but is not a substitute for - careful investigation of economic, commercial and technical aspects of a proposed investment project through market analysis and other types of pre-investment studies.

PROPSPIN does not possess the same comprehensive nature as COMFAR, which fully reproduces the structure and content of the Manual for the Preparation of Industrial Feasibility Studies. PROPSPIN is complementary to COMFAR since it offers a fast and low-cost means of screening project proposals to decide which of them would justify the cost of a full feasibility study. It can also be used for quick low-cost pre-appraisal of the project before formal submission to a financial institution. Development finance institutions may also want to evaluate PROPSPIN as a customized project appraisal aid.

PROPSPIN has not yet been released for widespread installation. However, development banks and other institutions interested in industrial investment projects may wish to have advance information on the technology being employed in order to orient their own efforts. In such cases, additional documentation on the system may be requested from the UNIDO Investment Co-operative Programme.

A few field trials will be organized this year where necessary equipment and skills can be made available by the user. A "starter kit" has already been dispatched to one South-East Asian country, and preliminary discussions are underway in at least two African countries. In the meantime, the Investment Co-operative Programme will continue to refine its match-making techniques, with a productivity boost from PROPSPIN. (Reprint of an article in UNIDO Newsletter).

APO Symposium on Computer Application in Manufacturing Operations

A staff member of the Technology Programme of UNIDO attended the Symposium and reported as follows:

The Asian Productivity Organization (APO) organized a Symposium on the Application of Computers in Manufacturing Operations in collaboration with the Hong Kong Productivity Centre (HKPC) from 28 May to 1 June 1984 in Hong Kong. This was the third in a series of computer-related international forums (computers in public administration 1977 and computers in office automation 1978) conducted by the APO. In response to the growing demand for effective small batch production with wide variety of products, the symposium intended to examine various forms of factory automation through the use of computer-based NC machines, robots, machining centres, flexible manufacturing systems etc. The countries represented included Bangladesh, Republic of China, Hong Kong, India, Indonesia, Japan, Republic of Korea, Malaysia, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka and Thailand.

In his opening address APO Secretary General, Mr. Hiroshi Yokota, mentioned that recent developments of computer technology had been making a great impact on factory automation and hoped that experiences from Japan and NICs would provide valuable insight into the computer applications to manufacturing operations in Asia. Noting that the application of computers in the manufacturing sector is still at an embryo stage in most Asian countries, Mr. Yokota said manufacturers should ensure that the various forms of automation can actually effect economies in the manufacturing operations. "This means that there is need to carefully assess the extent to which computers could be applied to manufacturing operations with the aim of increasing productivity, with due attention to human, social and organizational problems, prior to their production". Nowadays, manufacturers are under pressure to supply high quality goods at the lowest possible costs due to intensive competition in international and domestic markets. Market demands tend to be increasingly diversified and advanced which consequently need more complex and hence cost-increasing production systems. Such being the situation, Mr. Yokota said manufacturers should recognize that increasing costs of labour, energy and other resources are inevitable and should find solutions to the problems. "Recent developments of computer technology in the field of micro-computers for instance, have had a significant impact on factory automation. Compactness, ease of operation, improved reliability and multi-functional applications, not to mention low costs, are the essential factors behind the high growth in the use of micro-computers as a tool for solving the manufacturers' problems, for meeting the market demands and in turn for increasing productivity."

The summary of presentations, main findings and conclusions of the symposium is as follows:

1. Overview: Computer applications in manufacturing process and its future

Computers have made a strong impact on manufacturing. Rapid progress of the microprocessor technology put flexibility and intelligence on equipment and machines used in the manufacturing process. The computer application systems developed and used from the '60s are being integrated into a total application system: CIM. The computer integrates manufacturing organizations by networking and the use of a common data base.

Computers have become the survival tool of manufacturing to ensure highly productive and flexible manufacturing systems. This means the appropriate training programme to provide manufacturing engineers with computer mind and skills is to be developed and implemented. Collaboration is necessary among government, university and private company. The government should give financial and administrative support; university has the main role to develop and implement the education programmes; industry should support the university and engineers in various ways. The future of manufacturing depends on the use of computers. Small and inexpensive microprocessors are expected to realize highly productive and flexible manufacturing systems at a low investment if sufficient knowledge of their applications to manufacturing systems is available.

2. Flexible manufacturing systems and robots in advanced factories

A new trend in automation, which differs from automation in mass production and is called FA (factory automation), can be observed in Japanese industries. According to the extension of computer networks in companies, various attempts have been made in order to increase productivity and flexibility of manufacturing processes, especially in the field of low volume production with diversified products. Then, the word "FA" means also flexible automation or flow automation. There is a number of technological topics in FA, such as CAD/CAM, FMS (flexible manufacturing system), industrial robots and microelectronics; all those topics are complementary to one another. The FMS is viewed as a core of FA for small batch production. And the application of FMS has been increasingly popular in recent years, reflecting the growth of a wide variety of technologies including, CNC, DNC, AGV (automatic guided vehicle), machining centers and so on.

In Japan, annual productions of machining centres, NC lathes and industrial robots amounted to about Y 15 billion each in 1981. And now, the market of industrial robots is rapidly growing. Over 100 FMSs are now in operation in Japan, with many FMCs (flexible manufacturing cells) each of which consists of one CNC machine tool, one ATC (automatic tool changer), one APC (automatic pallet changer) and stockers for tools and workpieces.

There are three typical types of FMS, namely: the FMC shop, the typical FMS and the FTL (flexible transfer line). Judging from a survey of over 50 FMSs in Japan, those three types are applied to different situations according to required flexibility and volume of production. The most popular products to which FMS is applied are the diesel engine, the machine tool, the transmission, the compressor and the pump/valve, with the average number of machine tools included in one system equal to around 6. As for the control system of FMS, CNC/DNC is most popular and convenient where CNC machine tools and other equipment are controlled by a central minicomputer. However, the step-by-step installations of FMCs can be recommended in case of automation of small-size factory or if greater flexibility is expected in future. In addition, the introduction of FMS usually resulted in 80% reduction of direct workers, 80% reduction of machine tools, 80% reduction of throughput times of parts and 150% increase of operating time on the average. FMS can also extend the life of production facilities beyond current objectives. In order to cope with the dynamic change in products, production quantities and production circumstances, the application of well-suited FMS plays a dominant role.

State-of-the-art microelectronics series

UNIDO has initiated a series of state-of-the-art reports on microelectronics in developing countries with specific emphasis on opportunities for regional co-operation. Reports completed so far and due to be published soon cover (in the order of their expected publication) Venezuela, India, Korea, Pakistan, Bangladesh and selected countries of West Asia and North Africa. Based on these papers an overview has been prepared as part of the series looking at the technical, economic and policy aspects of the reports and drawing conclusions which have general applicability to developing countries.

International project funding

The International Development Research Information System (IDRIS) is a pilot project for sharing project information by a computer system. It has been set up by six agencies, International Development Research Centre (Canada), International Foundation for Science (Sweden), Swedish Agency for Research Co-operation with Developing Countries, Netherlands Universities Foundation for International Co-operation, German Appropriate Technology Exchange, and the Board on Science and Technology for International Development (USA). It will be evaluated and may be expanded. (Outlook on Science Policy, Vol. 6, No. 2.)

Getting the Show on the Road

The first meeting of the ACCIS * Technical Panel on Computer-Based Communication Services met in Geneva from 8-9 March 1984 at the headquarters of WHO, the panel's lead agency. Under discussion were existing and potential telecommunication links available for use by the UN system. The main objective was to establish a detailed work programme for the panel and to formulate specific tasks to be carried out before the second session of ACCIS (i.e. autumn 1984). The panel looked at five main areas of activity: links between the various UN organizations; outside access to UN databases; electronic messaging; awareness seminars and local area networks (LANs). (ACCIS Newsletter (2) 1, 1984).

Micros in Focus (3): Habitat's Micro Workshops

Since the March edition of the ACCIS Newsletter we have reported on early stirrings within the UN system vis-à-vis the ubiquitous micro. In this issue we take a look at a micro training package which has been put together by the UN Commission on Human Settlements (UNCHS/Habitat). Anticipating that microcomputers will play an important role in human settlements planning, UNCHS (Habitat) has sponsored the development of a micro training package, the purpose of which is to facilitate the transfer of microcomputer technology to developing regions of the world. The package is intended to provide all training materials necessary for a 2-week workshop on the use of microcomputers for data management. "Hands on" experience is a key feature of the workshop.

In the workshop, micro systems use the Urban Data Management Software (UDMS) program developed by Habitat, and participants benefit from the workshop in the following ways:

- each participant becomes familiar with the contents of the handbook on data management for urban and regional development;

- each participant gains a working knowledge of microcomputer applications to data management;

- each participant has the opportunity to conduct data management operations on a data file of his or her own creation; and

- each participant is able to evaluate the new data management techniques in the context of his or her own development problems. (ACCIS Newsletter (2) 2, 1984)

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News from Cogit Members

(Readers may remember the UNIDO-sponsored meeting on Information Technology for Development earlier this year on which we reported in issue No. 9. The meeting recommended the establishment of an open-ended Consultative Group on Information Technology, COGIT).

UKCCD ** sponsors Advanced Management Course for Developing Countries

The first UKCCD Advanced Management Course for Developing Countries took place at the Polytechnic of Central London during June and July 1984. The course, which was supported by UNESCO, attracted delegates from Egypt, Ecuador, India, Saudi Arabia, Singapore and Tunisia.

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* Advisory Committee for the Co-ordination of Information Systems.
** UK Council for Computing Development.

The course theme was the establishing and managing of Information Technology Training Centres, with the objective of equipping participants to assess their future national requirements for computer and IT training followed by them setting up and managing the operation of a major training establishment in their own countries. The course would also provide participants with points of contact within their major UK counterparts, which would open the way for subsequent advice and support. In order to achieve these objectives the seven week course was structured into alternate weeks of working visits to important training centres and weeks of full-time lecturing and tutorial periods. In addition to the formal lectures given by PLC staff, twenty outside lecturers were invited who represented the broad spectrum of computer training in the U.K. This gave the opportunity for participants to discuss issues of concern in a seminar atmosphere and establish personal contact. The programme of visits to typical training establishments was very extensive. It included private training firms; company in-house training, semi-public institutions such as NCC; Government in-house training, computer industry training and a number of public educational establishments, including the Open University. At the end of the course delegates each prepared a National Strategy for IT Training Plan, which were presented to a panel consisting of the Course Steering Committee.

Computer Systems Procurement '84 Organized by UKCCD

Around 200 delegates mainly from Egypt but also from the Middle East, Europe and North America attended the 'Computer Systems Procurement 84' conference in Cairo in April. It was organised by the Central Agency for Public Mobilization and Statistics (CAPMAS) of the Arab Republic of Egypt in conjunction with UKCCD, and was opened by the Prime Minister, Dr. Ahmed Mohieldin. The modern fully equipped CAPMAS Conference Centre enabled proceedings to be conducted in both Arabic and English and proceedings revolved around the UKCCD working paper 'Report on Procurement Methodology'. This looked at the issues which had to be dealt with if computer systems were to be procured satisfactorily and economically and were subsequently going to work successfully.

Each morning there were presentations and case studies; issues were presented; more case studies to illustrate those issues and lastly the papers were discussed by the speakers panel, with comments and questions from delegates generally. The afternoons became, in effect, workshops related to the presentations given in the morning and short invited papers were given which focussed discussion. Finally rapporteurs were appointed who made their reports at the opening session of the following day. The topics covered moved through from national computing policy to system studies; proposals and their evaluation; tenders; contracts; project management and control of changes. Whilst it was essentially a consideration of the procurement of large systems where considerable sums of money are involved there was much interest and discussion relating to microcomputers, where the procurement process is somewhat different.

(UKCCD is planning to publish a "Report on Procurement Methodology" which will include papers presented by the UKCCD contingent. The proceedings, in Arabic are to be available in due course from CAPMAS, PO Box 2086, Nasar City, Cairo).

BOSTID plans a symposium on microcomputers for management and science

The Board on Science and Technology for International Development (BOSTID), National Research Council, USA plans a symposium on the use of microcomputers for management and science to be held in November 1984 in Sri Lanka. The symposium will review the state-of-the-art uses of microcomputers in addressing developing country needs. The first of four major symposia, it will highlight current applications in three end-use sectors, agriculture, health and energy. Participants will also look to future applications as well as begin to probe the major policy issues important to donors and governments. Principal end use application sectors to be discussed will be agriculture, health and energy. Symposium participants will be selected for their expertise rather than as formal representatives of organizations and governments in order to be able to exchange substantive information, reach collective judgements on technology choice, review developments in application software and recommend policy directions.

International Federation for Information Processing (IFIP)

In addition to ICID - IFIP Committee on Informatics for Development - which we introduced in our last issue, a Subgroup on Messaging For Developing Nations may be of interest to our readers in developing countries. The Subgroup was instituted by IFIP Working Group 6.5 in 1981 and its three co-chairmen come from Brazil, India and Tunisia, respectively. Problems of computer messaging peculiar to developing countries include the diversity of local conditions that must be accommodated (e.g. language and telephone systems) and the high cost of communications (due both to low geographical density of users and to low usage of communication systems). These problems were looked at a working conference on

Regional Computer Co-operation in Developing Countries, held in September 1983 in Sweden and sponsored by ICID. The proceedings of this workshop are available from Elsevier/North Holland. The same issues were addressed at AFRICOM '84, the first African Conference on Computer Communications, held in May in Tunis. Proceedings will also be available from North Holland.

The application of messaging technology to the special needs of developing nations has been an important subject for IFIP WG6.5 since its inception. One important application is the use of electronic messaging between research institutions in developing countries and developed countries. Travel funds are severely limited for researchers in developing nations. While electronic messaging cannot substitute for all travel, it is a significant aid in maintaining daily (and often more frequent) discussion among widely separated researchers who were working together. Another application area involves introducing messaging technology directly into the domestic communications infrastructure of developing countries. However an analysis showed that while electronic messaging technology to internal domestic communications could be quite attractive, most such applications would require a significant capital investment. The Subgroup's activity for Latin America began with a workshop held in October 1982 in Rio de Janeiro, Brazil. The workshop decided that the best way to initiate a programme was to institute a pilot project using electronic messaging on a data network as a research tool. A pilot programme has been developed on a computer at a federal university in the state of Rio Grande do Sul, Brazil. Initially this network is to be assessed by researchers at other universities and research institutes throughout the state, using microcomputers coupled to the public voice network. As soon as possible the project is to be extended to universities and research institutes outside of the state and eventually to other Latin American countries.

Clearinghouse on Development Communication, 1255 23rd Street, N.W. Washington, D.C., 20037 USA. Although they were unable to be represented at the UNIDO meeting on information technology for development, they contributed a paper and are supporting COGIT's objectives. The clearinghouse is operated by the US Academy for Educational Development, a non-profit planning organization. It acts as a centre for materials and information on important applications of communication technology to development problems and is supported by the Bureau for Science and Technology of the US Agency for International Development as part of its programme in educational technology and development communication. It publishes the Development Communication Report, which is issued on a quarterly basis and is available free of charge to readers in the developing world and at a charge of US$10 per year to readers in the industrialized countries. In its recent summer issue it reports a new AID-funded Clearinghouse on the management applications of microcomputers for development. Its purpose is to disseminate information to people in developing countries - especially people working in small businesses and development-related institutions in the public sector - about applications, software and hardware, training and infrastructure. For this purpose the new clearinghouse has already begun publication of MC Newsletter. In addition, the Microcomputer Clearinghouse hopes to be able to develop a network of micro users who can provide technical assistance as requested. To have an effective network, there must be active participation, sharing of experiences and information on the part of persons of like interests. The address of the new clearinghouse is: Microcomputer Clearinghouse, 319 Cameron Street, Alexandria, VA 22314, USA.

CDF - Data for Development, 122, avenue de Hambourg, 13008 Marseille, France. This group is also interested in joining COGIT and the Director General of CDF will be visiting UNIDO to discuss possibilities for co-operation. Data for Development (DFD) is both a professional association and an organisation for international co-operation. It is a non-governmental organisation. It has no political, commercial or national affiliation, and it is non-profit making. Its general objectives are to create an awareness of data as a resource to be managed; to study and evaluate the role of information in economic and social development; and to promote international co-operation and exchange of experience in that field. Its members are of many disciplines and include administrators, economists, data specialists, ecologists, geo-physicists, medical doctors, statisticians, planners, etc. all of whom are concerned with information for development. DFD has consultative status with the United Nations Economic and Social Council and with UNESCO and has permanent relationships with the United Nations Secretariat, the United Nations Development Programme, and the United Nations Regional Economic Commissions.

From 1973 to 1982, DFD has worked mainly in the field of information systems in public administration. It has developed an approach for the integrated planning and development of government information systems (both quantitative and non-quantitative) which take into consideration the information gaps associated with economic and social development and with administrative management, and which attempt to optimise the allocation of available information resources. The approach is based on the concept of a Government Data Network (GDN) which regards any complex administration as a network in which the nodes are those units of the administration which collect, process and, in a large number of cases, use data while the links between the nodes represent the flow of information between the various units. The model thus takes account of the data flows within the administration; the procedures used for the collection, processing and use of data; the units of administration which operate the procedures; and the resources available. Hence an analysis of the model can reveal information gaps, duplication in data collection, deficiencies in the flow of information etc. leading to the design and implementation of a practical data network. There is no one general model for organising information systems in public administration. Thus the GDN approach aims at enabling any government to design its own data network taking into consideration the development objectives and problems of the country together with the economic, cultural and socio-political environments in which the network will operate, and the resources available in the short, medium and long-term. The approach thus leads naturally to the definition of a Government Information Plan (GIP).

DFD has launched a series of regional activities, including pilot projects, regional seminars and permanent study groups bringing together representatives of government planning agencies, statistical services, national computing centres and other institutions concerned with informations systems in public administration. In particular, the GDN approach is being used in a pilot project in Senegal, under the authority of the Bureau of Organisation and Methods, with the aid of the European Development Fund. A major regional programme has been launched by the U.N. Economic and Social Commission for Asia and the Pacific (ESCAP) in co-operation with Data for Development. This programme has adopted the government data network approach and includes country seminars. The programme is reviewed annually by a regional study group.

DFD is concerned with government data networks, systems and information plans in both developing and industrialised countries. After a survey of computerization in six countries (Canada, Hungary, Great Britain, Sweden, USA, FRG), it is now launching a study on new trends in the use of information technologies in Japan. DFD offers the expertise of its members to government and international organisations which request advice on matters relating to government information systems. It should however be emphasised that as most of its members are in senior positions committed to tasks in their own governments or organisations, DFD does not undertake work associated with developing and/or implementing information systems. Its specialisation lies in project monitoring and team leadership, feasibility studies, project evaluation and educational seminars. DFD is now diversifying its activities in order to address problems associated with the use of information outside Public Administration, especially small enterprises, social groups, trade unions, local authorities, individuals, and, using appropriate information technologies, how to improve the present situation in that respect for better economic and social development.

DFD disseminates the results of its work through the publication of reports. A periodic newsletter and news bulletin are also circulated to members. (DFD Newsletter)

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NCC - The National Centre for Information Technology

(The National Computing Centre Limited, Oxford Road, Manchester M1 7ED, United Kingdom)

NCC is the UK centre for Information Technology. Backed by government, the IT industry, and IT users, NCC directs technical programmes, administers national schemes, and develops products and services to encourage the more effective application of information technology. NCC operates increasingly on an international basis. By virtue of its national role, it acts as the UK's representative in the world-wide informatics community; through consultancy assignments and technology transfer schemes it places expertise at the disposal of governments and institutions throughout the world; and the results of its research are incorporated into products and services which benefit customers in five continents.

In co-operation with government, users, suppliers, professional organisations, and international agencies, NCC addresses important issues in communications, data processing, office technology, and security. Concerned equally with methods, techniques, and standards, these research projects are of international relevance. NCC administers, collaborates in, and advises on government and other centralised schemes to co-ordinate national effort in education, employment, and funding for Information Technology. NCC training courses, seminar programmes, training materials, software packages, books, and information and advisory services are available world-wide through an international network of authorised distributors. Affiliation provides organisations throughout the world with the benefits of a direct link to NCC's products, services, and experience. (NCC International Bulletin, No. 1, 1984.)

NCC/British Council Programme

All 16 students who took part in the latest NCC/British Council Joint Orientation Programme in the Sultanate of Oman were awarded certificates - six with distinctions. The 14-week course, the third in a continuing series, had three objectives: to increase the awareness of computers and their uses in the Sultanate; to provide the sponsors of the students with a detailed assessment of the capabilities of their employees; and to give students a grounding in BASIC programming. Sponsors for the third course included Royal Flight, Royal Stables, Royal Oman Police, the Palace Office, Ministry of Education, Diwan of Royal Court Affairs and Oman Refreshment Co. The British Council also sponsored an employee. The next course was held in September 1984. (NCC International Bulletin, No. 1, 1984)

The Chip Shop

The British Broadcasting Corporation's radio show, "Chip Shop", out to attract the new generation of computerniks, has been offering a new service: telesoftware i.e. the transmission of computer software by radio to microcomputers. The programme, broadcast on Saturdays at 17.00 (UTC), has been repeated each Tuesday night on Radio 4 VHF at about 23.00. AT 23 minutes past midnight, four nights a week after the shipping forecast on Radio 4, free software has been broadcast in Basicode. The Basicode programs can only be used when you have paid £3.95 for a cassette containing a translation program. Details of how to obtain this are available if you send an A4 stamped addressed envelope with a 21 pence stamp (or international payment voucher) to Fact Sheet 1, Chip Shop, BBC, London W12 8QT, UK. The cassette is suitable for BBC A and B, Vic-20, 64, Tandy, ZX81, Sharp MZ-80, Apple II and IIe, and a few others.

IDS Seminar on the influence of microelectronics on industrial policy

The Institute of Development Studies at the University of Sussex, Brighton, UK announces a seminar on "Microelectronics, Automation and Industrialization" to be held from 4 November to 13 December 1985 at the Institute's headquarters. The objectives of the seminar are fourfold:

- to describe the nature and likely future orientations of the microelectronics industry and the pattern of diffusion into downstream manufacturing processes and final products;

- to assess the impact of these new technologies on specific sectors which are of particular relevance to developing countries;

- to develop methodologies whereby this impact can be judged;

- to consider the implications which these technological developments have for the formulation of industrial policy.

The course will be limited to some 24 participants selected from policy makers as well as researchers. Representatives from international institutions and from private industry will be welcome. IDS itself cannot fund study fellows, however, applicants may be eligible for scholarships from the EEC, the various United Nations agencies (such as UNDP, UNICEF) or from funding bodies such as the Ford Foundation or the Rockefeller Foundation. Study fellows should be proficient in English. Further information on the course is available from: the Chairman, Teaching Area, Institute of Development Studies at the University of Sussex, Falmer, Brighton BN1 9RE, UK.

TECHNOLOGICAL DEVELOPMENTS

Buried oxide marks route to SOI * chips

Exploring a technology that jams more transistors into a given area and places complementary-MOS firmly in the fast lane, researchers at Texas Instruments Inc. believe they are approaching a practical oxide-insulator alternative to expensive silicon-on-sapphire wafers. In this effort, TI has plenty of company. Industrywide, laboratories are racing to develop a low-cost silicon-on-insulator technology to unseat SOS as the best candidate for ultra large-scale integrated circuits, like 16-Mb random-access memories.

* Silicon-on-insulator

SOI research is driven by the high cost of SOS, which now runs about $80 per 4-in. wafer compared to $12 per wafer for a comparable bulk silicon slice. Like SOS, SOI technology allows tighter packing densities by eliminating the need for space-taking dioxide isolation between on-chip transistors. SOI devices are radiation-hard, as well. And the oxide insulator has a much better interface with silicon than does sapphire, resulting in lower device-leakage currents and higher carrier mobility. Exploratory paths to SOI are numerous, and include silicon recrystallization by annealing deposited polysilicon, oxygen ion implantation, and porous oxidation of silicon. Several major semiconductor labs in the US and Japan are pressing on most known fronts. Not wanting to be left behind, a research co-operative in Britain is exploring four separate routes at once.

Last year, TI refocused its attention to ion implantation of buried-oxide SOI, which has its roots in basic research performed 15 years ago. The promising SOI process implants oxygen ions into silicon, burying a layer of insulating oxide beneath its surface. The ions travel too rapidly to damage the single-crystal silicon at the surface. The lattice, however, is damaged in areas where ions come to rest. The heavily implanted layer - 2×10^{18} ions/cm^2 - is then annealed at 1,150°C for two hours to form a sandwich of single-crystal silicon, a buried middle layer of oxide, and a silicon substrate. To demonstrate the manufacturability of the experimental SOI technology, TI's semiconductor lab in Dallas has fabricated 4-K static RAMs using conservative 2.5-µm C-MOS. The chips are showing 55-ns access times, the company says. The lab is now preparing to make a more ambitious 64-K static RAM. Right off the bat, lower capacitance in the source and drain junctions of SOI chips promises 30% better access speeds over today's faster bulk-silicon MOS memory products.

But what is needed before the SOI technology can move onto the production floor are ion implanters with current 20 times higher and one-third more voltage than existing systems. Voltage levels of current implanters bury ions only 0.4 um deep, requiring the lab to add to the thickness of the top silicon layer by an epitaxial growth using chemical vapor deposition. The SOI 4-K static RAMs are showing the carrier mobility of bulk silicon, while leakage is much lower than SOS. The cmps show a leakage of only 0.1 pA/µm at 5 V. "SOS will range between 10 to 100 pA/µm because of the poor interface of sapphire with silicon," he says. "We expect the first application for buried-oxide SOI to be in radiation-hard military products, but the larger impact is going to be in high-performance microcomputers, such as single-chip digital signal processors for the video band." (Excerpted from an article by J. R. Lineback in Electronics Week, 1 October 1984, copyright 1983 McGraw-Hill Inc.

SOI method could make 3D chip

Where is silicon-on-insulator (SOI) technology going in Japan? After what seemed like a slow start the Japanese are probably well up to, if not ahead of, foreign progress. This was borne out again this month as Japan's main device research forum, the annual International Solid State Devices Conference was again held with a lot of attention paid to SOI. Why the intense interest? Japanese researchers are now seeing SOI as a good route towards true 3D chips, consisting of multiple layers of semiconductor each supporting circuits. SOI is the generic term for technologies which place a thin film of silicon atop an electrical insulating layer (usually some form of silicon dioxide), itself positioned over a substrate such as silicon or glass.

Japan's Ministry of International Trade and Industry has already been sponsoring attempts at this objective for some time. Still, although Japan is now the acknowledged leader in two other major but tricky SOI techniques - dielectric isolation by oxygen implantation and oxidation of porous silicon - latest work has been more with a method already popular in the West, the recrystallisation of deposited amorphous silicon films over thermally grown silicon dioxide by laser beam annealing. Mitsubishi researchers have been refining their grasp of laser recrystallisation techniques, and can produce devices with nearly identical characteristics to conventional silicon ones, by selective laser scanning. Hitachi, Sharp and the Tokyo Institute of Technology have also been independently investigating how to improve the properties of the silicon films produced. Hitachi has been concentrating on a mathematical analysis of recrystallising the silicon film by the common method of leaving windows in the insulating film to the single crystal silicon substrate which forms a seed.

Hitachi and Sharp have also been working on a computer model of the melting and subsequent recrystallisation of the silicon film as the laser beam passes over. Hitachi's model, the first according to the researchers to accurately model this dynamic behaviour, bears out various experimental observations, one being that the speed of the recrystallisation depends on the oxide thickness. Hitachi's next step will probably be to try to match this velocity to the scan speed of the laser beam, when, predictions say, the best quality of recrystallised material should result.

But the problem of random nucleation of these regrown films - extra cyrstals popping up anywhere on the surface of the film - remains. Hitachi for example have been having some success with using silicon-dioxide films as the underlying electrical insulator - an addition which appears to control the stresses emerging from thermal mismatch between the various films. But the biggest breakthrough may have come from Tokyo Institute of Technology. Researchers there have extended the maximum crystal length that could be gained if the films were implanted with a high dose of phosphorous. This doping increases the crystal growth rate and reduces the random nucleation rate. As a result the team has increased the maximum crystal size to about 24μm from 6μm.

The Institute has been a prime mover in SOI academic research in Japan. Not only has it recently announced a useful multi-layer structure of amorphous silicon, poor for conventional devices but good for sensor developments, it has also been working on one of the most intriguing SOI structures of all - silicon on calcium-fluoride on silica (glass). This seems to have considerable promise as a low-cost, low-temperature process. Also, calcium-fluoride can be deposited relatively easily. True 3D structures? No one seems to be prepared for an early appearance - at least not until the knotty problems of how to connect each layer have been solved. (Electronics Weekly, 3 October 1984)

More on gallium arsenide

The gallium arsenide (GaAs) club is growing. Rockwell International's semiconductor products division is the latest company to emerge as a contender in the commercial GaAs market. So far Rockwell has invested £23m in the venture. Of this £12m has gone into a pilot production facility at Newbury Park, California, which was originally set up under a £18m contract from the US Department of Defense. The other £11m has been invested in a GaAs research programme in Thousand Oaks, California.

Among the devices Rockwell is developing are high electron mobility transistors that rely on multiple layers of GaAs and gallium aluminium arsenide superlattices to provide operating speeds three times faster than typical GaAs circuits.

In 1983, the GaAs device market was worth $48m, but industry sources expect this to grow dramatically to a $1bn by 1992. (Electronics Weekly, 12 September 1984)

Varian to produce GaAs devices

Varian Associates, Palo Alto, Calif., has announced a five-year plan to become a major producer of integrated circuits, solar cells and other solid state devices made with the compound gallium arsenide (GaAs). The first step of the plan will involve a $16 million expansion of the company's Solid State Microwave Div. in Santa Clara, Calif., which now produces a broad spectrum of gallium arsenide devices. The plan calls for developing the plant into a world class manufacturing facility with much of the processing equipment being supplied by Varian's Semiconductor Equipment Group. Critical process areas in the facility will be built to stringent Class 100 clean room standards.

The expanded Solid State Microwave Div. will concentrate on the production of three advanced solid state devices made with gallium arsenide: field effect transistors (FETs), digital and analog integrated circuits and solar cells. The Solid State Microwave Div. currently produces discrete semiconductor devices and microwave amplifiers and oscillators. Applications for the analog ICs will include replacements for hybrid components in receivers for systems such as radar and satellites. These "receivers-on-a-chip" could be as small as 1/10th of a cubic in. in size and have better performance than the 5 in.^{3} receivers currently used. Examples of uses for digital ICs would be microwave frequency synthesizers and analog-to-digital and digital-to-analog converters in electronic systems. Varian's GaAs solar cells are expected to be used primarily as power sources for satellites. (Semiconductor International, July 1984) (Reprinted with permission from Semiconductor International Magazine.

First Thomson gallium arsenide standard cell

Following the reorganization of the hybrid activities in Thomson-CSF's microwave components division (DCM) at Massy, it announced that custom GaAs integrated circuits will be available on the free market beginning in 1985, with the first samples being forthcoming at that time as well. In collaboration with six customers (on an Applicon system), DAG is currently completing the formulation of a 50-cell library (without counting buffer variants) for GaAs standard cells.

Samples of the first standard cell GaAs circuits for Thomson-CSF's needs should be available within three months, with service for outside customers being planned for 1985. A 500-gate array with two-level interconnections on 10-square-mm is currently being perfected.

For these two types of semi-custom circuits, the future fabrication delay should be of the order of two months, as in the case of silicon integrated circuits. In principle, customers will have to design their own circuits with the library provided to them. A large scale integration (LSI) market sector could be implemented in the future if the market warranted it. (Electronique Actualités, 3 February 1984)

Taking GaAs research seriously

By all accounts, Japan is taking its gallium arsenide research very seriously indeed. Most established silicon chip manufacturers now have more than a passing interest in the major III-IV compounds, too. However, unlike their European counterparts, such as Plessey, the Japanese developers are principally using compound semiconductors as a route of getting to ultra high speed VLSI, rather than in making single transistor devices as well.

Firms of strong consumer, rather than aerospace or military, orientation, have been pushing GaAs hard. Sony, for example, has successfully made a 4x4-bit parallel multiplier based on JFETs rather than on MESFETs as other researchers have done. This chip was, Sony say, a test vehicle for more complicated ones to follow. The 156 gate chip has a maximum power consumption of 70mW at 1.3V supplied, and can produce a path delay of 3.5nS. The transistors have conservative geometries - gate widths are 1.5μm by 10μm in length. Sony has recently moved to incorporate this multiplier in a 500 gate device which includes a 10-bit multiplier and 8-bit shift register too, but yield may well have fallen significantly with the more complex circuit. Toshiba, too are heavily involved in GaAs. At present they have a DCFL (direct coupled FET) technology with 1μm gate lengths and incorporating platinum processing; they have fabricated an array of 500 gates, a 1K-bit SRAM and a 4x4-bit multiplier. Fujitsu have also been tackling circuit design aggressively and have probably come up with Japan's largest memory - a 4K-bit SRAM announced recently. Fujitsu have been using 2 techniques - a DCFL and a BFL (buffered FET logic), and have produced a 16x16-bit multiplier. Hitachi have ambitiously made a 32-bit arithmetic unit with a cycle time of nearly 8nS based on BFL.

Leading the field in GaAs is probably Nippon Telegraph and Telephone's group based at Atsugi Electrical Communication Laboratories. NTT have designed both a 1K-bit static RAM with an access time of 1.5ns and a 16x16-bit parallel multi[illegible]ntly. Their main development is now the SAINT (for Self Aligned Ion Implantation [illegible]er Technology). In this an N+ layer is implanted into the parasitic resistance re[illegible]ying distances from the gate by simply controlling the degree of undercut of the [illegible] resist which is used as a mask for the implantation.

NTT claim that the Schotty gates fabricated after the main annealing render the device very stable, especially as during the main anneal the FET surface is covered with a cap of silicon nitride deposited by plasma CVD. But the NTT design suffers from the general problem of wide threshold voltage variation over a standard 2 in. water - some 60mV is reported. They deduce two causes for this - the crystal dislocation density and the dispersion in the gate lengths themselves. They have started to tackle the first problem by using electron beam direct-write techniques to obtain 0.3 m gate lengths, and consequently probably halving the relative effect of this dispersion. Making a dent in the crystal quality might be more difficult. NTT have already proved that the threshold voltages of these devices is strongly dependent on how close the device and dislocation are to one another. They are at present trying to analyse the characteristics of this region to work out a way of making it more uniform. Relief may be at hand sooner than expected. Toshiba have announced using an unspecified process already this year that they can probably reduce the defect density in GaAs down to the level of that of silicon, i.e. about 1000 per square cm, or about one-tenth that of previus bests. VLSI gallium arsenide may soon be a distinct possibility. (Electronics Weekly, 20 June 1984)

GaAs on silicon in near future

Hybrid ICS, utilising both silicon and gallium arsenide on the same chip could be on the way, according to Japan's Oki Electric Company. Scientists at the Tokyo-based company's research laboratories announced they had produced the first structure of gallium arsenide on silicon in the world capable of supporting devices. It has been very difficult to deposit gallium arsenide on a silicon substrate because of the very large lattice mismatch between the two materials. As a result, the two semiconductors don't lock neatly on the atomic scale. Oki has apparently solved the problem by interposing a layer of germanium between the two, a mere 0.16m thick. On top of this a Gallium arsenide stack of variable composition is laid down: five pairs of gallium aluminium arsenide layers, a doped layer and, on top, an undoped 0.1m thick layer.

The depositions are all made by the relatively new MOCVD (Metal Organic Chemical Vapour Deposition) process, which is finding great favour with other areas of gallium arsenide work, too, like superlattice fabrication. Oki say that the resultant gallium arsenide MOSFET devices, fabricated on the top layer, in a ring oscillator configuration gave 66ps gate delay at a power dissipation of 2.3 mW. (Electronics Weekly, 20 August 1984)

Process cuts costs of semiconductor silicon

A lower-cost route to the polycrystalline silicon used in semiconductors has been developed by Allied Corp. (Morristown, N.J.). The new process employs silicon tetrafluoride, instead of the usual tetrachloride, as the key intermediate in silicon production. With the tetrafluoride, manufacturers could use a much cheaper reagent in a subsequent synthetic step than the reagent used now. The standard process for making polycrystalline silicon is to convert silicon tetrachloride into silane gas (SiH_4) using the chemical reducing agent (electron supplier) lithium hydride. Then the silane's hydrogen atoms are removed to form highly purified polycrystalline silicon. In the Allied process (still experimental), silicon tetrafluoride is converted into the silane intermediate with the aid of the relatively low-cost reducing agent sodium hydride. Compared with the standard process, the silicon tetrafluoride/sodium hydride approach leads to a "significant improvement" in costs, says Fred Loozen, manager of new business development at Allied's chemical division.

The Allied process isn't the only advanced purified silicon technology in the works. Union Carbide has developed an improved process that starts with the chemical trichlorosilane. In a two-step process, this is converted into silane and then into purified silicon. The economics of the Carbide and Allied technologies are "roughly comparable," says Loozen. The Allied process has been tested in a one-year pilot plant study with units having yearly capacities of 40 tons of silicon tetrafluoride and 10 tons of silane. The company says it is now assessing the technology's commercial potential. (High Technology, June 1984)

A new amorphous silicon wafer has been developed by B. Y. Tong, P. K. John, and S. K. Wong, all of University of Westnern Ontario. The new chip involves using large sheets of amorphous silicon vs traditional chips having a single crystal structure. Use of a Theta pinch plasma machine allows the silicon to retain its molecular bonds as hydrogen is injected into the film. The films have been found to withstand temperatures of 500C+ for several hours and prolonged exposure to high intensity light without noticeable losses in efficiency or conductivity. The amorphous film can be created in a much shorter time and the electron beam evaporator uses less energy than conventional processes. Whereas traditional chips can be produced in thicknesses to 0.2 mm, the film can be deposited on substrate in layers as thin as 0.2 microns, so quantities of silicon required can be considerably reduced. Amorphous silicon is also intrinsically better than single crystal silicon chips since it can absorb light at all wavelengths vs crystalline chips that can only absorb certain wavelengths. Additionally, amorphous silicon can absorb 100x more solar energy than traditional chips. Amorphous silicon also has the ability to store optical images, an ability lacking in traditional chips. (Canadian R+S, February 1984)

Chipping away at silicon processing

An integrated-circuit chip is built up in layers to create a microscopic, silicon sandwich. It consists of a sequence of metallic films and insulating layers, etched with intricate patterns and doped with traces of elements that alter a layer's properties. The production of such electronic chips requires a complicated, expensive manufacturing process that limits the number of companies and laboratories than can make them. However, current research on the use of lasers and a technique called "chemical vapor deposition" may within a few years bring chip manufacture to, for instance, a university laboratory.

A recent, surprised discovery at the Sandia national Laboratories in Albuquerque, NM, illustrates the potential value of laser processing. The Sandia researchers use a newly developed technique, called "plasma-initiated laser deposition," for depositing thin layers of silicon on surfaces. The method depends on the interaction between light from an ultraviolet laser and a gas that has passed through a high-voltage, electrical discharge to create a "chemical soup" or plasma of charged, excited molecular fragments. The gas, in this case silane (SiH_4), enters the reaction chamber at a low pressure and passes through a 10,000-volt discharge. Ultraviolet light from a krypton-fluoride laser shines through a window onto the surface of a quartz-glass or silicon wafer. Only when both the plasma is present and the laser is shining does silicon deposit on the area outlined by the laser beam on the wafer's surface. In other words, the discharge activates the gas, and the laser defines where deposition should occur.

The researchers found that at low laser energies, silicon films made up of many randomly oriented crystals form on the surface of a single-crystal silicon wafer. However, when the laser energy reaching a given area is increased beyond a threshold value, the deposited silicon atoms line up in a very orderly arrangement so that the surface-film crystals take on a single orientation. The results for deposition on quartz plates were even more surprising and puzzling. In this case, Philip J. Hargis Jr. and his colleagues discovered that while low-energy, 10-millijoule laser pulses cause silicon deposition, higher-energy, 30-millijoule pulses cause etching to occur. Simply altering the laser energy changes deposition to etching or etching to deposition. When the experiment was tried on a single-crystal silicon wafer coated with a thin film of silicon dioxide (quartz), the high-energy laser pulses etched the coating until they reached the silicon base. At that point, silicon began to deposit within the etched groove.

Sandia's A. Wayne Johnson, head of the laser and atomic physics division, admits, "We don't understand this yet." In the case of etching, the discharge-generated plasma species are probably reacting with surface atoms to create volatile products that evaporate, leaving vacancies behind. But the chemistry of both the deposition and etching processes is far from being understood. Johnson, however, is enthusiastic about the flexibility and efficiency that plasma-initiated laser deposition seems to promise. He sees the possibility of designing a table-top unit for chip manufacture, one in which a single laser can both deposit and etch films as required while different gases are introduced to form the various layers and provide the necessary doping ingredients. He says such a system could be used for creating a small number of special-purpose chips by using the laser to "write" the needed patterns on a chip or for mass producing chips by shining the laser light through patterns or "masks".

Laser processing combined with some form of chemical vapor deposition would considerably simplify the manufacture of integrated-circuit chips. Normally, to create circuitry, a silicon wafer with an insulating coating, or in some cases, a metallic film, must be covered with a polymeric material called a "photoresist," which reacts to ultraviolet light. Light passing through an electron-etched mask strikes the resist, hardening. Solvents remove the unexposed resist, and acid etches the unprotected surface to create the circuits. Finally, the remaining resist is removed. As each layer of material is added, this set of operations must be repeated. The Sandia process, if successful, would eliminate the messy resist stage and do away with much of the apparatus needed for chip manufacture.

Researchers at the Lawrence Livermore National Laboratory in Livermore, Calif., are working on a similar scheme. Recently, they demonstrated that direct laser writing alone was capable of inscribing transistors and somewhat more complicated circuits on silicon chips. Their process begins with a wafer of silicon coated with an insulating silicon dioxide layer. Silane gas introduced into a vacuum chamber decomposes where the laser is focused on the wafer surface to form spots of silicon. Other gases allow the etching of the silicon dioxide layer to unveil underlying silicon, the doping of exposed silicon with phosphorus to change its conductivity and the deposition of tungsten metal tracks to complete the circuit. Work on chemical vapor deposition is also going on at the Massachusetts Institute of Technology's Lincoln Laboratory in Cambridge, where Thomas F. Deutsch and his colleagues used the technique to fabricate solar cells. An ultraviolet laser beam causes boron trichloride gas to dissociate and melts the wafer's surface to allow boron atoms to diffuse quickly into the material. (Article by I. Peterson in Science News, 17 March 1984).

Glass rivals gold in the semiconductor industry

A new glue for sticking silicon chips to the ceramic or plastic cases that protect them may save the semiconductor industry £17 million per year. The glue is made from a mixture of glass, silver and epoxy resin and can replace the gold and expensive silicon pastes traditionally employed for sticking chips to their casing. Chip firms spend about £20 million each year of gluing chips into their cases. And, although cheaper silver and epoxy glues are available, gold gives the best adhesion and helps to conduct heat away from the top of the chips. Simon Turvey, a technical specialist with Johnson Mathey Chemicals, which developed the new glue, says that gold and silicon are difficult to work with. Gold is rubbed onto the surface of the chip, and this can break the delicate circuits. The gold is next heated to a precise temperature, usually about 400°C, to create a permanent bond between the chip and its ceramic surround. At such high temperatures the glue can catch fire. Johnson Mathey took 16 years to develop their glue - Ausub - from original patents. The problem has been to find a glass that will sinter (fuse) at low temperatures, around 370°C, and bind the silicon and ceramic surfaces together. The glass, silver and epoxy resin mixture also needed to be as good as gold at conducting heat away from the chip's surface. Turvey believes that Ausub will cut the cost of gluing chips by 85 per cent compared with the gold method. A silicon diode can be glued for about 1.9 cents compared with 2.7 cent for gold. (This first appeared in New Scientist, London, 27 September 1984, the weekly review of science and technology).

New process for printed circuit production

A major new printed circuit production process that combines low cost and high performance was unveiled by scientists at the General Electric Research and Development Center.

Covered by a number of patents, the new technology will enable printed circuit producers to realize cost savings ranging into the millions of dollars a year. The process is inherently simple and low in cost, and it results in printed circuits that in many applications can directly replace those produced by conventional techniques. Fundamental to the new process is a family of special metallic "inks" consisting of a liquid polymer (several different types can be employed) "loaded" with fine, powdered metals - a mixture of iron and nickel. To define a circuit pattern, the polymer ink is transferred to an insulating substrate (e.g., circuit board) by a process known as "screen printing". A standard technique for circuit patterning, screen printing makes use of an ultra-fine mesh (resembling window screen, but much finer) in which all areas other than those defining the circuit are blocked out to form a sort of stencil. The ink is then pushed through the openings in the screen - to define the circuit pattern - employing a squeegee. After the circuit board has been patterned in this manner, it is run through an oven to harden and cure the ink. This process takes about 20 minutes employing a conventional cross-flow oven or as little as one minute with an infrared oven. Then the circuit is plated with copper to make it electrically conducting by dunking it in a special copper sulfate bath.

When the circuit board is immersed in this bath, a chemical reaction is initiated because of the dissimilar metals - the iron and nickel in the cured pattern ink and the copper in the plating bath. As a result, some of the metal powder in the cured pattern ink dissolves (going into solution as ferric sulfate), and pure copper from the copper sulfate bath takes its place. The process is known as "augmentative replacement" since the copper in the plating bath augments and replaces the metal powder in the printed conductor pattern. With the new process, circuits can be printed on virtually any substrate. In addition to the standard phenolic insulating board, the list includes all kinds of plastics, glass, paper, and even steel.

The patents granted GE cover the board technology, including the polymer conductors, insulators, and resistors, as well as certain specialized applications. Several potential applications are being explored by researchers at the Center and in the company's various product-manufacturing operations. (General Electric, Public Information, 26 June 1984)

New contrast enhancement material for wafer fabrication

General Electric Research and Development Center have invented a practical way to m. e next-generation microelectronic "chips" with present-generation processing equipment. Their basic development is a proprietary "contract-enhancement" material that is applied to semiconductor wafers at the beginning of the fabrication cycle. This coating greatly extends the ability of today's process equipment to make chips with ultra-small circuits. Aided by the coating, GE researchers have fabricated experimental microcircuits with linewidths of only 0.4 micron (a hundredth the thickness of a human hair), employing a commercially available optical projection system called a "stepper aligner". Without the coating, the stepper is limited to the production of circuit lines twice as wide - at best. This 50 per cent reduction in circuit widths is not the only benefit of the new coating. When employed in the manufacture of circuits with lines 1 micron wide and larger, it helps to produce chips with more precisely defined microstructures, resulting in improved operating characteristics. Basically, the purpose of the coating is to pick up a faint or blurry image from the optical projection system and convert it into a sharp circuit pattern on the semiconductor wafer. The goal of this research is to provide major cost savings for GE and other semiconductor manufacturers by making it possible to produce advanced VLSI (very-large-scale-integration) microchips without having to purchase new processing equipment. Processing equipment typically accounts for about 40 per cent of the capital investment required to set up an integrated circuit production line. (General Electric, Public Information, 22 May 1984)

Chemicals for semiconductors

The manufacture of semiconductor devices involves a number of highly complex stages, all of which can - to some extent - affect the overall yield and performance of the final product. One of the most critical stages is the wafer fabrication sequence which depending upon the technology can vary between 8 and 20 steps, most of which employ the use of chemicals to define patterns on the silicon surface, and enable semiconductor elements, passive components, electrical connections and insulating layers to be formed. Despite Plasma dry etching techniques becoming more popular, particularly for the very fine geometries of state of the art devices, wet chemical etching is still used by many device manufacturers throughout the world. The tendency today is for device producers to buy ready made mixtures of etches, where stability, and etch performance can be guaranteed by the chemical manufacturer.

As semiconductor devices become more complex and line widths and corresponding geometries become smaller, the chemical quality becomes increasingly more important. Despite major advances in processing techniques and clean room technology, there are still today a high number of device failures and poor process yields that are difficult to explain. One common denominator that is often overlooked is the quality of the chemical employed, particularly with respect to dissolved impurities and also to particulates known to be present.

Many research workers throughout the world have carried out systematic studies on the impurities present in process chemicals, and their subsequent influence on device performance and yield. It was found, that for example, analytical reagents contain impurities such as iron, copper, nickel, mercury, antimony, arsenic and sodium all of which are capable of being deposited on the surface of the wafer, by virtue of the electrochemical forces operating within the system. As a consequence, large chemical manufacturers in conjunction with major semiconductor producers developed a range of "Electronic Grade" chemicals in which the critical impurities known to be harmful to silicon processing, were reduced to a level where possible plating or false doping effects were minimised. In practice, this has tended to be a compromise, as different devices have different tolerances to critical impurities and certain processing steps are more critical than others. In addition to these difficulties, the economics of chemical production for a given quality form an important factor. In process quality control and final inspection, quality control using modern analytical techniques such as plasma emission spectroscopy enable the manufacture to guarantee product quality for a wide range of parameters.

Some of the most common chemicals and their uses in a "wet" chemical processing of wafers are:

Acetone (polar solvent)	removal positive
propanol methanol	resist films
Xylene (non polar solvent)	removal negative resist films
111 trichloroethane	degreaser
n-butyl acetate	wafer rinse after negative resist developer
Sulphuric acid	used with H_2O_2 as pre-diffusion clean, or photoresist remover
Nitric acid 70%	Component of silicon etch, polysilicon aluminium etch
Nitric acid 95%	Photoresist remover
O-Phosphoric acid	Component of aluminium etch
Hydrofluoric acid	Component of silicon etch, silicon dioxide etch, contact etch, slope etch
Acetic acid	Component of aluminium etch, poly etch
Hydrogen peroxide 30%	Used with acids in pre-furnace cleans
Ammonium fluoride 40%	Principal components of silicon dioxide etch
Hexamethyl disilanzane	Active component of photoresist adhesion promoter

(Processing, March 1984)

A semiconductor applicable with a paint brush?

A fixed-value semiconductor for the very simple design of thin-layer switching devices has recently been displayed by Jacques Bullot of the Laboratoire de Physiochimie des Rayonnements d'Orday in collaboration with the Laboratoire de Spectrochimie du Solide of Paris VI. The thin layer, measuring 0.2 to 1.5 microns, is produced, at room temperature, through the deposition of a colloidal solution of a vanadium pentoxyde thixotropic gel. The latter is prepared by soaking the melted oxyde in water at 700°C. The switching threshold is relatively low - about 6 volts - and the flip-flop time in the conducting state is short enough to allow the thin layer to retain its properties under an alternating voltage of 50 Hz. Its lifetime is several days and it permits current values above 50 mA. The procedure, patented by Anvar, should be of interest to Thomson and to American companies. (La Lettre de Sciences et Techniques, April-May 1984) (Original: French)

Bubble is back

When introduced in 1967, bubble memories, pioneered at Bell Telephone Laboratories by A. H. Bobeck, held such promise that many magnetic-disk manufacturers wondered if they would soon be looking for a new line of work. A nonvolatile form of magnetic storage than can survive all the heat, dirt and vibration that bedevil many operating environments, the technology seemed a good bet for the future. In a very thin film of garnet, the magnetic domains are oriented perpendicularly to the film. Without a magnetic field, the domains are snakelike and irregularly formed. But when a bias field is applied by permanent magnets perpendicular to the film, the snakelike domains oriented in the direction opposite the field take on a cylindrical shape even though immersed in the larger domain created by the bias field. The cylindrically shaped domains, usually less than 3 μm in diameter, are the bubbles. A rotating field created by two coils placed at right angles in a substrate generates the film's current, which marches the bubbles along an orderly path made up of storage loops and input/output tracks. Each predefined location is either full or empty (1 or 0). If power fails and the rotating field is lost, the permanent magnets keep the orientation of the cylindrically shaped domains. To read data, a bubble is duplicated and one sent to an output while the other remains in the storage loop.

Fabrication techniques for bubble memories have followed semiconductor technology, moving from photolithography to X-ray lithography. But since manufacturing cost per bit remained too high to make them cost-competitive with disk storage, national Semiconductor, Rockwell International, and Texas Instruments dropped out of the development race. Left are Motorola, Hitachi, Fujitsu, and Intel. Intel plans to reduce the price of its 1-Mb chip to less than $100, while it continues to develop and produce a 4-Mb version. (Electronics Week, 29 October 1984)

Supercomputers come out into the world

The world's most powerful and costly computers are about to break out of the golden ghetto that has confined them since their birth 20 years ago. Supercomputers could be valuable for a lot of industrial uses, as well as for many more scientists than the few who work with them now. But two related changes must first take place: a steep drop in price and a big increase in speed. Both are on their way. The market for supercomputers could grow 30-fold before the decade is out. Fewer than 100 supercomputers have been intalled, and most are owned by government laboratories. It is easy to see why: a supercomputer costs $5m-15m. That compares with $3m for a top-of-the-line mainframe computer from IBM, $300,000 for a powerful minicomputer from Digital Equipment Corporation, and less than £3,000 for a good personal computer.

A supercomputer is the classic number-cruncher; it quickly processes gigantic quantities of information - but information that is largely uniform and repetitive (e.g., data about the weather) These qualities distinguish supercomputers from two other kinds of machine with which they are often confused: general-purpose mainframes and fifth-generation machines. Mainframes, which are used by big businesses for their centralised data processing, are slower than supercomputers (though still very fast); but they handle a range of problems - e.g., record keeping, accounting - whose data structures are far more varied than those a supercomputer faces. This variety requires greater suppleness in a general-purpose machine, which must be designed to make an either/or choice when it is processing information four or five times more often than a supercomputer does. A supercomputer's purposes are also far removed from those of fifth-generation computer projects such as Japan's. These projects aim to produce artificial-intelligence machines - computers capable of imitating to some extent the reasoning process of humans. Supercomputers will, because of their speed and memory size, be an essential element in fifth-generation machines; but they will be at the service of more "intelligent" parts.

Supercomputers' distinctive character - vast processing power applied in a narrow range - makes them invaluable for certain kinds of problems. Up to now they have traditionally been used for complicated military and scientific jobs such as forecasting the weather, cracking enemy codes, predicting how a nuclear bomb will explode, and designing jet fighters. ... Supercomputers have begun to find their way out of defence and scientific establishments and into industry. Oil companies are buying them to model underground reservoirs to see how much oil and gas they might contain. Chemical firms are starting to use them to decode the molecular structure of complex proteins and to design new drugs. Carmakers are experimenting with supercomputers to learn whether computer-simulated crash-testing can be substituted for the real thing. These forays into industry have done little as yet to change the nature of the supercomputer business, which remains more a fine craft than an industry. The machines are put together by hand. The market is tiny: some 30-40 supercomputers will be sold this year, worth only $250m. (Apple Computer alone will have revenues five or six times that from personal computers.)

In the early 1970s there was only one supercomputer maker, Control Data Corporation of Minneapolis, Minnesota. Then Control Data's top designer, Mr Seymour Cray, left to start his own firm, Cray Research, also in Minneapolis. Cray today dominates the business with some 40% of the world's installed supercomputers. The number of competitors is now up to six. Three are American - Cray, Denelcor of Aurora, Colorado, and ETA Systems (the company created by Control Data to take over its supercomputer business). Three are electronics giants from Japan (Hitachi, Fujitsu and NEC). Big changes are already under way in this market. No fewer than 50 teams in American universities are building supercomputers of their own. Many of these researchers are working with an eye to turning their innovations into something profitable. What they, and others like them, need is for supercomputers to ride farther down the falling price-performance curve that has driven the growth of the rest of the computer industry.

America's commerce department reckons that worldwide supercomputer demand could reach 1,000 machines a year by 1990. If so, the market might then be worth some $2 billion a year. but nobody really knows how wide a market might be opened up by the relatively cheap availability of number-crunching power. Ten years ago nobody was predicting that personal computers would find a market beyond the do-it-yourself fanatics who were then building them from mail-order kits. (The Economist, 11 August 1984)

A newly-modelled world

Increases in supercomputing speeds will affect computing of all kinds. Faster switching in the hardware and more parallel processing should, for instance, bring artificial intelligence closer. But the most immediate benefit should come in what supercomputers do best: simulating the real world. In oil production, for instance, today's computers are good only for creating simplified models of geological formations. Researchers reckon that, with supercomputers 100 times more powerful, they could improve oil field simulations enough to boost secondary recovery by 10-20% - and make as much oil available as the North Sea find did. Aircraft design also can be improved. Aircraft still have to be designed in separate bits (e.g., wings, nose, tail, etc.) because supercomputers are not powerful enough to simulate airflow around the entire structure. They will need to be 1,000 times faster for that. Even so, Airbus Industries claims to have reduced the fuel consumption of its A-310 airliner by 20% just by simulating its wing design more accurately. The lifetime savings for a fleet of 400 A-310s add up to $10 billion.

Integrated circuit design and testing have achieved remarkable densities of switches on chips, but only in two dimensions. Three dimensional integration will now be necessary to get appreciable improvements in circuit density. At least a 100-fold improvement in supercomputer speed will be needed for it. The process control industry is beginning to rely on plant simulation for guidance in running complex plants such as chemical refineries and nuclear power stations. The co-ordination and control of automated assembly lines and the robots that man them will also require supercomputing power. The film industry is also resorting to supercomputers. Companies such as the Californian firm Digital Productions use them in systems that electronically simulate images of scenery. The price of some of the simulations is now competitive with that of the real thing. (The Economist, 11 August 1984)

How computers are built

Project to redesign how computers are built will center on submicron electronics, the new area of microelectronics research that focuses on the physical and chemical phenomena in materials used for miniaturized electronic circuitry. The ultimate goal is to facilitate the design of computers that are faster, smaller, more powerful, and more efficient than the present generation. The project has been undertaken by a team of researchers at the University of Michigan (funded by a three-year grant of $730,000 from the US Army Research Office in Durham, NC) and will be conducted by a multidisciplinary team of scientists and engineers who have formed the Ultra-small Structures Research Office (USRO), a unit of the university's Institute of Science and Technology's Special Projects Division.

To accomplish the goal, the computer of tomorrow will have to be put together in a completely new way, says principal investigator Roy Clarke. "Rather than scaling things down, as has been done in the past, we are using the 'bottom-up approach'". As Clarke explains, "During the 1950s, scientific investigations at Bell Laboratories and other major research centers set the stage for development of semiconductors based on silicon. Today, integrated-circuit semiconductor technology is rapidly reaching the limit in miniaturization, with electronic components of one micron (1/10,000 centimeter) in size arranged on a tiny silicon chip. When we try to miniaturize further, conventional materials and methods simply stop working.

"USRO is approaching the problem by first delving into the fundamental science of novel materials and microscopic processes which are not well understood at the present time. That is, we are studying the physical and chemical behavior within submicro-size structures, a scale at which molecules and atoms may be counted and classified. Our multidisciplinary approach," Clarke continues, "will shed more light on the basic mechanisms which limit further scaling down and, in doing so, we aim to develop new ways to perform data processing functions on such minute scales. For example, the way in which information is transferred and handled within present-day computers, via complex networks of interconnections, will most likely have to be abandoned for further significant miniaturization to be possible." Clarke points out that such fields as quantum statistical mechanics and chemical catalysis may offer insights for the construction of submicron circuitry. "One task that physicists are working on in this area concerns the growth mechanisms of small clusters of atoms and molecules. In the future, such structures may be incorporated into new electronic devices if their behaviour can be sufficiently well-controlled and understood." While basic investigations are being carried out, computer scientists will be rethinking computer architecture. "Assuming that ultra-small electronic devices are possible to make, they will be developing new concepts of how such devices may be used to construct a computer and what kinds of software will be needed", Clarke concludes. Additional funding for this project is being sought from industry as well as the federal government to support other USRO programs in specialized computing instrumentation for research, and education. (Information Hotline, July-August 1984, Science Associates/International, Inc., New York, N.Y. 10023)

MARKET TRENDS AND COMPANY NEWS

Flexible manufacturing systems (FMS) 1/

The ideas behind flexible automation in the manufacturing sector are not new: for example a UK firm developed one of the first flexible manufacturing systems in the 1960s, based largely on mechanical technology. Nevertheless it was only the emergence of information technology that made possible a number of key developments enabling automation in the manufacturing sector. FMS is one of the options open to production engineers.

One of the first systems in Europe was installed in 1981 at the Belgian plant of Caterpillar, the American agricultural machinery manufacturer. It was built by German machine-tool maker Scharmann and cost the company around £7 million in 1980. It includes a special-purpose machine capable of monitoring precise tool tolerances. It has been continually updated with fresh electronic equipment plus various software programs written by both Scharmann and Caterpillar. The facility now consists of three flexible machining centres which are interchangeable, plus the special-purpose machine, the entire system interconnected by a conveyor. The FMS includes automatic tool change, an automatic pallet change system plus some advanced memory systems. The system works on a distributed control network with a DEC minicomputer. It can run unmanned for at least eight hours. Caterpillar estimates it costs $800 an hour to run the system, on which the company is machining around 400 components a month, some weighing up to 2.5 tonnes. Though the FMS was extensively tested with a simulation model before its installation, Caterpillar spent about a year learning to use it.

The following article looks at the developments and the rate of application of FMS in the US industry.

Flexible systems invade the factory

In contrast to conventional "fixed automation" systems, which follow a preordained sequence of steps in making a product, flexible manufacturing systems (FMSs) can be programmed to alter their procedures to suit varying production requirements. For example, an FMS can be programmed to produce an assortment of parts simultaneously or quickly reprogrammed to accommodate design changes or new parts. Such systems have significant advantages over the hard automation systems used in mass production and semi-automated batch processing systems that now turn out most manufactured items. The primary advantage is cost. Hard automation systems are extremely efficient, but they are also expensive and can only turn out one type of part at a time. They require extensive modifications to accommodate new parts or design changes. As a result, they can only be justified for items produced in large quantities.

Flexible systems, on the other hand, radically alter the economics of automation because of their ability to produce multiple parts. Aggregate production volumes can be high enough to justify a flexible system's cost even though individual part volumes are low. Because it is fully automated, the FMS also has strong advantages over the semiautomated batch manufacturing systems now employed to make products in small quantities. These systems move components in batches through machines or processes individually set up by human workers to

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1/ FMS is the combination of machine tools and other equipment such as robots under central on-line computer control in an automated factory system. See also APO Symposium on Computer Application in Manufacturing, p. 4.

perform one operation on one type of component. Batch manufacturing is flexible, and allows diverse products to be produced, but it has drawbacks. It is labor intensive and involves high set-up costs, long lead times, and high inventory levels. The components in any batch spend about 90 per cent of the time waiting (queuing) for time on a tool. In addition, at each new setup, there is a risk of nonconformance: parts that do not conform with design standards and hence have to be reworked or scrapped. In contrast, the FMS allows automated manufacturing of components on a random basis. The FMS does away with the long setup times, queuing delays, inventory levels, and human errors associated with batch manufacturing.

The result can be a dramatic jump in productivity. The $16 million General Electric system, installed late last year, turns out a 2500-pound motor frame, in any of six styles, once every hour. By replacing stand-alone machines and human operators with an integrated system, General Electric has cut a job that once took 16 days to 16 hours. Flexible systems also improve quality and lower operating and capital equipment costs.

Flexible systems, by enabling the automation of low-volume production, hold the key to the workerless factories of the future. Such factories are already appearing. For example, Mazak Corp., a Japanese machine tool maker, has built a plant based on two flexible manufacturing systems. One turns out frames and beds for Mazak machine tools, and the other makes gear boxes and other small components. Altogether, the two systems make 180 distinct kinds of parts. A plant based on conventional batch systems would have required 240 workers. However, because of the use of FMS, the new factory, which opened in April and runs three shifts a day, requires only 15 workers on the day shift and only four controllers on the evening shift. At night the factory runs unattended - except for the night watchman. Mazak, which installed its first FMS in 1981, claims to be the only machine tool builder in the world to use FMS in its own operations. It now has FMS systems operating in three plants.

But the transition from batch to flexible manufacturing will not come quickly. For one thing, flexible systems still have primitive capabilities that limit the kinds of items they can produce. Many manufacturing jobs require the dexterity, intelligence, and perceptual capabilities of human workers. It will take decades of development for the FMS to reach the point where it can compete with humans. Still, technology does not appear to be a major barrier to the widespread application of FMS. Stand-alone machine tools have already advanced to where their incorporation into automated systems is fairly straightforward. For example, machines operating under computer numerical control (CNC) have reduced the role of the operator to that of an observer. The machine's computer-based controller can select the proper tool and set the correct tool speed and feed angle. Some CNC machining centers can store as many as 60 different tools in their magazines. A central computer can control these machines by transmitting the appropriate programs via data communications links. Computer-controlled material handling systems are becoming prevalent. They include robots, towline and wire guided self-propelled carts, overhead cranes, and power-and-free (asynchronous) conveyors that allow items to be moved at variable speeds between stations. Flexible system builders have barely begun to tap this technology.

Flexible systems based on machining centers and towline carts were first applied in the mid-60s to the machining of prismatic (box-like) parts made of steel, aluminium, magnesium, and other metals. The success of systems installed by such pioneering FMS users as Sundstrand and Ingersoll-Rand have inspired many imitators. In the late 70s, systems for machining round parts appeared, beginning with a semiautomated system installed by Harris at its printing press division in Forth Worth, Texas. Mazak currently is installing a system for rotary parts at its new factory in Minokamo, Japan. Now manufacturers are beginning to apply flexible manufacturing to other types of processes. For example, Westinghouse is currently putting the finishing touches on a system to forge turbine blade preforms at its turbine components plant. Lockheed-California is developing a system for riveting aircraft structures. A robot equipped with vision selects parts from an automatic storage system and loads them onto a riveting machine. Westinghouse has developed a prototype of a flexible system for assembling electric motors. The system, which can produce six styles of motor bell assemblies, consists of six work stations, four manned by robots, linked by a power-and-free conveyor. Flexibility is also beginning to appear in mass production applications. Most automobile manufacturers, for example, have installed robot-based spot welding systems capable of handling a variety of body styles.

Machine tools based on laser beams, electrical discharge, and other exotic processes could enhance flexible systems. A laser beam can weld, cut, drill, and bore, thus eliminating the need for tool changes. Laser beams never wear out, and hence produce more uniform results while eliminating downtime due to tool breakage. IIT Research Institute (Chicago) has developed a flexible machining system that includes a laser-hardening work station. The computer-controlled system makes plugs for valves and includes a robot that transfers the part from an input station to a lathe, to the laser-hardening station, to an inspection station, and then to an output station. IITRI wants to develop flexible systems based on lasers, electrical discharge, and other advanced machining processes that are inherently flexible. Automatic inspection and tool compensation would also improve flexible systems. In Avco Lycoming's machining system in Stratford, Conn., for example, operators still stand over many of the machines that could operate unattended. The reason: The operators serve as the eyes and ears and hands of the system's supervisory computer by monitoring tools and the workpiece to detect tool wear or incipient breakage, which they then correct. Human monitoring is especially critical in Avoc-Lycoming's application: machining very hard stainless steel castings for turbine engines for the M-1 tank. For this reason, Avco's system uses more human workers than is typical in an FMS. However, most companies assign at least a few workers to stroll among the machines as watchers. Automatic systems would eliminate the need for this task.

Many observers argue that the statistical sampling techniques traditionally used for batch manufacturing are not a sufficient safeguard when setups are constantly changing. An FMS should inspect every component it produces. For this reason, some machining systems incorporate inspection stations based on co-ordinate measuring machines. These computer-controlled devices inspect by touch; they use a movable probe to reconstruct an object's shape. Westinghouse's forging system employs machine vision to inspect finished turbine blade preforms.

Such automatic 100 per cent inspection allows the detection and correction of errors caused by tool wear and other slowly changing conditions before an unacceptable part is produced. The goal of inspection in flexible systems will not be to winnow good from bad parts but to prevent bad parts from ever being made. In the future, the results of inspection will be fed back to the system's supervisory computer for automatic correction. By monitoring the tool and the piece to detect signs of tool wear, it will be possible to do the compensation automatically. This will allow for real-time adjustment, permitting more uniform production as well as maintaining closer tolerances. Currently, however, human operators make tool wear adjustments.

There is also a need for in-process inspection to spot dynamic failures, such as a breaking tool. Research organizations, including Carnegie Mellon University and the National Bureau of Standards, are developing techniques for real-time tool and process monitoring that would allow detection and correction of such errors. For example, Paul Wright of CMU is exploring the use of thermal stress monitoring to detect tool breakdown. NBS is taking a different approach. It has developed a microcomputer-based device, called Drill-Up, that detects incipient breakage of a machining center drill by abnormal vibrations (sensed by an accelerometer), and orders the tool's retraction before it breaks. The device allows optimum replacement and prevents damage from broken drills. But tool monitoring is hardly a prerequisite to FMS operation. Most operational systems include a backup for crucial tools and simply replace them at predetermined times based on average tool lifetimes.

Existing direct numerical control systems will not be adequate for the flexible systems of the future because they are not equipped to deal with sensory feedback. Modularity and hierarchical organization is key to the control of such systems. NBS, for example, is experimenting with an advanced control system for its automated manufacturing research facility - a flexible machining system comprising eight work stations. The system's data base includes a "world model" that describes the parts to be made and the tools and processes available to make them. The hierarchical control system breaks a manufacturing task into subtasks and assigns them to appropriate subsystems, which may further subdivide the tasks. A sensory system integrated data from sensors and abstracts the information required by each processing module. The modules communicate with each other via mailboxes - locations in common memory where information is dropped and picked up. This makes it easy to add, remove or modify software modules or processors. A user programs the system by specifying a set of "if-then" rules describing a task. Rule-based programming languages, an outgrowth of artificial intelligence research, have the advantage of allowing a user to describe not only the action to be taken, but also the conditions under which it is to be taken, such as "Lower the drill head only if the chuck contains a drill". This in turn allows the system to check for error conditions and conflicting commands, thus avoiding catastrophe. In addition, rule-based languages simplify program modification: Task descriptions can be altered by adding or deleting rules.

Flexible manufacturing systems demand a new sensitivity to producibility on the part of the designer. Manual or batch systems place very little constraint on design. But even the most flexible automated system will not be as versatile as a bunch of stand-alone machines operated by humans. For example, machining centers can hold at most 70 tools in their magazines; adding another tool requires an expensive setup. As a result, companies will have to set rigid manufacturing constraints on designers to assure effective use of flexible manufacturing. Already this is happening. For example, Hughes Electro-Optical, which once allowed designers to specify any of 400 drill sizes under a half inch, has now standardized on 15 sizes. Rolls Royce has standardized on 100 turning tools for making jet engines compared to the thousands once used.

Effective use of flexible systems will also require companies to master group technology: techniques for identifying parts that can be made by similar processes, and developing processes that can manufacture similar parts. Some companies have developed computerized data bases that simplify the procedures. These systems list all the parts made by a company, encoded by their shapes, materials, and production techniques. Such systems allow quick identification of parts families that could be produced by a flexible system. By allowing a designer to quickly find a similar part that can be modified rather than design a new part from scratch, these systems prevent duplication of effort. Moreover, chances are that if the existing part is being made on the flexible system, so can the modified part. A group technology data base thus encourages expansion of existing part families capable of being made by existing flexible systems rather than the design of maverick parts that require additional manufacturing investment.

Limits to application of FMS

Cost limits the applications of flexible manufacturing. There are still many applications where production volumes, even when aggregated, are too low to justify the investment. For the moment, the FMS is filling a niche between fixed automation systems used for high volume production, and stand-alone machine tools. The FMS really comes into its own in mid-volume manufacturing. (Mid-volume is a variable figure that depends on the complexity of parts and the type of processes required to make them. 3,000-50,000 parts annually is a typical range.) The inherent inertia of manufacturers is also slowing the acceptance of flexible manufacturing. They have traditionally been reluctant to adopt automation because of high capital costs, organizational changes, and potential labor problems. Flexible automation does not alleviate these problems. If anything, it exacerbates them. Manufacturers will be very reluctant to junk their existing plants, representing a huge capital investment, in favor of the new technology. Industry observers point out that fewer than 5 per cent of the machine tools installed in the U.S. are numerically controlled, despite the fact that NC tools were introduced more than 30 years ago. It is highly unlikely that an industry so slow to adopt the NC tool will jump to accept the FMS, which is an order of magnitude more complex and sophisticated.

Lack of expertise and resources is also hampering growth. Few potential users have the expertise in all the technologies - computers, machine tools, and automated handling systems - required to design and install a flexible system. But now machine tool makers and users are beginning to asemble the necessary expertise. Kearney and Trecker, Giddings and Lewis, Cincinati-Milacron, and other leading machinery makers have even begun to form divisions devoted specifically to marketing and integrating flexible systems on a turnkey basis for customers. Cost is perhaps the biggest barrier, putting flexible systems beyond the reach of most manufacturers. For example, in the discrete parts industry, 87 per cent of the manufacturers employ fewer than 50 persons. Such companies cannot afford a multimillion investment. The cost of flexible systems makes even big manufacturers hesitate.

Evolutionary approach to FMS

A growing trend toward designing machine tools as modules may mitigate the problem. Modularity facilitates acquisition of an FMS in stages, beginning with an NC tool, adding a robot, another tool, etc., as the company accumulates capital and grows. Because few manufacturers can supply all the components of an FMS, however, modular growth demands standardization of mechanical, electrical, and software interfaces to allow interconnection among devices from diverse sources. The industry, led by NBS, is beginning to develop such standards. A typical strategy for an evolutionary implementation of a flexible manufacturing system is to begin by grouping tools into cells. The next step would be to add direct numerical control computers for downline loading of programs. Then scheduling and monitoring software is added. Finally, the manufacturer adds the systems needed for transporting, loading, and unloading material among the machines.

General Electric's aircraft engines business group is following this strategy in its rotating parts manufacturing facilities. It has already installed supervisory computers for its NC lathes. These computers load programs into the lathes via cables, then schedule and monitor production. The next step will be to add robots for loading tools ar parts onto the lathes, and automatic material handling systems for transporting parts. The first cell is expected to go into operation later this year at General Electric's Wilmington, N.C., plant. Another company that is taking an evolutionary approach is Avco Lycoming. The company, a pioneer in flexible manufacturing systems, now operates two systems, one making aircraft parts and the other making parts for a gas turbine engine The company is currently modernizing its Stratford turbine engine plant and plans to base its modernization on manufacturing cells - essentially FMS systems with humans serving as tool and part transporters - rather than going immediately to flexible manufacturing systems. The company argues that FMS currently is economically justifiable only for making parts in fairly high volumes and for making fairly large parts. Another company, Sikorsky, is also basing its modernization program on the cellular concept. Sikorsky's vice president of manufacturing claims that cells yield about 75 per cent of the productivity gains of FMS for a smaller investment and risk.

The evolutionary approach has drawbacks. It requires retrofitting tools. But more important, it may be too slow in a competitive business. The pay-as-you-go and go-slow approach is fine if your competitors adopt the same strategy, says one observer. But if a competitor opts for a greenfields implementation, the go-slow company may be at a disadvantage. In fact, a more daring competitor can always get an advantage by automating faster. In the aircraft engine business, for example, General Electric's English competitor, Rolls Royce, appears to be moving into flexible manufacturing at a rapid pace. Rolls Royce has installed a flexible manufacturing system to produce high pressure turbine blades. It includes an automated vacuum casting line, a flexible turbine blade machining line that uses robots to load blades into creep-fed grinding machines from a conveyor belt, and will soon include automated systems for laser surface hardening and the drilling of cooling holes by spark erosion techniques. An automated factory being built by Rolls Royce in Derby, U.K. will contain: a flexible system to machine compressor and turbine disks, automated part and tool storage systems, wire-guided robot trucks, and robots mounted on overhead gantries. The company is considering building a system to machine large casings; it will feature such advanced devices as standard pallets, laser machining centers, robots and computer-controlled storage systems.

Competition is serving as the greatest stimulus to the adoption of flexible manufacturing. In the U.S., for example, companies facing foreign competition or stagnant markets have led the way in implementing flexible systems. These include aerospace companies, such as Avco Lycoming, Lockheed-California, Hughes, and Sundstrand, and agricultural and construction equipment makers, such as John Deere, Caterpillar, Allis Chalmers, and International Harvester. Among the Western industrial nations, Japan and Europe appear to be most receptive to flexible automation, seeing it as a way to gain a competitive edge against U.S. manufacturers who now dominate world markets. Labor opposition could be the biggest barrier to flexible manufacturing. Flexible automation promises to finish the process of job elimination begun with the industrial revolution. Machine tools have already eliminated many jobs in mid-volume manufacturing. Computer-controlled machine tools have reduced humans to little more than watchers. Tool operators route parts, set up tools, load workpieces, inspect finished parts, and observe their tools at work. Flexible systems will eventually eliminate the need for tool operators. For this reason, many companies are proceeding gingerly with the installation of FMS, trying to enlist labor support for automation and transferring displaced employees or allowing attrition and recession to do their trimming for them. (Excerpted from an article by Paul Kinnucan, senior editor, High Technology, July 1983).

CMOS future for microelectronic circuits:

Low power consumption of complementary metal-oxide semiconductor integrated circuits drives next stage of ultraminiaturization

Looking for a winner? Consider complementary metal-oxide-semiconductor (CMOS) integrated circuits. MOS transistors are the feedstock for the manufacture of the most densely packed integrated circuits, computer memory chips. According to figures compiled by Lane Mason of Dataquest, Inc., a Cupertino, California, market research firm, MOS memory sales amounted to $4.02 billion last year, with CMOS making up just 14 per cent of the total. Projections for 1988, when marketing of the next generation of even more highly miniaturized chips will be in full swing, have MOS memory sales almost quadrupling to $15.5 billion. However, the CMOS share will be 70 per cent! CMOS is not a new idea, having been part of the MOS integrated circuit scene almost from the beginning. In the mid-1970s, however, RCA's solid-state division in Somerville, New Jersey, was nearly alone in proclaiming its virtues. At the time, low power consumption was the principal benefit conferred by the use of CMOS. This made it ideal for digital watches and the like, which had to be battery powered. But NMOS had better performance, was simpler to manufacture, and lent itself more readily to the miniaturization (more computer power on a chip without an increase in the price of the chip) that fueled the microelectronics revolution. Over the course of time, power consumption has taken on an increasingly critical role in the march of miniaturization. In short, nearly all the advantages of NMOS have evaporated as engineers have struggled to deal with this problem. CMOS is on the verge of being the higher performance technology, while it maintains its traditional low power consumption.

Fear of the electricity bill is not the main power consumption issue in today's microelectronics. Power consumed appears as waste heat. The metal pins that connect integrated circuits to a circuit board can dissipate up to a few watts. A chip generating much more than that will overheat with concomitant effects on performance and reliability. Moreover, the cost and size of the computer or electrical system built around integrated circuits depends sensitively on the heat generated during circuit operations.

The lower power of CMOS confers an extra blessing on circuit designers beyond portability and reliability. Some years ago, in an effort simultaneously to increase packing density, increase speed, and save power in NMOS circuits, designers settled on dynamic rather than static circuits. To illustrate the difference, consider a register (temporary storage site for data or instructions) in a microcomputer CPU. In a static circuit the contents of the register remain fixed until new information arrives to be stored (unless the power goes out or the computer is turned off, then all information is lost). In a dynamic circuit, the contents of the register leak away and must be periodically refreshed. The advantage of dynamic circuits is that they do not draw current between refreshings; the disadvantage is that refreshing requires additional circuitry including clocks to synchronize the updating with the operation of the register and thereby makes the designer's job harder. CMOS circuits naturally do not draw power and can easily be implemented as static circuits without the need for clocking circuitry.

Circuit complexity has serious effects in both design and physical implementation of a chip. With two types of transistors and consequently more total transistors required to accomplish a given circuit function, CMOS has historically been a more complex technology. But, as the number of transistors on a chip exceeds about 75,000, the burden on NMOS becomes so great that engineers are finding CMOS to be more attractive and less costly, David House, an Intel vice president, told those attending a forum on semiconductor memories that was held just before the solid-state conference. At the same time, performance of CMOS integrated circuits has been closing the gap with that of NMOS. SRAMs are a case in point. As befits its name, a SRAM is a static circuit. Data is stored in a circuit called a flip-flop, which remains in whichever of two states (high and low output voltage) it is in until a new input signal arrives. CMOS has made its greatest inroads in SRAMs. As it happens, SRAMs are the high-speed memory technology, in contrast to DRAMSs, which generally have larger storage capacities, cost less, but are slower ...

Significant as these advantages may be, heat generation will eventually limit how far even CMOS miniaturization can be taken because heat is also generated during the switching operation of all transistors. Under today's rule for miniaturization wherein the voltage applied to each transistor remains constant while device dimensions shrink linearly and the number of transistors on the chip increases quadratically, the total heat generated by switching varies inversely with the linear dimension. Sooner or later, the heat will exceed the limit. At this point, engineers must resort to reducing the rate of increase in the number of transistors, slowing down the switching speed, lowering the operating voltage, or finding more efficient heat dissipating techniques. Chips in supercomputers, for example, which operate at the highest speeds and consequently dissipate the most heat, are seldom as densely packed with transistors as those in other machines and are sometimes refrigerated with liquid coolants.

Use of CMOS rather than NMOS staves off having to make such choices or at least makes them less critical in the next generation or two of integrated circuits. But, if miniaturization is to proceed apace, some problems unique to CMOS remain to be solved. One of these is how to pack the n-channel and p-channel MOS transistors more closely together without degrading their electrical characteristics. At present, CMOS comes in two forms. If the substrate is p-type, the n-channel transistor can be fabricated directly, but a large lake (or well) of n-type silicon must be made on the substrate for the p-channel transistor. This is called n-well CMOS. Or, the substrate may be n-type with a p-type well. In either case, a wide barrier of insulating silicon dioxide spearates the n- and p-channel transistors to keep them electrically isolated and thereby determines the minimum distance between them.

Even with the oxide isolation, the transistors remain in electrical communication under certain circumstances, leading to a pathological condition called latch-up. Latch-up occurs because the CMOS structure results in the unintentional formation of a silicon controlled rectifier (SCR). SCRs are highly useful devices for switching large currents on and off in power supply controllers and the like. They comprise a series of four alternating n-type and p-type silicon segments. In n-well CMOS devices, for example, the parasitic SCR is formed by the source of the n-channel transistor (n-type), the p-type substrate, the n-well, and the source of the p-channel transistor (p-type). Latch-up refers to the condition when a transient current accidentally turns the SCR on. This results in a large current that lasts until the condition is discovered and the SCR is turned off. Unfortunately, there is no automatic test for latch-up when the chip is in operation. In the worst case, the current can overheat the device and destroy it. The susceptibility to latch-up grows as transistor size shrinks.

Ways to deal with latch-up are hotly debated. At the International Electron Devices Meeting held in Washington, D.C., last December, Tadanori Yamaguchi and four co-workers from Tektronix Inc. of Beaverton, Oregon, presented an elegant implementation of a previously proposed method that simultaneously allows tighter packing of n- and p-channel transistors and resists latch-up. In place of the chunk of silicon dioxide insulator, they etched a deep trench in the silicon substrate, lined it with silicon dioxide, and filled it with polycrystalline silicon. Ordinarily, the spacing between n- and p-channel transistors is from 5 to 9 micrometers. The trench is only 2 micrometers wide. The Tektronix engineers also used a so-called twin-well structure that will probably be part of any solution to latch-up. The substrate is heavily p-type (has a high electrical conductivity). On top of the substrate, they epitaxially deposited a lightly p-type layer (with a low conductivity). This epitaxial layer serves as a p-well for the n-channel transistor. An n-well is also created in the epitaxial layer for the p-channel transistor. The deep trench extends down through the epitaxial layer (6 micrometers) to provide the electrical isolation, even though the surface separation between transistors is small. Rather than burrowing down into the silicon, it is also possible to isolate closely spaced transistors by building upward, as demonstrated at the electron devices meeting by engineers from the NEC Corporation, Kawasaki, Japan. The team calls its technique selective epitaxial growth. The idea is to grow a 2-micrometer-thick layer of silicon dioxide on top of a (in their case) heavily p-type silicon substrate. The silicon dioxide has openings etched in it where the transistors are to go. Lightly p-type and n-type silicon is epitaxially deposited in the openings to act as p- or n-wells, according to whether an n- or p-channel transistor is to be formed. The silicon dioxide remains as the isolation material.

The ultimate in eliminating the spacing between transistors is to build one on top of the other. Like trench isolation, stacking transistors on top of one another is not a new idea, but it is getting more practical to do as fabrication technology improves. Accurately etching deep trenches with small dimensions is made possible by an increasingly popular dry etching technique called reactive ion etching rather than the old style wet chemical method. Ions from a plasma react with silicon to form volatile molecules that then depart, leaving a cavity. Stacking transistors is accomplished by means of a laser technique known as laser recrystallization. Two groups reported on new developments in laser recrystallization at the electron devices meeting. The problem that laser recrystallization solves is how to create a layer of crystalline silicon for the upper transistor. Insulating materials that cover the first transistor, such as silicon dioxide, are amorphous, so silicon cannot be epitaxially deposited. However, it is possible to put down a layer of polycrystalline silicon. Irradiation with a focused, scanning laser beam melts the silicon, which then resolidifies as a single crystal if the laser power and scanning speed are correctly adjusted.

One approach taken by engineers at the Matsushita Electrical Industries Company, Ltd., in Osaka, Japan, started with a polycrystalline silicon "heat sink" to cover the bottom layer, which is made in the usual way on a silicon substrate. The heat sink is covered by silicon dioxide for electrical insulation, and a polycrystalline silicon island is deposited on the silicon dioxide. The island is laser recrystallized. The heat sink simultaneously protects the already completed lower level transistor from heating during laser recrystallization of the polycrystalline silicon in the upper level and provides a smooth substrate for the second layer. The Matsushita group made simple CMOS test circuits (shift registers) in two ways. In one, conventional CMOS circuits resided independently in the top and bottom layers. In the other, which is the stacked configuration, the p-channel transistors of the CMOS pairs all lay in the bottom n-type substrate layer, while the n-channel transistors were all in the upper laser-recrystallized layer. Researchers at Fujitsu Ltd., in Kawasaki, Japan, took a different tack in laser recrystallization. Rather than irradiating the polycrystalline silicon directly, they covered the material with a "cap" that indirectly transferred the heat to the polycrystalline silicon. They claimed this method better promoted the formation of a single crystal. The engineers achieved a relatively smooth surface for the upper layer by means of phosphosilicate glass, which can be made to "flow" and thereby reduce rough edges. Silicon nitride insulator completely protects the upper transistor. In this way they made simple test circuits (ring oscillators) with the n-channel transistor of the CMOS pair lying over the p-channel transistor in an n-type substrate.

When might any of these or other novel ideas appear in commercially available CMOS circuits? Despite their place at the center of today's high-tech world, integrated circuit manufacturers tend to the conservative side when considering new technologies. Rick Davies, a CMOS manager at Texas Instruments in Dallas, points out that manufacturers want to be sure that they can mass-produce chips reliably and inexpensively before they will change an already working fabrication process, despite the promise of laboratory devices. But it seems that, if CMOS is to lead microelectronics across the frontier toward chips with several million transistors squeezed onto them, some of these ideas will have to be implemented sooner or later. (Excerpted from an article by A. L. Robinson in Science, 18 May 1984).

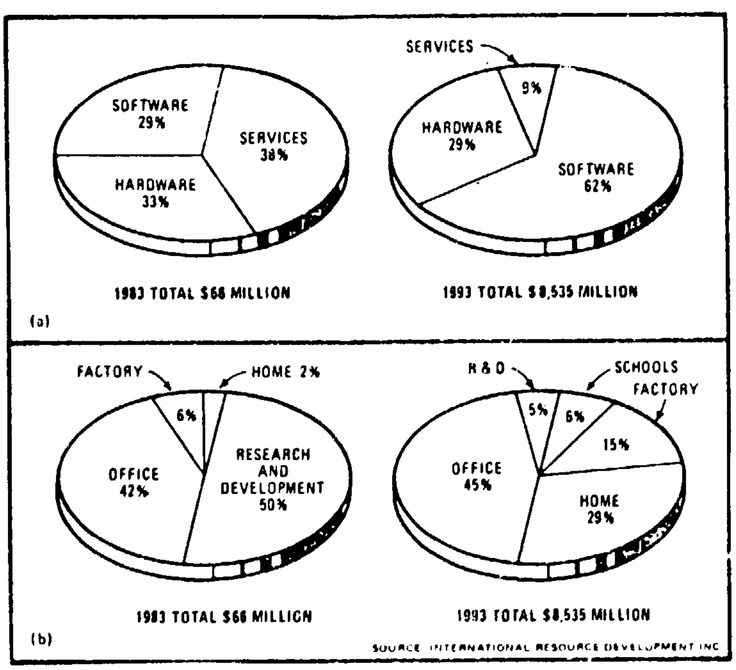
Artificial Intelligence:

Commercial products begin to emergy from decades of research

From the early days of computer science, when people like John von Neumann and Alan Turing began contemplating models of computational machines, the dream of building machines that think has fascinated scientists and society alike. From those heights of optimism, however, artificial intelligence plunged into an era of being labelled a useless discipline, from which it emerged as a somewhat arcane branch of computer science. In fact, despite an understandable wariness of popular notions about its capabilities, AI has taken its first careful steps toward becoming an accepted engineering technology in the commercial world. Noting its capability to offer sophisticated computing power to untrained workers, the information-technology industry has turned its attention to AI in hopes of finding new ways to meet growing demands for better software. In turn, new companies - and new groups in established companies - have responded with the first wave of commercial products based on AI technology. As a result of this surge of interest in artificial intelligence, U.S. industry will spend an estimated $66 million to $75 million this year to obtain some early benefits. Because AI techniques broaden the computer's capability into the realm of symbolic processing (the processing of concepts rather than just numbers), computers can get down to solving some of life's hard problems.

What are known as expert systems, or, more appropriately, knowledge-based systems, use AI methods to solve problems and to aid decision making by using a knowledge base along with rules of inference that apply to a specific field of knowledge. Some practical examples, now in limited use, include programs that diagnose diseases in several specialties, prospect for mineral deposits, assist in the drilling and analyzing of oil wells, analyze investments, configure computer systems, help repair locomotives, and assist business decision-making in conjunction with a spreadsheet program. These knowledge-based systems not only replicate and multiply the value of human expertise but also capture it and perpetuate it in computerized form. Other working AI systems give computers the ability to understand natural languages, English or others, albeit in restricted subjects or domains. Such natural-language systems make it easier for people without computer experience to use computers effectively for such functions as retrieving information from data bases, preparing the input for and running existing complex computer programs, and developing new computer applications without programming. Because AI technology has at last demonstrated some practicality, especially in areas of great need and value, the applications summarized above tend to be big payoff stuff. In the next two to five years the worldwide computer industry will produce a wave of AI products that could turn into a tidal wave after that. Two recent U.S. studies of AI technology and markets bear this out. One, from International Resource Development Inc., of Norfolk, Conn., predicts an estimated U.S. market for AI products and services growing from $66 million in 1983, to $8.5 billion by 1993. The other projects the AI market year by year from 1983 to 1990 (see figure and table below).

Exploding AI market. These market projections for artificial intelligence products suggest the emergence of another big growth market in the computer industry at the end of this decade. The future AI market is expected to be big in homes, factories and offices.



Product category	The Artificial Intelligence Market Market estimate ($ millions)							
	1983	1984	1985	1986	1987	1988	1989	1990
Knowledge systems	10	16	25	40	60	90	145	220
Natural-language software	18	32	60	105	190	335	600	1,090
Computer-aided instruction	7	11	15	20	30	45	70	100
Visual recognition	30	55	100	150	230	360	555	860
Voice recognition	10	14	20	30	50	80	130	230
Total	75	128	220	345	560	910	1 500	2 500

Source: DM Data Inc.

AI has a long history of international research and non-existent or precious little practical application. However, that state of affairs is changing because two necessary conditions have manifested themselves. First, there are important problems to solve that are too complex for conventional computational technology. Second, the recent availability of abundant cheap computing power and the promise of much more of it open the door for the discipline that has been called a useless science to finally yield some useful technology. The long-term goals of AI specialists are computer systems that surpass human capabilities in reasoning, problem-solving, sensory analysis, and environmental manipulation. However, AI still has many limitations and a great deal of research still must be done. For the present, though, the information-technology industry will be satisfied with AI applications as long as they can meet short-term needs. Even though research continues, it is now possible to accomplish this goal for narrow well-defined application areas, such as those addressed by knowledge-based systems and limited-domain natural-language systems (limited because they can understand only a subset of common words plus the subject's specific terminology.

Knowledge-based systems aim to solve real-world problems. Some examples are: a program called Mycin, which diagnoses blood diseases; XCON and XSEL, which Digital Equipment Corp. uses to provide instructions for computer-system configurations to manufacturing and to help customers configure systems; the Drilling Advisor produced by Teknowledge Inc., Palo Alto, Calif., for Elf-Acquitaine, the French national oil company, to advise drilling supervisors on drill-stem sticking problems; and the Dip Meter Advisor, developed by multinational Schlumberger Ltd. for its own use in oil-well logging (dip meter) analysis. About 50 knowledge-based systems have been built. Some are experimental, others are in use by the companies that built or commissioned them, and a few others are for sale. ...

Natural-language systems provide an interface between a person and a complex computer program that lets the user work with the human language he or she normally writes and speaks. For example, several programs using natural-language techniques have been developed to give computer users an easy-to-learn interface with data bases. ...

There are many definitions of artificial intelligence, though none is universally accepted. Definitions gleaned from several AI practitioners range from the abstract - like "the processing of symbolic information such as concepts, knowledge, and relations" - to the somewhat more deterministic, like "the study of techniques for solving exponentially hard problems in polynomial time". Perhaps the most comprehensive and easiest to understand is: "that part of computer science concerned with designing intelligent computer systems; that is, systems that exhibit the characteristics associated with intelligence in human behaviour, such as understanding language, learning, reasoning and solving problems." Though the most commercialized AI applications to date are knowledge-based systems and natural-language interfaces, other application specialties to which AI is beginning to be applied include computer-aided design and engineering, intelligent robots, vision for robots, automatic programming, AI system development tools, and military applications crucial to national defense. Although each specialization has its own practitioners with their own specific interests, research techniques, product development tools, and terminology, some of the more useful systems of the future are likely to combine the capabilities of two or more specialties. Common sense would suggest the combination of natural-language processing with knowledge-based systems, for example.

As is its nature, the science of artificial intelligence pushes the frontiers not only of software technology but also of software development methodologies. Some of the tools developed by researchers for their own work have become very important concepts applied to computing in general - ideas such as time-sharing, list processing, interactive editing and debugging, exploratory programming, graphics-oriented user interfaces, rich program-development environments, and even windows and mouse devices, all stem from AI work. The popularity of Lisp, the traditional programming language of the U.S. AI community, is based on practical considerations stemming from the highly dynamic nature of AI techniques. Unlike typical number-crunching or text-processing applications, where the structure of the data is known a priori, AI programs are forced to deal with data structures - and even executable procedures - whose size and composition are developed as the program executes. Lisp, which stand for LISt Processing language, was designed to manipulate linked lists of objects. With the acceptance of the programming language, Prolog, by Japan's fifth-generation computer project, however, Lisp may soon not be alone as the de facto language for AI development. Prolog - for PROgramming in LOGic - allows programmers to deal directly with logical associations between objects by defining a set of rules that a program can apply to meet its goals. From the point of view of the program developer, though, language and hardware advances take second place to new program-development environments that ease the creation of software. Some of these systems even go so far as to provide the fundamental mechanisms needed in knowledge-based systems. They may even provide the fundamental hierarchical data structures and search algorithms used in knowledge engineering. Consequently, the creation of programs using AI technology becomes possible for computer scientists who have not been trained in the particulars of AI.

The first AI products are harbingers of an evolution to a new generation of computer hardware and software. Major players in the international computer industry have recognized the strategic importance of AI and are already deeply involved. The Japanese government and the country's major computer companies and universities are about two years into the 10-year fifth-generation computer project. This massive national project has several objectives and parts, including the development of number-crunching supercomputers, improved conventional business data-processing computers, and advanced process-control and robot systems. But its most ambitious goal is to produce a whole new family of thinking computers with knowledge bases and powerful inference engines (hardware and software that draws conclusions using rules of inference and facts from the knowledge base).

Western Europe has several projects in various stages of implementation and planning. In the UK, a fifth-generation computer project, called Alvey, is under way. In 1984, a research institute devoted to artificial intelligence gets off the ground. Called the Turing Institute, in honor of British mathematician and computer theoretician Alan Turing, it is to be set up in collaboration with the University of Strathclyde, with sponsorship from industry. Industrial sponsors for the first year include, for example, ICL plc, Sinclair Research, Thorn-EMI, two Shell Oil Co. research laboratories and two government agencies. The institute will concentrate on fundamental research in computer architecture, automatic programming, knowledge-based systems and advanced robotics. In France, Paris-based Schlumberger has made the largest commitment to AI of any company in the country. Its several large research labs include the Fairchild Research Laboratory in Palo Alto, Calif., and Schlumberger-Doll Research in Ridgefield, Conn. The company also has a major equity position in Bolt, Beranek, and Newmann Inc., a Cambridge, Mass. research firm with a strong AI capability.

The European Commission has its Esprit project, while the three largest European computer companies - France's Compagnie Machines Bull, Britain's ICL, and West Germany's Siemens AG - have formed a joint research institute for knowledge processing. AI research is also conducted in the USSR and East European countries - Hungary even exports an AI programming language.

In the U.S., major corporations with large commitments to AI research and development include International Business Machines Corp., Armonk. N.Y.; AT and T Bell Laboratories, Murray Hill, N.J.; Xerox Corp., Palo Alto, Calif.; Digital Equipment Corp., Maynard, Mass.; and Hewlett-Packard Co., Palo Alto, Calif. In addition, there are many small and start-up companies whose business is AI. (Reprint of an article by T. Manuel and S. Ivanczuk in Electronics, 3 November 1984, copyright 1983, McGraw-Hill Inc. All rights reserved).

Reshaping the computer industry

Back before the Great Depression - when cars called the Dodo, the Fool-Proof, Billy Four, and Seven-Little-Buffaloes zipped along the nation's byways - the army of more than 100 auto makers then chasing the surging U.S. market could not imagine the radical restructuring and shakeout their industry was about to go through. Just as those companies could not envision today's auto industry, the more than 500 computer hardware manufacturers, 5,000 software companies, and 430-odd makers of communications gear now battling it out in the information processing industry will hardly recognize their business in the next decade.

The industry is taking on a new shape. Until recently, manufacturers of mainframes, minicomputers, microcomputers, and communications equipment had their own separate turfs. But the distinctions between the markets are disappearing. Now that customers are becoming more sophisticated and technology is growing more complex, manufacturers have to produce wide-ranging product lines. As a result, they now are all competing against each other in a market with few boundaries.

To survive, once fiercely independent companies - even former competitors - are scrambling to form alliances and partnerships to broaden their range of products. "A powerful convergence of forces - technological, economic, societal - is recasting the industry from top to bottom," says Stephen T. McClellan, an industy analyst at Salomon Bros. and author of "The Coming Computer Industry Shakeout". "The industry is struggling to come to grips with its own success." Driving this fundamental overhaul is the rapid convergence of computer and communications technologies - inexorably intertwining these once-separate industries. And customers, overwhelmed by the variety of equipment available, are beginning to insist that vendors supply more complete solutions to their information processing needs. "As the cost of developing the technologies and the products has skyrocketed and the market has become much more complex, the ability to get an economic return on your investment has become much more difficult," explains David N. Martin, president of National Advanced Systems, the Mountain View (Calif.) computer subsidiary of National Semiconductor Corp. "Hence, there have been many partnerships recently that would have been unheard of before."

This increased collaboration reflects companies' fears that if they do not offer complete product lines at competitive prices, the Japanese - to whom such co-operation is nothing new - will cut deeply into the information processing business in much the same way that they have penetrated the U.S. market for televisions, cars, and cameras by using low-cost, high-quality manufacturing. Also worrying these companies is the entry by International Business Machines Corp. into almost every segment of the market, which is forcing them to reassess their strategies and align themselves with other companies to be more competitive. Teaming up is an attractive response to Japan's manufacturing muscle and IBM's aggressiveness because it allows corporate participants to stay in the market while maintaining their own identities. Forming alliances, in fact, is becoming a critical element in almost any successful strategy - so crucial that many of the deals call for the partners to invest in one another or to exchange management. These agreements are "different from run-of-the-mill joint ventures, or arms-length technology swaps," says Robert J. Conrads, a partner in the management consulting firm of McKinsey & Co. "They are central to a company's direction and to its way of achieving future competitive advantages." Conrads calls this new phenomenon "strategic partnering".

Without this kind of co-operation, many manufacturers will not survive the restructuring. The information processing industry - which includes everything from office typewriters and copiers to computers and communications hardware and services - is growing at a more than 20% compound annual rate - which will take it from $268 billion in 1983 revenues to an incredible $1 trillion in annual revenues by 1990, according to market researcher Dataquest Inc. Even at that high rate of growth, the pie will still not be big enough to support all the current players. The industry "is just not going to be able to support hundreds and hundreds of companies when everyone has access to the same technology," notes Robert A. Fischer, president of McDonnell Douglas Automation Co. A shakeout, in fact, already has started in the crowded personal computer market. The pressures to form new relationships are shaking the industry to its foundations. It seems unlikely, however, that information processing will ever become an oligopoly like autos: the needs of customers are so diverse that not even the biggest manufacturer - giant IBM - could produce all the pieces to satisfy them. But throughout the industry, new alliances are changing the way companies do business:

- IBM in the past year acquired 22.7% of Rolm Corp. - to tap its expertise in making communications equipment - and a 20% share of Intel Corp., the chipmaker. Big Blue also began discussions to set up joint computer manufacturing in Asia with Korea's Hyundai Group.

- American Telephone & Telegraph Co. last year bought 25% of Olivetti, the Italian office-equipment maker, which in turn will sell AT&T's systems in Europe. And in June, AT&T began selling Olivetti's personal computers in the U.S.

- Burroughs Corp. and NCR Corp. are just two of the many companies buying small computers from Convergent Technologies Inc. for resale under their own brand names. Burroughs Vice-Chairman Jerome Jacobson has even been elected to the Santa Clara (Calif.) company's board of directors.

- Overseas, Japanese computer giants are aggressively seeking and signing joint ventures and other agreements with U.S. and European competitors. Fujitsu Ltd., for example, in March raised its investment in Amdahl Corp. to a controlling stake.

European information processing companies, struggling to stay in the worldwide race, also are forming long-term research and development alliances with each other. To fill in product gaps until that research pays off, major players such as West Germany's Siemens, Britain's ICL, and France's Bull are signing Japanese and U.S. partners. Companies are rushing into each other's arms even though the ultimate implications of these relationships are not yet clear ... Partners are becoming essential to survival, because producing broader, more integrated product lines is easier said than done. In some cases, the larger companies are finding that they lack the entrepreneurial spirit vital for developing quickly the necessary products or services. Others are looking for partners that can provide them with technological expertise such as the communications and software needed to tie all the pieces together ... For their part, the smaller companies need access to the professional management skills available at the larger corporations. The small companies can often take advantage of their large partners' better marketing and distribution channels. And, of course, the smaller companies are seeking greater financial strength from their new relationships so they can continue to develop better technology and expand their manufacturing facilities. That was a large factor, for instance, in both Rolm and Intel selling shares of their companies to IBM. Ultimately, many industry watchers predict, the industry will evolve down to three sectors: a few gigantic, vertically integrated suppliers, such as IBM, AT&T, and perhaps one or two Japanese companies offering soup-to-nuts product lines and low-cost, high-volume hardware manufacturing; a second, much larger tier of systems integrators assembling products from various manufacturers to create customized computer systems for different industry niche markets; and, finally, a horde of small, specialized suppliers providing the systems integrators with individual pieces of hardware or software tailored to specific markets. Since not all current players are likely to survive the restructuring, "the winners and losers will be determined by who can adapt and participate in new market segments". The biggest winners, as a result of this trend towards integration, are likely to be the largest companies, which can provide the most pieces of the product puzzle. And IBM stands to make out best of all, figures John F. Rockart, director of the Center for Information Systems Research at the Massachusetts Institute of Technology's Sloan School of Management. "If you look at IBM's major advantage, they can pull all the pieces of this together, including timesharing, office automation, and personal computers."

But other producers are quickly following IBM's lead in hopes of winning a place among the second tier of large-systems integrators. The onetime mainframe companies - Burroughs, Sperry, NCR, Control Data, and Honeywell - are all making alliances that will enable them to supply a full line of products, including telecommunications equipment, office automation gear, and small computers. Honeywell already has a joint venture going with Sweden's L.M. Ericsson, for example, to manufacture and sell communications equipment in the U.S. and it is now obtaining some large mainframe computers from Japan's NEC Corp.

The traditional minicomputer manufacturers are trying to do the same thing. Digital Equipment, Data General, and Wang Laboratories are creating their own complete product lines, often with the help of others. One area in which most computer and office-equipment makers are looking for help is communications.

Despite the fierce competition developing among second-tier players, some of these companies are pooling their resources in an effort to develop new technologies that they can all use to compete with the first-tier companies - especially IBM. The best example is the Microelectronics & Computer Technology Corp., or MCC for short, a joint venture of 18 companies - including computer makers Control Data, Digital Equipment, Honeywell, NCR, and Sperry, as well as chip-makers Motorola, Mostek, and National Semiconductor. It is only through such co-operation that the information processing industry will avoid a descent into oligopoly, says retired Admiral Bobby R. Inman, who heads MCC. "It's an effort to avoid being IBM-ized or GM-ized." Whether or not MCC's sponsors can pull it off is not yet clear, Inman says. The co-operative effort has proved it can gather sufficient resources to recruit research talent. "What's not established," he admits, "is whether the companies can be ready to [take the resulting technologies and] go into the marketplace with products and be competitive." Indeed, teaming up is no guarantee of success, as investors in Trilogy Systems Corp. recently discovered. Digital Equipment, Sperry, and Bull invested a total of $80 million in Trilogy, on top of $200 million from other investors. Their goal, to develop an innovative semiconductor technology called wafer-scale integration, which would combine a hundred or so individual chips on a single wafer that could then be used as a basic unit for building giant new mainframe computers to compete with upcoming IBM models. But because of technical snags, Trilogy in June scrubbed plans to develop the computers and admitted it is at least 18 months behind schedule in developing the new circuits.

If the larger, second-tier companies have trouble carving out a place in the new industry structure, the position of the smaller, third-tier companies is even more perilous. To compete, the small companies must make huge investments in R&D and large-volume manufacturing. Because they are not all that diversified, they are exposed to enormous risks if their one and only product fails. Yet it is a risk they must take. If they fail to keep up technologically or if they lose their cost advantage, their customers can just as easily switch to a competitor that is ahead. Some observers worry that all this togetherness could make the industry too incestuous for its own good. When Data General was working with Rolm on a proprietary project to develop a computer system for the military, for example, it worried that Rolm's relationship with IBM could prove compromising. But many industry watchers hail the move towards co-operation as healthy. "It's beneficial that the companies are working together and share technology," says Grant S. Bushee, analyst with market researcher InfoCorp. Adds Dataquest President E. David Crockett: "Globally, it helps avoid having too many companies reinventing the wheel and using their resources inefficiently. It's making them more competitive." (Business Week, 16 July 1984)

Table 2

TEAMING UP TO OFFER ONE-STOP SHOPPING

In the past, a manufacturer typically supplied only one slice of the information processing pie: software, communications gear, or hardware—microcomputers, minicomputers, or mainframes. Now these products are converging, and customers want to buy the entire system from one supplier. This is forcing the leading U.S. and European manufacturers to broaden their product lines rapidly—by investing in other companies or by acquiring technology and products from them

	PERIPHERALS/ COMPONENTS	SMALL COMPUTERS	MEDIUM COMPUTERS	LARGE COMPUTERS	SOFTWARE	COMMUNICATIONS
AT&T	Telectron (1)	In house, Convergent Technologies (4), Olivetti (2,8)	In house	No plans	In house, Intel (5), Zilog (5), Motorola (5), Digital Research (7), others	In house, Philips (3,8), Gold Star (3)
BULL	Trilogy Systems (2,5), Magnetic Peripherals (2)	In house, Fortune Systems (2,6,8)	In house, Convergent Technologies (4), Ridge Computers (5,8)	In house, NEC (5,8), Honeywell (6)	In house	In house
BURROUGHS	Memorex (1), Peripheral Components (2), Qume (4), Canon (4), Intel (9)	Convergent Technologies (4)	In house, Graphics Technology (1)	In house	In house, Midwest Systems Group (1), Graphics Technology (1), others	In house, Systems Research (1)
CONTROL DATA	Centronics (2), Magnetic Peripherals (2), Trilogy Systems (2,5)	In house, Columbia Data Products (4)	In house	In house, Microelectronics & Computer Technology (5)	In house, Chrysler Corp (5), Northrop Electronics (7)	The Source (2), United Telecommunications (2)
DEC	In house, Trilogy Systems (2,5)	In house	In house	In house, Microelectronics & Computer Technology (5)	Third-party agreements	Northern Telecom (5), Xerox (5), Voice Mail Int'l (8)
HONEYWELL	Magnetic Peripherals (2), Synertek (1)	In house, Columbia Data Products (4)	In house, Bull (2,6)	In house, Microelectronics & Computer Technology (5), NEC (5,6,8,9)	Third-party agreements	Action Communication Systems (1), L. M. Ericsson (3,5,8), Keycom (3)
ICL	In house, Fujitsu (4)	In house, Logica (4), PERQ Systems (5,9), RAIR (8,9)	In house	In house, Fujitsu (5,8)	In house, third-party agreements	In house, AT&T (6,8), Mitel (8)
IBM	In house, Intel (2)	In house	In house	In house	Microsoft (4), Comshare (8), others (4,7,8)	Rolm (2), Merrill Lynch (3), SBS (2), Sears and CBS (3)
NCR	In house, Magnetic Peripherals (2)	In house, Convergent Technologies (4)	In house	In house, Microelectronics, & Computer Technology (5)	In house, third-party agreements	Comten (1), Ztel (2), Intel (8)
NIXDORF	In house, LSI Logic (4)	In house	Spartacus Computers (6)	In house, Auragen Systems (5)	In house, Spartacus Computers (6)	In house
OLIVETTI	In house, Hermes Precisa Int'l (1), Lee Data (2,8), Ithaca (2,8),	In house, Corona (2,8), Kyocera (4)	In house, Stratus Computer (2,8), AT&T (8)	IPL (2,8), Hitachi (8)	In house, Digital Research (2,8), Shared Financial Systems (2,8)	In house, AT&T (8), Northern Telecom (8,9), Bolt Beranek Newman (8)
SIEMENS	In house, IBM (4), Furukawa (3), Intel (4), Xerox (6,8)	In house	In house	Fujitsu (8)	In house	In house, Corning Glass (3)
SPERRY	Magnetic Peripherals (2), Trilogy Systems (2,5)	Mitsubishi (7)	In house	In house, Microelectronics & Computer Technology (5), Mitsubishi (7)	In house, third-party agreements	In house, Northern Telecom (7)

(1) Acquisition (2) Equity position (3) Joint venture (4) OEM agreement (5) Technology development (6) Technology exchange or licensing (7) Joint product development (8) Marketing agreement (9) Manufacturing agreement DATA: BW

BUSINESS WEEK/JULY 16, 1984

ICs tailored to applications gain ground - by Bruce R. Bourbon *

Today's demand for application-specific integrated circuits - gate arrays, standard cells, and full custom - and the heavy attention being given this segment of the semiconductor industry is not just a passing fancy. Nor is it a reaction to a shortage of standard parts that will fade as capacity grows to meet demand. The explosive growth in the custom and semicustom markets is testimony to major changes in the IC industry. Recent advances are driving a movement toward custom ICs that not only will force its continued growth but cause it to dominate and change IC technology as we have always known it.

At the most general level is the obvious driving force of competition. In the design of electronic systems, the competitive need to develop new products and improve old ones is a continuing battle. This battle has spurred the development of IC technology to provide the means for adding product features and increasing reliability while reducing the size, power consumption, and cost of the product. The semiconductor industry has met and exceeded the demands of systems manufacturers in providing the technology to remain competitive and advance product offerings, while creating ever-larger markets. But the number of IC design engineers who can create designs in silicon has not grown. In fact, it has been estimated that there are only about 3,000 IC designers in the USA at this time.

This limited supply of competent design engineers, along with the lack of software to aid in the design process, had been the main factor in encouraging the use of standard ICs and had impeded the use of custom ICs in electronic systems. Standard products such as memories, logic chips, and microprocessors are used in designs because of their off-the-shelf availability and clearly defined behavior and performance: systems designers can just use a combination of these products on a board to achieve many of their product goals. Now, however, the situation has changed: the capability of IC manufacturers to pack more circuitry on a chip and other changes will lead systems designers to rely on application-specific chips for their competitive edge. Three factors in particular have conditioned the market to turn to application-specific ICs as a solution. Much credit goes to the hierarchical design technique that was first advanced by Carver Mead and Lynn Conway at the California Institute of Technology and later at other universities. Inherent within the Mead-Conway technique was the philosophy that systems designers should be trained to design ICs. Although computer-aided design tools to support the Mead-Conway technique have not yet become generally available, university training has resulted in a reduction of the perceived barriers to IC design. Hardware and software companies, fueled by an abundant supply of venture capital in the 1970s, have attacked the problems of providing low-cost CAD tools to design engineers themselves. Now the tools are friendly enough for systems designers, so any perceived barriers have dropped away. This change has occurred simultaneously with advances in process technology to a point where gate arrays and standard cell equivalents having up to 10,000 gates can be fabricated. The synergy of design training, CAD developments, and process improvements thus has created the explosive growth of application-specific ICs and will continue to fuel their rise to a major means of chip development.

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* Bruce R. Bourbon is vice president of the semicustom group of Gould AMI Semiconductors.

Table 3

Worldwide market for nonstandard ICs
(millions of dollars)

Market segment	Year										Compound annual growth rate (%)
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	
Gate arrays	120	145	265	455	635	790	950	1 100	1 240	1 400	31
Linear arrays*	10	25	35	55	80	110	150	200	260	325	47
Total semicustom	130	170	300	510	715	900	1 100	1 300	1 500	1 725	33
Standard-cell ICs	12	25	40	90	180	400	750	1 200	1 800	2 500	81
Full custom ICs	500	550	650	775	925	1 125	1 350	1 625	2 000	2 500	20
Total custom	512	575	690	865	1 105	1 525	2 100	2 825	3 800	5 000	29
Programmable logic	33	80	175	260	420	530	635	750	885	1 020	46
Total nonstandard IC market	675	825	1 165	1 635	2 240	2 955	3 835	4 875	6 185	7 745	31

* Includes linear-digital ICs.
Source: Integrated Circuit Engineering Corp.
(Electronics Week, 30 July 1984)

Gate arrays will initially benefit more from the improved CAD tools because they have a fixed physical structure, so it is easier to place and route logic elements automatically in creating the mask data for manufacturing. In redesigning a system to achieve higher levels of integration, a rule of thumb is that 80% of the system typically can be realized with gate arrays. Another point in gate arrays' favor is that they will always have relatively few numbers of layers to personalize, with the attendant advantage of lower tooling costs. Another advantage is in the area of component qualification. If a large manufacturer has a significant component qualification requirement, it can typically qualify the gate arrays once and not have to requalify each pattern on the chip. This contrasts with standard cells, where each circuit is different and must be qualified individually. Gate arrays will continue to serve in lower-volume applications where their lower development costs more than offset higher unit prices. Arrays' advantages include the lowest development time and cost, fast ramp-up of custom manufacturing and easy entry into the custom market, due to the relative ease of design. Gate arrays are often used for breadboards to prove systems concepts, since the engineering development time is short and costs are low. Because the macrocells are already characterized and proven, circuit and logic simulation are greatly simplified. And since wafers can be stored in an unpersonalized condition, the time to production is generally three to four weeks shorter than for full-custom chips. This results in lower inventory levels at the supplier, as well as gives the systems manufacturer greater capability in coping with peak load conditions.

Nevertheless, an ongoing migration from gate arrays to standard cells indicates that the latter will become the dominant form of application-specific ICs. Standard cells not only can provide higher density and lower-cost parts - they also can provide precision analog functions on chip, which results in broader application to the solutions of system circuit problems. In the future, the major cost difference between standard cells and gate arrays will be the cost of the additional manufacturing tooling for standard-cell circuits, since all levels of standard cells must be personalized and extra time is needed for the fabrication of standard-cell circuit wafers. Even this cost may disappear if electron-beam direct writing is eventually used for image creation, rather than optically prepared photomasks that are the accepted technique now. Customized standard cells generally use rows of fixed-height and variable-width cells, with variable-width wiring channels between rows. Power supplies are automatically connected when cells are abutted. Typically, standard-cell parts are considerably denser than gate arrays but generally are 40% greater in silicon areas than an equivalent full-custom chip. Like gate arrays of logic macrocells, these cells are also well characterized and simulated.

Full-custom ICs offer performance advantages over gate arrays and standard cells by drawing on all the features and flexibility inherent in a given process technology. Custom chip design is best for high-volume applications (more than 50,000 parts) because it results in the minimum die size. The resultant lower unit prices offset the inherently higher development costs. In some large complex designs, in fact, full-custom chips may be the only choice. With a typical complementary-MOS chip of 1,000 gates, arrays provide the most cost-effective approach for up to 20,000 parts, beyond this point standard-cell designs yield the lowest cost. Around 50,000 units, the higher development costs of a full-custom design are amortized over a large enough volume so that such ICs become the most cost-effective alternative. This is not to imply, however, that there are clear-cut lines of differentiation between the approaches. The custom market is, in fact, a continuum in which each design has different parameters that determine the optimum solution. The current overall emphasis on gate arrays and standard cells will further legitimize full-custom solutions, fulfilling the market expectations for shorter up-front costs and shorter production cycles. High-volume customers will move toward full-custom designs for cost reduction and performance improvements as internal design centers, CAD software tools, and work stations become more prevalent in the design community.

The total market for application-specific ICs (including gate arrays, programmable logic * arrays, standard-cell designs, and full-custom chips) should grow from $3.8 billion in 1983 to $13.7 billion in 1989 for a 24% compounded annual growth rate (CAGR). More impressively, merchant suppliers' share of this market should grow from 42% of the market in 1983 to 57% by 1989, growing by a CAGR of about 30%. This represents a market share of $1.6 billion in 1983, swelling to $7.8 billion in 1989. Such extraordinary growth will be reflected in each segment of the application-specific IC market: MOS gate arrays will go from a modest $153 million in 1983 to just over $1 billion in 1989, for a 38% CAGR. Standard-cell designs will undergo even more significant growth, however. Their share of this market will go from $43 million in 1983 to $1.2 billion in 1989, a CAGR of 72.1%. Full-custom designs will grow from $1.1 billion to $4.1 billion during the same time, for a

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* Current market figures quotations differ depending a.o. on whether captive market production is included or not, cf. also Table 3 on page [illegible].

23.9% CAGR. The MOS application-specific IC merchants will maintain 30% of the total market, growing from $1.3 billion in 1983 to $6.1 billion in 1989. Projections indicate that by the year 1990, 80% of the custom MOS manufacturing will be done in CMOS technology, primarily because of the system power-saving characteristics of this technology as well as because shrinking geometries are giving CMOS the high speeds that are required by the systems being made today.

Projecting the technology evolution over the same time period shows the number of active elements per chip increasing from the MSI range to very large-scale integration, with densities of more than 100,000 devices on a chip. In five years, the IC industry will usher in the era of ULSI (ultra large-scale integration) and will routinely place 1 million devices on a chip. This evolution means that manufacturers will be able to put entire systems on one chip before the end of the decade. As this capability becomes a reality, end users gain the benefits of reduced cost, less space consumed by circuitry, and dramatically improved reliability because of reduced part count. But a concomitant challenge arises; packing more circuitry on a silicon chip produces a design that fits into fewer end applications. To design complicated VLSI and ULSI custom circuits requires either tens of man years of effort by scarce IC design engineers or new design approaches. Led by sophisticated CAD hardware and software, these new design approaches are rapidly changing the design environment. But this is only an evolutionary step in what is really a revolution. This revolution, propelled by work stations, is moving the industry from computer-aided to computer-automated design. Systems designers will use advanced CAD tools to implement ideas into silicon in a fast, error-free way. The rapid emergence and growth of the gate-array and standard-cell markets testify to the benefits of managing IC design complexity through semicustom design approaches, fully supported by CAD software. The effort to develop VLSI circuit-design tools, such as silicon compilers, is another indication that CAD has made IC design simpler for systems engineers.

IC design has also been greatly simplified by techniques that automatically perform design-rule, continuity, and load checking, as well as flag problems. Since these tools will free designers from such mundane concerns, a greater level of creativity can be expected from systems designers. At the same time, most of today's circuit designers will be designing ever more complex and useful standard cells and macrocells to be used by the systems designers with their CAD tools. Even now, CAD has reduced nonrecurring engineering development costs by an order of magnitude, and continued automation will increase development times for semicustom solutions to as little as two to three weeks. Looking at the average 1980 development cycle, from design through prototype, of a 2,000-to-3,000-gate part, development time for an array design was 8 to 9 weeks, a standard-cell design required 12 to 16 weeks, and a full-custom design's development time ranged from 18 to 26 weeks. Today, this time difference is being reduced markedly. By 1990, moreover, as macrocell libraries become the data base for all three types of development, the length of the development cycle will depend more on design complexity than on design approach, and any difference in cycle time will be accounted for by wafer-fabrication time. From a cost standpoint, in the future, practically the only difference between standard cells and gate arrays will be the cost of the additional masks required to personalize standard cells. Even this may disappear if electron-beam direct-writing becomes a practical alternative to today's optically prepared photomasks or stepper reticles.

The growth rates and shortened production times that characterize the application-specific IC market have only been made possible by the availability of computer-aided and computer-automated design tools that reduce the cost, time, and risks of development by eliminating many of the labor-intensive tasks associated with every design step, from logic design, through breadboarding, to circuit layout. With the rapid improvement in, and proliferation of, CAD software, it is possible to project what further improvements in CAD technology may bring and what challenges remain. From the standpoint of the IC vendor, CAD will continue to be widely used and will be continuously improved for use in complex chip design. But more than that, CAD will encompass the processing of data that will help automate the entire chip manufacturing process, including process description, test-pattern description and generation, and generating the tape that controls the packing and assembly of the parts. In the future, the customer will also have a greater range of options with which to interact with the custom manufacturer. Depending upon the expertise of the systems house and the designer, the interface with the manufacturer can begin at any point, from the system description to the mask level. The designer can proceed to select from a catalog those functional building blocks necessary to define a system and then provide the IC manufacturer with the input for automatic placement and routing in the form of a program generator tape, so the product can be manufactured in a very short cycle time. Such a close relationship with customers will require IC manufacturers to develop effective means of postsales support. The idea of postsales support is important because of the rapidly growing need to support customers who are doing IC design. Manufacturers will also have to provide access to design centers for customers through distributor connections or captive design centers where customers can be trained and get applications support. This will require skilled software applications engineers who know how to use CAD tools and experienced logic design application engineers who will focus on how to do IC design. This means that manufacturers will have to train a customer's design engineers to handle gate arrays and standard cells as well as in the use of work stations and cell libraries.

Distributors have an existing established customer base and, if they are competent in offering design center services, their customer base will turn to them for gate-array and standard-cell support. Also, with an existing sales force calling on customers, they would have a natural marketing tool in their design shops. Their challenge, however, will be attracting and holding logic design engineers in what is primarily a sales organization. It is still an open question if they can succeed in switching from a sales-from-inventory operation to a high-technology service area. For standard-product manufacturers who enter the application-specific market, there will also be challenges. They must make the transition from marketing a relatively few products in high volume to running a wider variety of products in small quantities. From a design standpoint, the vendor must shift from complete control of the design to providing customers with the tools to do their own designs. The custom manufacturer holds the advantage where a large product mix requires extensive setup modifications of numerous pieces of equipment. One key area is photolithography, where masks or reticles may need to change as frequently as every run of 50 wafers. Typically, for a given number of wafers, a custom manufacturer will use 100 to 1,000 times more masks or reticles than a standard-product manufacturer.

Perhaps the most challenging problem created by the proliferation of software design tools and advancements in technology, however, is in the area of testing. Software and circuit designers who have learned to deal with CAD will have to master the techniques of computer-aided testing as well. The traditional techniques for generating test patterns - whether by manual development, fault simulation, or automatic test-program generation - become increasingly difficult and more expensive as circuit complexity increases. This is creating a strong trend toward designing testability into the chip along with self-testing circuitry. Various forms of the scan path test technique developed by IBM Corp. are the basis of most approaches for implementing testable designs because they lend themselves particularly well to the testing of today's highly sequential circuits. Unfortunately, both self-scanning and on-chip test circuitry impose penalties in additional silicon area, which the industry will have to accept. Another key development area is advanced processing. In the past, custom and semicustom ICs tended to utilize conservative, well-proven processes lagging the state-of-the-art. This was a deliberate policy, since an unproven process used on an unproven design could jeopardize achievement of a custom application. Now, with the advent of CAD, semicustom solutions can be developed much faster and with very little risk. Advanced processing techniques can be utilized in the design, which can be proved out by simulation techniques.

CMOS silicon-gate technology will dominate the application-IC area, with 1-µm geometries common by 1986. Electron beams will be universally used to make perfect masks and reticles in mimimum development time. High-pin count packages will accommodate the increasing system complexity of the future. The strong continued growth of application-specific ICs is clear, as is the direction of IC technology. These changes constitute a major cultural transition for the semiconductor industry and its customers. But to the semiconductor industry, change is a way of life. It has always met challenges imposed by changes in the market and the technology, and it is certain to exhibit the same kind of successful response to the changes imposed by the era of application-specific ICs. (Reprinted from Electronics Week, 3 September 1984, copyright 1983, McGraw Hill Inc. All rights reserved).

Table 4

Top ten U.S. IC producers

1983 rank	Company	IC production ($ millions) 1983	IC production ($ millions) 1984 (forecast)	1983/1984 % change
1	TI	1 505	2 230	48
2	Motorola	1 040	1 575	51
3	National	800	1 150	44
4	Intel	765	1 170	53
5	AMD	490	890	82
6	Signetics	415	700	69
7	Fairchild	380	475	25
8	Mostek	300	430	43
9	RCA	220	315	43
10	AMI	165	250	52
	Total	6 080	9 185	51

Source: Integrated Circuit Engineering Corp.
(Electronics Week, 27 August 1984)

The action in custom chips turns distributors into designers

Traditionally, distributors of semiconductors were not much different from door-to-door salespeople who took orders from a catalog. But the days of selling chips like brushes are quickly drawing to a close. The semiconductor industry is edging away from standard, fungible chips and is moving toward customized products. This new age of semiconductor sales demands a new breed of distributor - one who can roll up his sleeves at a drafting table and help tailor new semiconductor components to a customer's needs. In this emerging market, "distributors will have more influence over what parts go into the design of a product". Because of this trend, distributors will have to become "much more technically oriented".

The driving force behind this transition is the phenomenal leap chipmakers have made in what they call "circuit density". Their ability to pack more and more electronic circuits onto a fingernail-size silicon chip is changing the economic ground rules for many component buyers. Suddenly it can be cheaper to pay the cost of designing a special chip because that one device can do what would otherwise require a cluster of standard chips. As these more complex, customized chips replace off-the-shelf integrated circuits (ICs) in a growing range of products, distributors face losing a major chunk of their business - that is, unless they can change the way they do business and grab a piece of the new market. And distributors believe they can. In fact, some think they can capture an even bigger share of the multibillion-dollar chip market, thanks to new, automatically chip-design tools. These systems offer libraries of standard circuits that can be combined, with the help of a computer, to create a so-called semicustom circuit for far less than it would cost to design a customized IC from scratch. And customers of chip distributors increasingly need these new ICs to compete. ... Semicustom chips can reduce manufacturing costs and make it easier to modify designs for new models.

Because of their advantages, specialized chips will make up 14% of the $30.8 billion worldwide market for semiconductors in 1986, up from 12% of a $14.1 billion industry in 1983. By 1990, more than 17% of all semiconductors sold will be semicustom and custom chips, predicts Andy M. Prophet, analyst at Dataquest Inc., a San Jose (Calif.) market research company. By functioning as a major marketing arm of chipmakers and providing design services, distributors are expected to increase their share of the domestic market. Last year, U.S. distributors made 22.8% of U.S. semiconductor sales totalling $6.76 billion; by 1986, they are expected to command 24% of a market that will have more than doubled to $14.33 billion, according to Hambrecht & Quist Inc., San Francisco investment banker ...
(Business Week, 6 August 1984)

Semiconductors pace growth of components

Driven by the continuing demand for ever increasing functionality per integrated circuit, semiconductor manufacturers are turning to systems experts in order to choose the right set of features. With memory designs hitting device densities of more than a million, and microprocessors, peripherals, and interface circuits nearing half a million transistors per circuit, designers are turning to sophisticated computer-aided design systems and more regular design techniques to deal with the basic issue of chip density. Along with increasing circuit densities comes a host of tough technical problems: increased power dissipation, longer test times, more demanding tests, packaging, higher design cost, and tighter process control. As formidable as these problems are, probably the biggest hurdle is the choice of what exactly to do with half a million transistors. To address this issue, semiconductor component designers are relying on systems experts, both in house and at customer sites. Their product specifications have already given rise to multiple data configurations for dynamic random-access memories and promise to push the semiconductor industry toward greater market fragmentation in all product areas. Specialization in the memory market is an indicator of what is to come for other categories of semiconductor products.

Historically, the memory market has been made and dominated, to an unprecedented degree, by the DRAM. Now this market is fragmenting into largely separate markets divided according to memory types: DRAMS, erasable programmable read-only memories, nonvolatile RAMs, and electrically erasable PROMS. Within these groupings variety abounds, giving the system designer choices of speed, power, size, and configuration to meet specific needs. Software has become the name of the game for virtually every systems integrator and original-equipment manufacturer. Compatibility across a variety of different systems products has become a must. This means an increased amount of pressure on the semiconductor manufacturers to produce microprocessor families that are not only upward-compatible but also downward-compatible across central processing units. With downward-compatibility, designers can implement lower-cost systems by utilizing smaller data bus versions of the CPUs, while keeping true software portability. Early microprocessor designs, whose memory-addressing capabilities were limited to 16 bits, have given way to a new breed of processor, designed in the spirit of true mainframe computers, with full addressability. Existing 32-bit machines with 24-bit addressing will be enhanced to include full 32-bit addressing much like their mainframe counterparts. Greater numbers of transistors per IC allow support of virtual memory in hardware, thus supplanting the older, and more difficult to program, memory segmentation schemes.

Unlike memories, microprocessors have an end in sight for word size, with 32 bits universally accepted by manufacturers as the maximum for a standard product. With most major manufacturers already committed to a processor family and the high cost of developing and supporting a new instruction set, the near-term end of processor offerings has been reached. Most new work will concentrate first on integrating more support chips onto the processor and then on the area of specialized coprocessors, such as the standard floating-point processors. Peripheral products will continue to receive significant attention from both semiconductor manufacturers and system designers. Major advances in video processing technology and peripheral controllers are in the works at several firms, as support for the powerful new 32-bit processors.

In the analog and traditional TTL markets, hot new complementary-MOS processes promise to give older bipolar processes a run for the money. Full TTL sink-and-source compatibility is now available from CMOS-equivalent parts, implemented with a new variant of the old metal-gate CMOS process. As pin-for-pin replacements for bipolar parts, these parts offer the same propagation delays as their rivals but at a lower power dissipation, giving designers an alternative that allows full operational speed for high-performance processors, but without the power penalties. (While CMOS is making its way into the analog world, bipolar is still the king of precision for operational amplifiers and other parts requiring close-tolerance resistors and high gains.) National Semiconductor Corp., Santa Clara, Calif., has built precision 12-bit anlog-to-digital converters in a CMOS process that is compatible with logic implementation using laser-trimmed resistors. Intelligent ADCs and related parts are likely to replace the expensive trimming operation in the next year. These intelligent parts will use programmable bits to select corrective components for a high degree of linearity.

Driven by the availability of improved computer-aided-design tools, semicustom and custom design approaches are finally becoming accessible to the mass market of mid-volume systems manufacturers. With the process technology lag shortened from several years to as little as six months, both the semiconductor houses and their customers can afford to utilize the relatively fast design turnaround of CAD to rapidly bring products to market. Standard cells, a concept for over 10 years, are now a reality at most every custom supplier. Libraries of more than 300 fully characterized cells are becoming common and will continue to be refined, especially as block routers are delivered this year. An important trend in the standard cell library area is the inclusion of microprocessor cores. Typically an industry standard part, these cells are supported by glue logic cells as well as application-specific cells such as speech synthesis, analog circuitry, and high-density standard memories. Furthermore, EEPROM and PROM technologies are likely to be added over the next few years to the cell libraries. (Article by H.A. Davis, reprinted from Electronics Week, 8 October 1984,

Europe's computer makers realize they must band together to survive

Ask European computer makers how business is and most likely they will answer, "Good". Trouble is, that business is done mostly at home: few are all that successful outside their own countries. Companies such as West Germany's Siemens, France's Bull and Britain's ICL have focused so closely on home markets that they failed to take advantage of the new world markets developing as computer and communications technologies merge. But Europe's computer makers have begun to recognize that they must expand their markets if they want to stave off International Business Machines Corp. and other U.S.-based competitors that dominate the $27 billion European data processing market. To make this happen, they are doing what the U.S. competition is doing: lining up a broad array of alliances and co-operative research projects and pushing for standardization. Although the Europeans have previously tried half-heartedly - with government prodding - to team up, the efforts are now in earnest. "The competitive environment has shifted distinctly in the past two years," says Michael Watson, technical director for ICL PLC. "[With] the realization that we are in a global market, [there has been] a strong willingness to try and work out some form of collective strategy."

The convergence of computing and communications is a double-edged sword for European manufacturers. Their customers are demanding better communications among their computers and office gear - a move that could loosen the iron grip that U.S. mainframe makers have on their customers. At the same time, most European national markets are simply not large enough to support the research and marketing efforts needed for tomorrow's sophisticated integrated information systems. For that reason, European producers are trying to share the costs of developing new technologies that will make them all more competitive. In January, Europe's three mainframe makers, Bull, ICL, and Siemens, set up a joint research laboratory employing

50 engineers to work on artificial intelligence and other advanced software projects. And the 10 member-nations of the European Community are funding Esprit, a $3 billion, five-year co-operative research program.

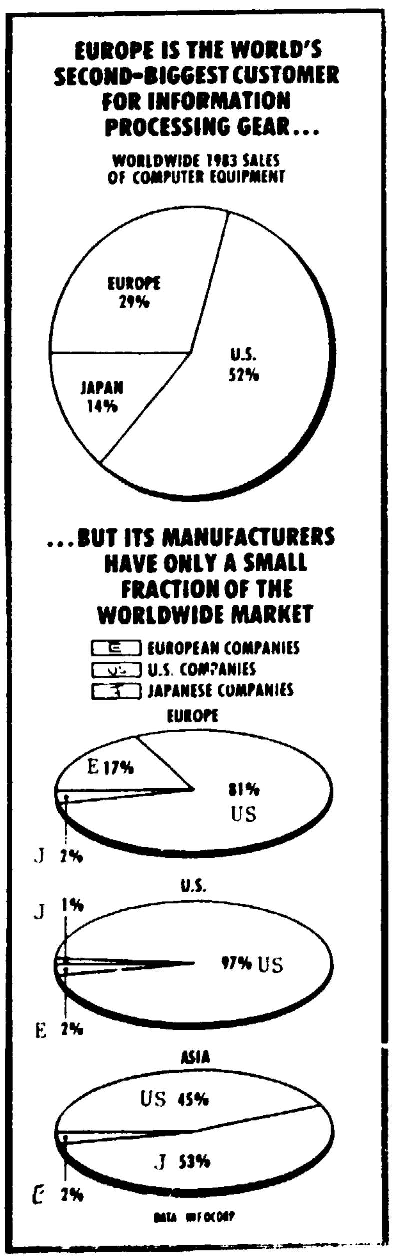
At the same time, 12 European computer makers pledged to adopt standard computer networking procedures starting next year so that equipment from different manufacturers will be able to work together. "We are going to see more co-operation in R&D such as in the Esprit program - requiring that results and knowhow gained are disseminated to all involved," predicts a member of the board of directors at West Germany's Nixdorf Computer.

This growing spirit of co-operation is being nurtured by European governments, which are growing concerned over the performance of their information processing industries. In 1983, European manufacturers captured only 17% of the European market, while U.S. companies grabbed a hefty 81% share, according to California market researcher InfoCorp. Worldwide, European companies won only 12% of the market. The EC nations are not only anxious about the immediate effects of this poor showing but also fearful of the long-term implications for their industrial competitiveness as information technologies spread across an increasing number of industrial sectors. That is not to say that European producers do not have their strengths. The Netherlands' Philips, for example, is a leading supplier of terminals and small computers for retail banking branch offices. And Siemens is strong in minicomputers for industrial control applications, while Bull holds a strong position in medium-sized mainframes. Nixdorf is a leader in automated teller machines. But none of the European makers has established a broad product line that can effectively compete with IBM's.

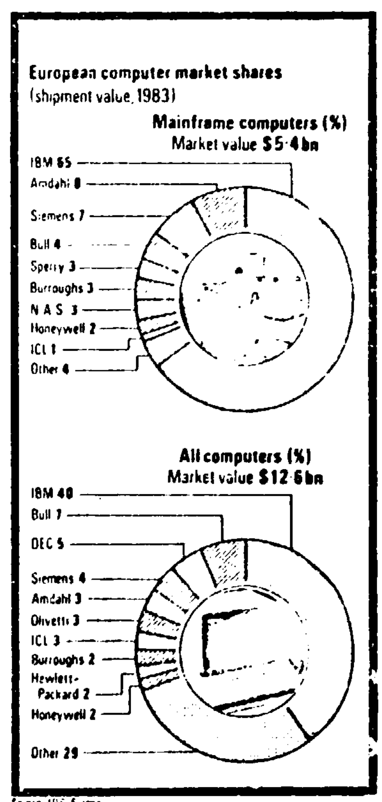
In their feverish attempts to catch up, the Europeans are forging stronger bonds among themselves as well as linking up with partners in the U.S. and Japan. The result: a plethora of agreements. "There are lots of marriages being made these days - marriages without engagements," quips Jacques Stern, chairman of Bull, France's state-owned mainframe maker. Among the most publicized of these deals is the teaming of Olivetti with American Telephone & Telegraph Co., which bought 25% of the Italian company. Bull is involved in a "ménage à trois" with Honeywell Inc. and Japan's NEC Corp. And ICL is working with three companies: Japan's Fujitsu Ltd. in integrated circuits, U.S. Three Rivers Computer Corp. in work stations, and Canada's Mitel Corp. in private branch exchanges (PBXs).

The rash of transatlantic agreements seems to run counter to the ever-increasing calls for greater European co-operation. But European manufacturers and government officials insist there is no contradiction. The U.S. and Japanese links are short-term efforts to assure access to products that European makers must have in their catalogs now if they are to compete effectively in world markets, declares a senior official of the French government. The agreements among the Europeans, he says, provide the basis for longer-lasting relationships. The move toward partnerships of all sorts is partly a European response to the increasing aggressiveness of IBM - the undisputed leader in virtually every European country. Despite monopoly charges filed against IBM by the EC, IBM has become increasingly competitive, both at home and abroad, since the U.S. Justice Dept. dropped its antitrust suit in 1982. "IBM's pricing is more aggressive in Europe than in the U.S.," comments Bull's Stern. "You can also see this new aggressiveness in the widening of their areas of activity over the past two years, and especially in the telecommunications field." There is no question that IBM sees telecommunications as a major target market in the coming years. "We believe it will soon be impossible to distinguish between companies which began as computer makers and companies which began on the telecommunications side," says Kaspar V. Cassani, president of IBM Europe. "That is why our strategy is to enter telecommunications markets."

IBM has already lined up contracts with several European nations' Postal & Telecommunications Administrations (PTTs), including one for a $20 million videotext network in West Germany. And it is helping to design a nationwide network linking banks with retail stores in Great Britain. The company also is continuing talks with European telecommunications equipment makers, including Italy's state-run Italtel, to strengthen its position in Europe. IBM's interest in the emerging telecommunications markets has spurred European governments and manufacturers alike to speed their efforts to develop communications standards. "What we don't want is for Systems Network Architecture [SNA, IBM's communications protocol] to be the standard, because every time it is changed, IBM knows about it two years ahead of everyone else," explains Dr. Reinhard Veelken, engineering and manufacturing vice-president at Siemens' Data Systems Group. Standardization is also seen as a way to introduce uniformity into Europe's fragmented markets and to broaden the market for all competitors. The European companies are steering clear of big mainframes, a market IBM completely dominates. Instead, they are moving into the faster-growing office automation sector, where IBM has yet to develop that much clout. The giant has already proven that it i not invincible in that market: its Personal Computer got off to a slow start in the Federal Republic of Germany when IBM failed to line up enough distributors. European giants such as Siemens and Philips still believe they have an edge over U.S.-based competitors because of the broad experience that they have in-house. Philips, for example, has long been active in the business communications field and has a large semiconductor operation. The same holds true for Siemens, which "has the task of co-operating with itself," says Veelken. Whether the Europeans can ever become competitive with their American rivals is still difficult to predict. Financial results for most of the European computer makers may be better now than they were two or three years ago - of the three mainframe makers, only Bull is still suffering losses. But the Europeans' relatively slim margins will hardly cover the enormous R&D spending needed for the years ahead, particularly in light of the competitive effort expected from AT&T in Europe during the 1990s. Says the manager of a large European competitor: "The battle between IBM and AT&T will dominate the information industry for the rest of the century, and the problem of European companies is how not to get caught in the middle." (Business Week, 16 July 1984)



(Business Week
16 July 1984)



(The Economist
30 June 1984)

Japan's 64K boom reached its peak?

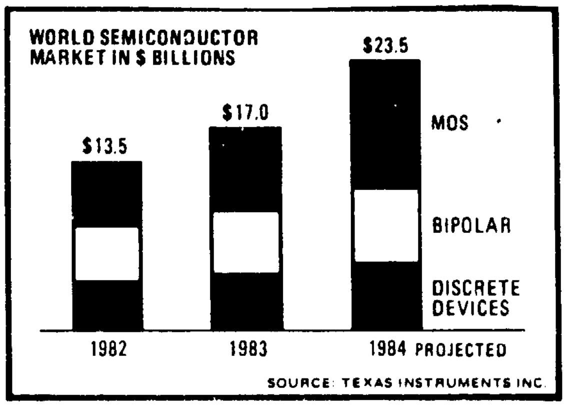
Japanese chip makers may be taking fears of an imminent memory market oversupply seriously. Hitachi announced that it is already easing down its monthly 64K DRAM output from eight to seven million units, the first Japanese maker to actively do this. At the same time however it is slowly stepping up its 256K DRAM production. Other makers could follow suit shortly. Behind this lies the simple fear of oversupply, and the lethal price crash it would produce. This is balanced by an almost equally strong fear that switching over wholeheartedly to 256K production too soon will smash the 64K market anyway.

Still, not all companies seem to agree that the time is now. Both Oki Electric and Toshiba have been stepping up production of 64Ks recently. Even industry analysts are having a difficult time deciding what will happen to both the market and the companies. Nomura Securities researchers reckon the 64K market will peak this year in favour of an expanding 256K market next year which has about twice the profit margin. Nomura further cautions against the companies which are expanding their 64K production, but is undecided about the wisdom of continued capital investment increases.

The capital investment issue is a particularly knotty one; Japan's 64K production has probably been doubled in the past year, with the three largest producers - Hitachi, Fujitsu and NEC each supplying 10 million units at peak production. At least three of the big producers are scheduled to bring new fabrication facilities on stream this autumn. The build up has been so sudden that semiconductor processing equipment makers are having difficulty with supply. Sputtering, chemical vapour deposition and testing equipment are believed to be the main items hit by the huge demand.

The delivery time on these equipments is now so long that it could seriously affect production capacities. As a result some $350-$700 million earmarked for capital expenses this year by the Japanese will probably not be used.

Total IC production in the first half of 1984 was once again a record - up over 70 per cent compared to the same period in 1983, with a book value of around $5.1 billion. Japanese forecasters are confidently predicting full year production to hit the $9 billion mark. (Electronics Weekly, 12 September 1984)



On the move. TI's forecast of world sales shows a 26% increase from 1982 to 1983, but a 38% rise from 1983 to this year. In 64-K RAMs alone, TI sees 1984 totals of 1.2 billion units after 1983's 340 million.

(Electronics, 3 May 1984)

By 1990, the worldwide semiconductor market should reach $69.5 billion in production

Of the top 10 semiconductor producers, five are Japanese. Hitachi, Fujitsu, NEC, Toshiba and Mitsubishi Electric all showed sharp increases in 1983. Hitachi rose from 6th place in 1982 to overtake Texas Instruments as the leading chip maker in 1983 with $552 million in production, mainly because of efficient mass production methods employed by the Japanese. The Japanese also will increase capital investment by 80% in 1984 while US companies will only increase capital investments by 70%. US companies made 52.9% of all ICs for sale in 1983. Japan increased production from 34.3% in 1982 to 36.9% in 1983. Industry analyst G. Norrett said that Korean companies that began production after 1980 should claim 20% of the world market by 1990. (Asian WSJ, 25 June 1984)

Table 5

Yearly world-wide market for semiconductor capital equipment

	1983	1984	1985
Total Water Process Equipment	1 838.1	3 500.3	3 616.8
Microlithography	650.5	1 297.4	1 304.8
Diffusion/Oxidation	127.7	200.9	195.6
Ion Implantation	154.0	290.5	300.2
Deposition	381.3	610.2	670.9
Etch/Strip	301.0	601.2	600.3
Inspection	223.6	499.7	545.0
Total Test Equipment	973.9	1 751.9	1 882.6
Automatic Test Equipment	654.3	1 258.6	1 363.6
Probing/Handling	237.8	370.3	377.3
Environmental Test	81.8	123.0	141.7
Total Assembly Equipment	319.5	509.8	719.1
Dicing Equipment	30.9	41.6	51.9
Bonding Equipment	184.9	314.2	437.7
Packaging Equipment	103.7	153.8	229.5
Total Equipment	3 131.5	5 762.0	6 218.5

(Semiconductor International, June 1984)

Silicon manufacture

Monsanto sets up in Britain

The United States chemicals group Monsanto last week announced plans for a £65 million investment in a new British silicon wafer research and production operation. The intention is further to improve crystal purity, which will involve developing new instrumentation, and eventually to manufacture wafers of up to 8 inch (200 mm) diameter. Monsanto expects to collaborate extensively with British university departments. World supplies of silicon wafers manufactured to the required purity and high degree of flatness are at present restricted to relatively few manufacturers. Demand is expected to increase rapidly, however. Monsanto is a leading supplier to the semiconductor industry in the United States but lags in Europe. The new Monsanto facility will be at Milton Keynes, a new development town in central England. The company explains that it was looking for a green-field site, which Milton Keynes possesses in abundance, and that Britain was chosen from a short-list of eight European countries. The British Government has helped with grant assistance, although the amount is not being made public. In declaring its intention to move towards 200-mm wafers, Monsanto seems to be making the point that it wants to keep two steps ahead of the competition: elsewhere, 150 mm is proving difficult. Monsanto boasts leadership in producing 125-mm wafers in a peak-to-valley flatness of less than 2 micrometres. But as modern wafer-stepping semiconductor manufacturing techniques become more widespread, edge-to-edge flatness will cease to be a major constraint. Local slope and crystal purity may become the limiting factors to cramming semiconductor devices into wafers.

Two trends are combining to make purity a problem. First, chips are becoming larger, so that there is a decreased chance that each chip will be flawless. Second, channel widths are now moving down to the order of micrometres so even very small local deformities in crystal structure can disrupt a device. Implanted ions tend to spread from their original deposition sites during the manufacturing process, for which allowance has to be made in the design. The extent of the spread is determined by the structure and purity of the original lightly-doped crystal, and this is where the thrust of the research effort is likely to be. Initially, Monsanto will import wafers from the United States for cleaning and polishing in Britain, but will later embark on crystal manufacture, hoping eventually to supply 50 per cent of the British silicon market. (Nature, 24 May 1984)

Philips and Siemens to combine forces

Concerned at the dominance of U.S. and Japanese semiconductor houses in world markets, Philips, of the Netherlands, and Siemans AG, West Germany, have embarked on a memory-chip development program that could call for a combined outlay of $530 million during the next five years. On top of that, about $230 million is sure to come from the German and Dutch governments. The aim of the program by Europe's two top chip producers, Siemens says, is to develop, by 1989, 1-Mb static random-access memories that Philips will produce and 4-Mb dynamic RAMs to be built by Siemens at a new plant in Regensburg. The German-Dutch co-operative deal also includes the development of a common CMOS technology for these memories as well as related computer-aided design techniques. (Electronics Week)

Toshiba plans European fab

TOSHIBA has unveiled both its first European semiconductor factory and an aggressive strategy in RAMs. The company is close to bringing out a 256K CMOS static RAM. "We have engineering samples already working", said Tadaaki Tarui, boss of Toshiba's IC division. He expects commercial sampling of the device to occur "in early 1985". The company's strategy for the Megabit DRAM is similarly ambitious. "We're pursuing two routes to the Mbit DRAM", said Tarui - "a CMOS route and an NOMS route." Tarui expects to have "internal engineering samples" of a CMOS Mbit DRAM "next year" and commercial samples in 1986. The NMOS Mbit DRAM will be earlier. Tarui said that the company would be commercially sampling the part in 1985 and would have it in production in the 1986/7 timeframe.

The new German factory which Toshiba opened last week is the company's first in Europe. Its other factories outside Japan are a wafer fab in America, and assembly plants in Malaysia, Korea and Mexico. Toshiba's general manager for international operations, Taizo Nishimuro, said that a Malaysian workforce cost one fifth the cost of a German workforce and that a Korean workforce cost a quarter the cost of a German workforce. The reason for wanting the German plant was to site production close to the market, said Nishimuro. As automation increases and headcounts drop, the economic arguments favouring the Far East are eroding.

For instance, the current headcount of 100 at the German factory will only increase to 300 when the company adds wafer fab capacity to its current assembly operation. The company anticipates beginning the expansion of the plant next year with a view to having fab production in 1986/7.

The plant cost £8m, including an unspecified level of grant from government. It has a capability to turn out one million ICs a month and, says the president of Toshiba's German operation, that level will be reached by the end of this year. ... (Electronics Weekly, 18 May 1984)

IBM versus Europe

The struggle by IBM's rivals in the computer industry to get more help from the company in coupling their own products to IBM's is not over yet. Last week, the European Commission suspended its legal action against IBM after the company agreed to provide competitors in Europe with full information on vital interfaces, as the links between computers are called. IBM also promised to make the information available within four months of announcing a new hardware product for its mainframe computers, and, in the case of software, as soon as the final form of the product is settled.

Companies in Europe and America had complained to the EEC's department of competition about IBM on four counts. In essence what they wanted was a better chance to build IBM-type computers or to connect their own systems to networks of IBM's computers. But IBM's competitors are waiting to see how the company interpret its broad guarantees to the European Commission. IBM may close the gap between announcing a product and delivering it to cancel out the advantage that the four month clause gives to firms operating in Europe. The undertaking does not settle the thorny question of what interface information is proprietary to IBM and what interface information should be a matter of public record. IBM chairman John Opel has already said the agreement with the EEC will make no difference to the way IBM does business. (New Scientist, 9 August 1984)

IBM/Rolm

Any doubts that computers and communications are about to become a single industry were laid to rest with IBM's takeover of Rolm Corporation. Rolm is a Silicon Valley company that in 15 years has turned itself from nothing into America's second-biggest maker of private exchanges (pbxs), sophisticated telephone switches for offices. IBM's action has rewritten the rules: both for itself - Rolm is its first takeover since 1962 - and for its fight with American Telephone and Telegraph (AT&T), and the Japanese, for mastery of the information industry.

IBM is offering more than $1.3 billion (or $70 a share, versus a market price of $48 before the bid) for the 77% of Rolm it does not already own. Rolm's board endorsed the bid. Rolm, second only to AT&T in America's pbx market, made $38m in the financial year ending in June, 1984, on sales of $660m. But its profits have fallen from 10% of sales in 1979 to just 6% last year.

In June, 1983, IBM took a 15% stake in Rolm, since increased to 23%. The complete takeover must first be approved by America's trustbusters. IBM is now free of the antitrust cases brought against it in America and Europe and is, at the moment, an insignificant figure in communications. So the deal will probably have no trouble passing muster under the American government's merger guidelines.

IBM says it will integrate Rolm's salesmen and R&D activities into its own business. That may not be easy. The white-shirted, blue-suited crowd at IBM look like aliens to Silicon Valley techies in their jeans and open-necked shirts. Rolm has said it is negotiating for considerable independence within IBM, something that must make IBMers shudder.

Until now, the giants in the telecommunications-cum-computer businesses have stopped short of full takeovers of other high-tech companies. IBM has a 20% stake in Intel, a Californian chipmaker, and a 60% stake in Satellite Business Systems. Last month, IBM extended a $6m loan to help Sytek, a tiny Californian company, gear up to make the networking system promised for IBM's personal computer. IBM has not stopped at the Atlantic's edge: the British government is now reviewing the company's proposed joint venture with British Telecom to provide a data transmission service in Britain. BT's and IBM's British competitors will not be reassured by the planned takeover of Rolm.

No part of the computer business has been affected as much by merger fever as the pbx sector. Since IBM first took its stake in Rolm last year, Wang has bought 15% of fast-growing Intercom, and NCR now owns 17% of Ztel, a Silicon Valley start-up that builds sophisticated switches. America's Digital Equipment Corporation and Canada's Northern Telecom have developed a machine that intermediates between pbxs and computers.

IBM's own pbx flopped in the 1960s. The first big computer/communications break-through looks like being a combination telephone and personal computer, for which pbx capability is essential. Wang and Intercom showed their combination off at a conference in San Diego earlier this month. Rolm has been developing one under the name of Mesquite, but IBM seem frustrated by its progress and by Rolm's independence.

The company which IBM sees over its shoulder, however, is AT&T. Freed from regulatory restraints, AT&T now has the potential of combining its own pbx machines and local area network with computers to push its way into the office automation business.

IBM's new era will be overseen by a new head. He is Mr. John Akers, who is to replace Mr. John Opel as chief executive in February. Mr. Akers is described as unusually plain-spoken for an IBM officer. More important, he is 49, well short of IBM's customary retirement age of 60. Mr. Akers will have plenty of time to put his stamp on IBM, an opportunity denied Mr. Opel, who got the top job in 1981, when he was 57. (The Economist, 29 September 1984)

Japan deals in AT&T

Japan's Ministry of International Trade and Industry (MITI) said it is planning a five-year joint effort with AT&T to foster native software development in that country. Although a final decision on the project, which is expected to cost some $125 million, is not due until late this year, the plan calls for AT&T to work with several Japanese computer companies in furthering the development of the Unix operating system. Japan's interest in AT&T is understood to be as an alternative to IBM, which successfully "stung" Hitachi and other Japanese manufacturers in 1982. MITI is concerned about the future of Japanese computer efforts given the relatively unproductive Japanese software industry. Few details of the proposed MITI-AT&T plan were available, but it reportedly centered on modifying Unix for use on large computers and making it more easily accessible to Japanese programmers. (Datamation, 1 October 1984)

TI can start novice in chip design for $500

The entry ticket to semicustom chip design can be as little as $500, provided the user has an IBM Corp. Personal Computer or PC look-alike and a new chip-design package from Texas Instruments Inc. Developed by TI's Design Automation Group in Bedford, England, the new IBM PC-based Transportable Design Utility for semicustom ICs can be used for schematic capture, database creation, and simulation of both gate-array and cell-based designs. The simulated circuit description is automatically turned into a chip layout on mainframe computers at TI's local design center. (Electronics Weekly, 29 October 1984)

IBM to build Intel chips

IBM has signed a deal with Intel to build Intel's 8088 chip, which is at the heart of the IBM PC, under licence. The move means that IBM has succeeded in guaranteeing its own supply of the popular microprocessor, which has been in short supply for some months. It also gives IBM more control over the cost of the chip, which may well put the company's competition under more severe pressure in the future. A spokesman for IBM also said that it has also acquired the rights to manufacture "certain other components," which were unspecified, but are thought to include the Intel 80286, a high-speed processor with advanced graphics capabilities, which is expected to be the main processor for the yet-to-be announced

"Popcorn" super-PC. IBM also recently increased its shareholding in Intel from 17% to 20%, bringing IBM's holding closer to the 30% ceiling agreed between the two companies when IBM made the original 12% investment over a year ago. (Electronics Report, May 1984)

APPLICATIONS

Highlights on industrial sectors: Paper Industry

- Millwide MIS *

The many types of dissimilar processes, and levels within processes, in the powerhouse, pulp mill, paper mill, and recovery area present a wide range of process control problems in today's pulp and paper mill. And there is an equally wide range of process control solutions - a diversity of systems and vendors covering almost every area where process control can be applied. Yet, incompatibility between systems makes it difficult to unify the many types of controls into a millwide MIS system. In short, there has been no practical path to millwide MIS. The reasons for the fragmentation in the total process control picture are rooted in the course of development that vendors have taken since computer control was first attempted on a paper machine in 1961. Essentially, the process control marketplace evolved in three distinct segments: instrumentation control of valves, pumps, and other actuators; supervisory control of unit processes, such as paper machines and boilers; and millwide MIS and control, really a 1980s development, in which multiple processes are co-ordinated, and information from each is correlated in order to optimize the entire mill. In the early days, specialization was necessary because the technology was so new. But today, the technical dissimilarities have effectively blocked the evolution to millwide control. A review from a market viewpoint of how the process control industry developed by segment shows how ingrained the problems of multi-vendor systems have become and why the industry is ready for a practical alternative.

Instrumentation control. Today, instrumentation control is considered essential to mill operation. The advent of reliable, low-cost microprocessors in the late 1970s spurred the trend from pneumatic and electronic analog to electronic digital control of the mill's instrumentation. In 1976, distributed digital instrumentation controls - an idea whose time had truly come - made a strong entrance into the picture with Honeywell's announcement of the TDC-2000. All the major vendors have spent heavily to develop competitive products and, in addition, a number of new vendors have introduced products into this market. There are over 40 vendors of distributed instrumentation control systems today with a wide variety of offerings. As a whole, instrumentation controls have developed as generic products, in that they control basic loops of any process. The implementation of these controls requires considerable mill effort to adapt a vendor's product to a specific process, or to accommodate interactions between processes. The main vendors in the marketplace today include Honeywell, Foxboro, Fisher, Siemens, and Taylor.

In short, the evolution of instrumentation controls has been driven by reliable, well established vendors, with current clear leaders. The vendors in this area have traditionally been oriented toward analog control technology. However, in the next few years, the current trend toward loop level control - and the associated turn from analog to digital technology - will see attrition among vendors, particularly those rooted in a hardware approach to instrumentation control.

Supervisory control. Measurex introduced the first integrated, digital, sensor-based supervisory system for paper machines in 1969, the System 1000. As with distributed digital instrumentation controls, packaged supervisory controls met a clear market demand. That packaged supervisory controls were another idea whose time had come is evidenced by the fact that there are over 2,000 paper machines now under supervisory control. Today's supervisory controls, regardless of vendor, are typically end-product oriented and provide substantial economic results, much more easily measured than results from instrumentation or millwide controls. Packaged supervisory control systems are usually sensor and high level, software-based. These systems provide all the necessary hardware and all the necessary software as well as installation, tuning, maintenance services, and documentation of system results. Vendors of packaged supervisory control to the pulp and paper industry are Measurex, AccuRay, Sentrol, Nokia, Lippke, and Yokogawa.

For the past ten years, Measurex and AccuRay have, beween them, had 70-75% of this market. The remainder of the packaged supervisory control market is shared by vendors who are primarily regional. One problem in the packaged supervisory marketplace is that there is

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* Management Information System.

little compatibility between vendors, so a mill cannot easily mix different vendors' systems. Also, the interfaces to the instrumentation control must be developed for each installation, with the mill usually incurring the cost.

As a whole, the packaged supervisory control market has been characterized by reliable, well-established vendors, with two clear leaders emerging. Traditionally, the technical driving force has been the development of increasingly advanced sensors and complex application software. With machine direction controls on paper machines having become well accepted, the trend today is toward cross-direction controls and pulping and energy optimization controls. These newer areas of control represent major economic benefits for mills.

Millwide control - great potential. Attempts at millwide control - the co-ordination and optimization of multiple processes - began in the 1970s. In the 1980s, the need for increased productivity, improved quality, and decreased fiber and energy usage are making millwide control economically justifiable, if not an economic necessity. And the technology is here to make it technically viable. Millwide control has been widely discussed over the past few years, with many vendors claiming solutions to a problem that has yet to be clearly defined. In fact, the concept of millwide control remains ambiguous in terms of exactly what its component parts are and what results should be achieved in order for a system to merit the "millwide" designation. Therefore, to provide a framework for discussing millwide control, it is useful to establish some common definitions, such as those already stated for unit processes or instrumentation level controls and area or supervisory level controls. To begin with, the objective of millwide control is to achieve the optimal operation of the mill relative to its orders, costs, inventories, and production capacity. The component parts required for a system to achieve this are:

- A real-time, global data base that contains complete information on the operation of individual mill areas and the entire mill complex;

- An external data base that extracts data from the mill global data base and combines it with data from other mill and corporate systems, such as standard costs, labour distribution, orders, and inventories; and

- Optimization computing functions to support pre-defined applications, such as product scheduling and ad hoc unplanned inquiries to handle the "what if" situations.

Implementing these millwide system components has required a dedicated computer to process multi-system information. Also, and very importantly, the millwide level of control is characterized by an emphasis on data base management and data communications, a totally different type of computing technology than that required for supervisory or instrumentation control. This computing technology has been widely associated with the corporate MIS activity in the past. The advent of the microprocessor and local area network communications has made it possible to economically handle the computing requirements of a millwide MIS. This blending of technologies is one of the most important trends taking place in the process control computing market and will require careful management by both the vendors and management. Most attempts at millwide control, however, have run into severe multi-vendor problems. The various systems available for all of a mill's instrumentation and supervisory control needs are not easily integrated. Extensive programming has been required to perform all the necessary multi-computer tasks and communications between systems. While several vendors offer some millwide capability, no clear leader has emerged from this incomplete segment of the market. Among the vendors that offer some millwide capability are Measurex, Honeywell, ASEA, Altim, AccuRay, Valmet, and Siemens.

Piecing Together Components. Clearly, mills have a variety of process control products from which to choose. Many of these products do an excellent job in controlling their particular portion of a mill. But the pieces are not designed to fit together. Creating the links is a tremendous job for any mill. And the resulting multi-vendor system can produce costs and problems that are greater than the benefits. These problems result from sophisticated data base and data communications requirements, duplicate hardware and software, heavy programming requirements, multiple computer architectures, and fragmented planning.

The various computing systems in each segment of the process control market were developed over different time periods to meet different technical requirements. As a result, the computing systems are not compatible. This is true even within vendor lines. Without exception, the vendor computers and operator consoles by product lines are not compatible across the three levels in the mill. Mill operators are faced with multiple consoles and a complex computing architecture. This technical fragmentation becomes more severe at the millwide level. It becomes very difficult to maintain control over a global, or common, data base with inputs coming from dissimilar systems supplied by a variety of vendors.

A multi-vendor system requires cabinets, consoles, computers, and software for each vendor. Because of the equipment duplication, the hardware cost is many times what it should be. This mill must enter into maintenance contracts with each vendor and sets of spares for each system must be inventoried. Hardware technicians must be employed to specialize in each system. Also, programmers must be retained to specialize in each computer's operating system, application programs, and communications. A key complication with multiple vendors is that several different types of operator interfaces are required throughout the mill and control room. The need to learn the operating procedures and physical layout of each interface impairs operator efficiency and prevents quick response to upsets. Millwide data is not uniformly and conveniently available to all those who need it, when they need it.

In addition to the programming that the instrumentation, supervisory, and millwide segments each require independently, extensive programming is required to interface and maintain the segments in a co-ordinated way. The investment in programmers is large. And it usually means there is less personnel budget for process engineers.

Patching several vendors' systems into one large multi-architecture inevitably produces a new level of problems. When problems occur, it becomes difficult to pinpoint the vendor responsible for its resolution. All too often, finger pointing ensues, causing frustrating delays. In addition, a new level of maintenance is required with a multi-vendor system just to prevent one system from adversely affecting another. Providing backup components for systems that have been modified for compatibility becomes exceedingly complex.

Effective millwide planning for process changes, expansion, or increased efficiency requires accurate, up-to-date, uniformly presented information from each sector of the mill. In a system where different types of computers are collecting information on each sector, data is collected through different methods, over different time periods, and presented in different formats.

The problems noted above, resulting primarily from a lack of coherence in the range of components required to fulfil a mill's control needs, have blocked the evolution to millwide MIS. What is needed to make millwide MIS practical is, essentially, one system that performs all necessary process control functions - and provides these functions as building blocks, without requiring a massive conversion effort. Along with distributed digital instrumentation control and packaged supervisory control, this total control system concept is another idea whose time has come. (Editor's Note: The above article is an edited version of a presentation entitled "An Overview of the MIS Technology Trends" given by P. R. Trapp, Vice-President, Marketing, Measurex Corp. to the Managing Information Systems Session of TAPPI's 1984 Technical Management Symposium/Annual Meeting held last February in Washington, DC and published in Paper Trade Journal, 15 June 1984.)

- Automatic Refiner Controls

Current microprocessor technology as applied to control systems is changing very fast and its implementation can prove to be expensive and time consuming. A thorough review and understanding of microprocessor technology is needed for proper application, and users should have a basic background in its operation and handling. A blend of tested control apparatus and microprocessor technology has proven to be cost-effective and fail-safe. Prior to reviewing the various types of refiner control systems available today, we should first address the most basic question: Why automatic refiner controls?

Benefits of automatic control scheme. Any type of automatic control scheme is assumed to provide benefits that are either tangible or intangible. Automatic refiner controls are no exception and are capable of providing benefits such as uniformity of product quality, the ability to duplicate grades of paper accurately, and runnability of equipment.

Automatic refiner controllers, for the most part, minimize the operator's requirement for mechanical knowledge of the refiner and allow concentration on set point requirements for desired results.

Another benefit of automatic refiner controls is greater setpoint accuracy. Each grade of paper requires a known specific energy input from the refiners. Because an automatic refiner controller is constantly monitoring refiner power and comparing this power to a predetermined setpoint, the required specific energy input is held to much closer tolerance.

Minimum operator attention is another benefit. Automatic refiner controllers not only control accurately to setpoint, they also protect the refining equipment from damage through the interlock systems. Less operator attention is required.

An additional benefit is protection of refining equipment. Nearly all automatic refiner controllers provide a comprehensive interlocking system to protect the refining equipment. This interlock can take the form of simple backout circuits based on a certain set of input conditions to more elaborate power limiting circuits.

Selecting the optimum control scheme to fit a specific need is certainly not difficult. Knowing the standard control schemes that are available today and the flexibility of present control hardware, along with a review of the variables and constraints, can easily lead to the optimum control selection. The factors for the selection can focus on maximum uniformity in product quality; process variables such as power, flow, consistency, freeness, and couch vacuum; refiner protection logic; required controls to interface with process computer; and whether refiner controllers are centralized or function as distributed controls.

Table 6. Manual vs Automatic Control

ADVANTAGES	
MANUAL	**AUTOMATIC**
1. Low Capital Cost	1. Improved Product Quality
2. Provides Refiner Protection Systems	2. Lower Operating Cost
A. Plate backout on loss of stock line pressure	3. Enhanced Refiner Protection Systems
B. Plate backout on loss of main motor	4. Automatic Loading of Refiner
C. Low packing water alarm	5. Automatic Gearmotor Speed Change
	6. Automatic Plate Positioning to Maintain Setpoint Power
	7. Expandable to More Complex Control Algorithms
	8. Less Operator Attention Required
	9. Can be interfaced with Process Computers
DISADVANTAGES	
1. Labour Intensive	1. Higher Capital Cost
2. Less Control of Product Quality	
3. Higher Operating Costs	

The following is a list of the most common features a state-of-the-art refiner controller should contain. If all of these features are available, the controller system will provide reliability, maximum controller and refiner protection, and flexibility for new applications, while providing ease of maintenance and repair.

- "State-of-the-Art" 100% solid state
- Multimode to minimize machine downtime
- Compatibility with various makes of refiners
- Dimensional compatibility with standard control panel configurations
- Plug-in circuit card replacement
- Options available for expansion of control capability
- Maximum refiner protection interlocks
- Controller input/output available for process computer monitoring
- Controller setpoint capable of being driven by process computer
- Maximum controller protection - fused inputs and outputs.

Several schemes available. There are several automatic refiner schemes available to the paper industry today. Each scheme fits a specific need, and as each scheme increases in complexity, more of the various needs can be met. The following are five of the most commonly used schemes:

1.	Automatic Power Control	Controls refining power based on operator initiated setpoint only
2.	Horse Power Days/Ton Control (HPDT)	Controls refining power to a setpoint which is a function of the flow, consistency and set point target
3.	Automatic Power Control Based on Stock Freeness Measurement	Controls refiner power using the output of a freeness measuring device as the process variable
4.	Automatic Power Control Based on Couch Vacuum Measurement	Controls refiner power using measured couch vacuum as process variable
5.	Automatic Power Control Based on Process Computer Output	Controls refiner power using the result of a computer processed algorithm as setpoint

Flexibility offers possibilities. With the flexibility inherent in today's microprocessor-based refiner controllers, it is often possible to develop multiple control schemes using a single refiner controller. With the addition of a selector switch for choosing the desired input signals, two or more automatic refiner control schemes can be implemented. In this control scheme, an external selector switch is used to select HPDT or freeness control. This allows maximum flexibility in that the control refiner can be brought on line using HPDT scheme during start-up. When the machine is stabilized, it can be transferred to freeness control.

Central control vs. distributed control. The industry-wide debate on central control schemes vs distributed control schemes has continued for many years. Our analysis leads us to believe the trend is leaning toward distributed control. We have adopted the distributed control concept when considering automatic refiner control applications used in conjunction with process computers. One essential feature involving a process computer as controller is that two independent but communicative software routines control the refiner. The refiner control software performs the arithmetic calculations required while the programmable controller or control relay boxes must translate the results in control action. Another essential is that back-up control modes must be limited to computer control or manual control. It is important to note that manipulation of tuning parameters is accomplished in software, and so higher technical competence is required to do routing process tuning. ... (Excerpted from an article by A. K. Dewan, director, product group, stock preparation, Beloit Corp., Jones Div., Dalton, MA., USA. Published in the Paper Trade Journal, 30 April 1984).

Chemical Industry

- Chemical process controls closing in on $1 billion in sales

High-tech innovations in process control instruments, using lasers, fiber optics, and other technologies, will push the market in the chemical industry alone to $908 million by 1988, according to Frost & Sullivan, New York City-based international marketing researchers. This growth, said F&S, represents a 41% increase over the market figures for 1983.

The instrumentation market is broken down in four basic segments, which look like this:

Control systems - will have the largest proportional growth for both supervisory and data acquisition systems and will have a 19% market share by 1988.

Measuring instruments - represent the largest segment of this market in 1983 at 58%; however, these temperature, pressure, flow and level instruments will shrink to 55% of the market by 1988.

Controllers - will remain at 22% of the market by 1988, but the digital component of the controller segment will rise 21% to capture 76% of this segment by 1988. (Paper Trade Journal, 30 May 1984)

- Chips will control glass furnace

Plant instrumentation for an important recuperative glass furnace has been supplied to Canning Town Glass by Turnbull Control Systems, a member of the Eurotherm International group. The £2.5m, 200 tonnes-per-day furnace was recently opened at Canning Town Glass's plant at Queenborough, Isle of Sheppey, UK. It forms part of a new £5.5m furnace and production complex. The furnace, which was designed by Heye Glas, Obernkirchen, is claimed to be the UK's first recuperative furnace to incorporate up-to-date fully automatic equipment. By comparison with traditional regenerative furnaces it cuts energy costs by 30 per cent and combines high thermal efficiency with a long working life by allowing exhaust gases to pass continuously through vertically mounted heat exchangers. Three production lines are used on a round-the-clock basis to produce many varieties of bottles and glass containers. The furnace replaces an old, regenerative type, which was controlled by pneumatic instrumentation. It runs on heavy fuel oil, though natural gas will soon be used as an alternative source of energy. The TCS control instrumentation has been designed for a dual-fuel combustion strategy.

All the instrumentation in the TCS control panel comes from the SYSTEM 6000 range of intelligent instruments. Each of the seven control loops on the furnace and the 11 on the three forehearths is provided with its own 6350 microprocessor-based controller, to maintain complete single-loop integrity. Combustion, air and oil pressure are also controlled by the 6350s, and indivudual melting, refining and working-end zone temperature control on the forehearths is provided. Furnace pressure control is linked to a system of dampers, which regulate the rate at which waste gas leaves the recuperators, and glass level is also monitored and controlled. Oil and combustion air flows are displayed and totalled on a TCS flow indicator/totaliser type 6434. This instrument has eight independent channels of flow indication and eight-digit integration, with optional inputs that can allow for pressure and temperature or density corrected values to be computer. Many other process variables, including waste-gas temperatures and oxygen content, are monitored by the TCS 6432 signal processor, a 23-channel device which provides both display and alarm detection. The TCS instrumentation uses an RS232 data link to communicate with a Hewlett Packard 1000 A600 supervisory computer, all data being up-dated at 30-second intervals. (Electronics Weekly, 5 September 1984)

Metalworking Industry

- Computers help produce jet engine parts

A computer-controlled "factory of the future", designed for the automated production of aircraft jet engine disks and compressor blades has been opened in Columbus, Georgia (USA) by the Pratt & Whitney Group of United Technologies Corporation. The plant, under construction for more than two years, represents an investment of approximately $200 million. It will produce parts for Pratt & Whitney commercial and military jet engines using highly automated manufacturing techniques including robots. A network of about 100 computers ranging from two central units to microprocessors will control virtually every phase of manufacturing operations - including the movement of materials, parts and tools. The plant has 640,000 square feet in office space. At present, there are 325 employees at the plant. The staff is expected to grow to 500 by year-end and, when full production is reached in 1986, there will be about 800 employees. A typical jet engine contains about 21 disks and from 2,200 to 3,200 compressor blades. The blades are attached to the disks and the entire assembly rotates at high speeds and under temperatures which can be 2,000 degrees Fahrenheit or higher. The disk and compressor blade production areas at Columbus are separate, but the operations are linked by the computer control network and a common, automated materials handling system.

The disks will be produced by Pratt & Whitney's patented Gatorizing (R) forging process. Two automated, 8,000-ton presses form high-strength metal alloys into shapes very close to the final dimensions of the finished parts. The presses are more than double the size of any other Pratt & Whitney Gatorizing press.

The metal alloy is provided to Pratt & Whitney in powder form and, before forging begins, is consolidated into a short cylinder resembling a log, which is called a mult. The mult is pre-heated in chambers at the plant to a temperature of 2,000 degrees Fahrenheit, which brings the material to a malleable, or superplastic, state. In this state, the material requires less forging pressure to fill the die cavity in the press, thus eliminating the need for the large tonnage presses which normally would be used to form the very strong alloys used in jet engines. Compared to conventional forging, Gatorizing also provides savings in critical raw material, reduces machining, and is performed in a cleaner, quieter work environment.

The compressor blades are formed on seven automatic screw presses ranging from 800 to 2,000 tons in capacity. This type of press provides more precise dimensional control of the blades than conventional presses. The blades are manufactured from titanium or nickel alloy bars which have been cut into short cylinders. The first step in the process is the extrusion, or forming, of the cylinders into preliminary shapes. With robots and conveyors handling all transfer operations, the cylinders are loaded into furnaces and heated. After heating, the cylinders are squeezed into a preliminary shape by hydraulic presses. Extrusion does not require the [illegible] operator [illegible]. When this stage is completed, a robot removes the [illegible] pickup stand. It then is transported automatically [illegible], [illegible] returned to storage until required for the forging operation. [illegible] are the heart of the compressor blade forging operations, providing [illegible] close tolerances and extreme accuracy. Equipment used is similar to that on the extrusion [illegible]. Following forging in the press die, the blade is removed by an operator and the small amount of excess material is trimmed. The contoured, or airfoil, portion of the blade is complete after subsequent finishing and chemical treatment. A large-diameter head left on the preliminary blade shape is shaped into the root of the blade in a machining center. The plant is equipped for complete, final inspection of both the disks and blades. In an automated test line, the blades undergo a fluorescent penetrant treatment for surface flaws and verification of contours and dimensions.

An automated system of guided vehicles and conveyors - following pre-established schedules stored in a central computer - moves raw materials and finished parts throughout the production operation.

"The whole idea of the system is to have very little material sitting on the factory floor at any one time", noted Demonet. "This improves productivity by reducing manufacturing, inventory and in-plant transportation costs, while also contributing to uniform, quality part."

Twelve battery-powered vehicles similar to golf carts and measuring about four-and-a-half feet in width by six feet in length will transport material which is in process as well as finished parts and tools. The vehicles follow electronic guidepath wires embedded in two-inch deep tracks in the plant floor, taking commands through an on-board computer which is linked to the facility's central computer network.

As a rule, each vehicle will be confined to a particular production area but can be directed to other locations in the plant, including a storage area used for parts which are temporarily between manufacturing operations or awaiting shipment.

The guided vehicles can transport up to 4,000 pounds and can travel at a maximum speed of 200 feet-per-minute, or more than two miles-per-hour. The vehicles have a number of safety features, including an emergency-stop provision in the event contact is lost with the guidepath wire.

When a vehicle arrives at a work station, photocells on the vehicle and the machine establish communication through a computer in the plant's central computer room. The vehicle deposits its cargo in a fixed stand and a conveyor then automatically moves the material onto the machine. When the operation is completed, the material is returned to the guided vehicle, which then proceeds to the next station in the programmed manufacturing sequence. The plant has 214 of these deposit/pickup stations.

The storage area has 4,000 spaces in three separate rack arrangements standing about 60 feet high. Three 'stacker' cranes move materials and parts into the spaces under the direction of a computer dedicated solely to that purpose. The stored item can be redirected into the manufacturing system or to the shipping department within minutes. Engine disks, compressor blades, and tooling needed for manufacturing, as they move throughout the plant, can be traced through the plant's computer network. The disks, because they are subjected to severe stresses during flight operations, are tracked individually. Each is placed in a separate pallet and monitored throughout processing in order to establish its individual identity, while the blades are tracked by lot number. Codes on both the disks and blades make it possible for Pratt & Whitney to trace the raw material for the parts to its supplier should analysis raise any question about its adherence to specified standards. Complete documentation on the parts is established as they move through the manufacturing system.

About 50 robots in the plant will play a major role in the materials transfer operations, principally in the loading of heat-treating furnaces and in moving materials from the conveyors to cleansing tanks. They also place parts on automated inspection equipment, such as gaging stations for weight and dimension checks on the compressor blades. (Industrial World, August 1984)

- Computer-controlled flame cutter

Large, high-volume steel service centers that fabricate products to customer specification usually can justify investment in highly automated equipment. But one doesn't expect to find a computer-controlled flame-cutter at a small steel center in Commerce City, Colorado, USA. Nevertheless, Jeff Jones, operations manager at Gate City Steel reports the equipment was worth the investment because "we didn't have to pay for features we didn't need while we got the things we do need". The Commerce City Plant is one of 10 Gate City steel full service steel warehouse and fabrication centers in the western U.S. At the Colorado location, it produces relatively small production runs of a wide variety of products in the computer, construction, electronics and machine industries. Cutting jobs are usually on 1/4" to 1" carbon steel plate. Almost two years ago, after losing business due to excessive down time with another machine, a decision was made to invest in new equipment. Jones recommended an MCD 1010 Shape Cutter, electronic tracer, and Compu-Path, their programmable shape cutting control, all manufactured by ESAB AB. According to Jones, the most important criteria for the machinery were reliability, ease of operation, and accuracy. Defect-free parts must be produced - often with only one day of turnaround time. Jones says that since the equipment was installed, there have been only 2 1/2 hours of downtime, and a total expenditure of only $290 on maintenance.

The MCD Model features a sturdy runway and beam construction. The 40 foot long, 10 foot wide runway can cut two domestic sized plates back to back. To increase productivity further, the MCD has 6 torches. Jones estimates that competitors' machines of comparable quality cost 25 per cent more than the model he uses.

Compu-Path, the cutting control, is utilized for many of the plant's jobs, which involve repetitive cutting of standard shapes like squares, circles, rings, gussets and strips. The operator simply inputs the dimensions into the computer. The machine cuts up to 999 rows automatically, handling all functions including kerf compensation, lead-in and lead-out, and corner slow down. No template drawing is required, reducing cutting time considerably. The time-saving factor is even more dramatic when cutting with Compu-Path is compared with machining the same part. According to Jones, "a part that could take 30 hours to machine can be cut in 3 hours". Compu-Path also has the ability to withstand heavy workloads. An added advantage is that, because it is enclosed, it can withstand contamination by carbon particulates, a common problem that plagues many tape machines when they are used to cut steel plate.

The digital electronic tracer is used when jobs require the production of irregular and non-standard shapes. One of the features for which it is most appreciated in the plant is that there are no moving parts in the tracing head, so there are no parts that can break down. It is also extremely easy to operate, as no mechanical adjustments are necessary. Forward offset, electronic kerf compensation and directional control are all calculated automatically using simple knobs on the control panel. Operators at Gate City Steel also cite the tracer's illuminated tracing pattern as one of its most convenient features, since it shows them exactly where they are on the template drawing. (Industrial World, May 1984)

Textile industry

The clothing industry is traditionally labour-intensive. For good reason. It presents two peculiar difficulties to would-be automators. First, textiles are floppy and soft, which makes it hard for robots to handle them and for computers to simulate their shapes. Second, much of the industry is - by definition - fashion-sensitive, so the same automated machinery must be able to produce, say, both mini- and maxi-skirts. Still, the difficulties seem to be worth overcoming. Automation promises substantial savings, and a reduction of up to 50% in the time needed to produce a garment. Japan has invested $60m to reduce its clothing industry's labour costs. Its first fully automated clothing factory is due to be completed by 1989. The EEC commission plans to spend $26m to the same end. But it is in Britain, with its big but import-shattered textile industry, that the most intensive efforts are being made to install new technology. British clothing manufacturers are buying 10% of the world's automated fabric-cutters. So far, automation has had a different impact on each of the three basic stages of clothing production: design, pattern-making and fabric-cutting and finally, stitching the pieces together. Design and stitching are the bits of production still most in need of the human touch. The problem with automating the design of clothing is to find ways of portraying realistic, three-dimensional "drawings" of garments on the computer screen. Other industries, such as steel and chemicals, find such computer-aided design relatively easy, and Britain's Clarks is confident that it will soon be able to design shoes on computer. But the materials of these industries are rigid. Fabrics are soft; so the computer must learn to depict the drape and fall of material on the body. Nobody is yet selling a computer that can do this successfully, although Gerber Scientific of Connecticut has a prototype which it hopes to put on the market soon. The second stage of garment production, pattern-making and cutting, is easier to automate. Gerber has invented a computerised pattern-drawing and cutting system that can copy standard dress patterns, automatically adjust for different sizes, add, if wanted, new features such as darts or pockets and even help work out how to waste as little material as possible as the cloth is cut. The pattern is stored on magnetic tape, which is fed directly to another Gerber innovation: the automatic cutter. The secret of this device is an ingenious way of handling the fabric as it is being sliced. A sheet of plastic is thrown over a stack of cloth resting on the bed of the cutter; air is sucked out through holes in the bed; and - presto - a rigid block of cloth that can easily be cut by an automated steel knife.

The third stage of garment production, assembling and sewing, is usually the work of a production line of operators with sewing machines. The only work which has been satisfactorily automated so far is delivering pieces of cloth to sewing-machine-operators in the correct sequence. In the late 1970s, a Swedish firm called Eton devised a "work station" that does this using a system of locks and keys. Each bit of the garment (sleeves, say, or collars) is put into a clamp which, in turn, can be hooked on to an overhead pulley system travelling around the factory. Each clamp carries a "key" denoting which bit of the garment it is carrying. By recognising and grabbing these keys, the system delivers to machine operators the bits of cloth they need in the order they need them.

Automating the seamstress is proving much more difficult. The problem is handling the fabric as it is sewn. Moving silk through a sewing machine is a very different task to moving wool. And the problems of handling material are further complicated by those of re-programming the machine to switch from one fashion to another. America's Singer is now developing a microprocessor-controlled sewing machine with an arm that can grasp cloth and move it through the machine. The arm is first guided through sewing operations by hand; it can then repeat the same motions automatically. But it can only do very simple sewing jobs - matching the edges of two pieces of fabric to make a seam, for example, would probably be too complicated for it. The Singer machine should cost $40,000 - two to three years' wages for a single machinist. Instead of replacing machinists, some reckon it is best to concentrate on robots that make them more efficient. Corah, one of Britain's largest high-street clothing suppliers, is installing 20 Austrian Stahl robots which pick up machinists' finished work with a suction gripper and dump the stuff on a bundle. A research group at the University of Hull in Britain, backed by Corah and the retailer Marks & Spencer, has built a prototype robot which can pick individual pieces of cloth, including knitwear, off a bundle and lay them down ready for the machinist to sew. Air jets make the top layers of fabric flap; when this is detected by the robot eye, the pieces are picked up. (The Economist, 15 September 1984)

Computers in Footwear Industry

Britain's shoe factories could cut costs with an automated system for channelling leather between sewing machines devised at the Shoe and Allied Trade Research Association in Kettering, UK. The association, which spends £1.2m a year on research, has installed one of the systems at the Northampton factory of the British Shoe Corporation. Over the next few months, two more shoe plants are due to take delivery of similar hardware, called Satratrack. The association is attempting to find a company that would take over sales of the system. According to SATRA, a commercial version of the equipment that links up 40 sewing machines would cost about £40,000 Satratrack is intended for use in closing rooms of shoe plants. In closing rooms, workers stitch together perhaps a dozen bits of leather to make the "upper" of a shoe. At a later stage - in the "making room" of the plant - the upper is fixed to the sole and heel to finish the shoe. The people who work in closing rooms spend a lot of time handling pieces of leather. These are normally sent between machining stations in baskets or on trolleys. Satratrack attempts to reduce the periods the leather is in transit so that there is more time for sewing.

The system has two conveyors, one on top of the other, that travel past a row of machining stations. The conveyors run in different directions. A supervisor feeds pieces of leather into a series of baskets each of which travels along the top of the two conveyors. Each basket has on its side a label which contains a bar code that a laser can read. The label is similar to that found on supermarket goods for scanning by a laser at the check-out desk. Before it starts its journey, the basket passes to a device that reads the code. The information is analysed by an Apple computer that works out to which machining station the container should travel. The basket then starts its journey on the conveyor. When it reaches the relevant machining station, a mechanical arm (activated by a control message from the computer) swings out to divert the container to a point in front of the machine operator. When he or she has finished the stitching job, the operator puts the basket on the lower of the two conveyors. This sends it back to the reading device, where the computer again checks on the progress of the work and directs the basket to the next station.

In other work at SATRA, engineers are collaborating with Hull University in a project to bring automation to the final "making" stage of shoe manufacturing. The workers will attempt to teach a robot to press a sole covered with adhesive to the underneath of a leather upper, in this way joining the two. In conventional factories, this is a skilled job. The engineers may need to give their robot a sense of vision so that it can do the task as well as a human. (Financial Times, 30 April 1984)

Computers in the lab

- Computers aid genetic design

It is hard to see what designing car parts has in common with genetic engineering. However, scientists at Battelle Pacific Northwest Laboratories in Washington, are applying the principles of computer aided design (CAD) to designing new genes. Battelle's scientists presented a software package, at Biotech 84, an international biotechnology conference held in London last week.

Everything the experimenter could do before in his head, or on paper can be done on a VDU, taking advantage of six-colour graphics. There is no need to constantly dip into and out of a number of computer files, or to print out information before going on to the next step.

"Most computer software programs currently available are based on alpha numeric stores of information, and provide printouts, mainly in the form of long lists of letters and numbers", says James Thomas, Battelle's CAD expert for the motor industry. The Battelle system is based on graphics. It offers the editorial freedom of a word processor, while other programs can be compared to an electronic typewriter. The scientists can do the usual things, such as call up stored information on the genetic profiles of certain molecules, and count the number of DNA building blocks in a particular chunk of genetic material. It is then possible to find areas of similarity, called homogies, between molecules. Also sections of the DNA called restriction sites can be mapped. These restriction sites are essential to the genetic engineering process. The program can also be instructed to display on the VDU a whole plasmid - a circular piece of DNA from a bacterium. The special trick of the Battelle package is to zoom in from a frontal view of a plasmid, that could consist of 4,000 bases, to focus on a minute section, a mere 8 units long.

However, the real novelty in the system lies in its ability to design any genetic engineering experiment that the scientist desires, without resorting to other computer files or to printouts. Pieces of DNA can be inserted or deleted at certain spots, and chunks inverted - all at any level of magnification. Richard Douthart, manager of Battelle's Northwest biotechnology operation, thinks the software, which should be available by September, will cost between $20,000 and $40,000. It runs on the larger VAX computers made by Digital Equipment Corporation. But it will be equally suited to the newer range of digital miniVAX computers. (New Scientist, 31 May 1984)

- Japanese decode DNA automatically

Automatic analysis of DNA is now possible thanks to a collaborative effort between Japanese industry and universities. The work took three years and was headed by Professor Akiyoshi Wada of Tokyo University. The first two parts of the system to be developed were a machine to automatically extract DNA segments and an automatic process for mass-producing electrophoretic films. The final part of the programme was the development of a package of analysis programs. These went on sale at the end of last month. To determine the way genetic information is arranged in a segment of DNA, the segment must first be tagged with a radioactive isotope, extracted and then separated into its component nucleotides. Manual extraction of segments of DNA is time-consuming and visual analysis is sometimes error prone, which is why the programme to automate DNA analysis was organized by the Science and Technology Agency of Japan (STA).

To automate extraction of the DNA segments, Dainj Seikosha, a subsidiary of Seiko, built a computer-controlled micro-chemical manipulator, which was announced in October 1982. The machine can control complex chemical reactions, involving reagents in quantities as small as one microlitre. A computer controls temperature, centrifugal separation and drying. Once the snippet of DNA is extracted it is broken into its component nucleotides for analysis. This is done by electrophoresis, where the DNA segment is placed on top of a specially prepared gel and film sandwich and subjected to a high voltage. Molecules migrate down the gel, the heavier ones moving more slowly than the lighter ones. Preparing these gels by hand is a slow process, involving many steps. To eliminate the need for most of these steps, Fuji Film developed a method of producing ready made gel film sandwiches consisting of a 0.3 millimetre layer of acrylamide coated with polyester film. Currently about 1 million films are prepared manually each year; Fuji expects to produce 10 million of its gel films per year. They were announced at the end of May 1984 and will cost between £6 and £9.

Finally, the pattern produced by electrophoresis must be analysed. Analysis by computer is both faster and more reliable than by eye. Mitsui Knowledge Industry, in co-operation with STA has developed a package of application programmes. The company expects to sell the programs, which run on microcomputers, to chemical and pharmaceutical companies, universities and cancer research centres. The price will be £1,500. (New Scientist, 16 August 1984)

- Microelectronics and the analytical chemist

The role of the analytical chemist has changed dramatically in the last 10 years. While chemical techniques are still an integral part of analytical methods the chemist must also be aware of the many instrumental methods available. Rarely does the modern analytical chemist perform an analysis alone - he will generally be partnered by an analytical instrument. Choosing the most efficient partner is an important part of the analytical process. The task remains challenging.

The impact of microelectronics on analytical instrumentation has been dramatic. Sensitivities have improved because of more stable power sources and the ability to discriminate against noise via signal overaging or signal sampling. Software control of analytical implementation has resulted in increased versatility and a greater degree of automation. (Yet another decision for the modern analytical chemist: automated vs manual methods of analysis.)

Fifteen years ago, the optimum method of analysis had to be retrieved from five or six techniques. Today that number has been increased considerably. Atomic absorption spectrometry (AAS) now offers flame or graphite furnace atomisation, with both offering more sensitivity and/or selectivity depending on the species to be determined.

Atomic emission techniques have also been improved. Inductively coupled plasma atomic emission spectroscopy (ICPAES) provides a technique capable of sensitive simultaneous analysis, and would certainly be suitable for our particular problem, the determination of cadmium, lead and copper in aqueous media.

The capabilities of voltammetric methods of analysis have also been extended due to the introduction of new working electrodes and more versatile (software controlled) potential waveform generators. Both sensitivity and resolution in voltammetry have been improved.

X-ray techniques are still, of course, used and the instrumentation has improved in line with other analytical instruments. However, it is still a relatively expensive analytical instrument and is more suited to routine analysis of a large number of samples.

In each of the above methods, chemical derivitisation, such as previously discussed, can still be used to minimise matrix effects and improve detection limits.

As well as the improvements in previously existing instrumental methods, one must consider the new methods that have been introduced. For example, ion selective electrodes have proved useful for trace metal analysis in recent years. However, they would not be very useful for the particular problem under consideration here, due to limited sensitivity and possible interference between the three metals to be analysed.

Chromatographic methods, both gas (GC) and liquid (HPLC), can also be employed for trace metal analysis. Ion-exchange HPLC can be used to separate the metals directly; detection can be achieved using electrochemical (for example, amperometric or conductimetric) methods. Reversed or normal phase HPLC can also be used following a suitable derivitisation (for example, dithiocarbamate complexion). The separated complexes can then be detected using electrochemical or spectrophotometric techniques. GC can also be used following derivitisation of the metals to a volatile species, and some dithiocarbamate ligands are also suitable for this purpose.

All of the above techniques could be used to perform the analysis required. Finding the optimum technique is becoming increasingly difficult. Many prominent analytical chemists claim that the final decision, when choosing an optimum method of analysis, will depend on experience. However, it is becoming quite difficult for any one person to have extensive experience in every technique. This experience then, must be drawn from every possible source available. Attending symposia and short courses on specialised analytical techniques can be most useful in this regard. Attending analytical instrument exhibitions can be most enlightening and informal discussions with colleagues in the field can also be very useful. Universities can also be useful with respect to obtaining information on analytical methods. Discussions with a worker in a particular field, or participation in a formal post-graduate course, can give an insight into modern analytical chemistry. Of course all this information must still be collated and put in perspective - in light of the particular problem being considered. Still a formidable task!

Future developments may see the advantage of a computer bank containing information on analytical techniques. Data could be input from many different sources, (for example, industries, universities) and collated using appropriate software. This approach could prove most useful to the analytical chemist faced with choosing an optimum method of analysis. (Excerpted from an article by Mr. P. Wallace, Lecturer in Analytical Chemistry, University College, Cork, published in Technology Ireland, June 1984).

Helping companies apply expert systems technology

Expert systems technology is expected to have a huge impact on industrial productivity. To assist companies in effectively applying this new technology, a group program is being proposed by Battelle-Frankfurt and Battelle-Northwest. Expert systems are computer programs that use knowledge and artificial intelligence programming techniques to solve problems an an expert level. The knowledge used in these systems is derived from the experience of a human expert, thus the term "expert systems".

The Batelle experts system program - still open for membership - will consist of four parts. They will provide:

- An introductory course on exp systems applications and techniques
- Guidelines for identifying :oblems solving using expert systems and for making business decisions regardin. .xpert systems applications
- Guidelines for developing expert systems and integrating them into existing software and hardware environments
- Two Battelle-developed demonstration expert systems that can run on an IBM Personal Computer. These systems will be valueable for hands-on demonstration and training purposes.

(Batelle Today, June 1984)

Telemetry uses microprocessor-based systems

Telemetry (or telemetering) basically means passing measured information over long distances from distributed sites to a central location and there is nothing new about that. A mile long cable running from a thermal overload switch to a lamp on an alarm panel in a control room is a primitive form of telemetry. With the many recent technological advances, however, particularly the advent of the microprocessor, the field of telemetry has expanded to include Supervisory Control and Data Acquisition (SCADA) systems. These involve a network of units to remotely monitor and control plant parameters over a distributed area and feature one central station and a number of remote outstations which continually converse at high speeds over a communications link whether radio, private cable, or PTT lines.

There are numerous areas where telemetry systems can be used to great advantage. The major areas include:

Electricity industry - monitoring and controlling of the National Grid from a National Control Centre which supervises the generation, transmission and distribution of electricity.

Water industry - managing the water resources of a local authority area by controlling remote pumping stations and monitoring reservoir levels from a central location where the automation of treatment plant operations may also be implemented.

Oil and gas - Automation and alarm handling systems used at the production stage right through to the pipeline transmission and distribution networks.

Telecommunications - alarm monitoring at radio stations and remote control of ancillary equipment.

Transport - signalling systems and traffic automation systems.

Many small applications also exist such as a point to point links in industrial plants for process control type operations.

The use of microprocessor based systems has meant that telemetry outstations have their own intelligence. On/off data such as pump status, valve status, and alarm points (digital inputs) are input as volt free contacts and measured valves such as flows, pressure and temperature (analogue inputs) are input as a milliamp or millivolt value (e.g. 4-20mA) from transducers. All this information is examined for significant change and those changes are encoded and sent by modern link to the central station for processing and display. Control commands are issued in the same way to the outstation which executes these via digital outputs (volt free contacts or electronic pulse) or analogue outputs (measured milliamp or volt output). As these units are basically computers of a specific nature, in addition to telemetry they carry out the other functions of a SCADA system. These are:

Data acquisition - The collection and storage of this telemetered data.

Control Room Information display - The presentation of this information, usually on VDUs, printers, plotters, wall mounted mimic diagrams, meters and chart recorders. ... (Electronics Report [Ireland], June 1984)

Microcomputer commuication in support of international agricultural networks
(by NifTAL Project and MIRCEN. P.O. Box "O", Paia, Hawaii 96779, USA)

Widespread availability of relatively inexpensive microcomputers is facilitating exchange of technical information and comment among scientists who are widely dispersed geographically. Computer conferencing is increasingly lauded as ideally suited for continuing information exchange on a global scale. And computer communications have been advocated for active management of international networks of agriculturalists. NifTAL became equipped, and gained experience, in microcomputer communications because of its isolated location on the Island of Maui and the immediate, local need for a link with facilities and individuals at the University of Hawaii's main campus in Honolulu. More recently NifTAL became interested in the potential of microcomputer communications and computer conferencing to further its international development goals. NifTAL seeks to provide farmers in less developed countries with an inexpensive alternative to purchased nitrogen fertilizer. Thus NifTAL offers comprehensive development support in the form of research, technical and material services, and multi-tier training in all aspects of agrotechnologies based on biological sources of nitrogen. The quality of legume inoculants available to farmers in developing countries is of concern to NifTAL. Strategies to ensure inoculant quality have included research into improved production processes, and training the producers how to manufacture high quality products. A new approach, called the Inoculant Quality Incentive Program (IQIP) involves formation of a Board on Standards, definition of uniform standards for inoculant products, award of "seals of approval" to be carried only by products of companies subscribing to the Board's standards, and creation of an awareness among users and retailers that the seal is a sign of quality they can trust.

During 1984 NifTAL proposes to determine whether microcomputer communications are accessible to LDC scientists who have a role to play in design and implementation of the IQIP and will organize a computer conference on the theme of legume inoculant production and quality control. The conference began 1 September and will culminate in an interactive question and answer session during 1-20 December. This latter session is possible due to the presence at NifTAL, Maui at that time of some of the world's leading authorities on commercial scale inoculant production. They will be serving as instructors in the hands-on training course on inoculant production. The participation of agencies promoting the involvement of scientists in the international agricultural networks is welcomed and encouraged. (MIRCEN News No. 6, May 1984)

Portable computerized seismograph for construction projects and prospecting

A compact microcomputer-based seismograph for use in connection with major construction projects or in the prospecting for ground water, oil, coal and other natural resources has been introduced by Atlas Copco Abem, a member of Sweden's Atlas Copco group specializing in electronics and geophysics. Called Terraloc, the portable unit will greatly facilitate work for field staff while at the same time providing better-quality data than with earlier instruments. Looking like a big rucksack, the Terraloc combines a video unit and a digital tape recorder within a single unit. It is available in a variety of versions ranging from 2 to 24 channels, the latter weighing 20 kg excluding batteries. Seismic data - concerning the size, stability and quality of earth and rock strata for example - are obtained with the aid of hammer blows, weak explosive charges or other energy sources and are subsequently registered on the 9-inch display. The operator checks signal/noise conditions on the screen, sums up approved seismograms in the unit's memory and stores the result on a cassette tape or a 21 cm field printer for future evaluation. At the same time, measuring site co-ordinates, time of day, instrument settings and other relevant data are registered and stored. The unit has a power consumption of only 42 W, a high degree of amplification and a large measurement area (from 24 microseconds to 5,000 milliseconds). (Science and Technology, September 1984)

Philips gives an underwater view

The excavation of the Amsterdam, one of the Dutch East India Company's larger trading ships and the most complete wreck since the Mary Rose, will be made possible by the use of a microcomputer as an underwater eye. The problem for excavators has been that while the ship is visible at low tide, underwater conditions are so murky that visibility is no more than 30 cm.

The Amsterdam is unique in that two thirds remain for excavation; nowhere else in the world is a wreck of an East Indiaman at this level of preservation to be found. The Amsterdam was driven ashore and wrecked at Hastings on her maiden voyage in January 1749.

Over the next few months, the ship sank to a depth of 30 feet, and although two and a half tons of early New World silver were saved, most cargo, supplies and personal belongings of the 335 passengers and crew were lost.

For the excavation of the Amsterdam a Philips P2000C computer will be used to record the position of objects within the ship. Large steel girders, with survey points attached, are placed above the wreck. Tape measures will be run from these survey points to every single object located by the project's divers. The computer will convert these diagonal readings to horizontal and depth measurements, enabling the archaeologists to plot the objects' exact positions, relative to a hypothetical grid over the site. The measurements are then scaled down to the site plan, which can then be drawn out. ... (Electronics Weekly, 16 May 1984)

English language quantified

The Oxford English Dictionary, generally known as the OED, plans to leap into the twentieth century by investing £7 million in the computerized production of a new edition, a marger of the existing 12-volume dictionary with the four-volume supplement still not yet complete. Announcing this plan earlier in the week, Oxford University Press said that the merging of the OED and supplement into a single printed work (to be published in 1988) is merely the first phase of an ambitious programme leading to the availability of the dictionary in an electronic form and eventually to the use of computers for novel lexicographical purposes. Oxford seems to have been able successfully to turn the respect and affection in which the OED is held into tangible support for the computerization project. IBM (UK) Ltd. is lending for the first phase of the project computer hardware (a 4341 processor and up to a score of terminals), software and the services of two specialists on secondment. This assistance, valued at £1 million over the duration of the first phase, compares with the £6.5 million in cash and kind committed in a year by IBM to the support of computer development projects in the United Kingdom.

The Department of Trade and Industry has also provided a grant of £228,750 from its fund called Support for Innovation. The donkey work of "data capture" (or keyboarding) will be carried out on a commercial basis by International Computaprint of Fort Washington, Pennsylvania, USA. In preparation for the later phases of the project, Oxford has also made an arrangement with the University of Waterloo, Toronto, Canada, which has undertaken to develop software for the computerized handling of lexicographical data. One obvious possibility is that the dictionary, supplemented by recently accumulated material, will be made available on magnetic tape or by means of a data bank, but there is also a possibility of making the whole work available on optical disks, one of which might be sufficient to contain the 1,000 million characters in the new edition. Oxford will pay a royalty for its use of software, which the University of Waterloo will be free otherwise to exploit.

For users of this dictionary, the chief disappointment will be that the new edition, to be called the New Oxford English Dictionary, will be innocent of the entries accumulated since the appearance of the first supplementary volume nearly twenty years ago. Keyboarding will begin in September this year, but between now and then the dictionary staff will be chiefly concerned to develop the means by which the entries in the OED and the four supplements can be accurately logged and merged, given the variety of typefaces and alphabets used and the need for subjective judgement in telling how supplemental entries supplement the originals. As things are, the project is cautious about the extent to which the resource being computerized may be used as an automatic source of novel dictionaries, but there seems a good chance that scholars will eventually be able to use the dictionary as a means, for example, of monitoring the rate at which nouns are being converted into adjectives or even verbs. (Nature, 17 May 1984)

Transducers are changing

The measurement and control functions performed by instrumentation are influencing our society increasingly through their role in such diverse areas as productivity, quality, safety, hygiene and health. Transducers, as the devices that convert measurement variables from one type into another, are a vital part of such instrumentation.

In a schematic representation of an instrument, the transducer is the instrument's interface to the system being measured and, where appropriate, being controlled. The transducer output is fed to the signal conditioner which performs at least one conditioning function such as amplification, noise filtering, level shifting and analogue to digital conversion. When suitably conditioned, the signal is fed to the display for visual presentation to the user. Where the user is a further instrument (such as a computer) the visual display is probably omitted.

Most instrumentation, regardless of its physical complexity, can be represented by this simple schematic or by slight modifications to it. While there may be a number of transducers within a particular instrument, for example in the display, we will confine ourselves here to the primary transducer appearing at the front end of the instrument. This transducer is often called a sensor as it is the instrument's contact with the real world outside the instrument. The lengths of the transmission paths depend on the physical disposition of the instrument's components. This can vary widely in practice. A liquid-in-glass thermometer has its transducer (liquid in bulb), amplifier (bulb to capillary cross-sectional change) and display (capillary scale) so physically integrated that we cannot really distinguish the signal transmission paths. At the other extreme, a satellite-borne instrument may have its transducer and some signal conditioning separated from its earth-based signal conditioning and display by many thousands of kilometers. The exact nature of the transmission media will depend on a number of factors that include distance, the operating principles of the transducers and intrinsic safety considerations. Pneumatic, electronic, and telemetric transmission media are now being augmented by optical fibremedia which offer particular advantages with regard to noise immunity and intrinsic safety.

Most transducers operate on analogue rather than digital principles, where the time varying input signal can take any value over a given range. As illustrated, the analogue output transducer is capable of converting this signal over all its range whereas the digital transducer can only convert the signal into discrete values or steps. Clearly, a specific conversion or quantisation error is associated with the digital transducer.

The range of transducers available to the instrument designer is wide and is being updated continuously as new technologies and materials emerge. Although a comprehensive review of contemporary transducers is beyond the scope of this article, a representative selection is listed at the end. In this table ten measurands (parameters) are listed together with details of typical transducers.

Over the last decade, the large-scale integration of electronic components has resulted in substantial reductions in both the physical size and cost of electronic circuits. Indeed, powerful single chip microcomputers are now available at costs well below those of many individual transducers. Significantly, the further advance of micro-electronics into many sectors, particularly consumer ones, is seen to be limited by this economic imbalance. Car manufacturers have, for example, identified low transducer costs as the key to the incorporation of further computerised measurements and control functions into their products. As the source of these economies lies in the technologies that created the microprocessor in the first place, transducers must now be designed so that they can be produced in the same economic silicon foundries. In other sectors, such as process control instrumentation, the economies derived from semi-conductor transducer technology are of secondary importance compared to their potential for improving transducer performance and encouraging a great distribution of intelligent measurement and control.

Traditionally, semi-conductor devices are well known for their often undesirable temperature dependence; this is exploited in instrumentation by using the semi-conductor as a temperature sensor. More recently, commercial pressure transducers that are based on silicon technology have been introduced. Force-related semi-conductor transducers of pressure, vibration, acceleration and so on subject a silicon substrate to deformation by an applied force. ...

Central to the development of these and other mechanically based transducers is the ability to micro-machine semi-conductors. Fortunately, the general semi-conductor fabrication techniques of wet chemical etching, dry plasma etching and electron/ion/laser beam machining are readily available. Indeed, it is one of nature's ironies that many of the artefacts of these techniques - for example, directional etching and mask undercutting - that prove so undesirable in normal micro-electronics fabrication are found to be essential for the production of micro-transducer geometrics. Achieving the full potential of silicon micro-transducer technology requires the inclusion on the sensing silicon substrate of the transducer's signal conditioning circuits. ...

One of the most obvious and important consequences of integrating the transducer and signal conditioning functions is the effective elimination of the signal transmission path from what is often the most sensitive stage of the instrument system. The signals that generally emerge from a conditioned transducer are relatively immune to noise and other extrinsic effects. The use of optical fibre media for the remainder of the system would of course provide total immunity. Clearly, it is only a short step to extend this approach to add analogue to digital converters and microprocessors to the sensing element. With this degree of integration a whole range of possibilities emerges:

- Non-linearities in the transducer's sensitivity can now be compensated for at source
- Reliability can be increased by providing multiple sensing elements and a multiplexer
- 'Smart' or 'intelligent' transducers can be created by adding a decision-making microprocessor

Fibre optics transducers - in which hair thin strands of glass or plastic act as either sensor or transmitter or both - are beginning to make inroads into process instrumentation, particularly for use in installations having hazardous atmospheres. Sensors for measuring vibration, strain and displacement, flow, pressure and temperature are commercially available and there have been recent developments of novel fibre optical gyroscopes and hydrophones. Infra-red (IR) absorption is being used with fibre optics as an analytical tool to detect such things as blood oxygen in a non-invasive measurement on the ear, methane in the atmosphere on offshore rigs and moisture concentrations in liquids. It seems likely that the development of fibres capable of transmitting in the mid-infra-red region for the telecommunications industry will have a spin off in IR analyses. As a result, for example, the sample removal from a milk tanker at the plant gate may, before long, be replaced by a fibre optics dip stick connected to an IR analyser to monitor quality in situ. Clearly, these developments, coupled with current work on integrating optics with semi-conductor substrates, will provide a further stimulus for novel transducer developments. Another particularly significant advance has been the development of techniques for fabricating Langmuir-Blodgett films. These are films of single molecule thickness which, when laid down on suitable semi-conductor surfaces, create a new range of chemical and biological sensors. By incorporating films that participate in specific chemical or biological reactions one creates new semi-conductor sensors that provide an electrical output in proportion to the progress of a particular reaction. The potential of these transducers in medicine, environmental monitoring and the pharmaceutical, chemical and food industries is enormous.

Looking to the future then, we can reasonably predict the development of integrated transducers capable of making multiple measurements of a range of parameters. In many cases these universal transducers will be complete instrument systems.

With the advent of integrated electronics, mechanics, optics and chemical technologies transducers - themselves vehicles of change - are changing rapidly. The next few years will see radical changes in both their design and application. The last decade has belonged to the microprocessor; perhaps the next decade will belong to the microtransducer.

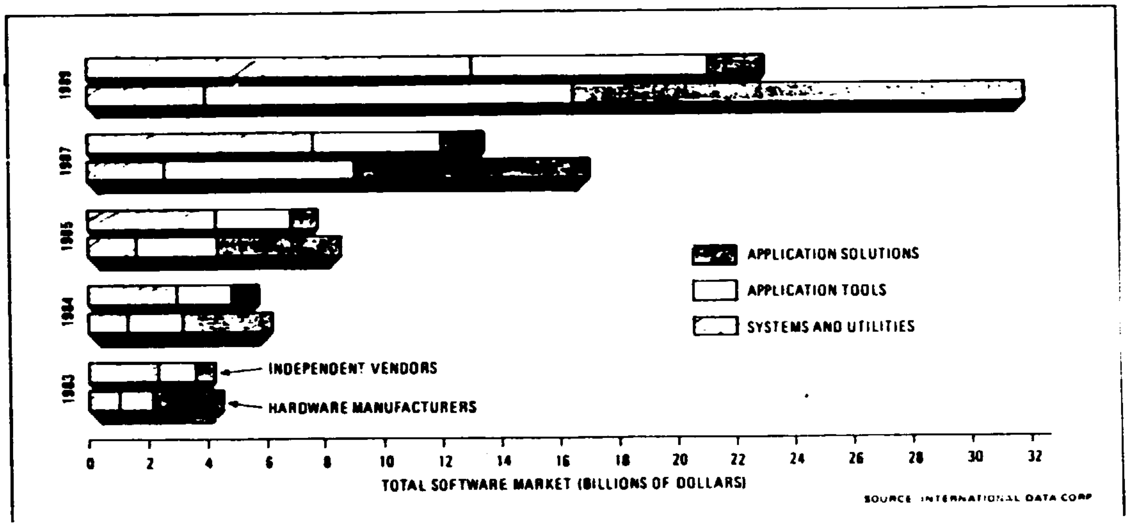
Table 7

Table of Typical Transducers

Transducer	Measurand	Output	Operating Principle
L.V.D.T.	Displacement	AC Voltage	Electromagnetic induction
Pilot tube	Fluid Speed	Differential pressure	Momentum transfer
Accelerometer	Acceleration	DC Voltage	Piezo-electric effect
Strain gauge pressure transducer	Pressure	Voltage	Mechanical deformation
Resistance thermometer	Temperature	Resistance	Temperature dependence of resistivity
Capacitance Probe	Level	Capacitance	Change in electrical permittivity
Turbine flowmeter	Flow	Rate of rotation	Momentum transfer
Polymeric humidity sensor	Humidity	Resistance	Change in surface resistivity
Newton moderation sensor	Moisture content	Neutron flux	Neutrons slowed down by water
Pellistor	Inflammable gas concentration	AC or DC voltage	Combustion sensed by Joule heating effect

(Technology Ireland, May 1984, excerpted from an article by Dr. L. McDonnel and Dr. V. Ruddy)

SOFTWARE



Billion dollar baby. Faced with a need to find ways of creating programs more quickly and reliably despite a shortage of programmers, software engineers will push the market for application tools to an annual growth rate of about 40% for independent tool makers. (Source: International Data Corp.).(Reproduced from Electronics Weekly, 10 September 1984).

Computer-aided engineering (CAE) will achieve sales of $200 mil+ in 1984, and is expected to grow 65%/year to over $1 bil by 1988, according to Dataquest. The business did not even exist 3 years ago. CAE differs from CAD in that CAE systems are used only to design electronic gear and are a tool for the engineer rather than the artist or draftsman, coming into play at the 'front end' where products are conceived. CAE systems allow engineers to manipulate graphic symbols directly on the computer screen. A CAE system costs around $65,000/workstation and the price is dropping quickly. Depending on the job, the systems can cut design time by 90%. Currently, the industry is led by Daisy Systems, Mentor Graphics and Valid Logic Systems, all new firms. (Fortune, 11 June 1984.)

Integrated CAD/CAM industry revenue will reach $28.7 bil by 1994, vs. $7.7 bil in 1989 and $2.1 bil in 1984, according to International Resource Development. Low-cost CAD/D (computer-aided design/drafting) systems will be at the forefront of the explosive growth. The systems will be installed in rapidly increasing numbers in architecture-engineering construction (AEC) offices. By 1994, there could be 1 CAD/D workstation for every 2 AEC professionals. Such a scenario would mean a $9.6 bil market in CAD/D revenues. (MIS Week, 18 July 1984.)

Cross-industry software applications will account for $34 mil of the $83 mil spent on information services in 1988, according to Input. End-user oriented tools will be the leading growth segment with a 29%/year increase in 1983-1988. Other high-growth areas are in planning analysis applications for end users, value-added networks, and education and training software. Related applications increasingly will be integrated through a DBMS. Vendors will expand into new delivery modes, including remote computing services and microcomputer software. In the systems software market, end use-oriented markets will grow the fastest: application development tools, 33%/year growth in 1983-1988; systems control software, 24%; and data center management software, 27%. (Computerworld, 12 March 1984)

The artificial intelligence software market will reach $700 mil by 1990, vs $15 mil in 1984, according to M. Weinberger, co-author of INC's forthcoming book, 'Data Basics - Your Guide to Online Business Information'. Artificial intelligence is moving into the mainstream of the personal computing industry, with product introductions by Microsoft, Texas Instruments, and Lotus Development. One application of AI, 'knowledge gateways', would provide a user the ability to access many data base systems by logging on to only one, with the computer doing the rest. Another AI application, natural language, would enable people to enter plain English commands in order to retrieve information. (EDP Weekly, 9 July 1984.)

Software industry shakeout

No one expected the halcyon days of the personal computer software business to pass so quickly. Industry experts had projected that this market would continue to double annually, and 3,000 hopefuls, as a result, had jumped into the fray. But the glut of suppliers, along with the soaring cost of marketing new products and a flood of me-too programs, is changing the picture dramatically. Rapidly appearing are the telltale signs of an industry shakeout - bankruptcies, buyouts, layoffs, and price-cutting. To make matters worse, the market has failed to live up to earlier predictions. "The market is still growing, but there are so many companies now that it's not sustainable for everyone", says Egil Juliussen, chairman of Future Computing Inc., a McGraw-Hill subsidiary that tracks the personal computer industry. The initially giddy estimates have been revised downward: Sales this year should still grow impressively - topping $2.3 billion, up from $1.45 billion in 1983. But this will amount to an increase of only 60%, a far cry from the original 100% forecast. ...

The tightening competition has changed the rules dramatically. Gone are the days when software-hungry computer enthusiasts were buying every major new program on the market. Now a staggering 20,000 programs are available for the 5 million or so personal computers in use. Hundreds of me-too products are fighting it out in major categories such as word processing, and consumers are buying only one version - whether it is word processing software, a data base, or a spreadsheet program. Forced into fierce marketing fights to differentiate their products, software vendors must spend more on advertising to get customer attention and win retail shelf space.

Once the dust settles from the current turmoil, the industry should end up with a different mix of companies. The larger personal software companies should continue to thrive along with the established, mainframe software vendors ... The hordes of startups and small companies, however, may not have the resources to go it alone in the fast-maturing market. Already, many are beginning to work closely with the larger software companies. ... Even software agents have cropped up. Operating like literary agents, they match independent software authors with publishers. ... (Business Week, 20 August 1984)

Esprit software projects

After months of political wrangling over the budget for Europe's research programme into information technology, Esprit, the European Commission has been let down by some of the companies supposed to benefit from the £450-million programme. Officials running the software technology part of the scheme are under budget because they have not found enough suitable proposals to support. Software technology, one of five areas of research covered by Esprit, is concerned with means of improving the methods of producing and maintaining programs. One source said that some applicants for the 50 per cent research grants had done little more than "dust down 15-year-old ideas".

Research into better ways of producing programs, which will centre round eight strategic projects in the Esprit plan, is considered vital to the computer industry. Some experts estimate that 60 per cent of software projects fall behind because of inadequate tools and management. A shortage of staff in the software industry, a lack of emphasis on long-term research and vague specifications from Esprit have been blamed for the lack of the right proposals. Officials at Brussels have promised to bring groups of companies together before they make their proposals in future. Overall, Esprit is over budget by £6.5 million so far. Over 100 projects are expected to have approval by the autumn. (This first appeared in New Scientist, London, the weekly review of science and technology.)

Cobol to get new facilities making it faster and easier

Cobol has a lifetime of more than 20 years and will get a series of new non-procedural facilities to make it faster and easier to use. This is the opinion of Don Nelson, chairman of the Codasyl committee, which has been responsible for the technical development of the language since its inception. He was in London for a Codasyl Cobol meeting staged by Micro Focus.

Nelson said that much of the controversy over the development of Cobol is now coming to an end. 'It's plugging holes from previous standards that has caused the problems. Adding fourth generation enhancements does not cause incompatibilities'. Nelson praised the UK for being responsible for many of the newest and most useful additions to Cobol, citing the recent update and analyse feature which uses non-procedural statements.

In recent years, the development of the Cobol language has been dogged by rows between users who want new facilities and those who think these will cause incompatibilities.

A meeting of the American National Standards Institute (Ansi) Cobol committee should be able to determine what the level of opposition to the new standard is, but Nelson thought the Cobol 8X now looks set to emerge in 1985.

In April, the International Standards Organisation decided to adopt the same Ansi Cobol which has caused so much trouble. (Computer Weekly, 17 May 1984)

Software for controllers

CATPAC (computer aided techniques for process analysis and control) is a software package being developed at the Philips Research Laboratories in Hamburg, FRG, for use in the design and evaluation of control systems for industrial processing. With the package mathematical models can be developed rapidly from measured results, and control strategies based on these models can be directly assessed by process simulation. The package is user-friendly and offers a series of mathematical procedures, with which the software can be adapted to particular needs. Results can be presented numerically or graphically and can be stored in the internal catalogue, with information on how they were obtained. (Electronics Weekly, 3 October 1983)

India offers to cut UK software labour costs

British software houses can save on manpower costs by subcontracting work to India, says the UK head of a Delhi-based software consultancy, Robsonia Software. It reently set up a London office. "We are looking for tie-ups with British software houses", says Robsonia Software UK managing director, Bidur Nanda, "and can arrange work to be subcontracted to our Delhi office or to other Indian software houses with which we have links".

Robsonia Software was established about two years ago in India as a specialist offshoot of the British-bred international construction agency called Robsonia.

"With its high calibre mathematicians and programmers, India has much to offer the West", explains Nanda, "but India's resources have not been recognized in the West". Nanda believes a key area for sub-contracts is in software conversion projects. "We can get that kind of work done quickly and cheaply in India. I regard the UK as the head and India as the body, and we want to bring the two together." Nanda belives that as UK industry is becoming more cost conscious it will look increasingly to India for cheaper programming. (Computer Weekly, 7 June 1984)

£22 million CAM programme starts in UK

A £22 million five-year Science and Engineering Research Council programme to boost computer-aided manufacturing (CAM) gets off the ground this weekend.

The programme, called the Application of Computers to Manufacturing Engineering (Acme) is to be run by a new directorate within SERC set up for the task. Acme has grown from SERC's successful four-year industrial robotics programme which it now subsumes, and marks a threefold increase over last year in SERC spending in the whole area of computer-aided manufacturing. Although the cash will be for projects in the field conducted by academic institutions, the institutions are to be "strongly encouraged to form a partnership with a commercial company", says Acme deputy director Dr. Peter Smith.

The significance of a separate directorate to run Acme is that it will have the financial and executive authority to stir up good research proposals in that area.

Smith is determined that Acme projects should be relevant to industry and sees no overlap with Alvey projects in that area. "We are complementary with Alvey. The Alvey programme is researching fundamental enabling technology for wide applications whereas we are more applied and are aimed only at the manufacturing industry. "The Alvey programme is providing input to our programme", he adds. "We will take the fundamental results from Alvey's fundamental work and will research applications for them."

The industrial robotics programme, which over the last four years has grown from a handful of projects to 50-60, and a budget of £1.4 million, demonstrates the value of the university/commerce mechanism, says Smith. (Electronics Weekly, 3 October 1984)

Microcomputer software sales 'set to top £750 m'

The value of the UK market for software for microcomputers will overtake sales of the machines themselves by 1986 and will reach about £750m a year by 1988, according to a study by the Economist Intelligence Unit. *

Most of the growth is expected to be in software for home computers costing less than £500 in 1983 prices, which will account for half of all microcomputer software sales by 1988. Machines costing under £100 will account for almost 30 per cent of total software sales. A further 10 per cent of the software will be for "home professional" machines costing £500-£1,000 and the rest for business microcomputers priced at more than £1,000. About 85 per cent of software sold last year was for use with machines costing less than £2,000. The software market for home use will be double the value of the sales of home computers by 1988. But software sold for business use will be worth only about a third of sales of business microcomputers, the study says.

The survey estimates the total UK software market at £127m in 1983 and puts the average annual growth rate up to 1988 at 40 per cent. In spite of the recent growth of UK software companies, of which there are about 3,000, the country is still buying more sofware from overseas - mainly the U.S. - than it sells abroad. In the first seven months of last year, exports totalled £10m, against imports of £27m. ...

The study says that while the quality of UK software is generally good, it is hindered by poor presentation and marketing. Most of the companies producing it are small and have not been in business long. (Financial Times, 30 April 1984)

AT & T joins software consortium

A £100m consortium between AT & T of America, NTT of Japan and the Japanese Ministry of International Trade and Industry (MITI) aims to automate 80 per cent of the process by which software is generated in a project lasting five years. Currently 90 per cent of the tasks needed to produce software rely on manual operations. The Japanese Finance Ministry has been asked to include the project in the next fiscal year's budget. AT & T's participation in the scheme is because the Unix system, developed by AT & T subsidiary Bell Labs, is considered to be the best operating system on which to base the proposed mass-production of software.

Crisis

In the US and Japan, the growth in software demand is expected to produce a crisis without some scheme to automate software generation. According to a recent US survey, software production spending is expected to exceed 80 per cent of the total spending on information processing in 1985. MITI will supply five supercomputers which will memorise a software development support system to be developed for the project, and NTT will have their computer terminals linked to the supercomputers. The project is scheduled to start in April 1985. (Electronics Weekly, 10 October 1984)

COUNTRY REPORTS

Australia: Austek to take on CSIRO chip software

The Federal Government-owned Commonwealth Scientific and Industrial Research Organisation (CSIRO) has signed a licence agreement for the commercial development of its technology for designing advanced silicon chips. The agreement covers chip design software developed over the past three years by CSIRO's VSLI laboratory in Adelaide, South Australia. Under the licence CSIRO will give exclusive rights to this software for two years to a company formed by the staff of the VSLI laboratory. The new company, Austek Micro systems will make VSLI chips, each designed for a specific high technology function and each containing as many as 100,000 transistors. The company will be based in Adelaide. Sixty per cent of the shares will belong to Australian investors and the remainder held by American investors. In its first years the company will design and make special purpose VSLI chips and microelectronic systems employing these chips. It plans to export 90 per cent of its manufacture overseas.

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* The markets for Microcomputer Software in Europe. UK market study (Vol. 3) Economist Intelligence Unit, 27 St. James' Place, London SW1A 1NT. Price: £1,100.

CSIRO chairman Dr. Paul Wild said CSIRO had set up the VSLI programme in 1981 with initial funding of SA1.5m over three years to the end of June this year. Actual funding had been about SA2.5m. He said it was always CSIRO's intention that the work of the programme would be transferred to industry. The future of the programme was now being considered.

To date Austek has raised $US 6.6.m in venture capital to fund its operations. Dr. Craig Mudge, the former boss of the VCSLI chip programme, has moved to head up Austek, and the company chairman is Sir Gordon Jackson, the former chief executive of CSR. Dr. Mudge said Austek's products would be sold into areas where a lot of computing power was required. These included computer graphics, medical electronics and avionics. (Electronics Weekly, 12 September 1984)

Australia in fifth-generation bid

The Federal Government in the 1984-85 budget has allocated $A250,000 to begin development on a so-called fifth-generation computer project in a bid to halt the exit of talented computer scientists overseas. Director of strategic planning in the Federal Department of Science and Technology, Andrew Bertie, said the allocation was important and showed the government recognised Australian expertise in the area. Fifth-generation work is taking place at Melbourne, Monash and Sydney Universities, the NSW Institute of Technology, and in private companies such as Kingdom Pty Ltd and Interactive Engineering.

In Japan MITI is spending $A450m on the project over 10 years. In Britain $A350m will be spent between government, business, and universities, and in the US, two teams are tackling the project. One is a consortium of 12 US firms expecting to spend $US75m a year over 10 years, and the other a Pentagon-funded scheme could spend SA1bn.

Joint Australian service industry plan

An international organisation is being set up to bring together computer services industries in Japan, Australia, New Zealand, Singapore and Korea. The decision was taken in Tokyo two weeks ago and represents the end of a year of discussions begun by the Japan and Australian Industry Association. At the moment trade for example between Japan and Australia is fairly limited. In addition, the markets of the less advanced countries like Korea have tended to be dominated by the US. Yet potential markets for software in the smaller countries are increasing enormously. According to Yong-Teh Lee, advisor to the Korean Ministry of Science and Technology, 'The annual growth of the Korean software market has been over 50%.' Some of the delegates involved in setting up the new organisation, which will be called the Asian Oceania Computing Industry Organisation, will now seek ratification for membership in their respective countries. (Computing, 28 June 1984)

AMI Ramping up Austrian venture

American Microsystems Inc., is ramping up production at its Gould AMI-Voest-Alpine joint venture in Premstaetten, Austria. According to Dr. Lee Seely, Gould AMI vice president in Santa Clara, Calif., the facility, which is known as Austrian Microsystems International GmbH, is the only complete offshore facility in existence. AMI GmbH, includes design, wafer fabrication, assembly and test under one roof. The plant was opened in October 1983 and occupies a total floor area of $11,712 m^2$.

Initially; the plant made 4µm NMOS and 5µm CMOS. Recently the plant began producing 3µm devices. Capacity is greater than 1000 four-inch wafers/week, Dr. Seely reported.

AMI GmbH is believed to be the only semiconductor operation in the world that operates, in part, from a castle. The castle, which contains a church and was acquired from a religious order, is part of the 45-acre purchase Gould AMI made for the joint venture. The castle is occupied by administrative, marketing and sales offices. A newly-constructed passageway runs from the second floor of the factory to the second floor of the castle. Products made at the factory here are sold to the European Common Market. Gould AMI owns 51% of AMI GmbH, while Voest-Alpine owns 49%. (Semiconductor International, August 1984)

Brazilian protectionism bears fruit for makers of small computers

Brazil's policy of protecting private industry in selected electronics field appears to be bearing fruit. Preliminary figures released by the Special Secretariat for Informatics indicate that, while multinational computer companies' sales dropped last year in comparison with 1982, the protected local manufacturers of mini- and microcomputers experienced a sales increase. The multinational manufacturers - who are allowed to produce and market only large and medium-size computers in Brazil - registered sales of $800 million in 1983, compared with $950 million the year before. Brazilian companies, meanwhile, had sales of $670 million, compared with $558 million in 1982. The study also shows that import restraints and government policies pressing multinationals to use more Brazilian-produced components have also cut into import levels. (Electronics, 31 May 1984)

Brazil's computer program takes a sudden outward turn

In a dramatic reversal of government policy aimed at developing native technology for superminicomputers, Brazil's Special Secretariat for Informatics has authorized four local groups to look abroad for partners. After reaching the conclusion that Brazil's market cannot support more than two or three manufacturers of 32-bit minicomputers, SEI's head, Col. Edison Dytz, attempted to persuade the four groups to merge. Failing that, the secretariat has decided to let the market determine how many of the four can make it. Other groups may also get the go-ahead to go abroad, and as many as seven of them could end up battling for shares in the market. Some of Brazil's largest companies are involved. An association uniting Banco Brasileiro de Descontos SA (Bradesco), the country's largest private bank; the Companhia Docas de Santos, a major electronics group based in Sao Paulo; and Medidata Informatica e Tecnologia SA, a Rio de Janeiro computer and software company, has secured rights to purchase Digital Equipment Corp.'s VAX 750 technology. Sao Paulo-based Itautec, the computer and automation services arm of Brazil's second-largest private bank, Banco Itaú SA, is buying technology for the F4000 machine from Formation Inc., of Mt. Laurel, N.J. ABC Sistemas SA has made a deal for the DPS6 from France's Bull and is already assembling Bull mainframes in Brazil. Sisco Sistemas e Computadores SA, the computer subsidiary of the Hidroservice group, which has diversified interests including engineering, is purchasing technology for the IPL 4460 from IPL Systems, Waltham, Mass.

What made the secretariat's decision to seek foreign technology unusual was a recent ruling that authorized three other Brazilian groups to develop minicomputers based on 32-bit microprocessors from in-house technology. Included in this program was the state-run computer manufacturer Cobra Computadores e Sistemas Brasileiros SA, of Rio de Janeiro, which makes minicomputers and microcomputers. None of these 32-bit minicomputer projects is anywhere close to launching a product. Now they will have to compete for the low end of the 32-bit minicomputer market with the imported machines, since the four groups authorized to use foreign technology will begin by importing systems and gradually increase the amount of components produced locally. Besides coming onto the market first, these machines will also be cheaper and more powerful. As one industry observer put it, "the VAX alone will blow the supermicros [the native-technology 32-bit machines] out of the water, particularly as the presence of Bradesco in the group will afford them ample leasing facilities." As a result, the original three developers of supermicrocomputers will have to get back to SEI with their own superminicomputer projects, including proposals for purchasing technology on the international market.

Cobra, which has had numerous financial problems and presumably will wind up under control of the government's National Economic and Social Development Bank, may well acquire technology from AT&T. Also in the market for superminicomputer technology are SID Sistemas de Informacao Distribuida SA, in Curitiba, which has ties to Sharp Corp. in Japan, and Labo Eletronica SA, a Sao Paulo minicomputer manufacturer that industry sources regard as the weakest of the group financially because of its computer-leasing obligations. Meanwhile, SEI has told another of the contenders, Edisa Eletronica Digital SA, in Porto Alegre, that its project for a superminicomputer based on Fujitsu's V870 machine is not of interest. The machines SEI wants Edisa to make are in Fujitsu's M series, compatible with IBM's 4300 series. (Electronics Week, 6 August 1984)

Brazil squeezes auto makers

Brazil's Special Secretariat for Informatics - which so far rules supreme in all things digital - has come up against no less an adversary than the automobile industry, in the form of local subsidiaries of Fiat, Mercedes-Benz, Scania, and Volkswagen, not to mention Ford, General Motors, and others. The new confrontation is over the question of microelectronics in motor vehicles, a key issue in Brazil's export-oriented auto industry. The manufacturers, all strongly committed to Brazil as an export base, want to introduce the latest technological developments, which include the integrated circuits that control fuel injection, carburetor fuel-to-air ratio, and other functions. But in doing so, they run up against Brazilian government policy, which states that, wherever possible, digital equipment should be produced by local companies with all their capital in the hands of Brazilian nationals. Col. Edison Dytz, the head of SEI, puts it this way: "Both we and the Ministry of Industry and Commerce have a policy whereby the car manufacturers should not verticalize their production, but rather take advantage of outside suppliers on the Brazilian market. That means, in digital equipment, companies with 100% Brazilian capital."

So far, says Dytz, the only company to have approached him with a concrete proposal is Ford do Brasil S.A. The project, for electronic fuel injection systems on the Escort, has been accepted. That is because, says Agostinho Gaspar, Ford Brazil's director of government and public relations, the company's technology will be transferred to a firm that is completely Brazilian in its capitalization.

General Motors do Brasil S.A. has no proposal before the government. According to Eduardo Antonio Vilela Feijó, supervisor for project engineering, GM is awaiting a clearer definition from the SEI as to who should present the project, whether the car manufacturer or the auto-part manufacturer. The decision is complicated by SEI's nationals-only policy and the fact that a number of companies do not want to transfer technology. "In fuel injection, for instance, Bosch has world-class technology for automated systems and has a Brazilian subsidiary, but they've already declared that they're not interested in licensing that technology to anybody else down here." says Feijó.

Volkswagen do Brasil, however, has a wide range of microprocessors in its Voyage and Paraty models, for which it has received special permission from SEI to import parts, explains VWB economist José Rocha de Almeida. The firm already has a Brazilian version of the Voyage with eight microprocessors, including a voice synthesizer and a chip that calculates how far the vehicle will be able to travel at average speed before requiring refueling. Volkswagen expects to export the cars to the U.S. starting in late 1986. McGraw-Hill World News. (Electronics Week, 15 October 1984)

China eyes the West

China's industrial leaders are watching the fifth generation race with close interest. China is putting a large amount of time and money into research and development, but regards it as a very long-term project. Unlike Britain, which must revitalise its factories urgently to gain export markets, China can afford to concentrate its resources on some pure research which may not pay off for many years. "We have a great deal of cheap labour which we are able to concentrate on software development," say the commercial secretary of the People's Republic of China in London, Zhang Xuan. "We will welcome opportunities to co-operate with foreign companies in this field." He says that computerisation is important for China, despite its cheap labour, because functions such as process control will always be done more efficiently by computer.

In the past, China has bought computer products from the US - especially IBM and DEC - and from Japan. But now it is anxious to become more independent, particularly because it has found the Japanese reluctant to share their expertise. It already manufactures mainframes and minicomputers together with their microprocessors. It also writes systems software, but is willing to give preferential treatment to those prepared to sell their know-how to China. More Chinese are now going abroad to learn; two years ago, 15 were trained in Birmingham by Sperry Univac. The country's research effort in this field is co-ordinated mainly by the Ministry of Electronics. It operates several universities and colleges devoted entirely to electronics, and a number partly devoted to electronics. These supply electronic engineers and scientists to the Ministry. The People's Republic officials observe the progress of their computer students and recruit the best of them for important posts after they graduate.

China's aim is not, like Japan's to seize a major share of the world export market; its products will be mainly absorbed by the huge domestic demand. It will remain a technical importer for quite a long time in the future, but it does hope to be able to export some of its inventions. (Computer Weekly, 21 June 1984)

China signs joint venture with Hewlett-Packard Co.

Hewlett Packard has come to an agreement with China Electronics Import and Export Corporation, Foreign Trade Organization of the Chinese Ministry for Electronics Industry. This will enable the joint venture company to promote and sell HP products in China. Manufacture of selected items of the present range of HP products is also envisaged. (Donaueuropäischer Informationsdienst, October 1984)

China starts trial 10 KIC production

China has started trial production of 10K integrated circuits and the development has been called a sign of improved production of semiconductors by officials at the Ministry of Electronics Industry.

China started producing integrated circuits in 1965 and currently produces 850 different semiconductor devices including large scale integrated circuits (LSI devices). Production figures for January and February this year were 21 per cent up on figure for the same two months in 1983, officials said. China's semiconductor output rose 30 per cent in 1983 compared with production figures for the previous year.

The Ministry of Electronics Industry said that semiconductors produced at different locations in China are randomly tested by being operated for 10,000 hours non-stop. Officials claimed that damage was found in only one per cent of the devices tested. (Electronics Weekly, 30 May 1984)

Gould signs China deal

Gould Inc has signed a 10-year licensing agreement with the China National Machinery and Equipment Import and Export Corporation of Peking, for the manufacture and assembly of dedicated, industrial computers called programmable controllers.

The agreement, which is valued at a minimum of $12m over the first three years, also calls for the establishment of a service and training centre.

Gould will provide Tianjin with technical training to include instruction in manufacturing techniques for the assembly of programmable controllers, testing operation, quality control process and maintenance of the equipment. (Electronics Weekly, 25 July 1984)

Canadian Research institute launches artificial intelligence program

A low-profile research group called the Canadian Institute for Advanced Research has begun its first major research project, tackling the development of artifical intelligence. The project, entitled Artificial Intelligence, Robotics and Society (AIRS), will attempt to develop machines that can think, make decisions and carry out actions based on their decisions. The AIRS program will also integrate artificial intelligence with robotics and will study the effects of artificial intelligence on Canadian society. Research will be conducted in Montreal, Toronto and Vancouver. In Montreal, researchers from the department of electrical engineering will work on computer vision and its application to robotics. In Toronto, computer science researchers will study sensory perception of computers, while the Vancouver-based researchers will study visual recognition by computers. A computer network will link the researchers in the three cities.

The institute - established in 1981 - differs from traditional research institutions. Unlike most other research groups, the institute is not tied to any government or university but is free to set its own policies and priorities. Dr. Fraser Mustard, the president of the Institute, said the organization's independence allows it to focus on research and on acquiring the best people for its projects. Ideally, the AIRS program will create an "intellectual dynamic" like that of research groups at Stanford University and the Massachusetts Institute of Technology, Dr. Mustard said. The institute is a financial conduit for the research programs, a non-profit corporation that solicits funds from numerous sources and disburses them to its selected programs. It does not have a permanent research team or any research laboratories of its own. Researchers are seconded from universities and the research operations are provided by McGill University in Montreal, the University of Toronto and the University of British Columbia in Vancouver. (Canada Weekly, 3 October 1984)

EEC proposal for more compatibility

The European Community has called on the computer industry to take rapid action to adapt its products to allow standardised interactive communication in screen mode between terminals and computers of different makes. While international standards already exist, there are no such products available on the market. The EEC Commission, as a customer, is recommending a solution to implement these standards in practice and it wants to obtain quickly the views of its current and potential suppliers. A suitable solution could then be incorporated in specifications for future invitations to tender. The problem is that, increasingly, users of computers in the Commission and, more generally, European institutions are getting access to different makes of machine. Until now, multiple access via a single terminal has been limited to line-by-line operation, known as "scroll mode", which is facilitated by numerous teletype-compatible terminals. In the absence of a generally accepted standard, the use of terminals in screen mode, giving a full page at a time, needs specific equipment for each different make.

In the Commission's view, this is a big obstacle to the everyday use of computer facilities, not only for its own departments, but for all users in Europe, as screen mode is commonly used for many applications.

The Commission has decided, therefore, to seek a common solution compatible with the equipment it uses. It hopes that this solution will also benefit the many users throughout the Community who have the same problem. A solution would also encourage the opening up of markets offering more opportunities to the European industry. The Commission has examined current international standards that might lend themselves to a solution. It has chosen two standards, which - in combination - cover all known needs and are compatible with the current state of the technology. The standards are: ISO 6429 and CEPT T/CD-06-01 for video-tex terminals. (Electronics Weekly, 5 September 1984)

ESPRIT contract

Under the ESPRIT programme, ICL, Olivetti, Bull and Siemens have been awarded the first-phase contract for the installation of an experimental telematics environment for the Information Technology Task Force of the EEC. The contract is worth over 1 million ECUs (approximately £700,000) and will be divided equally between the partners in terms of money and work involved. The project will entail setting up a local area network between workstations and office automation and data processing services within the task force and with participants in the ESPRIT programme. Besides being useful working tool for the IT taskforce, the EEC hopes that the joint venture will act as a showcase for other European collaborative ventures and that it will help promote the use of international standards in working and living environments. The Commission is to review the equipment to be used for the project and will be discussing the possibilities with the consortium. (Electronics Weekly, 11 April 1984)

Japan seeks bids from EEC firms

In a major move to improve its relationship with the European Community, Japan is now openly inviting EEC manufacturers of telecommunications and computer equipment to compete for tenders against its own companies. The opportunities have come about through the signing of agreements between Japan and countries that are signatories to the GATT Government Procurement Agreement and the US/Japan Agreement on Telecommunications Procurement.

Nippon Telegraph and Telephone's purchases from overseas firms, which in the fiscal year 1980 were about Y3,800m, have shown a rapid rate of increase since the introduction of new procurement procedures in January 1981. This has led to purchases totalling Y4,400m and Y11,000m in fiscal years 1981 and 1982. In the fiscal year 1983, purchases from foreign firms were more than Y30,000m, which includes the purchase of a traffic observation and management system.

Future NTT purchases for the fiscal year 1984, to March 31, 1985, will cover the following high technology areas - PBX and private line switching equipment, data terminal equipment, a character reader, modem and network control unit, network protective device, memory materials for computer system, facsimile equipment, power supplies, and measuring instruments. (Electronics Weekly, 25 April 1984)

French kids to be taught computing

Prime Minister Laurent Fabius announced at the opening of Sicob, the French computer and electronics exhibition in Paris, that within three years every French child leaving the schooling system will have received a grounding in computer technology. The French Premier said that, 25,000 teachers are now receiving computer technology courses to enable them to provide education for all of France's youngsters. He said that three French schools out of every five now had a computer. Next year the number of students at engineering colleges and high technology faculties in universities would increase by between 10% and 15%. "Computer technology is the key to modernising France," the Premier explained. "It involves a risk, and an opportunity for employment. The best way is to bring as many French men and women as possible into contact with this technology." (Computer Weekly, 27 September 1984)

FRG: Toshiba begins IC production

Toshiba Semiconductor GmbH, a wholly-owned subsidiary of Toshiba Corp., began operating its Braunschweig plant near the East German border in May. 16-kilobit static RAMs and 64K dynamic RAMs are assembled at this site with wafers imported from Japan. In June, static RAM assembly was added with the addition of dynamic RAMs planned for the future. (Semiconductor International, August 1984)

India: World Bank to boost electronics exports

The World Bank is examining the possibilities of helping India to enlarge its export markets for electronics goods. A three member bank mission is already in India for discussions and identifying the potential for such assistance. The World Bank, it is said, is keen on promoting the industry in the South Indian State of Tamil Nadu which is a late starter in the electronics field but fast catching up with earlier established states like Maharashtra, Kerala, Andhra Pradesh and Uttar Pradesh. Its Industrial and Technological Consultancy Organisation thinks that with the setting up of a free trade zone near Meenambakkam close to Madras, there would be big potential in Tamil Nadu for the establishment of export oriented electronics projects for making such products as components, professional electronic equipments, computer peripherals and bio-medical equipment both as export oriented and import substitution ventures. (Electronics Weekly, 15 August 1984)

Software export

Five new computer companies have decided to set up 100 per cent software exports facility at the Santa Cruz Electronics Export Processing Zone (SEEPZ). There are three companies already in the process of developing software in the zone and four others well established at SEEPZ which would then have 12 units offering just software - both standard and customised - for exports to developed and developing countries.

Mr. Gopalakrishnan, SEEPZ Development Commissioner said that the attraction to develop software for exports was also because of the easy licensing procedure at SEEPZ. Companies even without definite export orders in hand are given space upon specification of their hardware import requirements and software marketing plans, which have to be projected in five year periods. Mr. Gopalakrishnan said software held enormous potential for India, if only India could develop more computer literacy here. According to one projection, by 1990, microcomputer software alone will reach a business of $25 billion. If India can tap even one per cent of this market share, "we can early $250 million per year in software exports alone," he said. (Economic Times [India], 25 March 1984)

Larger export of computer software

Export of computer software to USA, West European countries, USSR, Gulf countries, South-East Asia, Australia and New Zealand in 1983-84 totalled Rs. 200 million, representing an increase of 48 per cent over the previous year's export of Rs. 13.5 million. With comparatively low cost of production and availability of a large pool of technological and scientific manpower, there is immense scope to increase exports of software. These exports are expected to total Rs. 1 billion in the next three years. The Commerce Ministry has initiated several steps to boost exports of computer software. (The Hindu, 9 June 1984)

Indian government picks Dow

The Government of India has chosen Dow Chemicals of the US as the foreign collaborator for setting up a polysilicon plant of the National Silicon Facility (NSF) proposed to be set up at Baroda, according to informed sources. The tie-up is yet to be approved. The NSF, a production, research and development centre will be owned by the Department of Electronics. DoE has allocated Rs. 600m for this plant in the 1984-85 budget. The plant will also manufacture silicon rubber and non-crystalline or amorphous silicon. Costing about Rs. 900m the plant will have a capacity of 200 metric tons a year. The Minister of State for Science and Technology, Shivra Patil told the Indian Parliament that a national silicon facility was to be created and it would use the locally available silicon. He said the country was trying to develop the needed technology but it would not hesitate to adopt it from any foreign country. (Electronics Weekly, 30 May 1984)

Indian SC firm looks to Silicon Valley

The state-owned Semiconductor Complex Ltd is proposing to set up a design centre in Silicon Valley. SCL is considering this step to keep abreast of the latest development in technology. It also hopes to train its engineers by working with experts in Silicon Valley and to take up development of a range of devices and software. Recently SCL finalised a collaboration agreement with Rockwell International Corporation of the US for the transfer of know-how on 8-bit microprocessors, 8-bit microcomputers and three types of peripheral devices namely - a versatile interface adapter, a RAM input/output timer and a 32K ROM. It is expected that the assembly of 8-bit microprocessors and two types of peripheral devices will begin in 1984-85 and all types of devices covered under the SCL-Rockwell agreement will be taken up for fabrication during 1985-86. It is likely that the agreement with Rockwell will be extended to include manufacture of 16-bit microprocessors and associated peripheral devices at a later date. SCL also plans to manufacture both dynamic and static random access memories, programmable read only memories, programmable read only memories and LSI devices. (Electronics Weekly, 30 May 1984)

Japanese semiconductor industry is growing into a Y2,000 billion business

The Japanese semiconductor industry continues to thrive. In 1983, Japan's production of semiconductor devices including integrated circuits and discrete devices passed Y1,500 billion and may exceed Y2,000 billion at the present pace. The industry is expected to grow at over 30 per cent a year for two consecutive years. Production continues to expand for videocassette recorders, office automation equipment and other products that use numerous semiconductor devices. In addition, the area of application of semiconductor devices has been widening. The auto industry, factory automation and other fields have become areas of semiconductor application. Semiconductor exports have continued growing at a high rate. Semiconductor demand in Japan thus has begn expanding at an accelerating rate. As a result of this growing demand, both in Japan and in other countries, the semiconductor shortage which has continued since aound the middle of last year has begun to show signs of being prolonged. Near the end of last year the general view predicted that semiconductor devices would be in short supply until this summer. Recently, however, the prediction is that the supply condition is not likely to improve at least before the end of this year. Until the middle of last year the shortage of integrated memories was often mentioned, but recently, most semiconductor devices have been in short supply. Business is brisk for memory, microprocessor and other logic ICs, linear ICs are also a growing business, and demand is very brisk for transistors, optoelectric devices and other discrete devices. (Journal of Asia Electronics Union)

Japan hits first target in fifth-generation computer R&D project

The Institute for New Generation Computer Technology, the organization co-ordinating Japan's fifth-generation computer research and development project, has achieved the first target in the 10-year program, a prototype relational-data-base machine. The prototype consists of two parts,a data-base processor, manufactured by Toshiba Corp., and a hierarchical memory, made by Hitachi Ltd. to be interconnected with a local network manufactured by Oki Electric Industry Co. The data-base processor includes a supervisory control processor, a relational-data-base engine, a processor to interface to the outside world, and a separate maintenance processor. Later versions will have four relational-data-base engines. The hierarchical memory subsystem uses 12 megabytes of random-access data-base memory, two disk drives, each holding 2.5 gigabytes, and two magnetic tape drives. Increases planned are to 128 megabytes of RAM, eight disk drives, and four tape drives. (Electronics, 31 May 1984)

Japan's fifth-generation computer project

The fifth-generation computer project which aims to develop intelligent computers is running into problems. One goal would be to make the computers simple to use, allowing people to speak to them using regular language rather than having to learn computer languages. Budget and staffing problems have forced the program to set aside some goals, such as development of technology to allow computers to see, to understand human speech and to translate languages. The major goal of the program remains development of computers that think. The 1st 3-yr phase of the 10-yr program will end 3/31/85, with the project just about on target. The 4-yr intermediate stage will be much more challenging. The 5th-generation of computers is intended to handle symbols, not numbers, and will be able to perform many instructions simultaneously. Intelligent computers will have to manage vast amounts of data and knowledge, and must then be able to use the knowledge to make inferences and reach conclusions. A prototype personal sequential inference machine that operates on a version of the computer language Prolog has already been built. The inference machine will then be used to write programs for other parts of the project. The 3rd part of the project is the effort to make computers easy to use. This goal has suffered most from budget restrictions, although private companies are continuing research on those problems.

The project will also develop intelligent programming techniques to allow the computer to do more of the work of writing programs. Budget problems may hurt the effort to develop hardware and software to do parallel operations, since computer experts are divided over the best way to achieve parallel processing. The project has increased co-operation between universities, government and industry, and has spurred greater efforts in the US and Europe. MITI had originally planned to spend Y100 bil for the entire program, including Y50 bil for the 2nd phase, which will now receive only Y25 bil. The government plans virtually no spending increases for FT85. The program will also face problems of attracting enough artificial intelligence researchers. (New York Times, 13 August 1984)

Japan's chip giants double R&D funds

Toshiba's new multimillion pound semiconductor research centre is the latest in a series of major investments by Japan's nine chip giants. The £62.5 million very large scale integration (vlsi) research centre, based near Tokyo, will specialise in the development of front-line technologies such as three dimensional large scale integrated chips sub-micron level vlsis on a silicon substrate and very high speed gallium arsenide devices. Investments are growing by an average of 50% annually and are expected to total well over £1.56 billion in 1984, up from £1.07 billion last year. And last year, overall production of integrated circuits rose by 39% on 1982, with a total value of £408 million.

Toshiba has already made development level 1 megabit dynamic random access memory (dram) and 256 Kbit static random access memory (ram) chips, using 1.2 micron technology, and says that its current research programmes aim for the development of vlsis in the four to 16

megabit range with microlithographic technology at the 0.5 micron level. The company predicts that the level of integration achieved will quadruple every three years. A key feature of the new plant, which opened this month, is the provision of 4,000 square metres of 'super clean' rooms. These rooms will be cleansed by a new 'down slow' circulation system, in which air descends from the ceiling and is filtered out through vents in the floor. Special automatic carriers will transport the wafers between rooms to minimise contamination. The design and testing of vlsi circuits will be carried out using computer-aided design systems and electron beam testers. Sub micron level drawing systems will include exposure, etching and electron beam technology. The research centre director, Dr. Yoshiyuki Takeishi, says that 300 researchers will be working in the new plant initially, a total which will rise to 500 staff within five years. Toshiba's overall capital investment in the semiconductor field stood at over £187.5 million in 1983.

Fujitsu has Japan's highest level of semiconductor plant and equipment investment, about £313.75 million, and this figure could grow as high as £500 million in 1984. Fujitsu will open a new integrated circuit factory in the autumn and is now expanding its present factory in Northern Japan.

Both Hitachi and NEC are expected to attain a 1984 investment figure of £312.5 million. Matsushita Electronics, a joint venture of Matsushita Electric and Philips, has embarked on an integrated circuit plant expansion programme costing somewhere between £203.215 million and £250 million, which represents more than a doubling of the past semiconductor equipment investment total. Oki has also doubled its investment levels to approximately £62.5 million for the coming year, and has recently achieved a 3 million a month production level of 64 Kbit drams.

Mitsubishi has just completed work on a £93.75 million state-of-the-art chip production plant which will have an initial output capacity of 5 million 64 Kbit dram chips a month. The new plant features an almost completely unmanned operation and an online computer link-up with the company's research and development headquarters.

Overall production has doubled in Japan since last year, spurred on in large measure by massive demand from the US. Total estimates suggest that more than half of this total is now being shipped to the US and Europe. (Computing, 19 April 1984)

Two years into its 10-year life, the Japanese government's project on future electron devices is still unsure where it is going. But, paradoxically, that is as it should be; its mission, after all, is to undertake high-risk research to uncover the technology that industry will need in the 1990s. The electron-device work actually encompasses three of the 12 areas of a larger research and development project of basic technology that was set up in 1981 by the Ministry of International Trade and Industry. Outside of their speculative nature and their government funding, there is little connection among the three - and even the likelihood of a payoff varies widely.

The entire future-electron-devices project represents a break with the past. MITI projects traditionally have been designed as catch-up, with little emphasis on original research. The VLSI project that ran from 1976 through 1979 was the first turning point; though it was largely devoted to development, it did chalk up some research advances. Now, realizing they must do original work, Japanese officials are orchestrating efforts in basic research. The superlattice work, with no specific target, is typical: four years of study of material technologies that can support new functions will be followed by six years of device development.

The three electron-device research areas now have 11 firms working on 14 tasks, with both those numbers subject to revision. Four are exploring superlattice materials; seven, 3-d VLSI devices; and three, ruggedization of devices to withstand extreme environments. Doing parallel work is the government's Electrotechnical Laboratory. Co-ordinating all those activities is the Research & Development Association for Future Electron Devices, a foundation set up to serve as liaison between MITI's Agency of Industrial Science and Technology and the firms that are participating in the project.

The MITI agency not only supervises the R&D association, but it selected the firms that are doing the work. Although the association has its own full-time executive director, Kazuyuki Harada, its research department is headed by a high-level scientist borrowed from the Electrotechnical Lab. Last year it was Toshio Tsurushima, who has since returned to the lab to head research on 3-d devices; now it is Mitsuo Kawashima, on loan from his position as the director of superlattice research.

Harada makes it clear that the results of the research will be "open to everyone because it would be unfair to restrict them to Japan." Thus papers have been delivered at such worldwide gatherings of experts as the International Electron Device Meeting, and annual symposiums are held in Japan. After the latest, the Second Symposium on Future Electron Devices, which took place this summer in Tokyo, it is possible to get an overview of each target area.

Superlattice work. Though superlattice devices, which can be produced by molecular-beam epitaxy or by organic chemical vapor deposition, are beginning to be used in quantum-well lasers, this project is ignoring optical devices because they are the subject of another research project. Included, though, are permeable-base transistors, for which government officials have coined the name "superlattice-structure devices" or "super grid-structure devices."

Three-dimensional devices are an obvious answer to the problem of how to pack ever-more-capable electronic systems into less space. The central processing unit could be on one layer, memory on a second, a display controller and similar circuitry on a third, and so on. But to get the most benefit, devices would have to be truly three-dimensional, with functional signal paths, rather than merely vias, running vertically.

Once the need for 3-d chips is established, the two big questions are whether yield can match that of conventional 2-d ICs, and what to do about dissipation. The leaders of the Japanese project assume that the devices themselves that will fill a need will be developed in the next decade. Thus they are moving on to develop the necessary technology and processes for silicon-on-insulator material, the only known building block for true 3-d devices.

The thought is that, if SOI can be applied only to 2-d chips, it will compete with silicon-on-sapphire material. That is, like SOS, it will improve environmental ruggedness by increasing radiation resistance, although doing it better. But if the technology can be indeed used to produce 3-d ICs, then the parts will be able to compete with all types of 2-d devices.

However, it is easier to conceive of multiple layers of silicon and insulator than to build them. For instance, a single layer of silicon can be recrystalized at high temperatures, but for multilayer devices the temperature must be low to prevent degradation of devices already fabricated. Precise temperature control is also vital to prevent growth from different directions. Another temperature-related problem is the prevention of localized stress.

The Japanese researchers say that a thin layer of nitride above the oxide insulating film, perhaps 1,000 angstroms thick, enhances recrystalization of silicon and may do the trick. Growth of sapphire on top of silicon as an overlying insulating layer has not been very successful, but there are indications that a magnesium-derived material might work better.

For devices that can operate in extremely harsh conditions, it was decided to eliminate such potential and wide-ranging applications as inside nuclear reactors (monitoring and repair), in aircraft engines, under the automobile hood, and with robots. Instead, the research effort focuses on space communications because the risk and difficulty merited government support. The research work includes three technologies: MOS, bipolar, and gallium arsenide. But in selecting the space arena, the Japanese are again playing catch-up. Much of the research is centered on hardening for resistance to cobalt 60 radiation. As one researcher wryly puts it, "If NASA would share its know-how, I wouldn't have to do this uninteresting work." (Reprinted from Electronics Week, 8 September 1984

Republic of Korea moves into the big league

The country already seems to be moving out of the branch plant stage where companies like Motorola and Fairchild found it cost effective in the mid-1960s to set up assembly lines there - into fully fledged VLSI circuit design and production shortly. The country's biggest electronics companies are all involved. Tristar Semiconductor, a subsidiary of the Samsung conglomerate has several years' experience in SSI and various MSI components, and is now putting the finishing touches to a massive investment ($150m in this fiscal year alone) to get to VLSI levels. First products will probably be 64K DRAMs. Included in this is a Silicon Valley design centre, at Santa Clara, California. A competitor, the Lucky Group's Goldstar Semiconductor, more cautiously is putting up a initial $30m for an expansion of its own. Another conglomerate, Hyundai also is getting into memory manufacture and has already established a design office in Santa Clara as part of an expansion, understood to be nearly $200m this year.

This has all been bolstered up by Korea's remarkable econonomic performance: last year it had a real GNP growth rate of 9.3 percent. This year the growth continues (first quarter was 9.7 per cent) allowing such substantial investment plans as chip plants to be firmed up. Along with shipbuilding and textiles, the electronics industry is Korea's biggest dollar earner. The first quarter of this year alone brought in nearly $900m, a massive 65 per cent up from 1983. (Electronics weekly, 15 August 1984)

Mexican company develops computer stand by system

Blackouts and brownouts can wreak havoc with any computer. Even the most fleeting dip in electrical current may cause a computer to "crash" and erase data stored on its semiconductor memory chips. Yet according to a Dataquest Inc. estimate, more than two-thirds of all mainframe computers are not protected by standby systems that can detect an electrical dip and instantly switch to backup battery power. The chief reason for not buying this kind of insurance is cost. Standby-power systems are expensive - $45,000 and up. Batteries also run out of power after about 10 minutes, so they are not much protection from blackouts.

But a small company called Grupo Fuerza Industrias Electricas - based in Mexico City - has developed a standby system that it believes overcomes all these drawbacks. It has done so with a decidedly low-tech approach, a vital necessity for any business based in the Third World that wants to compete in world high-tech markets. "Technology is like everything else in life," says Mario Gottfried, president of the Mexican company. "The simpler you get, the longer-lasting and easier to operate it is." Simplicity is the central force behind Gottfried's drive to transform the manufacturer of motors and generators into a supplier of high-tech products such as the uninterruptible-power supply and a wind-powered generating system also built with low-tech components. Despite its small size, Grupo Fuerza expects that its low-tech approach to products will help them sell in international markets, especially in other developing nations. "There are no fancy electronics in our products," boasts Gottfried. "You don't need costly spare parts or high-tech talent to maintain them. This is extremely important not only in the Third World. Several multinational companies with operations in Mexico already have bought the standby-power source, and Fuerza is mounting a sales campaign beyond Mexico's borders.

Gottfried believes that equipment built with homegrown technology can provide appropriate and affordable solutions to many problems in developing nations as well. He notes ruefully that importing costly, high-tech gadgetry - now often unserviceable for lack of parts and technicians - absorbed much of the nearly $90 billion in foreign debt that Mexico is unable to repay.

The Fuerza equipment is distinguished on two counts. First, it is put together from mundane parts. Second, Fuerza's Astronic No-Break power supply can generate electricity for an indefinite time. Battery-powered systems may be adequate for most power problems in industrial countries where long outages are rare, but in Mexico such systems do little more than provide breathing space for an orderly shutdown of the computer to minimize loss of data.

Gottfried's son Carlos, Fuerza's operations director and an engineering graduate of Southern Methodist University, designed the power supply system and has just been granted a U.S. patent on it. The key component is a flywheel-driven generator positioned between the computer and an electrical outlet. Incoming electric current keeps the flywheel spinning, and its inertia filters out power surges and dips that can upset a computer's delicate microcircuits. When a blackout happens, the flywheel continues to rotate and feed power to the computer. Before the flywheel runs down, a small engine kicks in to drive it. The system costs about $30,000.

U.S. sales of the standby-power system for computers should help improve cash flow. Three months ago, Fuerza licensed Computer Power Products, a Gardea (Calif.) subsidiary of Sweinhart Electric Co., to assemble the system from Fuerza's motor and generator, plus other parts purchased in the U.S. The California company has already made its first sale - to Merchants & Marine Bank in Pascagoula, Miss. It also expects to sell eight systems to Ford Aerospace & Communications Corp., and two government agencies are evaluating the system. The Gottfrieds hope to license other companies in the U.S. and Europe as well. But Grupo Fuerza needs to jump another formidable hurdle before it can do more than token business in international markets. The company must overcome disbelief that technological innovation, however simple, can originate in Mexico. (Business Week, 27 August 1984)

Netherlands releases report on state of electronics industry

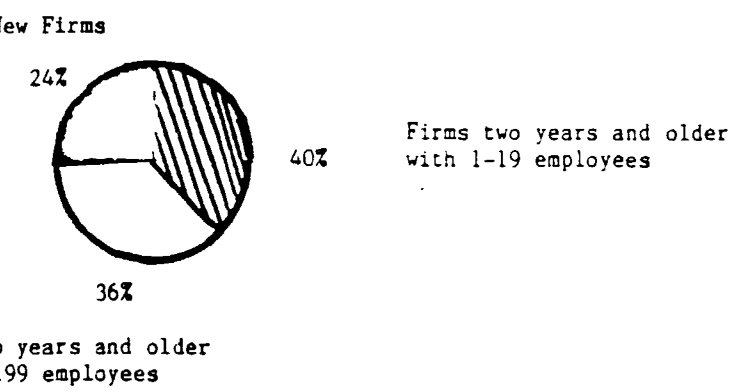
In the Netherlands, the microelectronics industry is growing very fast. In the last two years, one out of six firms has doubled its volume and a third of the microelectronics firms have increased their business by at least half. These facts were presented in the report "Future of Applied Technology" presented by the National Investment Bank (NIB).

Together with the centers for microelectronics in Eindhoven and Enschede, the Center for Integral Policy in Rotterdam and East-South Partners, Inc., an investment company owned by the textile firm Gamma Holding, the NIB commissioned an invenstory of the Dutch microelectronics industry by SKIM industrial market research firm. The study considered as part of the microelectronics industry all firms which either manufacture or use in their products chips (integrated circuits), modules, compónents or other products related to microelectronics.

Overall, the microelectronics industry as defined here includes a good 350 firms, of which many are subsidiaries of foreign firms, with an estimated total sales last year of 3.2 billion Dutch guilders and with about 15,200 employees. Only harware firms were included in the study; software, engineering and information services were excluded. According to the NIC report, the nucleus of the Dutch microelectronics industry is formed by 250 firms with fewer than 200 employees. In 1983, their sales volume amounted to over 1.2 billion Dutch guilders and they employed about 6,000 persons.

New Jobs

The Core of the Dutch Microelectronics Industry
Created 1243 Jobs in Two Years



In the last two years, these 250 microelectronics firms created 1,243 new jobs. While the actual numbers are low, that was a huge increase proportionately, the report says. The number of jobs increased by about a fourth.

About a fourth of those new jobs are accounted for by new microelectronics firms. Overall, two out of three firms saw an increase in the number of employees.

According to the report, the idea that research and development is limited to firms with more than 200 employees is completely erroneous. In the 250 firms studied, 168,000 days were spent in research and development in 1983, corresponding to 750 man-years or 1.2% of the available employees.

Research at such firms is usually application oriented; almost half of it is conducted by persons with HTS [secondary-level technical school] training and only a fourth is done by persons with university-level studies.

Most microelectronics firms are started by graduates of the technical universities. Within a radius of 15 kilometers of the technical universities of Delft, Eindhoven and Enschede, the concentration of microelectronics firms is greater than elsewhere. Still, there is no real clustering of companies like that of the Silicon Valley in California. (NRC Handelsblad, 21 March 1984)

Data General to make PCBs in Singapore

Data General of the United States is to build a factory in Singapore to manufacture custom-designed multi-layer printed circuit boards. The project will require an investment of US$ 25m with construction work on the seven-acre site having started very recently. The plant will eventually have a 120,000 square foot floor area and will be Data General's largest manufacturing plant outside the United States. Factory construction is expected to cost about $6m, while assembly and test equipment due for installation will require a further investment of at least $16.7m. The company has begun recruiting staff and 15 technicians are expected to be sent to Data General's Clayton facility in North Carolina for training shortly. The setting up of a printed circuit board plant in Singapore is part of Data General's expansion of off-shore activities in the Far East. Production is being upgraded in Bangkok as well, where permission has been granted by the Thai government Board of Investment for the setting up of a factory to manufacture computer peripherals and later the local assembly of computers. Production at the Singapore plant is expected to begin early in 1985. Details of planned staffing levels and the expected output of printed circuit boards have not been disclosed. In addition Data General will set up a regional office in Singapore to facilitate the company's international procurement of parts and components. (Electronics Weekly, 23 May 1984)

British electronics group Thorn - EMI PLC takes over INMOS *

Since February, when AT&T made a $56 million bid for the U.K. chip maker Inmos, the U.S. telephone company had been the center of frantic negotiations on both sides of the Atlantic. Now, however, AT&T [has been outbid by British electronic group Thorn-EMI PLC, whose $133 million play was enough to secure the British government's 75.6% holding in Inmos. AT&T] was batting for its first semiconductor plant in Europe and until then the Thorn-EMI announcement was thought to be the leading bidder. The cause of all the excitement was the British government's determination to rid itself of its interest in the semiconductor company. Inmos is one of the few chip makers in the world not already allied with a systems builder and is Britain's only presence in the mass market for chips. ...

At issue was the question of whether Inmos should be allowed to fall into the hands of a foreign, namely U.S., buyer or whether there was some way, perhaps via the ICL offer, to sell the company while retaining the technology in Britain. "The availability of leading-edge capability in silicon is something we have never had in Britain," said Barron shortly before the Thorn-EMI deal was closed.

The Thorn-EMI offer, which values Inmos at $175 million, gives taxpayers their money back and keeps Inmos's technology in Britain. In fact, Thorn-EMI appears to have got a bargain, according to some industry analysts who point out that a Korean effort to build a company similar to Inmos will carry a $350 million price tag. Inmos critics say the company has so far failed to justify early hopes. Its products tend to be at the Rolls-Royce end of the market and the company has consequently failed to grab a large piece of the chip market. At the end of 1983 Inmos was only just beginning to trade profitably, but it showed a loss of $19 million for the year. Inmos directors now predict profits of $10 million on revenues of $140 million for 1984. The company also expects to be churning out 64K RAM chips at the rate of 3 million a month from its Newport plant by the end of this year.

Managing director Barron says his company is meeting sales targets but is misunderstood by financiers who do not realize what Inmos's business is all about. Barron did not help in the government's effort to find a buyer. Not only was he against a foreign buyer but, like most entrepreneurs, he has been fighting to keep as much control over the company as possible. Inmos is understood to have rejected several overtures on Barron's objections.

Reportedly, senior Inmos management and company workers vigorously resisted the joint AT&T/ICL proposal, claiming it would damage Inmos's ability to operate in a co-ordinated manner. But the company needed to settle the question of future financing quickly. Semiconductor manufacturing requires large capital investments. Development of the transputer, though a relatively low-cost endeavor, will require more than $10 million. Inmos also needs $39 million to build a test and assembly plant near the Newport plant to replace certain offshore assembly activities. Cash for these projects will not be forthcoming from this year's profits, but a Thorn-EMI spokesman said the parent was prepared to provide Inmos with up to $23 million a year in expansion funds. (Excerpted from an article in Datamation, 15 August 1984 and reprinted with permission of DATAMATION r magazine (c) copyright by Technical Publishing Company, A. Dunn and Bradstreet Company, - all rights reserved).

Work starts on new Inmos plant

The Secretary of State for Wales, Nick Edwards, dug the first sod for Inmos' assembly plant at Coed Rhedyn this week. The £15m assembly and test facility will allow Inmos to perform every stage of integrated circuit production in Wales. It is due for completion next summer. The new plant is five miles from the company's wafer fab at Duffryn near Newport. The fab is currently turning out nearly two million chips a month. The assembly plant will substitute Welsh for Far East assembly. Edwards spoke of "the consolidation it represents of Inmos and the UK's position in a strategically important sector of advanced technology." The

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* See also reports on INMOS in earlier issues.

Duffryn fab is currently employing 750 and, when it is fully utilised, it and the Coed Rhedyn plant will together employ 1,500. That is projected to be the case in 1987. (Electronics Weekly, 12 September 1984)

UK Alvey Programme

As the £350 million Alvey Programme of support for advanced computer research in Britain gets under way, university workers are being told to find industrial sponsors if they wish to carry out research in fields the programme covers. The fields are fast chips, software engineering, expert systems and the man-machine interface. Although the £200 million that the government is contributing to the five-year Alvey Programme includes £50 million for universities, the money will be withheld from researchers who refuse to co-operate. "If computer scientists want to do research they must do it in partnership with industry," said David Thomas, director for Information Technology at the Science and Engineering Research Council (SERC) and director of Alvey's Intelligent Knowledge-Based Systems programme.

The funds available for computer science research are now split roughly between SERC and the Alvey Programme. Alvey is spending an average £10 million per year. SERC has a £13.5 million budget for this financial year for what it calls information engineering. This includes research into radio, instrumentation, opto-electronics and control systems, as well as computing. David Thomas, who liaises between SERC and Alvey, made it clear that the research council will concentrate on "long-term electronics research".

In the meantime the first Alvey contract has been signed with a consortium consisting of Newcastle University, York University, GEC, ICL, and two smaller companies, SDL (software) and MARI (hardware). The group will spend the next three years working on a project to produce a system that improves the quality of programs and the speed with which they can be written by programmers. Called Aspect, the system will be used in large-scale software projects carried out at different sites. British Aerospace will be the first user. The information technology minister, Kenneth Baker, said systems like Aspect provide the means to cut the £1 1/2 - £2 billion annual bill for writing software in Britain.

The Alvey directorate approved two more large-scale projects of research into advanced computer science. During the next five years a consortium of industrialists and academics, led by Racal Research will develop intelligent mobile terminals. These will be used: to provide motorists with traffic information; for fault diagnosis in the electricity supply system; and in mobile electric offices. The other project announced will be led by Plessey. The consortium, which includes the Universities of Edinburgh, Loughborough and Imperial College, London, will work on speech recognition for computers. The group hopes to produce a prototype computer within five years that will be able to process speech directly. The aim is to develop a system that would recognise more than 2000 words. According to the consortium, the development work is the first step toward a fifth generation computer than can communicate and be programmed by natural language. (This first appeared in New Scientist, London, 12 April 1984 and 17 June 1984 the weekly review of science and technology).

Alvey finds self help in companies using AI

A new report commissioned by the Alvey Directorate has found that UK companies are teaching themselves how to construct simple but effective expert systems. The report, which is published this week, consists of a short survey into the use of expert systems in UK business.

Alex d'Agapeyeff, head of Consultants in Information Technology, which is responsible for the report, told Computing: It is important to dispel the notion that expert systems need to be large and complex. We found that teams starting out from scratch can build effective, simple expert systems. D'Agapeyeff admitted that many companies were keeping their work in this area secret. The Alvey Directorate commissioned the report with the intention of finding areas in which it could fund demonstrator projects which can show a lead to companies developing large expert systems. D'Agapeyeff sees such demonstrator projects being set up around trade associations where any individual company's fears over commercial secrecy can be avoided with a public knowledge base. He will be making separate recommendations to the Alvey Directorate, based upon his findings in the report. (Computing, 26 April 1984)

Alvey pleas for small firm ideas

The Alvey Directorate is worried that not enough small software houses are coming forward with research plans.

So far, 28 software engineering projects have been approved out of 63 applications received. The bulk of these have been awarded to the small independent developers, but according to programme director David Talbot there are a number of proposals from large hardware manufacturers which will swing the balance heavily in the other direction in the coming months. Meanwhile, there is no queue of people from the smaller firms with big ideas waiting at Tablot's door. This position is surprising because in the early days of the Alvey Programme it was the smaller firms which were complaining that they would not get a look in and the whole project would be co-opted by the majors. Talbot says: "I said then and it continues to be the case that our problem is not one of money but one of human resources. We would like more to come forward now. There is no question of them being cut out by the big boys."

Software houses which have a very short history behind them tend to concentrate on the priority of short-term revenue, he says. Alvey is offering them a chance to change from a start-up operation into a mature organisation undertaking its own research and development. Up to now they have been reluctant to collaborate with each other and have been unduly suspicious, he says.

Alvey director Brian Oakley, writing in the programme's own newsletter, says he is worried about the slow submission rate for the software project. The same weakness has been apparent in the Common Market scheme. With the programme one year old, 40% of Alvey's constituent projects have been launched but only 25% of the software engineering side is under way.

The man-machine interface (MMI) element also lags behind schedule, but has just published its strategy document. Director Chris Barrow intends to fund three or four academic establishments as focal points for the fragmented community of about 650 MMI researchers in the UK. Leicester Polytechnic, and Loughborough and York Universities are considered prime candidates for the latest Alvey investment. Barrow says that the centres are needed to make MMI research groups large enough to function effectively.

They will promote work in the three areas picked as essential to the MMI effort: the human interface, displays, and pattern analysis. (Computer Weekly, 3 September 1984)

Uk and Japan to co-ordinate fifth generation plans

The UK will collaborate with the Japanese on three areas of fith generation work after meetings in Tokyo next month. A Department of Trade and Industry official will discuss the details of the projects, the first of which is for the machine translation of Japanese and English. Brian Oakley, the Alvey director, said: 'We made a decision to accept the continued pressure from the Japanese towards co-operation. Certain key projects in Alvey and at the centre for Japanese fifth generation work, Icot, are almost identical,' Oakley said. Oakley also revealed that the UK Government will launch a major initiative to train staff to build and use fifth generation systems in the autumn. A recent policy meeting held by the Alvey directorate, bringing together leading UK computer suppliers as well as software houses, detailed those areas in which they would be prepared to collaborae with the Japanese. Oakley said that the exchange of ideas will bring very large scale integration electronics and fifth generation hardware to the UK while Japan will gain from work into advanced software and systems methods. (Computing, 10 May 1984)

Disabled get London micro training centre

The first microcomputer training centre in the UK specially designed for the disabled opened in London last week with £100,000 backing. The MicroAid centre at Southwark and was sponsored by the Department of Trade and Industry (DTI), the Department of the Environment (DoE) and the European Economic Community (EEC). The DTI provided a one-off funding of £26,000 to purchase equipment and set up the unit, under its Information Technology Awareness Scheme. The EEC European Social Fund and an Urban Aid grant from the DoE provided £82,000 to help run the unit during the next three years.

Patrick Adams, co-ordinator of SouthWard MicroAid, told Computing: 'At the moment we have enough capacity for 12 people per session. We have specialist skills in assessing people for using computers - whatever their physical handicap.'

The centre is using three BBC microcomputers linked together via an Econet network system. The system is enhanced by disk packs. The MicroAid unit will be looking for local firms which want work performed on microcomputer software packages. (Computing, 14 June 1984)

Scotland to produce 5 micron CMOS in '85

Scotland's first Silicon Valley style chip start-up, Integrated Power Semiconductors (IPS), plans to have its 5 micron CMOS wafer fab up and running by September 1985. It will cost an estimated £11m. Chairman of IPS, Dave Wood said: "Our business strategy is to be a custom and semi-custom supplier. We think that's what customers need." Wood's goal is to provide a service in which the NRE (non-recurring engineering) charge for a power IC matches the NRE charge needed for a gate array. That goal is four years away. In the meantime, Wood intends to make second-sourced standard power ICs in a foundry. The first of these is scheduled to hit the market in April 1985. (Electronics Weekly, 26 September 1984)

Alvey's Promise of fast software

The Alvey directorate's Promise project aims to produce an Integrated Project Support Environment which will cut the cost of systems development and maintenance, reports Mike Norton.

The high cost of systems development and maintenance has been a major problems for the data processing industry for many years. The UK Government-backed Promise project hopes to overcome these problems through a process of automation. The Alvey directorate is investing £3 million in Promise to produce an Integrated Project Support Environment (Ipse). Few details are yet known about Promise but the membership of the consortium working on the Ipse gives some clues as to what the final Ipse may contain. Promise will be managed by Software Sciences (the project's name comes from a number of on-going productivity tool developments) and will involve Learmonth and Burchett Management Systems (LBMS) which helped develop the Government's systems development method. Strathclyde and Lancaster universities and the University College of Wales will also work on the project estimated to need about 100 man years of development.

The development of productivity tools, designed to increase efficiency by automating a traditional manual method, has evolved alongside methodologies designed to guide development teams through a project life cycle. These methodologies are simply ways of co-ordinating the efforts of teams of systems analysts, designers and programmers. Methodologies can use productivity tools but data still has to be transduced from one form to another, again and again throughout the project. Data will be duplicated over and over again until it is almost impossible to ensure that systems documentation accurately reflects the actual system. As soon as this happens maintenance costs increase, programmers have to slog through pages of code to try to discover how an application program works.

The Government's Structured Systems Analysis and Design Methodology (SSADM) was developed by LBMS and the Central Computing and Telecommunications Agency (CCTA). SSADM is concerned mostly with the design phase of the system development cycle. The Promise Ipse will therefore have to incorporate a number of other features to deal with project specification, analysis of the current system, formulation of user requirements (possibly with the aid of prototyping techniques), program specification, program generation and documentation.

The development of productivity tools and now automated system development tools illustrates that the industry and more crucially the Government is content to settle for machine solutions instead of tackling the more difficult task of creating a solid base of expertise in the UK. The recent crisis facing UK information technology was highlighted in a report from the tri-partite Economic Development Committee (EDC) which said: 'The EDC believes that new initiatives in training are necessary to meet an acute national shortage of people with IT-related skills.' The report also states: 'The problem is critical even before the effects of the University Grants Committee cuts have really shown in graduate output.' The Government has said no new initiatives are planned. No more money is available for producing skilled staff at a time when the Government through its various agencies pumps money into projects such as Promise. Ipses form a crucial part of the UK's IT thrust but tools are only useful if there are sufficient craftspeople to use them. (Computing Magazine, 20 September 1984)

Computer literacy debated in the U.S.

The responsibility of training the younger generation to cope with the impact of computerisation, of course, rests with the schools, and, in the US, they're straining under the assignment. The very issue of computer literacy is debated. Do all students need to learn programming or will familiarity with software applications suffice? Even more elementary is the matter of financing. How can schools with already limited capital resources acquire the equipment and train the teachers. To give every one of the country's 4 million elementary and secondary students a half hour of computer education a day by 1990, according to a paper by the Department of Education, the schools will have to increase by more than 70% the amount of money they spend on books; media and materials. The expenditures would grow to $1.8 billion from the present $1.05 billion level.

In vocational training, says Charles Hopkins, assistant director for support services at the state of Oklahoma Department of Vocational and Technical Education, 'one of the biggest things driving costs up is the type of equipment'. A basic, non automated lathe for a machine tool training programme, for example, used to cost about $500,000, he recalls. Today, it would take $2 million to $3 million to acquire a state-of-the-art automated lathe. Price inflation, albeit on a more modest scale, has also struck office equipment. Training a secretary previously required just a $600 investment on an electronic typewriter, but now a simple word processor can run to about $2,000. Product design used to mean sitting down at a draughting table with pencil and paper in hand. With computer-aided design (CAD), the systems start at $30,000 to $150,000.

Members of congress are concerned about technology training and they have proposed a number of bills and amendments to help subsidise training costs. One proposal will grant cash deductions to companies that donate new equipment, excepting microcomputers, to post-secondary vocational schools and community colleges. A computer literacy bill recommends the annual dispersement of such money as may be necessary for equipment, teacher training and model software. The same legislation calls for the recreation of regional centres across the country for the evaluation and dissemination of information on educational software. These centres would also be equipped to train teachers in the computer sciences. Another bill under consideration will establish a public, venture capital corporation funded with an annual $15 million from the Government for the purpose of stimulating high quality interactive educational software. Like any other firm of its ilk, the company would be charged with analysing and buying into software ventures... (Computing, 21 June 1984)

US firm goes to Cambridge University for research

Cambridge University is aiming to set up a European centre for computer science and artificial intelligence with US research and consultancy firm SRI International. The partners hope to get backing from governments and industry. Initially SRI, with an annual turnover of $170 million, will send scientists to work on projects with people from Cambridge's computer laboratory and Churchill College. Research areas will include natural language processing, software engineering and computer architecture. SRI was formed by Stanford University and still has close ties with the university: 400 of its 2,500 professional staff are teachers or researchers there. A fifth of all US artificial intelligence scientists work at SRI. (Computer Weekly, 31 May 1984)

American computer manufacturers team up

American industry does not go in for pooling resources. The practice can tame businessmen's animal spirits and sharpen antitrust concerns. So most of the high-tech research by American businesses has been done by individual companies or at universities. But with this effort now costing an estimated $40 billion a year (and rising) some companies have decided to team up. For two reasons: to confront competition from Japan and Europe, and to keep up with such moneyweight champions as IBM. Since January 1984, more than 100 high-level researchers - the vanguard of a group of at least 350 - have been at work in Austin, Texas, for a joint venture called Microelectronics and Computer Technology Research Corporation (MCC) *. They are not required to invent specific high-tech products. Their goal is long-term: assuring American dominance of the computer industry by improving computer designs and uses for an ever-expanding world market to absorb. It amounts to tackling by private means what the Japanese have achieved with public funds. MCC's $65m-a-year research budget is provided by 16 companies (see table below). They include some of the best known, though not necessarily biggest, names in American high-tech. After Control Data first proposed the consortium more than two years ago, 10 other firms signed up. Five more came in recently and two others are on their way. These shareholder companies expect no direct benefits for 6-10 years. The four main research programmes now underway - in software technology, computer design, advanced computer architecture and integrated-circuit packaging - will not be completed before then. After putting up an entrance fee which is now $500,000), each shareholder company has to fund at least one research programme. In return, it gets exclusive rights to exploit the results for three years. After that, they are opened up to general licensing, with all shareholders dividing the spoils.

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* See also issue No. 8

The members of MCC (with annual sales) are:

	$ bn		$ bn		$ bn
Advanced Micro Devices	0.6	Allied	10.4	BMC Industries	0.2
Control Data	4.6	Digital Equipment	4.3	Eastman Kodak	10.2
Harris	1.7	Honeywell	5.8	Martin Marietta	3.9
Motorola	4.3	Nat. Semiconductor	1.2	NCR	3.7
RCA	9.0	Rockwell	8.1	Sperry	5.1
United Technologies	14.7				

Combined sales: $87 billion. (IBM's sales: $402 billion)

(The Economist, 2 June 1984)

USSR aims for 5th generation

The third five-year plan for computing, running to the end of 1989, will involve a strong collaboration between the USSR and the other six East European partners in the Council for Economic Mutual Assistance (CEMA). Part of that plan will highlight fifth generation technologies. The Moscow Academy of Sciences, which will co-ordinate the Russian program, confirmed that it will cover five strategic areas: design and manufacture of VLSI microprocessors, development of parallel and multiprocessor architectures, design of operating systems to better support logic programming, creation of problem-solving software and development of expert systems and user-responsive applications.

According to the Moscow Academy, the Russian plan will be backed by an initial $100 million of state funds, and a spokesman stressed it was very much a "civilian, not a military, initiative."

According to the academy, the new program is definitely one of innovation. Academy delegates have been scouring the Eastern Bloc for state-of-the-art researchers for nearly two years, and they have been seeking collaborations with nations like Japan. befitting its political and international status, the CEMA project will be run by the International Committee for Computer Engineering (ICCE), an influential technology body based at the academy. ICCE already co-ordinates computing among the other six European CEMA members, GDR, Bulgaria, Rumania, Czechoslovakia, Hungary, and Poland. In 1982 these countries and the Soviet Union agreed to pool R&D resources in an open-ended commitment to a joint computing effort. Officially ICCE is led by General Giorgi Constantinovich Scribn, general sceretary of the academy's scientific section. But observers believe that the real architect of the fifth generation program is Yerengyi Velikhov. He heads the newly formed Informatics, Computer Technology, and Automation Division of the academy and is viewed as the Soviet's foremost computer scientist. (Excerpted from an article in Datamation, 1 July 1984, and reprinted with permission of DATAMATION r magazine © copyright by Technical Publishing Company, A. Dunn and Bradstreet Company, - all rights reserved).

STANDARDIZATION AND LEGISLATION

The IEEE takes a crack at standards for software engineering

To ensure product differentiation, companies sometimes sidestep standards efforts. Still, organizations will likely jump on the standards bandwagon if they are involved in developing critical software, whose failure could cause serious social or financial losses. Until the IEEE started its software engineering standards effort, a suit over the failure of critical software could not be decided with reference to a "standard blessed by a voluntary consensus of a standards-making-organization that said what reasonable and prudent people should do in building software," says Fletcher J. Buckley, at RCA's Missile Service Radar Division, Moorestown, N.J. He also serves as vice president of standards activities for the IEEE's software engineering technical committee.

"We're not out there beating the drum saying, 'You got to do this,'" notes Buckley. "We're saying these are standards that a voluntary consensus of concerned professionals in the field have established as a mimumum subset of things to be done when you're developing critical software."

Besides a number of ongoing projects, the 2,000-member standards effort has already developed five standards, available from the IEE Service Center in Piscataway, N.J., USA.

Standards	
ANSI/IEEE STD 730 (1984)	software quality-assurance plans
ANSI/IEEE STD 729 (1983)	glossary of software engineering terms
ANSI/IEEE STD 829 (1983)	software test documentation
IEEE STD 830 (1984)	software requirements: specification guide
IEEE STD 828 (1983)	software configuration-management plans

New initiatives	
No number	Guide for third-party software acquisition
No number	software quality metrics
No number	User documentation

Approved projects	
No. 982	software reliability
No. 983	software quality-assurance guide
No. 990	guide for the use of Ada as a program design language
No. 1002	software engineering standards taxonomy
No. 1008	software unit testing
No. 1012	software-verification plans
No. 1016	guide for software design descriptions
No. 1028	software reviews and audits
No. 1042	guide for software configuration management
No. 1044	classification of software errors, faults and failures
No. 1045	software productivity metrics

(Electronics Week, 10 September 1984)

Networking standards

Top industry and government officials have made an agreement to develop international network standards for computer systems. Following testing at the National Bureau of Standards (NBS) and General Motors (GM), demonstrations involving 14 computer companies and communications companies took place at the National Computer Conference in Las Vegas, July 9-12; Although these standards are not directed at the semiconductor industry specifically, they will have direct applications in the computer networks presently used in manufacturing, testing, design and business applications.

Using test methods developed by the National Bureau of Standards, nine companies are testing a network at NBS in Gaithersburg, Md. NBS and Boeing Computer Services are co-ordinating the testing. The nine companies are ACC (Advanced Computer Communications), Boeing Computer Services, Charles River Data Systems, Inc., Digital Equipment Corp., Hewlett-Packard Co., Honeywell Information Systems, ICL, Intel Corp. and NCR Corp. Also using the NBS-developed test methods, General Motors is co-ordinating testing of a different network at the GM Technical Center in Warren, Mich. The companies participating in this test are: Allen Bradley Co., Concord Data Systems, Digital Equipment Corp., Gould Modicom, Hewlett-Packard Co., IBM Corp. and Motorola. A "carrier sense multiple access with collision detection" (CSMA/CD) network is being used by the participants in the NBS/Boeing demonstration. This network is designed to show that international standards for computer compatibility will work in the business environment. A second network, known as "token bus", is being used by participants in the GM demonstration. This network is designed for use in factory computer systems.

The demonstrations for NCC in July 1984 were intended to show that the Open Systems Interconnection standards being developed by the International Organization for Standardization (ISO) with the support of organizations such as NBS, the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE) will work, and that products using these standards may be available soon. In the semiconductor industry, it is likely that equipment will communicate to a host computer using the SECS I and II communication protocol, developed by the Semiconductor Equipment and Materials Institute (SEMI). The host computer will communicate to other hosts and to higher level computers by the ISO standard ... The Open System Interconnection (OSI) Reference Model developed by ISO is a framework that divides the complex data processing communications functions of a network into seven layers. Each layer represents a group of related data processing and communications functions that can be carried out in a standard way to support all applications. Therefore, when new applications or technologies are added to a network, the entire software system does not have to be modified. The lower layers of the model handle the physical connections of a computer to a communications medium and the means by which data gain access to the network. The higher layers set up connections between systems and the data structure and organization so that data can be transmitted and received reliably in a form that can be understood. The SEMI SECS standards are roughly equivalent to the bottom two layers of the OSI standard. The fourth or "transport" layer of the OSI standard provides controls over the flow of information from the sender to the receiver, assuring the reliability and quality of the data. The July demonstrations will show this fourth layer working with two different local area network technologies, CSMA/CD and token bus. (Semiconductor International, June 1984. Reprinted with permission from Semiconductor International Magazine. Copyright 1983 by Cahners Publishing Co., Des Plaines, Il., USA).

A push to make computers talk to each other

In a laboratory at the General Motors Technical Center in Warren, Mich., engineers from such competitors as IBM, Digital Equipment, and Hewlett-Packard are working side by side to develop a system of computers and controllers to run a miniature automated factory. And at a National Bureau of Standards laboratory in Gaithersburg, Md., competing makers of office automation equipment - including NCR, Honeywell, Digital Equipment, and Hewlett-Packard - will soon begin a similar project. In both cases, the goal is to make pieces of incompatible computer equipment talk to each other.

These projects are one result of a long-term effort by computer users and the US government to establish standards for data communications. Although some low-level standards have been agreed upon, most computer and communications vendors have developed their own systems of high-level protocols, or operating instructions, that allow computers to exchange information over a local-area network (LAN). Varying standards have proliferated. ...

To push for rationalization of the market, the International Standards Organization (ISO), in co-operation with trade groups, the National Bureau of Standards (NBS), and other standards organizations began a joint project to develop protocols that would allow any computer to communicate with any other over a LAN. On April 24, using projects put together by industry volunteers, NBS announced that it was ready to demonstrate that the ISO system could work in a practical setting. For example, the factory project at General Motors Corp. will connect a group of mini- and microcomputers with programmable controllers that will run a mini-assembly line putting together miniature cars. The office system, co-ordinated by Boeing Computer Services Co., will tie together such equipment as graphics terminals and minicomputers. Both systems will be demonstrated at the National Computer Conference in Las Vegas in July.

Although these are not the first demonstrations of such capabilities, they are among the most elaborate. And they use the only internationally recognized standard, which 30 computer vendors world-wide helped develop.

The goal is to see the ISO standard widely followed. "The support here is equally strong from both the computer users and manufacturers," says Robert P. Blanc, director of the Center for Computer Systems Engineering at NBS. Adds Ralph K. Ungermann, president of LAN-maker Ungermann-Bass Inc.: "The technology wars between competing companies are winding down. [They] are working together."

One reason for the new co-operation is that big users such as GM are demanding it. The company will use the NBS-endorsed network in a new plant in Saginaw, Mich., next year. Any vendor that supplies equipment to GM will have to be sure it conforms to these standards.

If this does not inspire makers of automated factory equipment to adopt the standards, the participation of some of the major computer vendors in the projects should. Notes George T. Rehefeldt, a group vice-president responsible for robot and electronics business at Cincinnati Milacron Inc.: "If IBM and DEC agree that's what they want to do, that's what's going to be done."

The NBS projects do not end the struggle for universally accepted standards. The ISO system does not yet completely define the even higher-level "language" that the different vendors will use to communicate. And other companies are still attempting to establish their approaches as the standard. Xerox Corp. prefers its own communications protocols over the ISO's, even though it has benefited from ISO endorsement of the company's Ethernet local-area network.

But companies involved in the project are already starting to drop their own communications protocols in favor of the ISO system. Digital Equipment Corp. plans gradually to integrate the ISO standards into its own, so that its existing customers will not suddenly become incompatible. John Adams, manager of planning and operations networks, expects other companies to follow DEC's example: "It will be difficult for most vendors to resist." (Business Week, 7 May 1984)

At last, a standard for graphics software?

Buried deep in International Business Machines Corp.'s latest stack of personal computer offerings is a program that could give a huge boost to graphics software use - and to the Lilliputian company that developed it. Computer makers have been trying since the 1970s to devise a standard for graphics use that would allow software developed to generate charts and diagrams for one machine to run on another. IBM's decision to support a program written by Graphic Software Systems Inc., a tiny startup company in Wilsonville, Ore., could make Graphic's software the de facto standard. The package developed for IBM includes a $350 IBM PC Graphics Development Toolkit that gives programmers the building blocks necessary to write software. The kit's special ingredient is a device driver, which translates graphics applications - the programs that display specific tasks on a computer screen - into a language that any machine can understand. If Graphic Software's drivers become a standard, then software developers will need only to write one version of a graphics application to work on all computers. Thomas B. Clarkson III, Graphic Software's president, says that manufacturers are lining up at his door. Epson, Hewlett-Packard, and Amdek have licensed the program, with 50 more companies expected to follow by year's end.

The IBM endorsement is a dream come true for Graphic Software, which was started three years ago by four engineers with the primary intent of developing a standard graphics package. Their first break came in 1982, when they signed a contract with software vendor Digital Research Inc. to develop a graphics generation package. A call came "out of the blue," from IBM, says Michael Sisavic, chief operating officer. The company racked up sales of about $3 million in 1983 and expects to hit $5 million this year. With a boost from the IBM endorsement, he hopes revenues will triple next year.

The Oregon company's software has its roots in a set of rules proposed by the American National Standards Institute in 1982. These guidelines allow software developers to write programs that work on different makes of computers rather than on specific hardware systems. Developers currently spent as much as 50% of their time rewriting graphics applications programs to run on different machines.

Software developers and hardware manufacturers are delighted to see a graphics standard coming. "If a hardware manufacturer comes out with a machine, it's faced with the massive effort of convincing the leading software [developers to make their] packages to run on the machine," says Roger H. Badertscher, president of Mindset Corp., which makes a computer that specializes in generating graphics. With the new standard, the writers would have time to produce a greater number of more sophisticated programs. (Business Week, 15 October 1984)

ISO adopts ADA standard

The Pentagon scored a significant victory last week when the International Standards Organisation (ISO) agreed to adopt the US Ada-language standard without any changes. After extensive discussions, a committee of 39 top Ada experts from nine countries voted unanimously to put forward the US Ada standard as a draft ISO standard. The ISO Committee also agreed to freeze the standard in its present form and not allow any changes for at least the next two years. The only changes permitted will be ones of interpretation which will be handled by a single language maintenance committee.

Robert Mathis, director of the Pentagon's Ada Joint Programme Office and chairman of the ISO Ada working group, told Computing: "This is very good news for us. The problem with previous Department of Defense standards is the lack of an outside user community. This will now be encouraged further with the ISO decision." Mathis explained that the ISO committee made an unusual decision by advocating that only one language maintenance committee be set up. This will work on the correct interpretation of the Ada standard and catalogue comments received from users. "It will mean that co-ordinating the progress of the draft ISO standard will be simplified. Our biggest concern at the moment is how to handle comments from users of the standard," Mathis said. He added that, of over 350 comments so far, none related to any serious defects in the Ada language. (Computing, 5 July 1984)

COBOL standard

Prospects for a new Cobol standard in 1985 have jumped significantly following a meeting of the American National Standards Institute's (Ansi) specialist Cobol committee. For the first time in four years, voting and comments on the controversial Cobol 8X standard indicate that the concerted opposition which has blocked the standard's progress has now rumbled ... Rising concern over the slow progress of Cobol 8X earlier this year forced the International Standards Organization (ISO) to take the decision to drop its previous policy of using the Ansi standard and develop its own standard. Although the ISO used the Ansi 8X draft as its starting point, there were strong possibilities that discrepancies between the Ansi and the ISO Cobol would develop. Since the first Cobol 8X draft was published more than four years ago there has been considerable opposition from a section of US users who want to maintain compatibility with their existing applications, often written in the earlier Cobol 68 standard. Most of these opponents have now accepted the new standard as a result of compromises. Unless there is unexpected opposition when the Ansi standard goes out to its third public review period shortly, a standard will be ready by 1985, and manufacturers should start providing compilers immediately. (Computing, 7 June 1984)

Standard on C programming language

The C programming language has grown, both by its association with Unix and independently, to become a widely used systems and general purpose programming language. As a result, finding a standard has now become essential. In 1983, the American National Standards Institute (Ansi) set up a committee, known as the X3J11 Standards Committee, under the chairmanship of Jim Brodie of Motorola. The committee has the job of preparing a standard for the C programming language for informal review by December 1984, and to prepare a draft proposed standard for submission to the Ansi X3 secretariat by December 1985. At the moment, the schedules are being met: although the time scales seem rather long, this is in fact remarkably good progress for a standards effort. As the use of C spread to include more and more non-Unix-based systems, more and more independent suppliers started to provide C compilers. Not all of them worked (or work) the same way as the Unix versions of C, and the ugly vision of dialects began to arise.

There are three subcommittees working under X3J11: the language subcommittee chaired by Laurence Rosler of Bell Laboratories; the environment subcommittee chaired by Thomas Plum of Plum Hall; and the libraries subcommittee chaired by Bill Plauger of Whitesmiths. Each subcommittee meets sequentially during the quarterly week-long meetings of the X3J11 committee. Their responsibilities are to address and resolve the key problems in each area, with the whole committee voting on their recommendations. The attitude of the committee as a whole is that it wants to minimise the introduction of new features, to maximise the portability and reliability of programs written in the new language, and to invalidate the smallest feasible amount of currently working programs ... As things stand at the moment, the language work is well under way, the libraries well started, and the environment discussion is building up steam. It seems likely that a standard acceptable to the majority of C users will actually be produced, and a major worry - that Bell/AT&T will override the standard - has been avoided, because Rosler, who heads the language subcommittee, is also responsible for C within AT&T. (Computing, 17 May 1984)

Chip-protection act will mean $100 million for semiconductor makers

Enforcement of a measure that grants copyright protection to computer chip designs could boost sales in the semiconductor industry by more than $100 million a year. That is how much semiconductor makers currently lose to piracy, reports Tim Richards, an economist for the Semiconductor Industry Association. In addition, the lessened threat of copied masks should add incentive for semiconductor manufacturers to enter into more risky ventures. The industry has been rather conservative when it comes to new investment because it "automatically assumed that the fruits of its labor would be stolen," says Richards, who is based in Washington, D.C. The Semiconductor Protection Act of 1984, unanimously approved by the Congress and sent to the President last week, calls for fines of up to $250,000. The bill's primary target is overseas competitors. "Though we can't take legal action abroad, we can stop pirated foreign chips from being sold in our market," notes Richards. For a foreign chip maker to receive copyright protection in the U.S., it must demonstrate that no firm in its country is engaged in copying and selling the mask designs of any U.S. company. (Electronics Weekly, 15 October 1984)

Japanese copyright

The Japanese government is preparing legislation similar to the bill passed recently by the U.S. Congress that protects semiconductor mask designs from what are known as computer-chip bandits. The bill, which is being drawn up by the Ministry of International Trade and Industry, will be virtually identical to the U.S. Semiconductor Protection Act - which is retroactive to July 1983 and extends copyright protection for 10 years to makers of innovative circuit designs. MITI's main concern about the U.S. law is that its retroactive date is relatively recent, so that previous technology disputes between U.S. and Japanese companies would not be reopened.

The Japanese law will be ready in time for the opening of the special Diet session in December. It probably won't be passed until early next year, because more urgent legislative business, including the 1985 fiscal government budget and new telecommunications laws, will come up for action first. Although MITI seems to be following the U.S. example on semiconductor-design protection, another piece of MITI-inspired legislation that has led to sharp clashes with the U.S. - a software-protection bill - apparently is going to be resubmitted next year. If so, there will be another U.S.-Japan showdown on the issue, since the two countries' basic positions are unchanged. The U.S. still maintains its position that existing copyright law can adequately cover software protection. But MITI, in an attempt to extend its bureaucratic influence to this key area, continues to insist on an industrial-property patent law concept that includes possible compulsory remarketing of software to third parties, without the permission of the original developer. (Electronics Week, 29 October 1984)

UK copyright

UK copyright law as it stands at the moment should be sufficient to protect the rights of software producers, according to solicitor Trevor Cook. He said that although lawyers might take a negative view, the law had broad scope. Cook was speaking at a meeting of the British Computer Society Technology of Software Protection specialist group last week. He said "Using copyright law to protect software depends on the basic assumption that there is literary copyright in source code and this is accepted." But, he added, "problems do arise when there is no copy of the code and someone sees the results of a program and then writes one performing the same functions". Cook said that although such a case had not been tested in law, cases settled out of court indicated that this would be seen as an infringement.

Patents, on the other hand, were not a good way of protecting software, according to Roger Cullis, a patent agent with the British Technology Group. "You need to remember that a complete disclosure of the idea is necessary before a patent is granted, so you have to decide whether you'd be happy to have source code bared in this way. "And you can't enforce a patent until it's granted which may take up to five years. This may not be appropriate for a product which may come to fruition in six to 18 months and be over in an equal period of time. "On top of this you have to pay to file patents, whereas copyright subsists automatically and is free." Cullis also pointed to what he called a "time bomb" in the 1977 Patents Act which gave provision for the remuneration of employee inventors where they had made an outstanding contribution. In addition to hindering copying in the first place technical measures could also be used to help software producers protect software in law, according to Simon Elsom of the National Physical Laboratory. "Measures such as putting mistakes into software that do not affect its use could be used in court to show that copying has taken place."

Not everyone is so happy that the copyright law can protect computer programs. The Computer Law Reform Sub-committee of the Society of Conservative Lawyers said last week that original computer programs should be protected by a separate section of the Copyright Act, distinct from any of the existing classes of copyright works and subject matter. (Computer Weekly, 7 June 1984)

Copyright for software in Australia

The Australian Government has announced its immediate intention to extend to computer software the copyright protection usually given to literary works. This should end the present uncertainty about the legal status of software following the decision of Mr. Justice Beaumont in the Apple Computer versus Computer Edge case late last year that certain types of computer software were not protected by copyright under the 1968 act. The case is still under appeal before the full federal court. A joint statement issued by the Attorney-General and by the Ministers for Industry and Commerce and for Science and Technology, says that the intended inclusion of software in the existing copyright category of "literary works" rather than under the less restrictive patent law is intended to stimulate research and development in the local software industry.

Unless a federal full court decision supervenes, it is intended that passage of the proposed legislation should be secured in June, and should be understood as a short-term measure. It will not pre-empt consideration of fundamental issues remaining to be resolved, both at the domestic and international levels, on long-term policies for the protection of software and works stored in or created with the aid of computers. (Nature, 24 May 1984)

UK Federation Against Software Theft

The Federation Against Software Theft (Fast) has been formed to combat software piracy by a consortium of 32 UK firms and trade associations. The group will lobby Parliament to revise copyright laws making the unauthorized production of computer programs a criminal offense and underscoring the protection of software by copyright under civil law. The planned bill will recommend penalties of an unlimited fine and up to 2 years in jail for pirating software, and lesser penalties for selling, possessing, and exhibiting such material. According to Fast, $202.5 mil/yr is lost to piracy by the UK software industry. (Electronic News, 7 September 1984)

European Security Study Completed

The project on Data Security and Confidentiality carried out jointly by NCC (UK) and corresponding institutes in Germany (GMD) and France (ADI) has now been successfully completed. The objective of the project, which was started in 1980 and funded by the EEC and the UK, German, and French governments, was the study of data protection, privacy and security in the European context. Topics covered included: the effects of developments in microcomputers, telecommunications, and distributed systems on data protection; the interaction of freedom of information and data protection legislation; and the impact of data protection on the information-intensive sectors of industry in Europe. The study recommended to the EEC that steps should be taken to promote and co-ordinate these activities wihin the Community, and that further work should be undertaken to:

give guidance to users on the impact of data pr tection legislation on trans-border data flow;

study the data protection implications of office and industrial automation;

achieve the harmonisation of legislation between EEC countries.

(Computing, 5 July 1984)

SOCIO-ECONOMIC IMPLICATIONS

Rapidly developing computer technologies aimed at enhancing efficiency will both depress and alter the job market for about 80 per cent of the 19.1 million people employed in manufacturing fields, says an (US) Office of Technology Assessment (OTA) report released earlier this year. The potential long-term impact of programmable automation [computer uses in manufacturing, also known as PA] on the number and kind of jobs available is enormous and it is essential that the Federal Government, educational institutions, and industry begin to plan with these considerations in mind," the report states.

The OTA predicts little short-term effect from increasing computer uses in factories before 1990. Then, the overall trend will be a shift from "manual to mental" labors, and possibly more unemployment in states where metal working is based, the report notes. Government, educators and industry must plan how to retrain those workers likely to be phased out, such as machinists or tool and diemakers, say the report and experts in this area of study ... PA in manufacturing goods includes designing with the help of computers, manufacturing with robots or computerized machines and using computers to aid in management tasks such as payroll. The federal government this fiscal year is investing $80 million into researching and developing PA. Such automation will increase manufacturers' demands for engineers, computer scientists, technicians and adult education teachers. But for craftworkers, factory operators, laborers and clerical workers - the bulk of manufacturing employees - demand will shrink, says the OTA.

Meanwhile, researchers from Stanford University predict that new technologies will do little to increase the job market, with the so-called high technology industry itself employing relatively few people. The demand for caretakers, cashiers and secretaries will be almost 14 times higher than the job demand for computer service technicians between 1984 and 1995, researchers there estimate. Besides the retraining issue, OTA says the government also should study computers' impact on the workplace. Higher stress is expected, and the OTA speculates that workers may also face boredom as computers take over their former responsibilities and challenges.

OTA recommendations are fighting U.S. "functional illiteracy" in basic reading, science and math skills; immediately implementing job training, retraining and counseling programs for workers displaced by PA; cross-training or teaching workers a variety of job skills; developing better education and career guidance programs for both youth and adults; and fostering overall improved worker training in new technology through an orchestrated effort by government, industry and educators. This OTA report will serve as background information for Congress members who must vote on legislation related to computer advances. For example, a House Committee on Science and Technology subcommittee will consider a bill that would create several centers for industrial technology (to study robotics and PA) and also create a federal robotics center under the National Bureau of Standards. One committee aide says "As we move ahead on legislation, [the OTA study] flags areas where we need to study more."

This week a National Academy of Science committee released a report saying that future high school graduates need strong math, science and reading skills in order to compete in a job market changed by technology. And members of the Committee on Science, Engineering and Public Policy also note that these graduates will face life-long returns for more schooling to keep pace with high-tech advances and thus remain employed, says Markley Roberts, one panel member and an economist with the AFL-CIO. "It's going to be a tough, competitive job market for a long time," says Roberts. "We are very concerned with job losses over the long run." OTA says no one can accurately predict exact job losses or shifts in the wo. markets because neither the future economy, retraining efforts, nor the need for entry level positions can be predicted. (Science News, vol. 125)

Where is technology taking us? By James M. Buchanan *

There is no doubt that much of the new technology has the potential to enhance the quality of our lives, but it also has the potential to cause massive unemployment and significant social upheaval. The tendency has been to adopt the new technology without regard for the legitimate concerns of workers or the need to plan for its implementation and adjustment.

Labor does not oppose the advent of the new technology. The issue is not whether it should be introduced. The obvious consideration, if humanity is to be respected, is for more consultation with employees' representatives and the greater recognition that labor adjustment programs presently in place are far too inadequate to deal with any massive displacement of workers. There is a need for conditioning on all fronts and it is absolutely necessary that governments be prepared to take some strong initiatives, even to the extent of designating which sectors of what industries in which locations would be eligible for complete revitalization into the field of microelectronics. The facts are that any reduction of the working hours cannot be made at the sacrifice of a decent standard of living because, economically, pulp and paper industries depend on consumer spending. Reducing workers' income would only mean less to spend on the goods produced by the industries that have increased productivity through the microelectronic innovations. Canada is truly on the threshold of new industrial revolution, one that will have an even greater impact on society than the first industrial revolution. It will take our united efforts to adjust to the changing times.

The mandate from the delegates to the last CPU convention is to have the national office work out proposed contract language for better protection. CPU's research director has been working closely with other unions to achieve an in-depth analysis of what may be expected in upcoming negotiations regarding technological change, job security, and related issues. These are "bread and butter" issues for our members. If the workforce is taken into the inner circle in the planning stages, necessary adjustments can be made over a period of time to offset many of the frustrations that have plagued the unions in the past. The policy of the union in the face of all this technological phenomena still remains "necessary reductions through attrition only". As a result, the CPU must strive for guarantees that proposed changes will not result in layoffs of regular employees.

The CPU cannot sit and wait for the tide to be full and be washed away with the undertow. Its task is to prepare itself now for the immediate future, which could be tomorrow for many of its members. "Where is technology taking us?" It could be subjecting union members to completely different life-styles and it is up to the union leaders to have some control over how that change will come about. (Paper Trade Journal, 30 April 1984)

Bifu plans to step up its opposition to new technology

The big UK Banking, Insurance and Finance Union (Bifu) is about to underline its opposition to wholesale introduction of new technology. Bifu, with 156,000 members in the high street banks and finance institutions, will decide new technology policy at its annual conference. A key motion is: "This annual delegate conference reiterates its policy of resistance to new technology in the absence of negotiated new technology agreements."

The motions indicate continuing conflict between the major banks and their staff, following a dispute at Lloyds Bank Jersey Trust, where staff won a new technology agreement with management after resisting introduction of screens. The union will now be opposed to any job losses from new technology, and will resist automation unless the banks make the kind of guarantee the union is looking for. (Computing, 10 May 1984)

Computers can't hurt the smart companies

The news this week for all the modern-day Luddites is not good. We all remember the original Luddites, those jolly 19th century English workers who tried to prevent the use of labor-saving machinery by smashing it. Although their 20th century descendants are no less devoted to the status quo, they eschew the use of sledgehammers on their mortal enemy, the computer. Instead, they rely on surveys and other up-to-date devices to call attention to

* Buchanan is president of the Canadian Paperworkers Union. This article is condensed from the August 1983 CPU Journal.

their cry that the computer and its cousins will replace people and cause wholesale dislocation and unemployment, leaving only the numbing and boring tasks for the few remaining humans in the workplace.

But along comes a study from the Center for Policy Alternatives at the Massachusetts Institute of Technology. It says that, contrary to what many fear, the most profitable companies of the future will not feature mindless jobs and will not substitute computers for people in their dealings with customers. Instead, believe the experts surveyed in the study, the most competitive companies are likely to be those smart enough to use computers, robots, and the rest of the high-tech electronic family to break the assembly-line pattern of repetitive little jobs and delegate more authority to satisfy the highly skilled workforce of the future. With computer-controlled manufacturing, "it will become more and more important for workers to understand how the entire production process fits together, rather than working with a small piece of it," concludes the study. What will become crucial as computers take over routine functions and manage robots and manufacturing functions, the study continues, is the ability and willingness of workers to solve sudden problems and to reprogram production as demands change. The unsuccessful companies of the future, then, will be those that simply attempt to superimpose the new technologies on the old modes of rigidly hierarchical management and narrowly defined jobs. And the unsuccessful employees of the future will be those who fail to turn to their advantage the power that is afforded by computer technology. (Editorial in Electronics Week, 8 October 1984, copyright 1983, McGraw Hill Inc. All rights reserved).

Education - tomorrow's technology growth

Education is the basis of the semiconductor/integrated circuit design and manufacturing industry. This industry was established and propagated by individuals who were well disciplined in their fields - primarily in electrical engineering, physics and chemistry. The future of this industry will be secured by those individuals who are currently studying in the universities and colleges around the world. The key here is "around the world". Periodically the question arises as to whether the United States can maintain its lead in the world market without a re-evaluation of its educational system and the priority that is placed on the engineering disciplines.

In a presentation made for the Department of Commerce, Dr. Robert N. Noyce, vice chairman of Intel said, "Another result of the rapid growth of our industry has been the shortage of trained personnel, whether technicians or PhD's, which is the basic determinant of success in any brain-intensive business. While the electronics industry tripled in the last decade, our nation's output of scientists and engineers has remained essentially constant. Japan is producing, on a per capita basis, nearly four times as many electrical engineers as is America. This lag in our support of technical education has had another undesirable side effect: the depletion of the common pool of research results and new technology from which we all draw. In a time of limited financial and human resources, we must find new ways of assuring that those resources available are most efficiently used. In short, we must usher in a new co-operation among industry, government and academia, to provide the research and manpower upon which to build this industry." Dr. Noyce echoes the voices of many individuals within this industry who are also concerned about the potential lack of manpower that is qualified in the technical disciplines of the design and manufacture of semiconductors and integrated circuits.

Most of all the solutions to this problem are aimed at the college and university level. While it is prudent to encourage these institutions to increase their activities in the engineering disciplines, they also must have the resource pool - the young individual who decides to enter a college program in engineering or the sciences. The semiconductor industry, through its allied associations and societies in co-operation with the universities, should undertake a publicity program aimed at the secondary level of public and parochial education in this country. This program's primary thrust would be to highlight the semiconductor/integrated circuit device industry and cite the benefits available to the future engineer who elects to join this industry. As Dr. Noyce points out, Japan is graduating four times as many engineers as this country. Can the US afford to give up four times as much of the market? (By Donald E. Swanson, Editor, Semiconductor International, August 1984. Reprinted with permission from Semiconductor International Magazine. Copyright 1983 by Cahners Publishing Co., Des Plaines, Il., USA).

ROBOTICS

The diffusion of robots will undoubtedly accelerate in coming years. But a new OECD report concludes that it would be wrong to exaggerate the overall consequences of robotisation on manufacturing or the number of jobs that will eventually disappear as a result. What is the position of the robot [in OECD countries] today?

Table 8

1. Population of robots 1/

	1974	1978	1980	1981	1982	Average annual growth (%) 1981-82	1974-82
Japan	1 500	3 000	6 000	9 500	13 000	37	31
United States	1 200	2 500	3 500	4 500	6 250	39	23
Germany	130	450	1 200	2 300	3 500	52	51
Sweden	85	800	1 133	1 700	1 300 2/	-	41
United Kingdom	50	125	371	713	1 152	62	48
France	30	n.a.	580	790	950	20	54
Italy	90	n.a.	400	450	790	56	31
Netherlands	3	4	49	62	..	-	-

Note: Data based on narrow definition of robots.

1/ Accurate data on the world population are not available, but the following estimates are indicative: 1980 - 13,700; 1981 - 22,000; 1982 - 31,000.

2/ Data revised downward as a result of definitional changes.

Table 9

2. Robots per 10,000 employed in manufacturing

	1974	1978	1980	1981
Sweden	1.3	13.2	18.7	29.9
Japan	1.9	4.2	8.3	13.0
Germany	0.4	0.9	2.3	4.6
United States	0.8	2.1	3.1	4.0
France	0.1	0.2	1.1	1.9
United Kingdom	0.1	0.2	0.6	1.2

Table 10

3. Use of robots by industry
(Percentage distribution based on number of units)

Canada (1981)	
Automobiles	63
Plumbing Fixtures	9
Electrical Engineering	6
Metal-working	6
Appliances	5

Germany (1981)	
Transportation	46
Electrical Engineering	14
Mechanical Engineering	12
Metal-working	6
Plastic and Materials	6

Italy (1979)	
Automobiles	28
Household Appliances	8
Metal Industries	8
Electrical Industry	6
Rubber Industry	1

Japan (1980) 1/	
Automobiles	30
Electrical Machinery	36
Plastic Moulding	10
Metal Products	5
Iron and Steel	1

Netherlands (1982)	
Metal-working	64
Mechanical Engineering	12
Electrical Engineering	9
Transport Equipment	5
Construction Materials	3
Rubber and Plastics	1

Sweden (1979)	
Metal-working	51
Mechanical Engineering	15
Transportation	22
Electrical Engineering	9

1/ Percentage distribution based on total sales.
Source: OECD Observer (as reproduced in Science News, vol. 6, No. 1).

World robot population

Robot populations in 1983 totaled 12,500 in Europe, 8,000 in the US and 16,500 in Japan, according to the British Robot Assn (BRA), which also predicts that many small-scale robot makers will be out of business by 1990. BRA says that worldwide there are too many suppliers and far too few buyers. Other robot populations include FRG (4,800), France (2,600), Sweden (1,900), Italy (1,800), Belgium (500), Spain (400), Australia (300) and Finland (120). (New Scientist, 23 February 1984)

Japanese robots up by 25%

Japan's production of industrial robots is rising at an annual rate of approximately 25% and will top 30,000 units in 1984. According to figures from the Japan Industrial Robot Association (Jira), there are now about 130,000 robots in factories. Jira also claims that output of assembly robots will rise in proportion to other types, to account for more than 40% of this total, spurred on by the new factory automation plans of such industries as food and growing robot installations in the car and electronics industry. Assembly robots are also expected to feature prominently in the rising volume of exports to the US and Europe. Total robot output in 1983 was 26,000 units and this is expected to rise to 30,000 units in 1984. The British Robot Association, however, puts the total number of robots in Japan at only 13,000 in a survey last year. [See above news item.] Growing robot demands from European, South East Asian and US markets led to a doubling of robot exports in 1983. (Computing, 2 February 1984)

Robots that can "see"

Though robots have just come to India, they have been excellent in performing repetitive tasks on the production line in Western Europe and Japan. However, if there is a faulty part on the line, they will weld it or work on it; they cannot "see" anything wrong. Now a British company has set out to iron out this disability. It offers a visual inspection machine. Visual Machines Limited (VML), Manchester, is using a system based on work done over the past 12 years in the department of medical biophysics at Manchester University Medical School. Chris Taylor, under whose direction this work has proceeded so far, says "the development was undertaken to overcome the limitations that humans have in applying quantitative rather than qualitative judgement to visual tasks." For instance, humans are good at deciding that a cell on a microscopic slide is of a particular type, but not very good at seeing that the nucleus of a given cell is 10 per cent smaller than usual for its type. Such tasks can only be done comparatively slowly by humans and their performance suffers when they are asked to do them on a repetitive basis due to varying degrees of concentration. The solution now offered for industrial as well as medical use, is based on a television image of the object to be inspected and a vision processor which analyses this image. Software for the system is derived from a physical model or drawing of the component so that the attention of the computer is focused on its important areas. So unimportant visual changes that do not relate to the function or quality of the product can be ignored. This processing method gives greater operational consistency than image comparison methods. A major advance incorporated in the VML's system is that it can be integrated with a central computer to issue instructions to robots to take appropriate action, such as removing a defective product from the production line. A typical system would have a number of TV cameras to obtain different views of the object. These inputs to the memory form a whole image of the object at high resolution, comparable to that of a television image. The processor "looks" at the stored image and makes the use of grey level data to extract the necessary information. Its first task is to find where the critical parts are. It then concentrates on those parts, checking that they are present and correctly located, and making any measurements required.

The advanced software of the VML's system enables it to combine flexibility with the ability to perform complex tasks. It can be configured to meet very specific manufacturing requirements, at the same time giving a performance comparable to that of hardware systems.

Now that the manufacture of two, three and four-wheelers is taking off in India, robotics are bound to make their appearance in the automobile industry, not so much as a substitute for human labour but as a quality control measure n critical areas of assembly. (Science Age, September 1984)

Robots that can smell

The chemical process industry will benefit from the development of robots designed for on-line analysis, hazardous gas detection and industrial hygiene. Currently, 1,000 scientists are engaged in the study, mostly from Carnegie-Mellon, Stanford, Yale and MIT.

Researchers at Carnegie-Mellon will place on a silicon chip integrated circuitry materials that are broadly sensitive to groups of gases. Upon exposure to a gas or an odor, the chip will generate an electronic signal to the host computer. Humans recognize 100-1,000 scents. A lemon peel contains 400 chemicals, each with a distinct odor, and gasoline 600, but the human nose is able to integrate all the smells into a single olfactory experience, while robots will be able to distinguish each specific odor. (Chemical Week, 14 March 1984)

Towards a more "intelligent robot"

Edinburgh University in Scotland has been given its biggest-ever single research award of £3 million to help develop a word processor which will not only be responsive to the human voice and have a vastly boosted vocabulary of 10,000 words, but will eventually cut out the keyboard and special, complex computer language. Three departments - linguistics, electrical engineering and artificial intelligence - will link up in a project aimed at producing machines capable even of understanding different accents and interpreting stresses and inflections in a bid to give Britain a lead in the world word processor race.

Under a separate £600,000 grant, Edinburgh University's artificial intelligence department will be collaborating with the GEC Electrical Projects Company on robotics. The department has already developed a robot assembly language which gives robots the three-dimensional models they need to recognise components and put them together.

At present, the robots are restricted to particular jobs and they are expensive, but if their assembly language could be extended to cover design, so that the computer would become a "drawing board", costs of design would fall and production would be speeded up.

Edinburgh has already established a front rank position in the field through its school of information technology, regarded as the most advanced university centre of its kind in Europe. (Science Age, August 1984)

Robot makes clean start in aviation

British Aerospace and Thorn-EMI subsidiary, Hazmac, have completed a development programme that could result in a much wider use of robots in the aviation industry. The programme has led to the introduction of the first Workmaster heavyweight robot at BAe's Filton plant.

The anthropomorphic robot has been installed to spare workers the hazardous task of high-pressure water cleaning the internal structure of the F-11 combat aircraft tailfin - which is one of the plane's fuel tanks. This is part of a major maintenance programme carried out by British Aerospace on United States Air Force F-111 fighter-bombers based in Europe. Further development work could see the Workmaster Robot used for high-pressure water profiling of the latest synthetic materials used in compartment fittings.

The R6-140 robot in use at Filton has won the full support of staff formerly faced with the hazardous cleaning job. The Workmaster Robot allows for a remote, repeatable, unmanned operation with components mounted on a special jig located in a set position within the washing area - the water pressure reaching around 7,250 psi. And the robot is able to use the same high pressure reciprocal plunger pump supplied by Jevit Limited used in the previous manual operation. (Electronics Weekly, 1 August 1984)

A 30 per cent cheaper robot thanks to the use of new mechanical reduction gears

"Robots are a matter of 80 per cent mechanics and 20 per cent electronics" - this statement has once again been proved true with AID's new six-axle loading and assembly plant (AID is a medium-scale enterprise in Grenoble working in innovative areas; it has a staff of 46 and a turnover of 17 million francs). Its founder, François Danel, has designed and patented a flat hypocycloidal motor-reducer unit. This consists of a flexible toothed crown which at two points engages two opposingly toothed pinions. The crown, of flexible plastic material, has an extra tooth, producing a differential effect between the two pinions. This kind of self-blocking system provides a precise and highly rigid articulation for robots. It is a "flat" version of the American "Harmonic Drive" reducer with which most robots are currently equipped. This ingenious mechanism has made possible a considerable weight and moment gain which has favourable effects on the overall architecture of the robot. This explains why AID has succeeded in designing and offering for sale a 4-to-6 axle loading and assembly robot costing 150,000 francs instead of the 350,000 francs for equivalent models (Scemi, Puma, etc.). An initial series of 50 machines has been built for Education Nationale following the tender for "100 robots" from the Agence de l'Informatique. It can handle parts of up to 1 kg, but an "industrial" version (2.5 kg) is also proposed. AID is turning these robots out at the rhythm of 20 units a month. It should be noted that the CNC 7600 R numerical control system was developed in collaboration with the Swiss firm Cybelec of Lausanne (60 persons), which equips the majority of numerically controlled shears and benders. A joint company, Cybelec and AID, has recently been established at Annecy under the name Cynum Industrie. By the end of the year it will employ some ten persons and will produce the control cabinets for the future AID products. We might recall that last year AID developed the first press-folder loading robot in collaboration with Colly, an achievement through which it gained a mastery of the special numerical control technology for sheetworking equipment. (La Lettre des Sciences & Techniques, April-May 1984, original: French)

Advances in software systems may bring integrated robotics

Although there are about 8,000 robots working in the U.S. today, the software systems to integrate them adequately with humans have yet to be developed. Some 300 manufacturing engineers, researchers, and executives tackled this problem at the conference on robotics research held at Lehigh University in mid-August. Entitled "Robotics Research: The Next Five Years and Beyond," the meeting was sponsored by Robotics International of the Society of Manufacturing Engineers, Dearborn, Mich., and included the presentation of 29 technical papers on a wide range of research topics, including robot software systems. "We can expect more and more advanced robot software," predicted Roger N. Nagel, director of Lehigh University's Institute of Robotics. The field is moving so fast, he says, that researchers are tackling new problems without solving pre-existing ones.

Among the current research objectives are full-structured computer languages, extensions for robot motion and control, sensor communication and control, three-dimensional manipulation and reasoning, data-base access and communication, and operating system support. "No such robot software product is available today," notes Nagel, "but researchers are developing the pieces." Ultimately, the instructions given to industrial robots would be the same as those now given to an assembly worker for such tasks as packaging or shipping, he explains. This would require software systems that incorporate 3-d geometry for path planning and object gripping, and that include collision avoidance and detection programs. "Many of the robots in factories today use an augmented teach-box programming methodology," Nagel explains, but these systems don't create robot programs, detect collisions, or simulate sensors. This teach-box method, along with graphics and a more sophisticated manipulator language, is the basis of the software systems that will eventually be used, Nagel predicts. "No language or software package in use today is task-oriented," adds Robert H. Thornhill, manager of the Robot Product Center at Martin Marietta Data Systems, Orlando, Fla., in explaining CAM-I, a robotics software project. However, "some high-level languages exist that offer several advanced capabilities as stepping stones." Among them are Unimation Inc.'s VAL basic language and SRI International's AL and RPL robot programming languages.

The CAM-I project, established in 1972 and based in Arlington, Tex., was created to "develop prototype software for a robot planner for total programming of the robot or robot-tended work cell in an off-line graphic mode," says Thornhill. He thinks the ideal off-line graphic programming system for robot work cells is still several years away, but he notes that both Japanese and West German firms are now working in partnership with American companies in order to attain this software-systems goal. The prospects for computer-integrated manufacturing appear to be bright. "CIM is revolutionizing the design and manufacture of products," Thornhill told the conference. But according to Nagel, the impact of this new development on the assembly of electronic components may not be as great as it has been on heavier manufacturing, despite the growing precision and improved repeatability of industrial robots. The most challenging problem in developing robot software is the definition of interfaces, such as sensors and data bases, says Nagel. Along with this, "We need to get more of the artificial intelligence community working on robotics." The question is whether all this activity will lead to some kind of robot software standardization. According to Nagel, defining such a standard was the original intent of the CAM-I project. If it were to get wider acceptance, he predicts, CAM-I could become the de facto standard. (Electronics Week, 27 August 1984)

Robots find jobs down on the farm

Robots checking crop growth, harvesting fruit, planting tissue-cultured seedlings, fumigating, cultivating, or milking will soon become familiar sights on U.S. farms. So maintains Gary Krutz of the Agricultural Engineering Department at Purdue University.

Besides easing the life of the farmer and providing more efficient methods of raising crops and animals, farm automation can be one way to successfully compete with the low-cost imports currently threatening the U.S. agricultural community, explained Krutz in a paper delivered Aug. 15 at the International Computers in Engineering Conference in Las Vegas. "Research is under way at universities such as Purdue and in industry, but the industries involved are robotics and automation companies, not the traditional agriculture manufacturers," he says. Still, Krutz predicts that farmers will have no trouble accepting robots because computers are already so widespread for management applications such as financial planning and harvest simulations. In fact, the transition to intelligent machines will be easy because most of the agricultural robots now in prototype are controlled by the same personal computers that many farmers are already using ... According to Krutz and his colleagues at Purdue, the actual robotic manipulations - that is, the precision of the end effectors now in production from such manufacturers as Panasonic Industrial Co. and Unimation Inc. - are considered adequate for almost any agricultural work. In fact, one application for such precision is the very sensitive task of transplanting tissue cultures created by genetic engineering. Krutz sees such cultures (clones of particularly desirable plants) proliferating on farms during the next several years. "One hand will wash the other," he predicts. "The more tissue cultures there are to be transplanted, the greater the need for precise machines to do the work. Even current-generation robots can transplant seedlings quicker - and almost as delicately - as a human could do it, but they're not used because the vision systems to guide them are still relatively primitive."

For some applications that do not involve such precise eye-to-hand co-ordination, much of the current vision technology is usable. "Color vision can spot fruit that's ripe for picking," Kurtz says, "while infrared sensors are good at detecting potential sources of disease before a crop becomes infected."

Martin-Marietta's manager of technology evaluation and transfer explained that the operation of a prototype robot harvester depends on the reflectance spectrums from fruit and leaves. Green fruit and fruit with serious defects reflect less light and can be rejected. Tungsten illumination at 2,500K further enhances fruit reflectance, although lower color temperatures are also acceptable, he says. In the prototype harvester, a Zilog Z8000 microprocessor processes a photo array of 256 pixels, enhancing fruit and leaf contrast and correlating it with reflectance curves stored in a 65-K dynamic random-access memory. Servo control in the arm is directed by another microprocessor slaved to the Z8000. All control can be located remotely and overridden by the farmer in the field. ... (Electronics Week, 20 August 1984)

Robots ready to take jobs in clean rooms

Ruggedized robot systems that spray paint, bend metal, weld, and perform other heavy tasks are finding their way into dirty factory environments. But the electronics industry is in need of a cleaner kind of automaton. Noty only must the robot perform lighter tasks requiring better precision, but it must also avoid fouling the area in a clean room, where even a small amount of oil residue or airborne particulate can be deadly to product yield. Indeed, as production integrated-circuit geometries move below the 1-µm level, some chip producers are envisioning the day when human beings may be removed from wafer-fabrication areas entirely, leaving critical tasks to cleaner and more predictable mechanical friends. With these requirements in mind, a growing number of robotics manufacturers are busily involved in cleaning up the robots in their existing product lines, while at the same time developing next-generation arms that will be cleaner than their predecessors. ... (Electronics Week, 15 October 1984)

Robots in the laboratory

Small microcomputer-controlled robots seem a natural for laboratory work. Their flexibility to perform many different tasks, their ability to work in unpleasant or dangerous environments with toxic and radioactive substances and their legendary tirelessness could revolutionize the business of laboratory analysis. Drug, oil and chemical companies are now seriously looking at how robots a few feet high could be employed to measure and test their products. Although little in the way of software exists for such delicate tasks and the robot arms themselves are imprecise, one robot manufacturer believes it could sell £1 billion worth of equipment. Computer-controlled instruments, especially for processing liquids, have been around in larger laboratories for some time. But these are special purpose devices designed for a particular job. Robots are more flexible. "Flexibility is even more important in the laboratory than it is in the factory," says Derrick Porter, head of the automation and instrumentation group at the Laboratory of the Government Chemist (LGC). "You need to be able to get the device to do lots of different things and make it easy to program." Several small robots have already been developed, mostly for educational use. They are controlled by microcomputers which either contain pre-written programs, or are equipped with a memory which records the movements of the arm as it is taken through its paces by a human operator and plays them back on demand ... The LGC is making some effort to encourage the design of British systems. It is acting as the co-ordinator of the recently formed Laboratory Robotics Club. This is grouping of instrument manufacturers, robot builders and large laboratories with an interest in developing robotic equipment for use in labs. Club members pay an annual subscription of £400 in return for which they get access to the research and development of the group as a whole. Members include oil companies and pharmaceutical and chemical manufacturers, as well as robot builders. One of the aims of the club is to ensure that products are designed so that they do not require a lot of effort by laboratories to get them working. This was not the case when microcomputers for controlling instruments and processing data first came out. "A lot of mistakes were made in the rush to put micros in labs," says Porter. "There were no proper interfaces, no software and people ended up spending a lot of time trying to get them to do something useful. The people who made the mistakes with micros are not going to do the same with robots." One of the reasons why manufacturers will have to get things right this time, says Porter, is that laboratories no longer have the people or the money to spend on rigging up equipment that they did in the mid-1970s when micros were introduced. Future progress in laboratory automation seems to rest on two critical developments; better motor technology so that precision devices can be built, and software that can be used by non-specialists. "There is still an enormous amount of work to be done on the software front," says Porter. Zymark believes that there is a demand for at least 30,000 systems like Zymate worth almost £1 billion - a prize which is bound to spur on the development of small robots. (New Scientist, 18 October 1984) (This first appeared in New Scientist, London, the weekly review of science and technology.)

Robots making trouble

All over Eastern Europe ambitious and impressive plans to introduce robots in manufacturing industry are running into resistance on the shop floor and from the management of the factories. One of the problems is that as production is piecemeal and unstandardized, the cost to the end-user cannot be recouped quickly, if at all, from higher productivity. The Prague government has introduced price subsidies to push through its programme, which envisions the production and installation of 13,000 robots and manipulators in 1986-90. A second problem is reliability. Czech robots operate for only 80 to 400 hours before needing attention, users claim. With 11 producers and poor after-sales, few managers - even with subsidies - are willing to undertake investment that could take between eight and 15 years to recoup. Another problem is shortage of skilled staff.

In the USSR, which produced an impressive 10,700 robots last year, too many of the machines are cobbled together by factories in-house. There is also a demarcation line between industries. Apart from producers like the Lada car works, which makes flexible robots for several engineering applications, most Soviet robots cannot be used outside their immediate sector. ... Experts have criticised the obsession with press, stamping and dye operations for robot applications, claiming that these can be automated more simply and better with robots produced for more complex tasks. ... The GDR , the third biggest robot producer in the Eastern bloc, hopes to bring numbers up to 11,000 this year. It has been more flexible than Czechoslovakia and the USSR with applications ranging from brick-stacking to machine-tool operation. (Electronics Weekly, 25 April 1984)

Robot safety

The dangers that arise when people work with robots is high on the list of topics being considered by the UK Health and Safety Executive. Last week, the HSE published a report * which predicts that more sophisticated, more powerful robots will soon be standing alongside their human operators. Safety problems arise with robots because of their ability to move about, and the unpredictability of their movements when the original control program is made more complicated. The growing number of tasks that robots perform places more emphasis on programming for safety and on the development of sensors. As robots receive signals to start a different task, human beings can be taken unawares. Designers, according to the HSE report, are aware of the need for in-built safety measures. The report also points out the need for speed governors, a deadman's control, segregation of robots from workers, and an awareness of dangers from power sources.

In future, robots may be developed along two routes, according to James Barrett, an inspector of factories for the Engineering National Industry Group (ENIG), which is made up of academics, industrialists and trade union representatives.

He says that more sophisticated machines will be programmed to have a "sense" of their work place, and the need for people to be in close contact with them to direct their work will be reduced. On the other hand, robots are likely to be smaller for some applications, and will interact closely with people.

The HSE is not the only organisation turning its attention to robot safety. The International Association of Labour Inspectors, affiliated to the International Labour Office in Geneva, has sent a questionnaire to all its members to discover their attitude to the introduction of robots.

Barrett, from FNIG, is analysing these results, and will report to the European Commission in 1985.

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* Manufacturing and Service Industries 1983. Report available from HMSO Government Bookshops, £6.

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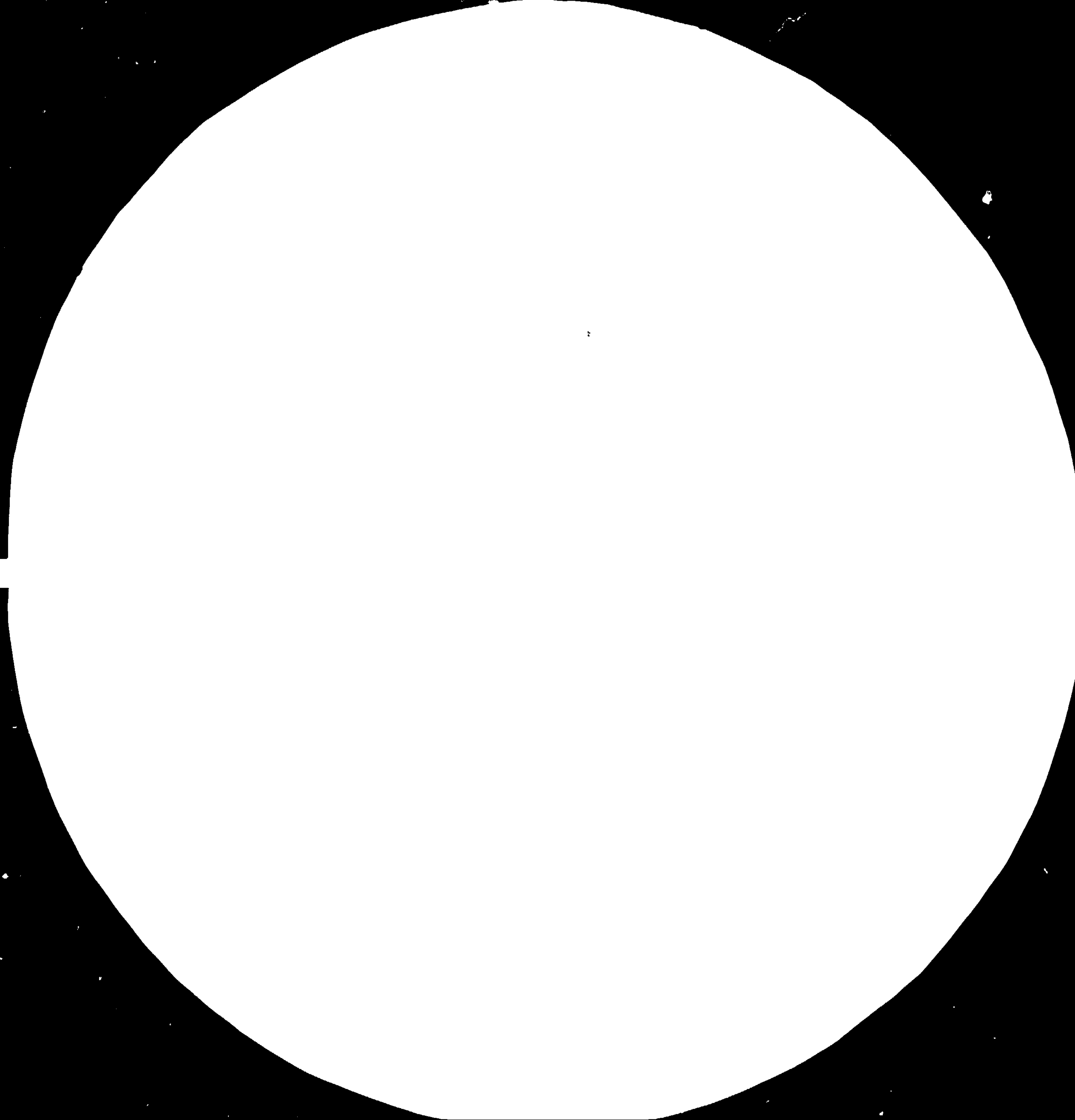

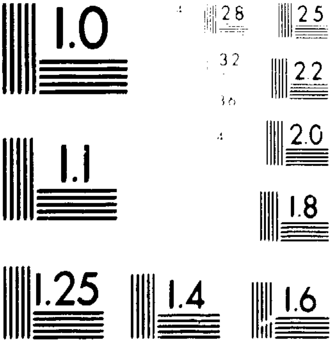

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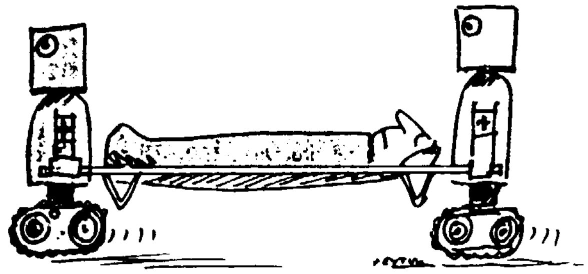

Robot safety (cont'd)

(New Scientist, 8 November 1984) (This first appeared in New Scientist, London, the weekly review of science and technology).

A robotics lexicon

Anthropomorphic robot: A robot employing arms that make movements resembling those of a human arm (i.e., bending, reaching around corners).

Cartesian robot: A robot with motions resulting from movement along horizontal and vertical tracks, rather than through the use of joints - often called an othogonal robot.

Degrees of freedom: The number of co-ordinate axes around which or along which motion can occur. To have meaning, this number must include a definition of axes.

End effector: The hand (or gripper) of the robotic arm - the interface between the arm and the device it's acting on. It may or may not be a holding device; for example, it may be an electric screwdriver.

Footprint: The area and shape of the floor space required by the robot and its controller.

Payload: The mass that can be moved by the robot, given its specified performance in terms of accuracy, speed, repeatability, and the like. Larger payloads may sometimes be accommodated at reduced performance by the robot (slower speed, for example).

Pick-and place robot: A limited-motion robot, with little control over its path, designed to move from one point to another. Generally used for transferring a part from one place to another, such as from one conveyor to another or from a parts bin to a location on an assembly line.

Repeatability: The positioning error - or more precisely, the relative accuracy of positioning - made when a point, previously located, is recalled.

Resolution: The distance between two adjacent points that can be distinguished from each other.

Robot: The Robot Institute of America defines robot as "a reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmable motions for the performance of a variety of tasks".

Work envelope: The set of all points that may be accessed by the robot. This area varies with the end effector, which may increase or limit the set. All points may not have total freedom of all degrees of motion. For example, the highest point in the envelope may not be one that the robot can reach with its end effector pointing down. (Electronics Week, 3 September 1984)

GOVERNMENT POLICIES

Spotlight on China: can China become a high-tech powerhouse?
Beijing aims to catch up in electronics - and to import the knowhow it needs

The People's Republic of China is determined to become a commercial powerhouse, if not a world leader, in high tech. And it is ready to go on a buying binge for the capital equipment and production knowhow it needs to reach that goal. The country has amassed huge foreign exchange reserves - more than $14.3 billion at the end of 1983, or double the June, 1982 figure. So China can afford to import vast quantities of equipment, and it is already starting to spend large sums on computers and electronic components to tide the country over until it can become more self-sufficient. To get the ball rolling faster, Beijing's Electronics Ministry wants to double the nation's output of sophisticated hardware - semiconductors, computers, communications equipment, and consumer electronics -

over the next half-dozen years. Its target for 1990 is $12.5 billion. China's electronics output was roughly $6.3 billion last year. And by the year 2000, China wants an electronics sector that can turn out $40 billion worth of products annually.

The Chinese readily admit they are as much as 15 to 20 years behind the West in making their high-tech move, but they believe they could leapfrog the normal learning process if China can tap the U.S. - or, if necessary, Japan - for relatively advanced manufacturing knowhow. Planners in Shanghai, at the center of a region designated as China's "Silicon Valley," want to jump ahead 10 years by 1990, lifting three-fourths of the area's electronic plants to the level where Western factories stood in 1980. But the Chinese recognize that imported technology cannot close the gap, only narrow it. "We should realize that no foreign country will sell its most advanced technology to us," wrote Huan Xiang, an internationally prominent Chinese economist, in a recent article. "We should buy technology that is not too outdated and use this as a starting point to make our own developments." Otherwise, he noted, China will be forever doomed to crawling behind the West. The exact size of China's current high-tech market - counting both finished goods and production technology - is difficult to pin down. But whatever the total, everyone agrees it is growing fast. One figure comes from China Electronics Import & Export Corp., the main trading arm of the Electronics Ministry. According to Li Deguang, vice-president, his corporation bought about $240 million worth of equipment last year, and he estimates these purchases will grow at least 30% this year. But the U.S. Commerce Dept., using a definition of high technology that goes beyond the ministry's narrow focus on electronics - including, for example, jet aircraft and automated materials-handling equipment - reports that U.S. high-tech sales to China rose from $300 million in 1982 to more than $1 billion last year. Commerce Secretary Malcolm Baldrige told Congress that he expects this year's figure to hit $2 billion, thanks to the liberalization of U.S. export controls. However, U.S. computer companies, which recorded only $50 million worth of business in China last year, question that prediction, since total U.S. exports in 1983, including agricultural goods, reached only $2.17 billion.

Chinese officials emphaisze that their top priority now is on buying the wherewithal for improving domestic manufacturing capabilities, instead of importing finished goods. The country has earmarked $1 billion for imports of all manner of foreign technology this year. The goal is to acquire a complete infrastructure for making the gamut of high-tech products - from programmable controllers to satellite ground stations and television sets. China is also interested in biotechnology. Heading the Chinese shopping list is production technology for integrated circuits and computers. The nation has made stunning progress in homegrown technology in those two fields. In January, China announced development of a supercomputer called Galaxy that can carry out more than 100 million instructions per second. And at the Guangzhou trade fair in March, China exhibited a domestically built, 16-bit personal computer, dubbed Great Wall 100. In semiconductor products, China has managed to construct 30 chipmaking plants, which last year produced 23.5 million integrated circuits (ICs), a 74% increase over 1982. So far, however, China has had little success in converting its research and product development capabilities into large-scale manufacturing. By way of comparison, the same number of world-class IC lines in the U.S. could produce about seven times as many chips as Chinese factories do.

Most Chinese computer users, including government agencies, prefer imported machines because locally made models - when they can be had - are not only technically inferior but also far more expensive. Last year China's entire output of mainframes and minicomputers amounted to only one machine per day on average - and that was 50% better than in 1982. Total production of desktop microcomputers in 1983 came to less than 3,500 units, more than double the year before but far less than just one week's output at Apple Computer Inc.'s automated Macintosh factory in California. The Chinese goal for next year is 1,000 mainframes and minis, and 10,000 microcomputers. ... The catch, of course, is getting access to modern manufacturing technology. That has not been easy. A year ago, shortly after the Reagan Administration announced plans to relax controls on high-technology exports to China, spirits were running high at the Jiangnan semiconductor device factory opposite the willow-lined grand canal in the historic city of Wuxi, 70 mi. west of Shanghai. It will house China's most advanced IC fabrication plant - once U.S. suppliers deliver the $1.7 billion worth of equipment that was ordered in 1982-82. In May 1983, a delegation from the U.S. Commerce Dept. toured the facility, staring through small windows into barren "clean rooms" where paper signs taped on the floor marked the future location of the delayed American shipment. The U.S. officials assured the anxious Chinese managers that the easing of restrictions would mean quick approval for the equipment, which will produce simple chips for use in color TVs.

Now, a year later, only one of the seven key pieces of equipment has arrived. The paper signs, still taped to the floor, have yellowed around the edgers. "We had great hope when the delegation was here," says Huang Lanfang, the factory's vice-director, who began studying semiconductor technology in the early 1960s. "We didn't expect another year of delay," she adds. The necessary approvals finally came in March. But so much time has elapsed that some of the U.S. suppliers, including Calma, KLA, and Digilab, no longer produce the items that were originally ordered. And some of the prices that China originally agreed to pay for what was then state-of-the-art equipment now seem ridiculously high. Because of the Wuxi case, and others like it, the Chinese seem more willing now to turn to Japan and the FRG for hardware and knowhow. For example, a Tianjin factory is producing older devices, such as individual transistors and diodes, with equipment from Japan's Fuji Electric Co. "Compared to the Japanese, American prices are competitive, and U.S. equipment is advanced," says Wang Haifa, deputy general manager of Shanghai Instrumentation & Electronics Import-Export Corp., which has helped negotiate the import of 10 production lines from Japan - but only three from U.S. companies. "The only difficulty is the licensing problem." ...

The Chinese are beginning to make headway in their push for technology transfer in other electronics fields, too. Their main successes have been in consumer electronics, often with the aid of Hong Kong companies. Several Japanese companies have sold China complete production lines for TV sets, too. As a result, total TV output has climbed 15% a year since 1982 and will reach a projected 7.3 million sets this year. Production of color TVs is growing much faster - up 84% last year, to 520,000 sets. China's efforts to import production facilities for semiconductors are also progressing, despite the frustrating Wuxi experience. Solid State Scientific Inc., a Pennsylvania chipmaker, has agreed to sell an antiquated semiconductor production line, shut down a few years ago, and teach the Chinese how to run its 3-in. wafer fabrication line to make chips for such applications as digital watches. And the U.S. last year gave ITT Corp.'s Belgian subsidiary the go-ahead to build a world-class chipmaking plant in Shanghai. The company will help the Chinese churn to state-of-the-art chips, including the latest computer memories, for use in digital telephone switches, which ITT will also help China produce. A half-dozen small U.S. chipmakers are now negotiating joint venture deals with China, reports Glen R. Madland, chairman of consultant ICE. The companies plan to assist the Chinese in acquiring and building entire semiconductor plants, then hand over the necessary production skills and knowhow. In return, the U.S. companies will be able to buy ICs for less than it costs to manufacture them in the U.S. Ultimately, believes a highly optimistic Madland, China "will do better than Japan" in world semiconductor markets. (Excerpted from an article in Business Week, 11 June 1984).

Sweden: Government bill puts priority on long-term basic research

Environmental protection, data/information technology, materials technology and biotechnology are the priority areas in a new research and development bill recently presented by the government. The first time that a total programme for state R&D has been drawn up, it covers the R&D activities of 10 ministries and will mean that the next state R&D budget will be nearly Kr. 10 billion ($1,300,000,000), up Kr. 500 million. The bill stresses the need for a long-term build-up of R&D competence, meaning more support for basic research at the expense of sectorized work. It is intended that business and industry will also contribute to the attainment of this and their representatives will be invited to discussions on this matter with the government. Most of the new funds provided by the bill are for this purpose, including a further Kr. 125 million for basic research within the sphere of the ministries of education and agriculture. Among other measures, the number of state research posts will be substantially increased, rising by 170, and funds to help Swedish researchers work abroad will be boosted. Much of this money will go to the technical/natural sciences and medicine, but the social sciences and humanities will also be supported. At the same time, the difficulty of attracting foreign researchers because of heavy Swedish taxes will be tackled by considering tax relief for this group. The Board for Technical Development (STU) will receive a further Kr. 2.2 billion over the next three years, of which Kr. 700 million in 1984. A special STU council will evaluate R&D projects. STU will introduce a special type of cash support to inventors, worth up to Kr. 200,000 person annually. Valid for both individuals and groups, the grants will number 15-20 per year. Total R&D investments in Sweden, including those of the state and industry, amount to 2.5 per cent of the gross national product. Very few countries have a higher figure relative to their GNP, it is stated. (SIP: Science and Technology, Stockholm, March, 1984)

MISCELLANEOUS

Dirty work

There is growing recognition that high-tech chemical use poses a serious threat to public health and the environment, but little attention has been paid recently to the hazards faced by electronics production workers. Industry has written off health and safety activism as a front for union organizing. However, a cover story in the May-June, 1984 issue of MIT's Technology Review may place concern about high-tech working conditions back on the agenda. In "The Not-So-Clean Business of Making Chips," Dr. Joseph La Dou concludes, "the semiconductor industry, which uses large quantities of toxic metals, chemicals, and gases, may be creating significantly greater health and safety problems than heretofore realized." He describes several particular occupational hazards in detail. La Dou, who has practiced occupational medicine in Silicon Valley for years, is acting chief of the Division of Occupational and Environmental Medicine at the University of California at San Francisco. Alison Bass, who wrote a Technology Review sidebar, "Defining Toxic Exposure: A Battle of Semantics," charges that the Semiconductor Industry unilaterally improved its health and safety record in 1981 by re-defining "one-time exposures" to toxic materials as occupational injuries rather than illnesses. By a stroke of the pen, employers reduced their historically high incidence of occupational illness without significantly increasing the reporting of injuries. Injuries not be reported to authorities if no work time is lost, but illnesses must be. (Global Electronics Information Newsletter, PSC, July 1984)

Computer rat trap goes buzz, buzz, suck

Computers make noises that attract rats. So much so that in Japan rats are the third largest cause of computer failures. To combat the problem Ikari, the country's leading rat catcher, has developed a trap which attracts rats using sound. Proliferating multistorey buildings in Japan's cities have caused an explosion in the population of Rattus rattus, or roof rats. As the name suggests, roof rats are good climbers. They can get into a computer room, regardless of what floor it is on. Once in the computer room, R. rattus causes serious problems. Gnawing at a cable or urinating on a connector can transform large quantities of, say, a bank's financial transaction data into instant gibberish. Worse, because intermittent, such failures are especially hard to detect.

The computer rat problem came to light about seven years ago, when the ministry of international trade and industry (MITI) was drawing up computer safety standards. Worried, MITI commissioned Ikari to develop a solution. The first question to determine was what was attracting rats to computer rooms in the first place? Certainly not food. The answer turned out to be the ultrasonic hums given off by computer power supplies. The rats seem to think that these are made by other rats.

The idea that it was sound that was attracting the rats came, according to Yosuke Watanabe, manager of Ikari's research laboratories, from a paper published by British researchers on ultrasonic communication in rodents. Further investigation, in co-operation with the Japan National Broadcasting Corporation, demonstrated the frequencies centering around 24 kilohertz were particularly beguiling. The trap that Ikari built consists of three devices: an ultrasonic sound generator programmed to make simulated squeaks: a powerful vacuum generator, activated by the approaching rat, which sucks the helpless 200-250 gram creature off to the third device, where it is gassed with carbon dioxide, disinfected, then packed into a cardboard container for subsequent disposal.

Such a large trap will, as Watanabe points out, normally have to be installed when a building is under construction. He says that Ikari have completed trials of their prototype, and hope to have it in mass production by the end of the year. (New Scientist, 31 May 1984) (This first appeared in New Scientist, London, the weekly review of science and technology).

RECENT PUBLICATIONS

Corrigendum: (Footnote on page 50 of issue No. 9)

UNIDO/IS.440 Guidelines for software prodution in developing countries
The autnor's correct name is H.W. Kopetz.

Relevant UNIDO documents:

ID/WG.419/13 Report of discussion meeting on information technology for development, Vienna, 21-23 March 1984

UNIDO/IS.489 State-of-the-art series on microelectronics
No. 1: Venezuela by R.C. Callarotti
No. 2: India by S.C. Mehta and G.S. Varadan
No. 3: Republic of Korea by K. Chon
No. 4: Pakistan by M. Aslam
No. 5: Bangladesh by T. Hussain

Relevant documents published by other UN organizations

UNESCO: International inventory of software packages in the information field

UN Centre for Science and Technology for Development (UNCSTD):

Within the context of the Advance Technology Alert System (ATAS) launched by UNCSTD recently, the publication of an ATAS Bulletin, each issue focusing on a specific topic, is well under way. Each issue will be published in a pre-publication version, reviewed in an editorial workshop and thereafter published in the final version. The first three bulletins will focus on the following subjects:

ATAS I: Tissue Culture Technology (to appear shortly)
ATAS II: Microelectronics for decentralized development (to be published in final form in May/June 1985)
ATAS III: Information Technology (publication of final version planned for summer 1985)

Euripa: Barriers to information

The European Information Providers' Association (Euripa) has just submitted the first progress report of its study on barriers to the development of the European information industry. This study, contracted out to Harry Collier of Learned Information, Abingdon (UK), is being carried out on behalf of the Directorate General 13 of the Commission of the European Communities. Current problems, as opposed to barriers, identified by Euripa members, were in order of importance, lack of skilled personnel, marketing weaknesses, deficiencies in software technology, shortage of high cost of capital, incompatibility of systems, and production costs. Future problems identified were, in order of importance, in shortage of high cost of capital, incompatibility of systems, lack of skilled personnel, marketing weaknesses, deficiencies in software technology, and production costs. The additional problems identified were: lack of market data and forecasts, public procurement policies, deficiencies in hardware technology, competition by public sector, lack of strategic co-ordination, language barriers, copyright or other, legal and regulatory, barriers to free flow, and tax.

According to the study, the more serious long term barriers, as opposed to mere problems ranked above, arise out of the essentially international nature of electronic publishing. The geographic location of a host computer is of little importance in a world of international networks, semi-automatic log-on, and in the not too distant future, expert systems. This opens the competition internationally, in an industry where a large geographic market base is essential if adequate returns are to be made: the information industry needs an international market place.

The biggest needs of the information industry are for an initial education, continuing education, an international, as opposed to a purely national perspective, personal contacts between fellow-professionals, recognition by government agencies that the world is changing, minimum boat rocking, including market place intervention by government in order to allow the industry to find its feet and its market place, the modification of basic legislative frameworks in areas such as international copyright, an agreement on international co-ordination, with the recognition that it is only a European industry that can, in this area, compete with the USA and Japan. Electronic publishing does not fit into the concept of traditional publishing, although it appears to do so, nor does it anywhere else. It demands new, radical marketing insights and concepts, unlike traditional publishing. It also demands an international outlook for both the product and the marketing, the concept of "domestic", "home", "export" and "overseas" quickly blur together. The report concluded that the major ingredient missing in the current European electronic publishing scene is expert managerial expertise, at both the company level and government level. (Infotecture, European newsletter on on-line information industry)

European Component Distributor Directory now available

The 1984 edition of the BENN European Electronic Component Distributor Directory has been published. Publishers BEP of Luton, UK, claim that their newly published directory lists more than 3,500 distribution outlets throughout 14 European countries, together handling new products of around 7,000 component manufacturers worldwide. Fourteen countries have been covered in this Edition - Austria, Belgium, Denmark, Finland, France, Fed. Rep. of Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland, UK and Ireland. Most extensive coverage has been given to UK (391 principal entries), Germany (190 principal entries), France (182 principal entries), and Italy (100 principal entries). The 454 page Directory has been brought fully up-to-date by a fresh questionnaire survey and telephone/telex follow-up exercise amounting to some 2 man-years of research effort - the results of which are now available for only £40 UK/$99 Overseas. The 1984 edition of the European Electronic Component Distributor Directory incorporates a cross-reference index of component manufacturers detailing their distribution outlets in each country, a source for buyers searching for a particular brand name component and a source for industry analysts tracking the distribution strategy of individual manufacturers. (Electronics Report [Ireland], July/August 1984)

Electronic Market Data Book 1984

The US Electronic Industries Association has published the Electronic Market Data Book for 1984, the most comprehensive source of statistics on the US electronic industries. It numbers 150 pages, presents an in-depth profile of each of the major industry groups: consumer, communications, computers and industrial electronics, electronic components and government electronics. Another section provides complete trade, employment and R&D information. It is available at a cost of $60 from Marketing Services Department Publications, EIA, 2001 Eye Street, N.W., Washington, D.C. 20006.

Computers and development: high tech - low priority?
(by U. Beyschlag) *

Experience shows that, in developing countries, computers are usually no more than status symbols or expensive gadets for a few rich companies, administrations and individuals. They fall into the same category as steel mills and large power plants, more an obstacle than an aid to development. Yet we have left behind us the period where we emphasized conventional industrial development. Consideration of such high technology devices in development aid would represent only a repetition of previous mistakes. "Basic Needs" and "Appropriate Technology" are now the real key issues, aver the critics.

Enormous capital costs would have to be invested in computers with essentially all the money going to industrialized countries. In addition, computers need highly skilled personnel for operations and maintenance. While expensive foreign experts would have to be hired, the application of computers would kill off jobs held by the countries' own citizens. Is this the whole truth? We believe that it is not.

Criticisms such as these are justified for many of the applications of computers in the recent past and even still today. We should be careful, however, not to take this as the basis for a consideration of the computer in future development strategies. There are two reasons for this:

- Even for experts in the field of computing, the speed with which the computer develops in respect to new areas of applications and the price-performance ratio is breathtaking.
- There is no technology that has such a potential for adaptation to new tasks and environments.

Several characteristics of the computer and historical developments in electronic data processing indicate their relevance to future development and strategies. A device that is purchased today in an industrialized country for less than US$300 can, among others, interact with a student in a wide range of educational programmes, such as courses in Mathematics, Physics and foreign languages. It can provide individual advice on income tax reduction and other complex, personal problems, and can offer entertainment through various games. A small box, connected to the computer, permits access to hundreds of public and private databases and the exchange of immediate electronic mail via the telephone system. The number of applications of this same computer also increases over time. This is possible through the purchase of standard programmes, the exchange of programmes with other users or the individual writing of new programmes by the user himself.

A computer with the capabilities described above is the size of a typewriter. Only 25 years ago, it would have filled a large room and cost several million dollars. The price of computer hardware will continue to drop and the quality will continue to increase at enormous speed. In addition, the quality of the software has increased considerably over the last year, but the price has also risen due to the labour intensiveness of software production. The software proportion of the costs for data processing systems in the industrialized countries lies today at 65 per cent, with a tendency towards a continued increase. Computer technology is therefore labour-intensive. Use of the computer was very complicated in the early days of electronic data processing. Modern systems are becoming increasingly user-friendly. The dialogue between the user and the machine is now often very natural, adapted to the user language and culture.

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* Ulf Beyschlag is a computer scientist at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland and is also involved in several developments and activities.

Computers can be grouped roughly into three classes, the mainframes, the minicomputers and the microcomputers. The mainframes, at prices of $500,000 and above, are rarely of interest to developing countries. They are useful in scientific environments, government and large companies. Applications are the same or very similar to those in industrialized countries. Mainframes require demanding infrastructure such as air conditioning and very well trained operations and maintenance staff. Minicomputers, with prices above $15,000, appeared first in the sixties. They are the most popular computers in developing countries at present. Applications vary from classical ones, i.e. those of the industrialized countries, to those that are very specific to the needs of a particular country. Even though they are more easily adaptable, their infrastructural requirements and prices are still high and inhibit widespread use.

Mainframes and minicomputers dominate the image of the computer in public opinion. Since the middle of the seventies, however, microcomputers have revolutionized the field. The cheapest are sold today for $150. The heart of such devices is a microprocessor costing less than $10. Usually, they are robust, easy to use and consume very little energy. The range of possible aplications is virtually unlimited. In the last few years, they have started to be used in developing countries, and are becoming increasingly popular. For many people, it is difficult to see where the use of the computer could be of any interest in developing countries. Looking at a few existing applications, however, we find that even the poorest countries have started to profit from the capabilities of data processing systems. Telecommunications administrations use computers for the processing of telephone and telex bills. Computers help governments to generate economic forecasts, a mandatory prerequisite for any substantial international assistance. In rural co-operatives, they can assist book-keeping and in larger banks they take care of clients' accounts. Economic considerations are also often a decisive argument. If, for example, a government considers a given project positive for the development of the country and this project is economically justifiable only if computers are used in its implementation, a decision for implementation with the computer can normally be expected. Within the next few years, the fast development of information technology, in particular the microcomputer, will make its application possible and attractive in areas where we can hardly imagine it today. One focus point will have to be the fulfilment of basic needs. In education, low cost microcomputers with attractive, animated and culturally adapted programmes could help teachers fighting illiteracy and raise the general educational level world-wide. Nurses and barefoot doctors, equipped with pocket size information systems become more efficient and effective in providing local and western-style health care. Agricultural co-operatives could have access to all biological, meteorological and economic information that would allow them to be increasingly productive. Computers and telecommunications together could be the basis for an urgently needed decentralization of many national economies and administrations.

For the moment, the development of future computer applications in the Third World is largely a matter of speculation. Many more studies and pilot projects are needed for a better understanding of information technology's role in future development strategies. Those responsible for all aspects of development (government officials, civil servants and development aid workers in developing and industrialized countries) have to be made aware of the chances and the risks of information technology. Developing countries have to prepare themselves for this inevitable new technology. The labour intensiveness of electronic data processing and falling hardware costs should make it possible to reduce the import costs from industrialized countries to below 5 per cent of the total costs for an electronic data processing system on average. This depends on the know-how and the facilities that exist in a given country. To reach this goal, technology transfer in the field of electronic engineering and software engineering is urgently required. Train-the-Trainer courses, currently the most efficient method for technology transfer, should be organized on a large scale. Some sixteen months ago, Development Forum celebrated its tenth anniversary with a colloquium entitled "A Speculation on the Barefoot Microchip". The result was remarkable, but not as promising as hoped. Imagination and initiative are still needed to move us towards a better preparation of developing countries for affordable and profitable applications for them of information technology. Unless we act soon, the Third World may lose a bright chance to catch up with the industrialized world. If this opportunity is wasted, the developing countries can also say goodbye to any hope of self determination. Can they afford this? Can we? (Development Forum, June 1984)

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The following has been excerpted with kind permission of the authors from an article entitled "Back to basics: Microcomputer transfer to developing countries". The authors spent ten months touring the Middle East and North Africa to investigate the circumstances surrounding transfer of microcomputer technology to developing countries. In their opinion it is unrealistic to expect an organized information system magically to appear merely by purchasing computer hardware and appropriate software and training someone to use them. A good deal of preparation is necessary to succesfully adapt an existing manual information system for use on a computer. This adaptation process is so crucial that it often is the factor determining the success or failure of a particular microcomputer transfer project. The authors describe, as a case in point, the creation of a national health information system in Egypt:

A belated success: the Egyptian health information system
(by Alice Trembour and Robert Schware) 1/

This case involves the creation of a national health information system, a project of the government of Egypt. 2/ In 1981 the Ministry of Health proposed the system as part of a reorientation of its approach to health problems in Egypt. The ministry wanted to begin systematically examining current health needs nationwide and establish priorities for meeting these needs. Initially, data were to be gathered at local levels to assess the effectiveness of current health programs such as immunization, fertility regulation, urinary schistosomiasis among school children, tuberculosis and rheumatic fever control. Other areas of interest were the relative effectiveness of technical equipment, training needs, the cost (and cost effectiveness) of various parts of each program, and an overall assessment of the efficiency of health interventions compared to the Ministry of Health's targets for each program.

Trained personnel would gather raw data in 3,500 local health facilities - district hospitals, rural centers, emergency care units, and family planning centres - spread through 250 districts in Egypt. They would record answers to the same questions each month on simple questionnaires. The data thus collected would be too voluminous to be handled manually so it was decided to introduce a microcomputer system at the district level to handle the data. Electronic data processing would also quickly transform raw data into meaningful output, making speedy action possible such as in the discovery and eradication of an epidemic.

The health ministry commissioned a detailed needs assessment comparing various microcomputers and software written specially for the Egyptian system and allowing data entry and printouts in Arabic. The study also examined the data processing workload that would be required to satisfy the Health Ministry's needs. The statistics department and the Bureau of Health in the Ministry were to supply data as well from their own sources, such as figures on population distribution according to sex and age, birth distributed according to the mother's age and her medication supervision as well as rank of the child among siblings, village population and number of families in each village in the district, and tuberculosis control. Finally, the study gave hardware and software requirements for processing all the data from these sources and producing the monthly and yearly reports the Ministry of Health wanted.

Once it was decided, on the basis of the study, which hardware and software to use for the system, two microcomputers and programs were acquired for testing under actual environmental and manpower conditions. In the course of the testing, however, it became clear that the data to be processed were incomplete, and what data did exist were unorganized even as they were recorded on the questionnaires designed for the project.

The Health Ministry was forced to suspend further testing and implementation of the information system until some basic problems were resolved. First, the data collection process at the local facilities was thoroughly overhauled. This involved retraining the clerks responsible for it and emphasizing the need for accurate and complete recording of data. Second, the upgrading of the Health Ministry's entire statistical apparatus became mandatory since accurate and complete statistics were essential if the information system was to produce accurate indicators of the efficacy of Egyptian health programs.

This "taking care of the basics" process took two years, during which one microcomputer sat unused and the other was only used for routine word processing and clerical work in one of the Health Ministry's offices. But the two years were not wasted time. Dr. Aziz El Kholy, the director of the medicine and health care sector of the National Information for Egyptian Development project, summarizes the positive effect of the two-year

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1/ Alice Trembour is a journalist and editor in Boulder, Colorado. Robert Schware is a senior member of the technical staff at Computer Data Systems Inc., Rockville, Maryland. Both authors have written other computer articles and books. They can be contacted at: 603 Ray Drive, Silver Spring, MD 20910, USA.

2/ A component of the National Health Information for Egyptian Development Project, The (Egyptian) Academy of Scientific Research and Technology, USAID, and the Georgia Institute of Technology. See USAID, 1981: A Proposed National Information Policy of Egypt, USAID PASA NF/EGY-0016-7-77, (September).

period before final testing and use of the microcomputers. "The microcomputer, just be being there, became the motivation for people to change their thinking and information-gathering behavior," he says. "It forced them to become organized and also to solve the problems of effective and efficient data collection". 1/ He advises others concerned or involved in microcomputer transfer to ignore the details of hardware and software issues entirely, "fossilize one's ambitions" for a project, and be prepared to wait however long it takes to do the preliminary organizing work before attempting to use the technology.

1/ Personal interview with Dr. Aziz El Kholy (12 January 1984), Cairo.

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