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On page 61 you will find an article on "Public domain software for development" prepared for the Monitor by Dr. R. Schware, mamagement information systems and micro-computers consultant, Washington, D.C.

A meeting of the Consultative Group on Informatics Technology for Development (COGIT) was held at UNIDO headquarters from 14 to 16 December 1987. More on this inside these pages.

The *Microelectronics Monitor* proposes to accept industry-related advertisements from companies interested in reaching planners and policy-makers as well as entrepreneurs and members of the scientific community in some sixty developing countries throughout the world and inform them about their products and services.

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I. UN NEWS AND RECENT EVENTS

UNIDO News: Meeting of the Consultative Group on Information Technology for Development (COGIT), 14-16 December 1987, Vienna, Austria

In 1984 a meeting of professionals and representatives of non-governmental organizations active in the field of applied informatics technology for development proposed establishment of a Consultative Group on Information Technology (COGIT) which could advise UNIDO on an action-oriented approach to help build up indigenous microelectronics and informatics capabilities in developing countries.

Since then, although a number of agencies have been active, it was not clear that substantial acceleration had taken place. The COGIT group was therefore reconvened to review the status of activities in the field of informatics technology and work out means of international co-operation to speed up applications.

The formal objectives of the meeting, held in Vienna on 14-16 December 1987, were to:

(a) Review practical experience in the application of informatics technology for development and to identify concrete measures of co-operation at the international level, including co-operation among developing countries, so as to promote such applications in a manner consistent with the requirements of developing countries;

(b) Review UNIDO's past and planned activities in this field and suggest a programme of action.

Participants at the meeting were from intergovernmental and non-governmental organizations, from selected developing countries, and experts from developed countries.

Opening the meeting, Mr. Domingo L. Siazon, Jr., Director-General of UNIDO, underlined the significance of microelectronics and informatics technology to the industrialization process and the double opportunity they represented. They constituted a rapidly developing industry in themselves which (especially the software sector) countries could enter without having to invest heavily in capital equipment. And they were a force of change in other industries: they transformed manufacturing processes, products and even the competitive environment itself. Nevertheless, despite national and international efforts, it had to be recognized, the Director-General pointed out, that in many cases the application of microelectronics and informatics had failed to yield the results expected of them in developing countries. Similarly, the applications had not enjoyed the diffusion anticipated, thus lessening their impact on development. The task for the meeting was therefore to help UNIDO identify and spell out the details of a coherent microelectronics/informatics programme for UNIDO that would contribute most effectively to the development of developing countries.

K. Venkataraman, Senior Technical Adviser, Department for Industrial Promotion, Consultations and Technology, noted that the meeting was part of a series of activities initiated by UNIDO in regard to microelectronics and other emerging technological advances. It was also intended to provide substantive input to the programme module on microelectronics and informatics technology in the new UNIDO programme approach to development and transfer of technology. COGIT meetings were planned to be theme-oriented and participants would be invited according to the chosen theme and their field of expertise.

Conclusions and recommendations

After reviewing current trends in microelectronics and informatics technology and the needs of developing countries in that respect, the group adopted a number of conclusions and recommendations as inputs to the UNIDO programme in this area. It noted that developing countries were at different levels of development and would need to take action at one or more of them. International co-operation, including South-South co-operation was called for. However, selectivity was important in view of the vastness of the field of informatics technology.

General trends

The group agreed that both established and leading-edge technological developments in microelectronics and informatics technology had important implications for developing countries, especially in the long run. Those at the leading edge, however, such as expert systems and computer-supported production may have primarily a potential for future applications in developing countries. Governments should therefore monitor these developments with a view to keeping their professional experts informed and advising enterprises on their implications for industry. However, any applications should take into consideration the local conditions and constraints and fit into the local productive structure.

Awareness

It was felt that Governments, producers in industry and development finance institutions had to be more aware at a practical detailed level of the opportunities, limitations and threats posed by developments and trends in microelectronics and informatics technology as well as the structural change involved. In particular Governments should play a major role in that effort. They should establish policies applying to their own operations and those of enterprises, research and training institutions and users. Such policies would promote rational use of microelectronics and informatics technology generally. Governments should support those policies through public sector purchasing and preparing human resources information campaigns in areas for which they were directly responsible, e.g. health, education, administration and State-owned industry. An awareness campaign should try to reach all sectors of the population from decision-makers down.

Industry should be the object of targeted awareness campaigns, drawing on the experience with such campaigns in other developing and developed countries. The general benefit of microelectronics and solutions found in specific sectors could be demonstrated both within and between countries by means of travelling exhibitions. UNIDO should also sensitize Governments by means of workshops and seminars, audio-visual presentation of real developing country problems and solutions, and supporting studies. One of the most effective ways to draw attention to microelectronics and demonstrate its effectiveness in different sectors, the group felt, was with pilot projects. UNIDO should undertake pilot projects in sectors such as small-scale industry, tourism, etc.

Selection and acquisition

Noting that almost all informatics technology was imported by developing countries, the group found that serious mistakes had been made in the selection and acquisition of both hardware and software. It was therefore important that UNIDO continue its workshops, advisory services and preparation of manuals to strengthen developing countries' capacities in this area. Software tools should be an essential part of transfer of software technology.

Maintenance

The group concluded that developing countries faced serious maintenance problems in both the hardware and software for microelectronics and informatics technology. Building up a maintenance infrastructure was in many cases an urgent necessity. Agreeing that rigid controls in this respect were likely to be self-defeating, the group recommended an appropriate combination of buyer's incentives and vendor obligations (such as maintaining a sufficient stock of spare parts for all hardware, plus training of local maintenance technicians until they can work alone). UNIDO should provide guidelines and advise Governments on suitable strategies. Where national markets were too small for vendors to comply, UNIDO should promote subregional maintenance centres or enterprises.

Applications for development

To identify, promote and accelerate local applications in industry and other economic sectors, there was great need for indigenous effort, the group concluded. Not enough was being achieved for lack of skill and infrastructure. This required focused capacity building, concentrating on areas such as software, which should be considered as an industry in itself. To realise any application, demand and supply would have to be stimulated in an interrelated and dynamic fashion, hardware and software know-how relevant to appropriate solutions would have to be acquired, and the associated skills developed.

The group recommended that to help developing countries build up the necessary resource base, UNIDO continue to draw attention to problems of commercialization and use of public purchasing. Key areas were software and close interaction with users to determine relevant applications. UNIDO should therefore support applications designed to improve productivity and efficiency and rehabilitate existing industries. It should address particularly the potential of informatics for small enterprises. To develop technological enterpreneurship, UNIDO should promote programmes to allow professionals to set up on their own and make Governments and development finance institutions aware of the need for venture capital for software development, which was generally not considered a traditional industry.

The group also called on UNIDO to draw up and circulate an inventory of applications of significance to development, and inventories of application possibilities in specific industrial sectors, and continue to work with other international organizations such as UNESCO and WHO to promote and initiate microelectronics applications.

Skill building

The group recommended that UNIDO assist by defining the threshold level needed for skills relevant to applications, maintenance and software, and provide guidelines and training. There should be selected and interrelated skill-building in basic areas such as maintenance, software, integrated circuit design and product design. Such skills should however extend beyond applications to management of the technology.

In the long run, each country's greatest asset would be its body of indigenous skills in exploiting trends and developments in microelectronics and informatics technology for the benefit of its own socio-economic development. Some countries, it agreed, had developed high-level technological and managerial skills. The group felt UNIDO should support mechanisms to share these higher-level skills by networking the institutions involved. This would be supported in some cases by integrated national, regional or subregional development institutions with training facilities in each area, plus a possible silicon foundry. UNIDO should help developing countries to set up such institutions. Guidelines for setting up national or regional institutions should also be disseminated by UNIDO. The group noted in this context the UNIDO initiatives in Latin America and the Caribbean, and in the Arab Region. It was proposed that UNIDO work on subregional institutional mechanisms for African and Caribbean countries. In this connection, the representative of the Commonwealth Secretariat indicated the readiness of his organization to work with UNIDO to promote such initiatives.

Mobilization of international co-operation

The group concluded that in many cases international co-operation could play a major role in promoting informatics for development. It recommended that UNIDO stimulate and mobilize such co-operation between developing and developed countries in informatic applications for development, i.e. at the level of enterprises (via joint ventures and technology transfer agreements), between research and training institutions, among professional groups and between high-ranking professionals in their individual capacity. UNIDO should maintain and enlarge its roster of experts available for problem-oriented activities and develop other mechanisms. The group noted in this connection that UNIDO was working on an international project for microelectronics applications and software development, which would link scientific institutions and enterprises in helping developing countries. It urged that an international project should be formulated and implemented soon.

Each of the invited participants presented or made available a short paper giving a brief account of ongoing or planned programmes of his group, the background to the methodologies chosen, the future goals and long-term objectives. The experts from developed countries presented papers on current trends in their special fields. Participants from developing countries outlined their priority needs in the area of microelectronics and information technology. The UNIDO Secretariat presented an issue paper and made available experts' reports, state-of-the-art studies in selected developing countries and reports of expert group meetings.

Course on information systems in developing countries

The London School of Economics, Information Systems Department, is offering graduate courses in the "Information Systems in Developing Countries" area, which are supported by UNESCO. There is a two-tier course structure, whereby students, according to qualifications and background, study Information Systems in Developing Countries either as part of an M.Sc (named Analysis, Design and Management of Information Systems) or else as part of a Diploma (the Diploma in the Management of Information Systems). Both courses teach extensively Information Systems and topics from Information Technology. In addition, they cover the following topics: Development Economics, Social Policy and Planning in Developing Countries, Technology Transfer and Development, National IT Policies, Application of Information Technology in Developing Countries.

The London School of Economics offers a unique environment for the study of Information Systems and, in particular, Information Systems in Developing Countries. Students are encouraged to attend optional courses and thus benefit from studying a variety of subjects within a university internationally renowned in the field of Development Studies.

The area of information systems in developing countries is also a major research field within the department.

(For information write to Mr. C. Avgerou, Co-ordinator of the Information Systems in Developing Countries courses, London School of Economics, Houghton Street, London WC2A 2AE, UK)

The technological village

During a recent meeting in Latin America, the Italian Society for International Development (SID) announced that it was starting up an experiment in order to bring the most advanced technologies to the most remote rural areas.

The technological village wishes to serve as the example of an integrated system of services geared to the development and valorization of the technological capabilities of the area in which it operates. Some experiments are already under way in Arequipa in Peru, in Nanning, Kwangsi, China and in Trieste, Italy.

The major goal is that of developing technological production and research in favour of the developing areas, through strengthening the interconnections between the worlds of production and research and the worlds of universities and consulting centres.

The first thing to be set up is the communication network of the village which, being small in size and with characteristics that can be repeated anywhere, it has the possibility of benefitting from previous experiments, from expert staff, from information and from already experimented marketing structures.

The technological applications which interest the small and medium-sized industries are possible, merely by combining scientific work with industrial work.

It should be noted that the technological village can contribute to the creation and strengthening of links between small and medium-sized industries with specific reference to the production and the use of local resources. It favours therefore the development of initiatives of scientific research and technological innovation, the results of which are then disseminated to the production, university and public sectors. The bases therefore are created for setting up open centres for documentation and specialized information and for the dissemination and development of advanced services. (Bulletin IBIPRESS, No. 144, 27 September 1987)

II. NEW DEVELOPMENTS

The superconductive computer

... What makes superconductor prospects so attractive? For computer designers, the main appeal of superconductors stems from their low power consumption and low heat dissipation.

One of the ways computer designers have been improving computer performance is to pack ever larger numbers of circuits into chips, thereby boosting the amount of processing that is done by each chip during a single machine cycle. Until the late 1970s, the density of circuits on a state-of-the-art silicon chip had been doubling each year; since then the rate of doubling has slowed to every two years. But higher circuit densities also boost the electrical resistance of the chip. With more resistance, the chips run hotter, thus increasing their vulnerability to failure. Some 10 per cent of the cost of installing a typical mainframe goes to buying the air-conditioning systems needed to keep the computer from overheating; supercomputer systems are often dwarfed by their companion cooling systems.

A superconductor that loses no energy as heat, could, in theory, allow considerably denser circuit packing than any semiconductor chip. Still, any application of the stable high-temperature superconductors discovered so far would require cooling systems even more expensive than today's, because these materials must be chilled hundreds of degrees below room temperature before they achieve superconductivity.

The first stage in the development of an all-superconductive computer (see figure 1, page 4) would be likely to use the new materials for chip interconnects, the fine lines on printed circuit boards that currently are made of copper and other metals. Next might come on-chip connections between silicon transistors. Finally, and perhaps most distant, there would be manufacture of integrated circuits (ICs) in which both active elements and connections would be fabricated entirely out of superconducting materials.

Chip interconnections would require that the new oxides be selectively applied to circuit boards in paths with current densities high enough to be practical. (Current density is the term physicists use to describe the amount of current a given volume of a substance can conduct.) Today's metallic interconnections are usually sprayed onto masked boards in so-called thick film fabrication (as opposed to the much finer "thin film" used on chips themselves).

Superconductor chip interconnections would also require so much refrigeration that their use would effectively be prohibited in an otherwise conventional mainframe. But since designers have learned that today's state-of-the-art silicon technology, CMOS (complementary metal oxide semiconductor, which dissipates less heat than the conventional NMOS that is based on so-called n-type transistors), runs twice as fast when chilled, use of superconductors for chip interconnects might dovetail with certain cryogenic advances for high-end computer designs.

Otherwise, the potential gain of superconductor interconnects probably is not worth the cost: most heat generated by computer hardware is given off by ICs, not connective wiring. Also, though some designers of computers have complained that as much as 50 per cent of processing time is wasted transmitting signals through various connective wires, such interconnect delays are due more to limitations of silicon that cause complex circuits to require many chips, and thus many connections, than to interconnect resistance per se. The speed of electricity through any medium is a constant for that medium, unaffected by resistance. In fact, IBM research indicates that some of the new high-temperature superconductors actually conduct electricity at a slower constant rate than copper does; current flows through copper wires at about one fourth the speed of light.

There is another problem that limits the potential of superconductive interconnects when used between conventional ICs: as these ICs heat up they could raise the temperature of interconnects enough for them to lose their superconductive property.

On-chip connections could be limited by the same problem. But replacing today's metallic on-chip

Figure 1: Three steps toward constructing an all-superconductive computer

Component	Requirements	Obstacles	Recent Breakthroughs	Time frame
Chip interconnections	Thick film fabrication with current densities high enough to be practical for most architectures.	Refrigeration, especially when combined with conventional silicon technology. Also, limited payback because conventional wiring does not represent a significant processing bottleneck.	High current densities achieved in film work at Stanford University in March 1987.	Possibly within one year.
On-chip connections	Thin film fabrication with current densities high enough to be practical.	Brittleness of ceramic compounds; refrigeration, especially when combined with conventional technology.	Fabrication of simple working microelectronic device with sprayed-on ceramic superconductor by IBM, April 1987.	Prototype chips possibly within two years.
All-superconductive circuits	Fabrication of a two- or three-terminal microelectronic switching device.	Conventional semiconductor technologies are likely to continue to improve, which tends to bias any cost-benefit equation against new technology.	None, beyond reports of unstable superconductivity at higher temperatures.	Possibly within 10 years.

CONCLUSION: It will be at least a decade, if then, before technological advances yield an all-superconductive computer.

connections with superconductors might offer a bigger gain than superconductor interconnects. Today's chip designs attempt to minimize the total metal length of the on-chip connections between active chip elements such as transistors. Even so, since the connectors must carry enough current to meet the power needs of the active elements (plus what the connectors themselves dissipate), the most densely packed chips are typically half-covered with metallic conductors, sprayed on in thin films. Superconductive on-chip connectors could reduce the chip's power needs significantly while allowing denser circuit packing. Thin-film fabrication of the 1-2-3 substance was demonstrated at Stanford and at IBM earlier this year.

A more distant prospect would be the development of an IC on which even the active elements are fabricated from superconductors. One candidate for a superconductive switching circuit would be the Josephson design. Some problems remain with aspects of Josephson systems outside their switches, however. It is also conceivable that another property of superconductors, such as their ability to circulate electricity in a closed loop indefinitely, could be exploited in a completely new circuit design. ... (DATAMATION, 15 August 1987, pp. 77-78) (Reprinted with permission of Datamation[c] magazine[c] copyright by Technical Publishing Company, A. Dunn and Bradstreet Company - all rights reserved)

Superconductors outpace optical fibres

Two research groups in the US have shown independently that high-temperature superconductors transmit ultrafast pulses of electricity. Moreover, they do so smoothly without distorting the current. One researcher involved with the new discoveries, Gerard Mourou of Rochester University, predicts that superconducting transmission lines for long-distance communications could have 100 times the capacity of optical fibres.

Other researchers involved make more guarded predictions than Mourou, who directs the Ultrafast Science Center at the university's Laboratory for Laser Energetics. They believe that the main implications are for short-distance links of a few millimetres within computers. They note that there is a huge technological gulf between measured transmission distances of 5 millimetres and the multi-kilometre-scale networks of fibre-optic communication systems.

The pulses of electricity each last a few trillionths of a second. Because so many bursts travel through the superconductor each second, the wires have the potential to carry many more messages than existing cables. Today's highest speed communications rely on wires that transmit pulses lasting billionths rather than trillionths of a second.

The two research groups are both in New York State. One is a joint team from the universities of Rochester and Cornell. The other group is from IBM's T.J. Watson Research Center in Yorktown Heights. The experiments of the two groups differ in detail but share some important features. Both groups transmitted "ultrafast" pulses through a thin-film layer made from an oxide of yttrium, barium and copper. Neither group detected any distortion in currents after electric pulses had passed through 5-millimetre-long strips of the superconductor.

The university experiments relied on a thin-film device made by Robert Buhrman, professor of applied and engineering physics at Cornell. His group deposited the superconducting film at 700° C on zirconium oxide that contained impurities of yttrium. Normally, scientists have to fabricate the materials at temperatures that are up to 150 degrees higher.

The group etched the film to form lines that were just 15 thousandths of a millimetre wide. The depth of the film was slightly more than one third of a millimetre. At Rochester's Ultrafast Science Center, Mourou's team passed pulses lasting 10 to 15 trillionths of a second through the cooled, 5-millimetre superconducting transmission line. Mourou said that current density was very high, a million amperes per square centimetre.

At IBM, Daniel Grischkowsky and eight colleagues passed pulses lasting just 1.9 trillionths of a second through an unpatterned superconductor film deposited on strontium titanate. The film was one thousandth of a millimetre deep. The group saw no stretching or distortion of pulses passing through the superconducting film when it was sheathed in non-superconducting aluminium to form a transmission line. (This first appeared in New Scientist, London, 22 October 1987, p. 29, the weekly review of science and technology)

£10 million earmarked for UK superconductor plan

Nearly £10 million is to be made available for the first year of a national research and development programme for recently discovered high-temperature superconducting materials.

The Department of Trade and Industry (DTI) is to make up to £3 million available next year to encourage collaborative industrial research projects into electronics and high-power applications. This will be matched by companies participating in the programme which include GEC, Racal, Plessey, British Telecom, the Atomic Energy Research Establishment, the Central Electricity Generating Board, BICC, Pirelli and Hawker Siddeley.

Industrial research is to be split into two camps, one looking into electronic applications and the other into high power. However, participating companies have yet to decide whether to form one large industrial consortium for each area or whether to have many smaller groups.

The Science and Engineering Council (SERC) is to spend between £2 million and £3 million to set up two university-based multidisciplinary research centres in superconductivity. This research will also be split into small and large-scale uses.

These centres are to each employ 25 full-time staff. Work is to be carried out by the staff and visiting academics on short-term contracts.

The SERC has sent out letters to the heads of 11 universities asking for bids to establish the superconductivity centres.

The centres will concentrate on basic research into these new materials and will work closely with companies participating in the industrial research project. ... (Electronics Weekly, 9 September 1987)

In superconductors, it's the chains that count

How does high-temperature superconductivity really work? In particular, what unique structural properties of the crystals allow them to pass electricity with virtually no resistance?

The most prevalent theory holds that, in crystals of compounds such as barium yttrium copper oxide, the copper oxide forms both layers - planes - and chains. It is thought that the chains are crucial to the crystal's ability to superconduct. Recent results from several laboratories, reported at the American Computer Society meeting, reinforce that theory.

Daniel Cox, Arthur Epstein and colleagues from Ohio State University, Columbus, in collaboration with scientists at Brookhaven National Laboratories, used neutron scattering to produce a diffraction pattern of the structures of barium lanthanum copper oxide and barium yttrium copper oxide.

The diffraction patterns suggest that both compounds need copper oxide chains and planes to be superconducting. Cox and Epstein also found that the more perfectly aligned the chains become, the better the material is able to superconduct.

Chemists from AT&T Bell Laboratories have also done a number of experiments that show that the copper oxide chains, if not actually responsible for superconductivity, are essential.

Robert Cava is defining oxygen's role. He finds that, in compounds of less than seven oxygens, superconductivity diminishes; in fact the compound $Ba_2YCu_3O_6$ is only semiconducting. When oxygen is lost, it is lost exclusively from the copper oxide chains.

The maximum superconducting temperature is also affected by replacing copper atoms from the chains with aluminium. Aluminium is a common contaminant, notes Bell scientist Lynn Schneemeyer.

Although barium lanthanum copper oxide and barium yttrium copper oxide are the best-studied superconducting materials, Cornell University chemist, Frank DiSalvo, believes they are not the only ones that will work.

DiSalvo points out that other compounds have been made that substitute calcium or strontium for barium. And there is a second class of compounds of barium, lead, bismuth and oxygen that can superconduct at about 13° Kelvin. (Barium yttrium copper oxide superconducts above 90° Kelvin.)

DiSalvo believes that complex structures, including transition elements such as platinum, silver, nickel, palladium or cobalt may qualify as high-temperature superconductors.

Even with the pace of research today, high-temperature superconductors are a long way from commercial exploitation. Bell Laboratories' Donald Murphy points out that superconductivity in these new materials is too easily 'turned off'. It's not possible yet to "make a powerful magnet out of the materials because, in bulk form, they are not able to carry large currents and remain superconducting". Murphy concludes: "We are trying to discover ways to raise the critical temperature and current density of the superconductors even further. We're trying to make them work in the real world." (Chemistry and Industry, 5 October 1987)

Superconductors hit a watery problem

With the right recipe, even high-school students can make the new family of liquid-nitrogen superconductors. However, the new materials may be much harder to keep than to make.

Researchers have been plagued with unrepeatable results, apparently because some materials can be unstable in the superconducting phase. Now a group from AT&T Bell Laboratories in Murray Hill, New Jersey, reports that the superconducting phase of yttrium-barium-copper oxide degrades when exposed to water.

Some scientists had suspected that the new superconductors might be sensitive to water. Some hints came from experience. Another reason is their composition: the best-known member of the family contains copper in an unusually high state of ionization, known as +3, which is less stable than the standard +1 or +2 states.

Quantitative measurements showing that the new ceramic superconductors react with water in the liquid state or humid air were reported in Applied Physics Letters (17 August, p. 532). M.F. Yan, R.L. Barns, H.M. O'Bryan Jr., P.K. Gallagher, R.C. Sherwood, and S. Jin of Bell Laboratories found that $YBa_2Cu_3O_7$ reacted with water, forming cupric (copper +2) oxide, barium hydroxide, oxygen and Y_2BaCuO_5. The compound did not have to be submerged in water to react with it. Its superconductivity was degraded when exposed to humid air.

The sensitivity to water should not prevent applications of the new materials. The Bell Laboratories group writes: "It should be possible to protect them with coatings of metal, glass, or plastic." In fact, an earlier paper in Applied Physics Letters (vol. 51, p. 203) reported liquid-nitrogen superconductivity in wires of the new material clad with metal that could protect against ambient moisture. (This first appeared in New Scientist, London, 27 August 1987, the weekly review of science and technology)

Superconductors stir patent frenzy

The science community is busy hunting for patents filed by IBM on its breakthroughs in superconductivity. New materials discovered last year by IBM's laboratory in Zurich, Switzerland, show superconductive effects at much higher temperatures than anything previously known.

Routine patent searches show no filings but in the past IBM has disguised patent applications by lodging them through subsidiary companies in foreign languages. IBM does this because, although pending applications are secret in the US, many countries publish pending applications after 18 months. Also, IBM has to file in these countries if it wants a world monopoly on a technology.

This has stirred Japanese companies into frantic activity. They are filing their own patent applications on anything remotely relating to superconductivity. A survey conducted by Japanese newspaper Nihon Keizai Shimbun in July showed that in the year following IBM's discovery, major Japanese companies filed over 1,500 superconductor patent applications. Sumitomo alone lodged 700.

The Japanese hope that this shotgun approach will give them a share in rights on the new technology. They also want to avoid being branded as plagiarists. But if IBM has been smart, and filed a wide range of patent claims covering all variations in the new range of metallic ceramic superconductors, the Japanese will be left out in the cold.

There are other reasons why around 40 per cent of all industrial property filings now originate from Japan: inventors and companies file to gain prestige, even when an idea is trivial; and Japanese patent law limits the number of claims to monopoly which can be written into any one application, so there is an incentive to file several separate applications which in the Western world would be rolled into one. (This first appeared in New Scientist, London, 27 August 1987, the weekly review of science and technology)

New Intel computer

Intel launched a powerful 32-bit parallel processing computer.

The machine is based around the company's 80386 chip technology and will come in a variety of sizes which contain between 16 and 128 chips plugged together on a high-speed communications network.

Up to 16 Mbytes of random access memory (RAM) chips will be available for each 80386 processor although the maximum memory capacity for the whole machine will be 1 Gbyte of RAM.

The machine is called the iPSC/2 and is a logical development of Intel's 16-bit iPSC parallel processing computer. (Electronics Weekly, 2 September 1987)

Cray gives up the MP supercomputer

Cray, the American producer of maxi-processors, has decided to suspend its parallel processing supercomputer project "MP" (multiple processor). It is however to put increased effort into its Cray-3 project and to develop the existing Cray-2 and X-MP.

According to experts, the capacity for the MP was expected to be 100 times higher than that of Cray-1 with a processing speed of 1 nanosecond. The cost of the project, which was begun in 1985 and was due to be marketed by 1990 was fixed at $US 50 million. If the project were to have been finished, these costs would have run up instead to $US 100 million.

Official sources have attributed the decision to suspend the project not just to the cost but also to the fact that the activities carried out did not conform with the previous experience of the firm. They were based essentially on the exploration of new technologies and pure research.

Now Cray intends to concentrate all its forces on the production and marketing of other product lines. In fact at the beginning of 1988, the introduction onto the market of the Y-MP will be announced. The year after, the Cray-3 will be marketed. It will use the gallium arsenide technology, have a memory capacity four times greater than the current Cray-2 and it will process data 10 times faster than before.

A few months ago, Cray signed a collaboration agreement with Digital. In fact, as of this year, the American company has added a new line of less powerful products to its range of superprocessors.

The agreement with Digital foresees the joint production of a processor which will have the capacity of making the communication speed between minicomputers and work stations five times faster. (Bulletin IBIPRESS No. 145, 4 October 1987)

Europe's supercomputer effort goes on show

A prototype version of Europe's first supercomputer went on show in Brussels last week. The Supernode, developed by British and French groups under the EEC's Esprit programme of research into information technology, will be available as a commercial product within two years, say the participants. Supernode will cost thousands rather than the millions of pounds that the present generation of supercomputers cost.

The project will form a basis for future programmes of hardware and software development, says John Elmore, head of advanced information processing in Esprit.

The supercomputer is based on the Transputer, a processor chip developed and sold by the British company Inmos. The project team has designed a special version of the Transputer that includes a floating point processor and extra memory on the same chip. Previously, the Transputer processed problems described by only whole numbers. Numbers that include fractions are more useful for describing real engineering problems in a form that the computer understands.

Using many processors to carry out computing tasks in parallel rather than relying on one very complex processor is not new. But Dave Watson, one of the scientists involved in the Supernode project, says that the Transputer lends itself particularly well to parallel processing. He also says that the new device is significantly faster than other pairs of floating point and 32-bit microprocessors.

Supernode is made up from one or more sets, or nodes, of Transputers. Each node, consisting of 18 processors, could be the basis of a powerful workstation, capable of carrying out 300 floating point operations per second. Up to 64 nodes can be connected together to make the equivalent of today's scientific supercomputers.

The project partners are the British companies Thorn EMI and Inmos, Apsis and Telmat, from France, the universities of Grenoble and Southampton, and the Royal Signals and Radar Establishment which acts as the prime contractor. They say that within a few years they will be building machines that are capable of 400 megaflops (millions of floating point operations per second) and that cost about £250,000. Comparable supercomputers today would cost about £25 million. Both Thorn EMI and Telmat intend to start commercializing Supernode before the Esprit project runs out in 1988.

Each node consists of 16 worker Transputers, plus one that controls how they are linked. Another Transputer, with 16 megabytes of memory, stores and distributes data to each of the worker Transputers.

The Transputers have four links each. All of them are connected to a switch which in turn is connected to the control Transputer. The configuration of the node - how each Transputer is connected to every other Transputer - can be changed by the software that runs on the controlling Transputer. It tells the switch to change the links in a certain way. This means that the node can be customized to cope with specific problems. Tasks such as signal and image processing, for example, are best carried out by a certain configuration of processors. The switch can be programmed to change the connections between the Transputers each step of the way to make the operation as efficient as possible.

This also means that the machine can be partitioned into independent units that many people can use at the same time. If one of the Transputers is damaged, the switch can also change the links so that the computer can bypass the faulty processor.

More powerful versions of the computer will have more than one Supernode. In this case, each set of 16 Transputers has two switches that allow any of the links to be connected outside the node. A programme running on the control Transputer can set up virtually any series of interconnections.

The Supernode will be used for applications such as computer-aided design and engineering, signal and image processing, and to solve problems in physics and engineering. (This first appeared in New Scientist, London, 8 October 1987, the weekly review of science and technology)

London scientists line up parallel computer

Computer scientists at University College London (UCL) have produced a novel type of parallel computer called GRIP (it stands for graph reduction in parallel). The researchers have produced a scaled-down prototype of a commercial machine and expect to have a full-sized prototype working within a year.

High Level Hardware, an Oxford computer firm specializing in scientific systems, hopes to exploit the research in a machine running at 50 million instructions per second (MIPS). This compares with the 5 MIPS of its present Orion minicomputer. ICL is also involved in the project.

GRIP makes use of off-the-peg components to speed up design. When GRIP is complete it will have 80 processor chips mounted on 10 printed circuit boards, which will also contain their own five megabytes of random access memory. A bus or bundle of wires for passing messages between computer components will connect the boards together.

The important bit of GRIP is the software. Parallel techniques used in existing supercomputers are all based on a fixed hardware layout which determines what the computer can do. Peyton Jones, head of the team at UCL, wants to produce a computer that can be programmed to do a wide range of tasks.

One advantage of GRIP, says Jones, is that the machine could be more responsive to conditions in the data it processed. For example, weather forecasting programmes that run on present supercomputers continue crunching away on readings that are of little interest to human forecasters, spending the same time on those as the data from a typhoon. GRIP-type programmes could adjust the "resolution" of the number crunching to suit the importance of the data.

GRIP has its own computer language - called the Oxford Language - written by the Oxford Programming Research Group. The Group has also produced another piece of systems software for the computer known as a compiler. This programme translates the language instructions into lower level instructions to the GRIP hardware.

Graph reduction is a mathematical term. A graph is a system represented as a series of nodes or junctions. A road map is a graph, but computer programmes too can be expressed as graphs. The problems the programmes are to solve are expressed in the shape of tree structures with twigs and branches representing different steps leading down to an answer at the base of the tree.

Calculations represented by different twigs can be carried out simultaneously provided they do not depend on data from one another. This is where the parallelism comes in. The process of breaking up the programme into twigs or discrete steps is known as reduction. The reduction is done by the compiler which then distributes the twigs around the clumps of memory in the machine from where they can be passed to a processor for execution.

Communication between processors is kept to a minimum in GRIP, unlike the conventional notion of a parallel computer with hundreds of processors connected to one another and passing results around a network. The GRIP team have side-stepped bottlenecks that can build up in a network by restricting the number of processors in GRIP and by ensuring that their chatterings are kept to a minimum. (This first appeared in New Scientist, London, 27 August 1987, the weekly review of science and technology)

High density gate arrays

Make room for some big new gate arrays. Better make plenty of room - LSI Logic Corp. is shoving the density barrier of commercial arrays out to a whopping 100,000 usable gates. The company's new arrays are fabricated with a new 1-μm, triple-level-metal CMOS process packing a million transistors onto a single 1.5-by-1.5-cm chip.

LSI Logic's new LCA100K Compacted Array Plus family promises to deliver huge semicustom designs from a channelless sea of 236,880 total gates. That kind of size is catching other suppliers and some customers by surprise. It significantly raises the gate-count stakes in application-specific integrated circuits by nudging mask-programmed logic arrays into territory that once was the secure turf of standard-cell ASICs.

LSI Logic is first out of the chute with 100,000 usable gates, but competing suppliers like Motorola, VLSI Technology, and NEC are preparing their own large CMOS arrays. Clearly such big arrays bring an ASIC company added prestige, but some observers question their usefulness. They say that density level is better served by standard-cell ASICs and compiled designs. LSI Logic and others, however, see a real market, especially in the high-end computer markets. As they refine their technology they are likely to offer arrays that are larger still.

Huge gate arrays, however, face some serious obstacles. Most test equipment cannot handle them, some design tools need to be improved, and major strides in packaging technology are needed to accommodate their big pad counts. Some observers wonder who is going to use them, and for what.

LSI Logic thinks the availability of 100,000 usable gates on a quickly customizable logic array will quickly be embraced by the traditional users of 50,000-gate CMOS devices. Those devices are being used mostly to build central processing units for supermini, mainframe, and minisupercomputer systems. The big new payoff is likely to come in several emerging areas, such as parallel processing, and in new real-time computing markets, such as signal processing, which now have no hardwired options for algorithms bogged down in software.

With the high gate densities, LSI Logic expects to see software-embedded algorithms hardwired for greater speed in image processing, artificial intelligence, speech recognition, and high-resolution computer graphics. In addition, the fast turnaround and lower nonrecurring engineering costs of large gate arrays compared with standard-cell ASICs should make the new Compacted Array Plus series popular with system designers who want quick complex prototypes, packed with dense on-chip memory. ...

Motorola Inc. is right on LSI Logic's heels. It is expected to introduce in November a new triple-metal family of CMOS high-density arrays, called the HDC series. The HDC family will offer greater gate-utilization rates - approaching 80 per cent, compared with 40 per cent for LSI Logic's new series - delivering up to 80,000 usable gates from a 483-by-483-mil master of only 104,832 total gates. And Motorola plans arrays supporting more than 100,000 usable gates.

In Carrollton, Texas, Thomson Components-Mostek Corp. is considering adding a third layer of metal to its recently introduced double-level-metal 12000-series CMOS channelless arrays. The third layer could push the usable gates of a total of 128,000 from about 50 per cent to almost 90 per cent, near the 100,000 level. Also expected to push semicustom CMOS arrays to and beyond 100,000 usable gates are such Japanese powerhouses as Toshiba, Fujitsu and NEC.

NEC, unlike most American suppliers, is planning to serve the high end with a channeled array, stacking layers of metal interconnection atop each other for high utilization. NEC will move into the 50,000-gate range in November with the introduction of a 1.2μm triple-level-metal CMOS-V product line. The company is considering fabricating four or even five layers of metal interconnection in its push towards 100,000 gates.

At Honeywell Inc.'s Digital Technologies Center in Colorado Springs, Colo., a next-generation submicron combined bipolar-CMOS technology is being prepared for a new line of military-targeted arrays with densities in excess of 100,000 usable gates. ...

In fact, the increasing size and packing densities of new arrays is changing the rules of the game, say executives at VLSI Technology Inc., San José, California. The company serves the market for 100,000-gate plus designs with cell-based ASICs and compiled designs, which offer densities approaching hand-packed levels. ...

So VLSI Technology is moving to add dense gate arrays to their product line: it plans to announce high-density channelless arrays, most likely in early spring. The arrays are expected to be in the same density range as LSI Logic's new family.

Meanwhile, LSI Logic continues to run testing prototypes based on the new arrays in its new 6-in. wafer facility in Milpitas while waiting for customer designs, which are expected by mid-1988. The cost of most of those parts will range between hundreds of dollars and thousands, depending upon complexity and volumes. Power dissipation is initially being quoted at 12-μW/MHz per gate, about the same as the older 1.5-μm family, which covers a range of 10,000 to 50,000 usable gates.

LSI Logic is aiming much of the development work now at testing techniques and high-pin-count packages. The company has built boundary-scan testing into its products to speed up post-production testing. It also has a proprietary circuit option aimed at speeding test times. Its arrays offer up to 364 device pads, of which initially only 256 input/output signals will be made available because of test-equipment limitations. LSI Logic plans to increase the available I/O pins with the arrival of new testing gear, and hopes that tape-automated bonding techniques will make packages possible that support its arrays' high pin counts. (Reprinted from Electronics, 29 October 1987, pp. 55-56,)

Silicon wafers cut processing costs

Researchers at GTE's laboratory in Waltham, Mass., USA, have developed a new way to make silicon chips that can be used for transistors - those ubiquitous power-switching devices that find their way into a host of electrical appliances. The discovery may lead GTE into the transistor business.

With conventional methods, electric connectors are implanted onto the surface of silicon wafers used in transistors. However, GTE adds the metal tantalum disilicide to molten silicon before it is formed into silicon bars. When the bars are sliced into wafers, the wafers have microscopic metal threads running through them.

The company claims that transistors formed by this process can handle higher power because the connections run the whole thickness of the wafer. Also, the built-in threads reduce processing costs because connectors do not have to be added - a step that requires clean-room conditions, GTE claims.

What is more, the new silicon chips are sensitive to light, important in such applications as electronic cameras, optical communication systems and solar-energy equipment.

A GTE spokesman says the company is currently studying whether to license the new process or produce transistors itself. (High Technology Business, September 1987)

TI to roll out its first family of products made with biCMOS

Texas Instruments Inc. is all set to begin shipping a brand new family of interface chips that are notable for two important reasons: these ICs run cooler than any other high-performance interface chips, delivering bipolar speeds at CMOS power levels. More importantly, at least to TI, they are the first family of products from the Dallas chip maker to be made by its flavour of biCMOS, a process that TI is convinced will be its technology driver of the 1990s. It is not alone: although there are relatively few suppliers or customers of biCMOS circuits as yet, chip makers are rushing to jump on the bandwagon.

The devices are made with a new process based on Impact, TI's mainstream high-performance bipolar technology, which has been modified to accept CMOS on the same substrate. The result is Impact CS. The company has big plans for its biCMOS process: it will use it across the board, building memories, gate arrays, application-specific ICs and even linear circuits. ...

That combination is coming just in time for designers now working on the next generation of 32-bit microprocessor systems, which are requiring far more interface chips than ever before. Add to this the accelerating trend toward surface mounting, and it is easy to see that designers who want their boards to stay cool will need low-power, high-speed interface chips.

The SN74BCT interface family will include 8-, 9-, and 10-bit biCMOS bus drivers, memory drivers, latches, registers and transceivers. Available this month will be four octal bus transceivers and four 8- or 9-bit-parity transceivers. By the end of the year, this family will number 37 devices, and by the end of next year it will grow to 98.

The advantages of biCMOS technology over pure bipolar go far beyond the relative performance of individual drivers or transceivers. A typical 32-bit microprocessor system may contain 10 or more interface devices. Just one bus driver is activated at a time, causing a typical driver to be in the disabled state as much as 90 per cent of the time. When the interface units are pure bipolar, the disabled drivers are all burning up power, since they remain in the high-impedance state awaiting their turns to be activated.

The picture changes radically when the drivers are biCMOS. When the total current draw of all the disabled biCMOS drivers is compared with that of disabled bipolar drivers, the reduction in supply-current demand of biCMOS technology is overwhelming. In some cases, biCMOS devices can bring about a power savings of almost 100 per cent.

Gate power consumption for the SN74BCT chips remains quite low, even as system operating frequencies increase. For example, power consumption of a biCMOS octal line driver is about one fourth that of the corresponding bipolar device, even across wide operating frequencies, for single-output switching up to 10 MHz. Studies indicate that traditional bus interfaces consume 30 per cent of a system's total current.

System designers are fully aware of the trade-offs involved in using bipolar logic to drive buses. To get the needed drive currents of 48 to 64 mA, power consumption must be high, because bipolar drivers gobble up chunks of supply current even while idling.

BiCMOS technology eliminates this waste of energy by employing different three-state tactics. To reduce power consumption, TI designers added a pair of n-channel CMOS transistors and two gates - inverting and noninverting - to the basic gate to cut current flow to the bipolar transistors in the disabled state. During normal operation, in the active state, a logic 1 is applied to the enable-control line to turn on CMOS transistor A and turn off CMOS transistor B.

Current flows from the supply through transistor A and into the base of the bipolar Darlington output stage. Current can also flow into the base of the saturating bipolar transistor, since transistor B is off. In the high-impedance state, the logic level on the enable line is reversed (logic 0). Transistor A is now off and transistor B is on. Neither the Darlington nor the saturating transistor can draw base current, putting the gate in its high-impedance state.

The result is a significant reduction in supply current flowing into the basic gate. A biCMOS driver that draws 30 mA when active draws just 10 mA when disabled. Furthermore, a biCMOS driver draws far less current than its advanced bipolar counterpart, which draws 150 mA whether active or disabled.

Although lowering system power is the primary motivation for making biCMOS interface chips, the devices must maintain high performance levels. TI's SN74BCT family offers speed and drive capabilities equivalent to advanced bipolar logic. Propagation delay times for a complete biCMOS gate function are comparable to those of advanced bipolar technology - 3 to 5 ns. ...

Impact-CS is a bipolar process to which CMOS transistors are added. The devices that result are basically bipolar types; that is, they accept TTL-level inputs, and they drive buses to which TTL devices are connected. But thanks to the CMOS transistors, these chips draw less power in both the enabled and disabled states.

The bipolar process produces output transistors capable of supplying the 48-to-64-mA currents needed to drive the capacitive inputs of MOS memories and the low-impedance backplanes of high-speed bipolar systems. Another benefit of bipolar output transistors is their lower voltage swing compared with CMOS transistors (0.5 to 3.5 Vcc, compared with ground to V_{CC}). A narrow voltage-swing range reduces the effect of transient-voltage noise on the ground pins.

With the Impact-CS process, bipolar devices can be fabricated with current gains of 100. The typical n-MOS transistor boasts a normalized current gain of 39μA/V^2, while the figure for the typical p-MOS transistor is 12μA/V^2. Both n-MOS and p-MOS transistors have internal threshold voltages of 1.0 V.

The disable circuit provided by the CMOS transistors consumes considerably less current than a pure bipolar circuit; CMOS devices draw virtually no current in the standby or unclocked state.

Impact-CS is a combination 2.0-μm bipolar and 1.5-μm CMOS process that uses two metal levels for interconnections. The metal pitch on the first level is 4.0μm, allowing for high-density packing of transistors. Also, reducing the metal pitch allows the transistors to switch faster, because it shortens the interconnections between devices.

The metal pitch can be as small as it is because Impact-CS incorporates a high degree of surface planarization, or smoothing, of its device surface. MOS devices usually contain greater topographical bumps and discontinuities on their surface. The smoother the surface, however, the better the step coverage, which in turn results in more reliable devices. ...

The simplest implementation of a biCMOS device requires just two CMOS transistors to control the operation of the bipolar output stage. Future implementations of biCMOS technology may incorporate greater numbers of CMOS transistors in strategic locations, particularly as the Impact-CS process moves toward more-complex and more-advanced devices. (Reprinted from Electronics, 1 October 1987, pp. 81-82, copyright 1987, McGraw-Hill Inc., all rights reserved)

Computing with light

Digital electronics dominates computing, but it is not the only way that machines handle data. Optical devices process information by manipulating beams of light. For 30 years, optics has converted signals from airborne radar into images of the ground below. Optical processors also analyse the radio-frequency spectrum, clean up pictures, and compare the characteristic radar signatures returned by different objects.

The attraction of optical circuits are that they are faster and they can process data in parallel. Electronic switches are slower than the fastest optical type, but a more serious limit on the speed of electronic circuits is the time it takes electrons to move from point to point. Light travels faster through air and optical fibres than electrons can through wires. Light can also travel a more direct path between two points than electrons, which often follow circuitous routes to prevent interference between circuits. Virtually all electronic computers are sequential - they perform one operation at a time. A single optical device, such as a lens, can process information from many inputs at once. Optics also allows circuits to have more connections because photons do not carry any charge, so light signals - unlike electrical currents - do not interfere with one another if their paths come close or cross.

Optical processors have lagged behind electronic computers because they are less flexible and lack digital accuracy. The most successful optical processors have had sensitive applications that kept them under security wraps. Military and security agencies continue to develop better optical circuits but they are prepared to talk only about basic research and general ideas. One of their aims is to meet the formidable requirements of star wars. Another goal of optics is to clear the bottlenecks of information that appear as designers cram more and more circuits on an electronic chip. The US Department of Defense wants to develop optical neural networks, which would work more like the human brain than a digital computer, and might help to control weapons systems. Telephone companies also need increasingly efficient switches for their fibre-optic communications circuits. In industry, optical devices might even handle signals directly from optical sensors. Some visionaries believe that optics could be the basis of computers 1,000 times more powerful than today's best.

Optical computers have not become more common partly because electronics is so well established. Optical devices exist that can process information in the same way as an electronic computer can handle it, such as optical logic gates, but they are no more sophisticated than the electronic circuits of 30 or 40 years ago. We take it for granted that we can programme an electronic computer to perform a variety of tasks, yet the most powerful optical processors are dedicated to specific tasks. You have to change their hardware to programme them. It has been decades since a programme for an electronic computer consisted of wires plugged into sockets in the back of the machine, as it did in the 1940s. Optical computing technology is still at the stage that electronic computing achieved in the Second World War.

Other optical processors share some fundamental concepts of the device for synthetic aperture radar. In each case there is an analogue input signal, varying continuously rather than being limited to binary ones and zeroes. If the signal does not start as light, it is used to modulate a steady beam of light. Then light signals pass through lenses, prisms or other devices, which manipulate the signals to produce patterns. This output may be an image, as in synthetic aperture radar, or a plot of data, such as a breakdown of frequencies present in a radio signal.

Optical processors already perform some operations more efficiently than electronic computers, such as Fourier transforms. Optical processing of analogue signals offers many types of mathematical operations. An important example is the Fourier transform, a mathematical means of analysing complex waveforms. Fourier transforms are essential in engineering analysis and signal processing. For example, when a lens focuses coherent light - light waves of the same frequency and the same phase, such as those produced by a laser - the pattern of light in its front focal plane is a Fourier transform of the pattern of light in its rear plane. If that light passes through a second lens, a second Fourier transform reconstructs the original image. Digital electronic computers need sophisticated programmes to approximate a Fourier transform. Some optical devices perform a Fourier transform just by refracting passing light. Fourier transforms are not limited to two-dimensional images. A Fourier transform of a function that varies with time, such as a radio signal, breaks the signal into its component frequencies. This is important to modern warfare where a knowledge of the enemy's radio frequencies can help in intercepting or jamming communications. Fourier transforms can also help radio astronomers to deduce the nature of cosmic radio sources.

For analysis of the radio spectrum, incoming radio signals affect a transducer that vibrates a crystal. The vibrations vary the crystal's density and its refractive index, bending and scattering light as it passes through the material. A lens focuses light emerging from the crystal to form a pattern showing the spectrum of frequencies of the radio signal. Similar techniques are used for correlations and pattern recognition, which are important in applications ranging from robot vision to analysing data collected by spy satellites. While the basic principles are well known, little has been said about details and specific applications because military and security agencies sponsor most of the work in this field.

Researchers are also exploring the possibility of making optical connections in electronic circuits. The time that it takes signals to travel through a circuit limits the design of supercomputers. No matter how close circuit boards sit together, their connection wires limit the speed at which they can communicate. Most electronic components work more quickly as they become smaller, but not wires.

Transmission problems increase when manufacturers pack more and more electronic functions onto a chip. Signals form bottlenecks at the limited number of electrical connections that fit around its perimeter. The best techniques of fabrication squeeze fewer than 300 connections around the edge of a chip; this may not be enough for very-large-scale-integration chips containing several hundred thousand devices. You might be able to pack optical connections closer or make them on the surface rather than the edge of the chip.

Optical, rather than electronic, distribution of timing signals could also help chips to operate faster. If a wire distributes timing signals throughout a chip, the timing cycle must last as long as it takes an electrical signal to travel the length of the chip. Flashing light to several photo-detectors on the chip could speed up operations. Two signals, going in opposite directions, from the four detectors on the chip would cover the length of the chip eight times more quickly than a single signal.

In the long term, optical switches - and optical logic devices assembled from them - may find applications in large, digital optical computers. In the near future, they are more likely to switch telephone signals. The only switches generally available for optical fibres must convert light into electrical pulses. This is far too slow to keep up with the number of telephone calls that could travel along an optical fibre. ...

Many researchers in optical computing dream of going beyond switches and matrix processors to build optical supercomputers. Some talk of building a computer a thousand times more powerful than any available today. Others dream of making an optical central processor that, by the year 2000, will perform more than a million billion (10^{15}) operations per second, compared with 100 to 1,000 billion for today's Cray supercomputers.

On the other hand, past predictions that have come to naught have taught some veterans to be cautious. The trend in computing does seem to point to optics, or "photonics" as some call it. Optical technology is young; electronics may be approaching some plateaus. But neither the promise of light nor the limitations of semiconductor electronics are certain. A decade ago, Josephson junctions were the supercomputing technology of tomorrow. However, conventional electronics made better progress than expected, while Josephson junctions ran into technical roadblocks severe enough to cause IBM to abandon the technology. Now, though, room-temperature superconductors may revive the Josephson junction. Electronics has a headstart on optics in experience resources and basic technology. Optics has much promise but will not find it easy to catch up, especially as the threat of optical devices will spur on those who have dedicated their lives to conventional electronics. (This first appeared in New Scientist, London, 1 October 1987, the weekly review of science and technology)

III. MARKET TRENDS AND COMPANY NEWS

Excellent forecast for the semiconductor market

According to a recent report by experts in the sector the world semiconductor market is experiencing a rapid expansion especially in the Far East.

It has been estimated that semiconductor sales at the international level will reach $US 45.2 billion by the end of the decade. It should be recalled that they will reach $US 32.1 billion at the end of 1987 with a growth rate of 21.8 per cent and that they will amount to $US 37.8 billion by the end of next year.

In Europe, semiconductor sales will grow at a steady rate to reach 13.5 per cent in 1980 and $US 6.3 billion in 1990.

As regards the USA, the 1987 growth rate will reach 20 per cent compared with the previous year. In the years to come this rate will diminish slightly, between 6 per cent and 12 per cent, so that by 1990 semiconductor sales will reach $US 14.5 billion.

The Eastern market seems most inclined to experience favourable growth in this sector. According to forecasts, the Japanese market will attain by 1990 $US 17 billion with an annual rate of growth similar to that of the United States.

But the largest increase will be seen in the Middle East where, over recent years, an electronics industry has managed to enter the international market on a very competitive footing and has even created problems on several occasions for the major Western electronics and informatics groups. South Korea, Hong Kong and Singapore seem destined to double their sales from the current $US 2 billion to $US 5.4 billion in 1990.

The figures mentioned above clearly show the important role which the Eastern markets will play in the next few years. This will certainly not make the current disputes any easier to resolve between the American and Japanese semiconductor manufacturers.

An agreement to diminish the opposition which arose as a result of the presumed "dumping" and to avoid the closing of the Japanese market was initialled last autumn. According to the American manufacturers, however, the Japanese have not yet satisfactorily fulfilled the commitments undertaken. (Bulletin IBIPRESS No. 149, 2 November 1987)

The world market of Unix systems

Unix, the operating system of Bell Laboratories, will between now and 1991 occupy 22 per cent of the world market and will have, in Europe, an annual rate of growth of 28 per cent. Unix's greatest penetration is in the sector of small systems and, while it still presents some imperfections, now has all the advantages for becoming a market standard.

In 1981, one system in 100 ran on Unix. This grew to six systems in 1986 and is expected to increase to 22 by the beginning of 1991. The Unix standard was slow to catch on, but today it seems destined to become a market standard. Norms exist for manufacturers, developers and professionals (Unix system V), while for the users the norms (Posix) defined by the standardization body IEEE are expected to be issued in the very near future.

In 1986, the main markets were the United Kingdom (24 per cent value) and FRG (23 per cent), Siemens being the major supplier of Unix in Europe with 43 per cent of the German market, while other major suppliers such as Altos, Bull, Olivetti, Unisys and NCR shared the rest of the market.

As regards the American market, the major suppliers of Unix were ATT, DEC and IBM and, while the United States represents the lion's share of the installed units, growth is now less rapid than in the rest of the world.

Unix's penetration is currently very high in the field of education and administration, while its penetration is reduced in agriculture, mining, construction and distribution.

Unix is still suffering from weaknesses in certain areas: real time and lack of file security and protection. (Bulletin IBIPRESS No. 151, 16 November 1987)

The future market of desk-top computers

In 1990 Europe will boast a desk-top computer market of around $US 1.9 billion, equivalent therefore to 1,615,000 installed units.

According to the research conducted by Frost and Sullivan, Europe is at the point of full development. The sales for 1986 amounted to $US 396 million, representing 212 thousand units. In 1987 it can already be foreseen that this figure will rise considerably with 333,000 units sold for a total value of around $US 588 million, calculated on the constant dollar value of 1986. The reason for this rapid increase lies in the steady improvement of the functions these desk-tops offer and in the constant reduction of costs in this sector. It appears that the prices drop 7.9 per cent on an average every year.

The study has shown that the greatest demand for this type of computer will come in the near future from large industries who will use them for their own staff, in particular their salesmen. Small firms who will see that large computer capacity can be combined with portability are a further category of users which will help to boost this market. (Bulletin IBIPRESS, No. 148, 27 October 1987)

Euro transducers on the up

Transducer sales in Europe are set to soar over the next five years to produce a market worth £2.56 billion.

Frost and Sullivan, the market research firm, says in its report, The Transducer Market in Europe, there is a vast market for transducers of all types in Europe.

Demand for serious transducers such as pressure transducers, which are the only thing between us and another Chernobyl catastrophe, will be backed up by demand for less serious devices such as those used for controlling gizmos on car dashboards.

The study covers 25 different types of transducer used across Europe and took the "hidden" market into consideration. "The open or available portion of the market runs at less than half the total: In 1987 for example 44 per cent of the market will be free for trade," says the report. The rest are prespecified in a captive area, it adds.

Breakdowns in the report which are by geography and type show the FRG leading the way with more than 27 per cent of the 1987 total. Next comes the UK with 17 per cent, with France in a strong third with 16 per cent. The rest of the total is made up jointly by the rest of Europe.

By product type pressure transducers make up more than 30 per cent of all devices with the most popular type in that group being strain gauges. The next most popular are semiconductor types.

The report costs $2,650 from Frost and Sullivan, Sullivan House, 4 Grosvenor Gardens, London SW1. (Electronics Weekly, 14 October 1987)

Microcontrollers

The market for microcontrollers is going like a house afire as the number of applications explodes for these cost-effective devices. Semiconductor vendors from around the world are, as a result, investing major resources into a potpourri of new and improved products, and they are developing a wide variety of new strategies and technologies to set off their new chips from the crowd and grab as much market share as they can.

Worldwide sales of single-chip controllers now stand at 500 million units worth $1.6 billion; after a gradual rise to 555 million units and $1.77 billion in 1988, the market will begin to overcome design-in lag and could shoot to 1.25 billion controllers worth almost $3 billion by 1991, according to estimates by Dataquest Inc. of San José, California.

The most exciting segment of the market is the high end, the 16-bit parts for computationally intensive real-time jobs. This segment got off to a slow start in the early 1980s but is now rocketing at a compound annual growth rate of over 90 per cent, and the number of alternatives the customer has to choose from is expanding quickly. Until last year, Intel thoroughly dominated the 16-bit microcontroller market with its 8096; the only other major competitor was Mostek's MK68200. Since then, however, 16-bit chips have appeared from Harris, NEC and National Semiconductor. Texas Instruments is expected to jump in and it already has some design wins for controller applications handled by its 320-series digital signal processor. Intel is looking to defend its market position with the new 80C196.

However, the market for the older 4- and 8-bit microcontrollers is not being neglected; its growth prospects are still considerable. There are many more players already working this territory, so they are scrapping it out, looking for ways to reduce the cost, speed up the programming turn-around time and enhance both the performance and flexibility of their offerings. There is a trend towards parts optimized for particular applications and market segments, both in terms of hardware features and modified instruction sets. There is also a growing movement towards incorporating these designs - and some 16-bit parts - into standard-cell libraries as core cells or megacells, as National is doing with its 16-bit HPC16000.

At both the high and low end of the market, not only are companies introducing second-generation entries to strengthen their positions, but some are shifting from their roles as second-source suppliers to making proprietary new designs, notably Siemens and SGS. Newcomers such as Seeq Technology, Catalyst Semiconductor and Sierra Semiconductor are seeking to establish a presence with niche-oriented offerings.

The intense action at the 16-bit level - a wider variety of new architectures, new strategies and new players - is a response to the tremendous market opportunities in view. High-end 16-bit microcontrollers, says Patricia Galligan, an industry analyst at Dataquest, are designed for use in computationally intensive real-time control applications requiring the execution of some sort of algorithm, such as instrumentation, process and machinery control, robotics, data communications and in various automotive areas such as engine control and antiskid braking. The 16-bit parts are also expected to find wide use in computer peripherals and military systems.

After a sluggish start while designers caught on to how well these parts handle extremely demanding tasks, the growth rate in the 16-bit segment is now accelerating hard, from $4 million in 1985 and $8.7 million in 1986 to an estimated $32 million this year, and should explode to about $230 million by 1991, says Galligan. However it is not just the growth that is leading major semiconductor companies to focus on this market, she says; they see that there is still room for capturing a major share of the market, if not leadership. "Until mid-1986 there were only two main players, Intel and its 8096 and Thomson/Mostek with its microcontroller variant of Motorola's 68000 architecture, the MK68200," says Galligan. Up to the end of 1986, she says, Intel held a dominant 67 per cent of the market, to Mostek's 33 per cent share. But this could change by 1988, with the entry of 16-bit products from Harris, Hitachi, NEC, National Semiconductor and possibly Motorola and Texas Instruments as well.

Intel Corp., Santa Clara, California, is moving to defend its position in the 16-bit controller market with the second-generation 80C196, which has an enhanced architecture and a feature set that allows performance improvements of 50 per cent to 200 per cent.

Despite its strong showing to date, Mostek's 68200 has had a rocky history since its introduction in 1983 as an n-channel part. In April of this year, a higher-performance CMOS version, the MK68HC200, with a modular die layout for easier tailoring for custom applications was introduced - only to be shelved by the Mostek subsidiary of Thomson Components as the mother company and SGS completed their merger. Depending on whether a second source can be lined up, the CMOS version could be back on the market again in 1988.

There are other new 16-bit players. National Semiconductor has moved squarely into the 16-bit market with the HPC16000 series of high-performance controllers, which will be available both as standard parts and as components in a cell library. Already in production with parts aimed at automotive and industrial applications, National is gearing up to produce its next round of standard parts targeted at colour graphics, Ethernet communications, and Integrated Services Digital Network applications. Also in the works is a version with an on-board gate array.

Also competing for 16-bit sockets is NEC Corp. with its V25. Built around an internal 16-bit address bus, the V25 uses an 8-bit external data bus and combines the instruction set of the 16-bit V20 microprocessor with many of the on-chip peripherals and features found on NEC's 8-bit 78000 microcontroller series.

Harris Semiconductor, Melbourne, Florida, is setting its 16-bit entry off from the crowd with a highly unconventional approach. The company will introduce early next year a real-time 16-bit control-oriented processor built around a Forth-language-based architecture licensed from Novix Inc. of Cupertino, California. Harris has developed a Forth-optimized reduced-instruction-set computing-engine core which together with a variety of supporting building blocks will be used to build the real-time controller. In addition to the Forth-based core, the controller will incorporate a proprietary 16-by-16-bit multiplier, on-chip RAM and ROM, and three 16-bit counter/timers. By mid-1988, the core processor and building blocks will be available as part of a cell library based on a 2.0-μm CMOS process.

Motorola Inc. is also working hard on an entry for the high-end 16-bit area but is not ready to reveal details. The chip is, for the time being, known as the 68HC16; according to Steve Marsh, director of applications engineering, "it has consumed nearly the majority of our design resources". He will add only that Motorola probably will unveil it within the next six months.

Another company due to announce a chip with at least some 16-bit characteristics is TI. Although it has not made any public admissions, TI is expected to offer next year an extension to the TMS7000 microcontroller line dubbed the "road runner". It will be a CMOS 8-bit microcontroller with some 16-bit processing elements. It will be upwardly compatible with the 7000-series software. It will also have on-board EEPROM for self-configuration capabilities, plus features that will support semicustom configurations.

For numerically intensive real-time applications requiring digital signal processing, TI is successfully selling its 320 DSP family against conventional 16-bit microcontrollers such as Intel's 8096, despite the fact that control was not the 320's original target market. TI is now selling DSP chips for control jobs with a companion 8-bit controller. In the future, it will likely introduce some 16-bit DSP chips with enough peripheral logic to make them single-chip controllers.

Although the more mature 8-bit microcontroller market has a less dramatic growth rate, the total sales numbers keep the traditional players in the game and continue to attract newcomers. Dataquest's Galligan expects annual worldwide sales to grow more than threefold, from 250 million units to more than 750 million in 1991, while dollar values will more than double, from about $1.1 billion a year to almost $2.2 billion. The main markets for such devices are in home entertainment, appliances, air conditioners, and games, as well as non-real-time applications in industrial controls and automobiles.

Even though the 8048/8051 architecture invented by Intel constitutes more than 30 per cent of the sales of all 8-bit microcontrollers worldwide - ahead of Mitsubishi with 16 per cent and Motorola's 6805 with 15 per cent - Intel has lost control of its own architecture to a variety of competitors with second-source rights, including NEC, Toshiba, Phillips/Signetics, Oki Semiconductor and Siemens. (Reprinted from Electronics, 1 October 1987, pp. 55-57, copyright 1987, McGraw-Hill Inc., all rights reserved)

Japan's TRON* tactics

TRON stands for The Real-time Operating Nucleus, the object of Japan's national research project to develop a new, all-Japanese, operating system. The results of the research project are now being implemented in products that, over the next few years, may have a huge impact on the fast-growing workstation markets in Japan and abroad.

TRON began life in 1981 when Prof. Ken Sakamura of Tokyo University's information science department developed the basic TRON architecture with the help of graduate students and computer researchers. In June 1984, a TRON association was formed, under the auspices of the Japan Electronic Industry Development Association (JEIDA), to push the development of commercial TRON products. Sakamura was chairman of JEIDA's microcomputer application committee at the time. Fujitsu, Hitachi, Matsushita, NEC, NTT, Oki and Toshiba are now among the members of the association, which costs ¥500,000 ($3,450) to join.

At its present stage of evolution, TRON architecture is divided into several distinct layers. The association merely defines the specifications. Manufacturers are then free to implement TRON systems in any way they choose.

At the most basic level is the instruction set processor (ISP). This is a 32-bit microprocessor that can execute a specified instruction set and is the actual nucleus for which the TRON name was chosen. Two operating system kernels - ITRON, for industrial applications, and BTRON, for business applications - will be able to run on the ISP. There is also a CTRON (central) kernel specification, designed for large (non-ISP) computers used as central file servers. Communication among all of the TRON types will be through MTRON (macro) kernels residing on each machine. TRON's highest level is the applications and man-machine interface layer, while an OS shell fits between this and the OS kernels.

The advantage of the TRON architecture, claims Sakamura, is that it is "tailored to take advantage of the technology of the 1990s," especially high-density VLSI fabrication techniques. More important, it was designed from the start as a 32-bit architecture, with provisions for future upward compatibility to 64 bits. This will make TRON chips much more efficient than current commercial 32-bit chips, which must maintain backward compatibility to 8-bit or even 4-bit versions, asserts Sakamura.

In addition, the ISP specification contains some instructions specifically designed for multitasking, multiwindow applications, such as context switching, bit map manipulation, and queue manipulation. Two-byte coding, necessary for representing Japanese ideographic characters, as well as other languages, such as Chinese and Arabic, is also a standard feature rather than an inefficient add-on.

TRON specifications will extend far beyond coding, however. Even such things as the keyboard bulging surface with keys arranged in curved lines, and alternate graphics input by electronic pen, have been decided on. In the longer term, Sakamura also envisions the extension of TRON specifications to cover the man-machine and machine-machine interfaces, both hardware and software, for virtually all home and industrial appliances, including optical disks, VCRs, and robots.

One of its biggest selling points is that TRON is an open architecture available without charge - other than the association membership fee - to anyone who wants to use it. The only requirement is that those wishing to display the TRON trademark must submit their products to be verified for conformance to the TRON specifications. It is not limited to Japanese companies - any foreign company can join the association and will receive equal treatment.

TRON has received an enthusiastic reception from the big names in Japanese computers. Mitsubishi, Hitachi, and Fujitsu are co-operating to develop a three-level set of TRON microprocessors. Mitsubishi's M/32-100, still a working name at the moment, will be a 4.5 MIPS chip for PCs and business workstations. The 6 MIPS Hitachi H/32-300 is targeted at engineering workstations, while Fujitsu's F/32-300 will average 12 MIPS with a 20 MIPS peak speed and will be aimed at top-end business workstations.

The three companies have worked out performance specifications and are writing the chips' documentation together, but they are developing the simulation logic and circuit layout patterns individually. Fujitsu and Hitachi have been working together since October 1986; Mitsubishi joined in spring 1987. Initially, the Hitachi version will be the standard; after it is de-bugged, all three companies will manufacture the chip from the same mask patterns. Matsushita and Toshiba are developing TRON chips independently.

The most important strategic point, however, may not be the overall TRON architecture itself but one of its features: its division into layers. This means that the TRON chip can run a non-TRON operating system, while TRON OS kernels can run on conventional chips. In fact, the latter has already happened. Matsushita has introduced a prototype BTRON personal computer based on the 80286 chip because its TRON chip is not yet ready. NEC is developing an ITRON OS to run on its proprietary V60 processor.

Industry executives downplay the point. Declares Hitachi's Ikeda, "We are producing the chip and the OS as a single project. By taking this approach, if there are chip and OS interface problems, we can modify the chip itself." The possibility of interchangeable operating systems has serious implications, particularly in the light of the persistent questions about TRON's propagation outside of Japan.

On the one hand, there is Prof. Sakamura's optimistic outlook. One of the most appealing aspects of the entire effort, in fact, is his idealism in promoting the new architecture as a sort of Japanese gift to the rest of the world. "I am sorry to say that the extent of Japan's contribution to industrial standardization in the world does not match its industrial clout," declares Sakamura. "I would like to see the trend reversed, at least in the case of computer architecture." He sees the TRON project as a manifestation of the spirit of volunteerism, contributing to society as a whole. "I sometimes describe the TRON project as a volunteer organization like the Red Cross," he says.

The companies are not so idealistic, however. They appear, in fact, to have little hope that the TRON OS will become important overseas. Both because of Motorola's strength and AT&T's plans to deliver Unix for the Intel 80386, "I think Unix will become

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* See also Microelectronics Monitor No. 22, p. 34.

dominant in the world market in the future," says Tsuyoshi Watanabe, general manager of Fujitsu's microcomputer development division. Accordingly, Hitachi and Fujitsu are creating a version of Unix for their TRON chips for delivery next spring. It's uncertain whether a single machine with a TRON chip will be able to run both Unix and a TRON OS, or if there will be some minor hardware differences. The target markets are certain, however. "Our - Hitachi and Fujitsu's - main target of Unix is for the US," says Watanabe. "The TRON OS main target is Japan."

If Watanabe's version is borne out, it will give Japan a competitive advantage. At home, its workstation market would become less penetrable, since it would be dominated by a unique operating system. Foreigners would find it difficult and financially unrewarding to create TRON-compatible hardware and software. On the export side, Japanese manufacturers would have a high-speed chip running an industry-standard operating system, around which they could build their usual outstanding, low-cost hardware. This would give them a hot product for the overseas Unix workstation market.

On the other hand, if Prof. Sakamura gets his way, the complete TRON architecture will be spread throughout the world as Japan's contribution to the development of the computer. The TRON association is considering making and distributing short promotional movies in various languages to explain to the world the role it envisions for TRON in the computer industry as a whole.

Either way, if TRON is a commercial success, it is likely to have a major impact on the world workstation market. (Reprinted with permission of DATAMATION ^r^ magazine ^c^, 1 October 1987, pp. 76-21/24, copyright by Technical Publishing Company, A. Dunn and Bradstreet Company - all rights reserved)

DATAMATION's Japan 10

1986 RANK	1985 RANK	COMPANY	OWNERSHIP	1986 JAPAN DP REV ($ MIL)	% CHG ($ U.S.)	% CHG (YEN)	1986 TOTAL DP REV ($ MIL)
1	1	Fujitsu Ltd.	Japan	5,457.8	54.7	9.5	6,575.7
2	2	NEC Corp.	Japan	5,122.9	72.8	22.3	6,324.6
3	3	IBM Japan Ltd.	U.S.	3,821.1	38.1	-2.2	40,591.0*
4	4	Hitachi Ltd.	Japan	3,896.7	62.2	14.8	4,728.8
5	6	Toshiba Corp.	Japan	1,978.8	53.8	8.9	2,085.0
6	5	Matsushita Electric Industry Co.	Japan	1,632.9	41.5	0.2	1,944.0
7	7	Nippon Telegraph & Telephone	Japan	1,168.5	51.9	7.5	1,168.5
8	8	Mitsubishi Electric Corp.	Japan	1,102.9	45.8	3.3	1,345.0
9	10	Nippon Univac Kaisha Corp.	Japan/U.S.	905.9	55.6	10.1	905.9
10	9	Oki Electric Industry Co. Ltd.	Japan	668.5	7.3	-24.0	879.6

* Includes parent company revenues.

(Methodology

The 1986 Japan 10 survey was compiled exclusively by DATAMATION from information culled from its in-house database, which tracks the results of over 200 companies worldwide. All revenue and earnings figures have been adjusted to calender year calculations and converted to US dollars using the OECD average exchange rate for the year.) (Reprinted with permission of DATAMATION ^r^ magazine ^c^, 1 September 1987, copyright by Technical Publishing Company, A. Dunn and Bradstreet Company - all rights reserved)

National Semiconductor buys Fairchild

American semiconductors

America's efforts to keep Japanese high-tech firms from its shores have had strange results. One of the few winners is National Semiconductor, a chip maker. This week it bought rival Fairchild for a bargain $122 million.

Together with the recent $425 million merger of Advanced Micro Devices with Monolithic Memories, the Fairchild deal could be the beginning of a period of consolidation within the American chip industry. Although some product-pruning is inevitable, the addition of Fairchild's $510 million in 1986 sales to National's $990 million should create the world's sixth largest chip company - after Japanese giants NEC, Hitachi, Toshiba and fellow Americans Motorola and Texas Instruments - but only a tenth of NEC's size.

The seller, France's Schlumberger, will take a $220 million after-tax loss on the sale. Despite flashy technology, Fairchild has provided nothing but grief for Schlumberger since they paid $425 million for it in 1979. National's boss, Mr. Charles Sporck - who ran Fairchild's manufacturing operations from 1959 to 1967 - reckons he can turn things around. National is already in better shape: in the quarter to June 1987 it earned its first profits since 1985.

America's computer-makers have no reason to cheer the protectionism that brought Mr. Sporck's coup. In late July America's customs men decided to classify circuit boards (with central processors stuck in) as unfinished computers rather than parts. This change could cost computer-makers hundreds of millions of dollars a year.

It will allow the customs men to charge 10% per cent duties on all such products imported from Japan and Canada, while computer parts imported from those two countries are exempt from duties. It also makes some "computers" imported from Japan liable for the 100 per cent duties originally devised to punish the profitable product lines of Japanese firms that were supposed to be dumping microchips. Unless they can strike a deal with customs, this change could punish IBM along with the Japanese. (The Economist, September 1987)

* * *

America is losing a chip-making pioneer that played a key role in shaping the industry. But it is gaining a semiconductor giant with all the makings for world-class stature, potentially commanding chip sales of $1.7 billion in 1987.

Taking over Fairchild's technologies, product lines and businesses would instantly cause National to:

- Climb from 11th in total worldwide chip sales to the No. 6 spot.

- Jump from No. 6 in military chip shipments to undisputed market leader, giving the combined company at least a $100 million lead over its closest competitor.

- Leapfrog Texas Instruments Inc. and Hitachi Ltd. to become the No. 1 supplier of analog circuits.

- Shoot up three places to second in total bipolar sales with the addition of Fairchild's strength in high-speed bipolar logic.

- Rise to No. 3 in emitter-coupled logic shipments behind Motorola Inc. and Fujitsu Ltd. with a boost of $75 million in Fairchild products added to its own $20 million annual volume.

- And move up from 13th to No. 7 in gate-array shipments with a combined total of $90 million. (Electronics, 17 September 1987)

How National climbs the rankings by buying Fairchild

Total semiconductor sales

Ranking	Company	1987 sales ($ millions)
1	NEC	3 090
2	Toshiba	2 825
3	Hitachi	2 450
4	Motorola	2 270
5	Texas Instruments	2 220
	National/Fairchild	1 700
6	Philips	1 550
7	Fujitsu	1 390
8	Matsushita	1 370
9	Intel	1 230
10	Mitsubishi	1 125
11	National	1 120
-	Fairchild	580

Analog semiconductor sales (1986)

Ranking	Company	Sales
	National/Fairchild	400
1	TI	325
2	Hitachi	320
3	National	300
-	Fairchild	100

Military IC sales

Ranking	Company	1987 sales ($ millions)
	National/Fairchild	273
1	AMD (with MMI)	170
2	TI	160
3	Harris	160
4	Fairchild	155
5	General Electric	125
6	National	118

Bipolar semiconductor sales

Ranking	Company	Sales
1	TI	1 300
	National/Fairchild	945
2	Philips/Signetics	780
3	Motorola	785
4	Hitachi	725
5	National	610
6	NEC	600
7	Fairchild	335

Source: Integrated Circuit Engineering Corp.

(Electronics, 17 September 1987)

More and more chip-makers are expected to merge

Industry observers expect to see more merger action among semiconductor manufacturers soon. They think companies around the world are very likely thinking hard now about making key acquisitions to avoid losing market-share standing.

The purchase of Fairchild Semiconductor Corp. by National Semiconductor Corp. provides a sterling example of why this is happening: National was No. 6 in military chip sales and Fairchild was No. 4, but by combining forces a company that is No. 1 in military markets - by far - is created. The recent merger of Advanced Micro Devices Inc. with Monolothic Memories Inc. builds a company that is No. 2 in military sales, but still slightly ahead of the two former leaders in this segment of the marketplace, Texas Instruments and Harris.

Making the merger mood more urgent is the limited number of viable combinations. "Semiconductor companies will start wondering - if they do not make a purchase, then someone else will," suggests Richard Skinner of Integrated Circuit Engineering Corp., a Scottsdale, Arizona, market analysis company. "Look at TI. This National-Fairchild combination puts National in roughly the same ballpark. If everyone else is out buying, you had better be out there buying too. Just like that, you could drop from No. 5 to No. 10 because of mergers."

ICE estimates that former military-chip leaders TI and Harris will achieve $160 million each in 1987 military sales. The AMD-MMI combo is expected to rack up $170 million in this market segment in 1987, with $135 million coming from AMD, while the National-Fairchild total is expected to hit $273 million.

"We might see more acquisitions as opportunities present themselves, but I do not think Motorola or TI should panic just yet," says ICE's Bill McClean. Strategic alliances with smaller chip-makers are an alternative to the cost of a merger, he says. "TI is approaching it that way - with alliances to gain access to the technology without having to take on a business."

The track record for chip-company acquisitions has been dismal in the 1980s, but financial analyst Michael Gumport of Drexel Burnham Lambert Inc., New York, thinks the failures can be blamed on the purchasers. "All the purchases by non-semiconductor companies - Schlumberger's deal for Fairchild, United Technologies Corp.'s for Mostek, Exxon's for Zilog, and so on - have ended up terribly. I think these more recent ones [by chip companies] will work out much better."

By nearly all accounts, there are likely to be fewer semiconductor companies by the end of the century. Jack Beedle of In-Stat Inc. in Scottsdale, Arizona, predicts there will be only 10 to 12 giants shipping semiconductors, with 75 other smaller chip houses serving niches. "The big are going to get a lot bigger," he says. "The giants will have to be $3 billion to $4 billion in size. There will probably be four of those in Japan, four in the US, and a couple in Europe." Beedle thinks it is possible that the industry will see several attempts by corporate raiders to buy up chip houses and turn them into candidates for a surviving giant. "It's happened in the retailing and oil industries - why not here?"

Acquisitions also present one way of heading off legal tangles when strategic alliances turn sour. "Every US manufacturer is having to decide whether it can afford to go solo or find a way of sharing the cost of business by alliances or mergers. It seems a safer course to buy up some company when you look at the recent legal tangles of intellectual property or ownership, like the AMD-Intel scrap," notes Michael Boss of Dataquest Inc. in San José, California (Reprinted from Electronics, 17 September 1987, p. 44, copyright 1987, McGraw-Hill Inc., all rights reserved)

The battle between IBM and Fujitsu ends

The great dispute between the Japanese electronics company Fujitsu and the American group IBM seems to have been resolved. With the help of the American Arbitration Association an agreement has been reached which will set out the form of compensation and collaboration between them.

The Japanese manufacturer was accused by the American firm of violating copyright due to the fact that the Japanese group had used the OS compatible systems on its own computers. Fujitsu based its defence on the fact that until 1978 IBM had marketed its software unpatented and it therefore had no legal protection under copyright laws.

The arbitrators have decided that Fujitsu should pay a sum which has not yet been fixed but which, according to official sources, should be in the region of hundreds of millions of dollars. In exchange the American group will renounce all the legal claims on the products sold by Fujitsu since 1983.

For the next 10 years, moreover, once copyright has been paid, each company will be able to access information on some 1,000 software programmes of the other company. Both of them will be able to consult the documentation regarding the architectures of products about to be created by the other. They will also stipulate an agreement regarding the possibility of using each other's operating systems on their own machines.

This will make it possible for Fujitsu to develop compatible systems, but under the strict control of IBM. According to the statements made by IBM, it has the firm intention of seeing that the directives set down under the arbitration are respected to the letter and that any interference on the Japanese side is avoided.

It would seem therefore that the objective of the Arbitration Association in this long dispute has been reached. It wanted, on the one hand, to ensure the protection of IBM's copyrights and, on the other, to create the conditions for boosting world competition in the mainframe market. (Bulletin IBIPRESS, No. 146, 12 October 1984)

Chip firm thwarts IBM clone clobberer

IBM's attempt to produce a range of unclonable personal computers may have been dashed on the rocks with the launch by US chip house, Chips and Technologies, of a chip set for the bottom of the range computer.

In April, IBM announced a new range of four PCs called Personal System 2. It was its biggest effort yet to clobber the clones which had been taking an increasing share of its business. IBM had hoped that, by using a good deal of proprietary hardware, it would deter the clones.

But Chips is now claiming it has cloned the chip set for the bottom of the range Model 30, and that it has actually rated it 25 per cent faster. Industry sources suggest that Chips is also working on a clone for the more up-market Model 50. IBM's version runs at 10 MHz, but Chips' - expected to be introduced in November - is likely to run at about 16 MHz.

Chips has lined up two European silicon foundries, SGS of Italy and Thomson of France, to provide local sources for its chip sets. That will allow European clone-makers to buy Chips', chip sets without having to pay the 14 per cent EEC tariff.

Between 1985 and 1986 IBM's profits plunged by nearly 27 per cent and profits fared even worse, dropping by 36.8 per cent. The launch of the "unclonable" PS2 was an important strategic move to differentiate its products and stamp out competition. Its failure may have serious implications for IBM's future.

Chips' president, Gordon Campbell expects the PS2 to be "the first world-wide standard in the PC area". To that extent the signing of European foundries is a hedge against currency fluctuations which could affect margins where goods are manufactured in one country and sold in another. Chips already uses six Japanese and two American foundries.

Chips is the fastest-growing company in the history of the semiconductor industry. It was founded in 1985 and has just closed its second year's trading to the end of June 1987 with revenues of $80.2 million and a gross profit of $41.7 million. All the money borrowed to start the company was repaid in April 1986. (Electronics Weekly, 26 August 1987)

Chip-makers add to product lines
by Ralph Emmett Carlyle

The word "proprietary" will be popping up a lot at Intel Corp. press conferences over the next nine months as the resurgent chip maker embarks on a new product blitz. The new strategy, if successful, will turn the Hillsboro, Oregon-based Intel into a predominantly systems company by 1991, as well as put it on a collision course with Digital Equipment Corp. Intel believes it has found a way to minimize its exposure to the violent cyclicity of the semiconductor business and to Japanese competitors.

"We are only interested in products we can run with for a long time without attracting competition," says Ed Slaughter, general manager of the Intel Development Organization (IDO), who is in charge of beginning new businesses for Intel. The company spent over $100 million to develop its 386 micro - an investment comparable with that made by computer companies developing a large-scale operating system.

"When you spend that kind of money, you do not want to sell your chip at $5", notes Slaughter, whose three IDO divisions are busy assembling a proprietary architecture aroung the 386 that could prove to be a potent weapon for Inte's biggest customer, IBM, to use in its battle with DEC to build corporate networks at large commercial sites.

Intel's Fastpath, a high-speed control unit that links mainframes to LANs, peripherals and other hosts (such as the VAX), was the first product chosen by IBM for its Industry Marketing Assistance Program, and it has provided the chip maker with a useful entrée to the IS shops of large corporations. Extensions to this mainframe connectivity platform and related networking enhancements for the 386 will be among the new products in the coming months. Company sources add that a new version of Intel's supercomputer, the massively parallel Cube family, will emerge next year.

While some companies are attempting to broade. their product lines to balance losses in what Slaughter refers to as a "no-profit contest for market share with the Japanese", long-time leading US chip-maker Texas Instruments has something much more radical in mind. If Intel's goal is to seek the higher ground of a systems business, Dallas-based TI is intent on finding shelter from the storm in the software business - and, as with Intel, the ubiquitous IBM could play a pivota' role in its plans. Since 1976, TI has developed what is generally regarded by experts as the largest single-image communications and computing network in the world. Single image refers to the fact that terminals on the TI net can gain access to multiple users simultaneously.

Today, TI is pumping millions of dollars a month into the creation of expert system and artificial intelligence software that is being embedded into the network to turn data into useful information and automate the semiconductor development process from design to the time when the customized chip reaches its destination.

One spin-off from TI's pioneering efforts in AI has been a family of CASE tools that it says will enable typical MVS shops to reduce their applications development cycle time by a factor of five, and to bring about a sixfold increase in software development productivity. Early beta sites polled by DATAMATION, such as Amoco Oil of Chicago, have been very enthusiastic about the new software family, called Information Engineering Facility (IEF). A new version of IEF for IBM's VM customers will be forthcoming, and IBM - which has nothing comparable to IEF - may enter a joint marketing arrangement with the chip-maker.

Chip-makers diversify

Intel Corp.
Hillsboro, Ore.

Microcomputers
Network software
Network design and integration
Supercomputers

Motorola Inc.
Schaumburg, Ill.

Cellular switches via Codex subsidiary

National Semiconductor Corp.
Santa Clara

POS terminals
IBM plug-compatible mainframes (marketed by subsidiary National Advanced Systems)

Texas Instruments
Dallas

Artificial intelligence
Expert systems software
CASE tools
Factory automation

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Is US losing ASIC market also?

The application-specific integrated circuit (ASIC) market is considered by many to be the last bastion of hope for US semiconductor manufacturers in their battle with foreign competitors. Now a report from Integrated Circuit Engineering Corp. (ICE), Scottsdale, Arizona, shows that three of the top five world-wide ASIC suppliers in 1986 were Japanese firms (Table 1).

Table 1: 1986 ASIC sales leaders
(Account for 41% of the total ASIC sales)

Rank	Company	Sales ($M)
1	Fujitsu	309
2	LSI Logic	190
3	NEC	167
4	MMI	150
5	Toshiba	120
6	TI	112
7	Ferranti	101
8	Motorola	89
9	Signetics*	59
10	VTI	51

* Does not include Philips.

According to the report, the top 10 1986 ASIC vendors included five US manufacturers, but European and Japanese vendors accounted for over 50 per cent of the top 10 sales volume.

ICE forecasts that the average annual growth rate for ASICs will be 24 per cent through 1991; in 1991 ASICs will claim one out of every five dollars spent on ICs. "However, profits for ASIC vendors are not assured, as there are many pitfalls in the ASIC marketplace," says ICE's Dean Winkelman. "In one example, plummeting prices caused by competitive pressures forced manufacturers MMI and AMD out of the CMOS gate array market."

According to information from Winkelman, AMD will most likely be vaulted into the top five portion of the ASIC listing during 1987, due to the company's merger with programmable logic device sales leader MMI, who is currently number four.

"Surprisingly," says Winkelman, "TI is currently the only top 10 ASIC vendor to have significant sales in three major ASIC categories - gate array, standard cell and programmable logic. Fujitsu and LSI Logic have displayed market strength in bipolar and CMOS gate arrays, respectively. Meanwhile, TI and VTI occupy the top 10 listing primarily because of strong standard cell sales." (Reprinted with permission from Semiconductor International Magazine, August 1987, Copyright 1987 by Cahners Publishing Co., Des Plaines, Il. USA)

Motorola cash for ASICs

Motorola is spending millions of dollars to win a major slice of the growing application-specific IC market. So far its efforts have been most successful in bipolar gate arrays, where it is the world's third largest supplier. Now it has trained its sights on the CMOS gate array and standard cell business.

At present Motorola can offer up to 8500 gates using a 2-micron HCMOS process. In December it will introduce products from 5,500 to 100,000 gates which will run on a 1.2-micron three-layer metal process.

In standard cells the company has launched its first core cell for application-specific microcontroller chips based on the 6805 microprocessor.

It will execute the standard 6805 instruction set, said Motorola's Mark Shaw. The company will offer support tools including an evaluation board, a simulation model of the 6805 which runs on work stations and a 68-pin grid array evaluation device.

To back up the product offerings Motorola is setting up a network of design centres in Europe. The UK centre is already established in Aylesbury, and it is currently being expanded. Independent design centres, including distributors, will be appointed early next year.

In addition, Motorola is planning to qualify Portsmouth Polytechnic and Leicester University (UK) as approved training centres for customers to learn about Motorola ASIC products and the supporting design tools. (Electronics Weekly, 14 October 1987)

ES2 opens its French wafer fab*

European Silicon Structures (ES2), the pan-European chip company, opened its wafer fabrication in Rousset in the south of France which produced its first silicon in September, one year after building work began.

At the same time, ES2 announced a desk-top chip design system called Solo 1200. With it the systems engineer can design a chip without making mistakes

* See also Microelectronics Monitor No. 23, p. 17)

because the system incorporates an expert system called Design Manager which eliminates errors, according to the company.

From completion of the design ES2 said it can produce prototypes in two weeks. "We anticipate that most of our customers will be satisfied with four weeks," said Robb Wilmot, chairman of ES2.

The company has completed 60 designs and is now designing at a rate of 200 a year with a financial run rate of $10 million a year. Nearly a half of that figure is accounted for by sales of software and software-related tools.

Wilmot said he is anticipating a design rate of one a week in 1988, a financial run rate of $30-40 million by autumn of next year and break even by mid-1989.

The company has picked up its first design, won in Japan by its partner called Best, a subsidiary of Mitsui. Wilmot reckons the company has built the largest custom chip (1.1 cm a side) the fastest delivered custom chip (two weeks) and has put the most designs on one wafer (28).

Wilmot reckons the company is already taking a quarter of the full custom designs on offer in Europe. He reckons that will be up to 30 per cent next year. (Electronics Weekly, 14 October 1987)

US makers chip in for a raid on the market

The race is on in the US to develop the first of a new generation of fully automated flexible manufacturing processes capable of making a variety of microchips. The aim is to restore the US advantage in chip-making in the face of competition from Japan and South-East Asia, but the use of such techniques could also help boost the efficiency of US manufacturing. Because such techniques are unlikely to be licensed to foreign companies, the implications could be profound not only for competitors of the US in Europe and Japan but also for the newly industrializing countries such as South Korea, Brazil and China.

The initiative was launched earlier this year by Semiconductor Manufacturing Technology, a research co-operative comprising 14 top US chip manufacturers including IBM, Texas Instruments and National Semiconductor. Between 30 and ..) leading chip-makers are expected eventually to join the estimated $US 1.5 billion venture.

Since the early 1970s US manufacturing has been losing out to competition from Japan and the newly industrializing countries, reaching a $US 132.3 billion deficit on balance of trade in 1986. The situation is particularly acute in electronics, a $US 250 billion a year industry employing 2.5 million. Electronics is the single largest manufacturing sector in the US, bigger than car manufacturing, aerospace and steel combined.

The semiconductor industry accounts for only 7 per cent or $US 17 billion of the electronics industry's total sales but, as the provider of the basic building blocks, it is the key to success in the electronics and manufacturing industries.

The comparative advantage of the US in semiconductors was huge in the 1950s, 1960s and early 1970s, after which the rot set in. Its share of world manufacturing fell and by mid-1984 it lagged behind Japan for the first time, a situation which is not expected to change in the immediate future, despite Washington's hostility towards Tokyo.

The US decline is partly because of its inability to compete with Japan and South-East Asian economies, which have adopted state-of-the-art automatic fabrication techniques to produce high volumes of high-yield sophisticated custom-designed chips at low cost.

Japan's and South-East Asia's superiority rests on the manufacture of basic chips such as dynamic RAMs which are set to be displaced by more complex and specialized devices.

This is particularly true for Japan, which has invested heavily to gain its present advantage in electronics. A Japanese company, NMB Semiconductor, boasts the world's most sophisticated automatic chip plant.

US industry analysts Dataquest say for such a plant to justify its $US 209 million investment, automation must translate into lower costs through higher yields and reduced production time.

However, Dataquest's research at the NMB plant shows that there is still room for improvement. For the high fixed costs to be recovered within a reasonable time, it is crucial to run such a plant at near maximum capacity. However the plant is operating at just over 50 per cent capacity because of recession in the industry.

Dataquest says that the only way around this impasse is to move away from the highly mechanized fabrication plant, capable of producing only a single or limited number of products, to one which produces a variety of complex devices.

This is at the heart of Sematech's initiative: to develop new flexible manufacturing processes and technologies needed to mass-produce with low rejection rates the types of specialist semiconductor products which are presently aimed at specialized markets and command high prices. The US is aiming to translate into manufacturing efficiency the last remaining area where it has a lead in electronics - innovation.

Sematech aims to develop the new manufacturing process by the late 1990s, but given the large investment required and an unprecedented call for co-operation between rivals in the scheme, the success of the venture is far from certain.

Normally research groups like Sematech would recoup their investment by selling their technological know-how under licence, even to foreign competitors, but given the circumstances of Sematech's creation, these conditions are unlikely to prevail for several reasons.

First, Sematech is a US-only club. Second, half of Sematech's $US 1.5 billion investment is being sought from the federal and state governments, and politicians are unlikely to allow technology partly paid by taxpayers and designed to restore comparative advantage in US manufacturing industry to be sold to competitors.

Third, the US defence department sees the project as a means of preventing the US becoming dependent on Japan and South-East Asia for semiconductor products. The Pentagon is likely to use its influence to deny export licences for Sematech technology on national security grounds.

A Sematech spokesman said: "The technologies would be licensed to US companies not participating in Sematech, but it is not envisaged that they would be licensed to companies outside the US."

How widely available Sematech technologies become will largely be determined by the US Government. So far more than 100 site proposals have been received from 36 State governments and New York State is to promote a $US 40 million bond issue to support the project.

Federal Government funds have still to be pledged, but the Senate has proposed a bill to authorize an initial $US 100 million in aid. With the Pentagon a firm backer, longer-term support is likely. (South, November 1987)

Beating the booby trap in chip designs

It is supposed to be less expensive to build electronic systems with semicustom chips, such as gate arrays, than with off-the-shelf chips. After all, a whole printed circuit board full of standard chips can often be crammed onto one gate-array circuit. So why do so many systems companies continue to stuff circuit boards with regular chips?

The reason is a booby trap, says William Loesch, president of Ikos Systems Inc. More than a third of all gate-array designs are flawed and must be redone. Worse, the mistake is not discovered until after the chips have been delivered. Since a redesign takes 6 to 15 weeks, plus $20,000 to $70,000, many electronics engineers are scared of missing the target date for completing new products. The electronics industry works under gruelingly short product-design cycles that are not very forgiving of delays. So Loesch's three-year-old Sunnyvale (California) company has developed a $55,000 computer that is extremely adept at testing gate-array designs before they are etched into silicon. The Ikos machine, Loesch says, checks a design 150 times faster than even a supercomputer can do it. (Reprinted from the 21 September 1987 issue of Business Week by special permission, copyright 1987 by McGraw-Hill, Inc.)

Second user equipment

Summer brought a welcome period of peace for IBM users, after the unprecedented launch activity of the first six months of the year. Since August there have been only two major product announcements - the triple capacity disc drives and the 8750 switch - both of which had been widely forecast.

Users have therefore had time to take stock and calculate how best to develop their installations. The result has been a major change in second user equipment values, as published in Econocom UK's latest issue of The Guide to the Data Processing Market.*

Most significantly, the prices of 308X mainframes, which held fairly steady throughout the first half of the year, have begun to drop sharply. The top-end 3084QX, for example, has lost a quarter of its value in the past three months: users of these systems have seen their assets depreciate at a rate of £100,000 a month.

Bad news for 308X users, then, but one can almost hear the clinking of glasses in Armonk. The rather desperate policy of scrapping list prices on the 3090E range, adopted earlier this year, appears to be beginning to produce the desired stimulation of sales.

It also means that users of 3090 systems have bad news for their accountants. Econocom notes: "With IBM scrapping the list price on 3090s it has aroused a feeling of uncertainty in the market place concerning its second-hand value.

"Whereas before the market was settling down at around 75 per cent of list price, suddenly there was no 'list-price' on which to calculate market value."

Econocom is for the first time able to publish market prices for three 3090E models, the 150, 180 and 200. They range between 69 per cent and 80 per cent of the last listed prices.

The second major area of change is at the bottom of the 4381 market. The 4381-11 has lost more than half its value in the past three months dropping from £96,000 to £40,000 (compared with the list price of £107,000). In contrast, the top end 4381-14 has held its value at £300,000, around two thirds of the list price.

This presumably reflects the fact that shipments of the 9370 range, announced last October, have now started. With a performance rating of 0.5 to 2.5 mips, the 9370 overlaps the 4381 at the bottom end, while at the top there is no IBM alternative other than an entry-level 3090.

The System 3X market is the most active of all, reports Econocom. The big change here is that the new System 38s (announced in June 1986) are now available in sufficient numbers for Econocom to be able to quote going rates. These are around 65 per cent of list price for small systems and 80 per cent for large ones.

Activity in this market sector has again been stimulated by IBM price cuts. Other factors affecting user plans are the impending arrival of the System 3X successor (code-named Silverlake), and the long lead times quoted by IBM for upgrading System 36 Bs to Ds.

The fourth market area showing significant change is in big discs. The launch of the triple capacity 3380s cannot yet have had an effect - first deliveries are due about now - but the various special offers announced at the same time must have had an impact.

In addition, Econocom observes, IBM is making special offers: "It seems that a volume discount of up to 20 per cent may be available for as small a quantity as one!"

These developments have resulted in 3380E drives falling about 10 per cent in value, with a proportional fall in the going rate for the earlier A and B series drives. Curiously, though, 3380D drive values are holding steady.

The older 3370 and 3375 drives are now down to a couple of thousand pounds apiece, while the 635 Mbyte 3350, announced in 1975, now sells for £150 - just the thing to beef up an Amstrad runn[illegible] out of Winchester capacity!

This issue of Econocom's guide contains two new sections. The first provides a listing of the plug-compatible alternatives to IBM mainframes, from Amdahl and National Advanced Systems. It lists memory and channel configuration options, processor cycle times and mips ratings. System prices and values are, however, curiously missing.

The mips ratings, based on Econocom's own research, are out of line with those published by other analysts. Amdahl will be pleased with Econocom and NAS correspondingly disappointed.

The second addition is a section listing manufacturer and market prices for DEC VAX systems, including peripherals.

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* Each section of the guide is headed with a brief narrative highlighting the major trends during the quarter.

The guide is available free from Econocom, London UK. Interested readers should contact Margaret Bendor on 01-948 8377.

Econocom observes that "as upgrades to the 11/700 range become more expensive relative to the value of these machines, more users are swapping out ... which causes a lowering of the market value".

Econocom is finding the VAX 11/750s and 11/780s are falling in value, and now average just over a quarter of the list price.

Surprisingly, Econocom is able to quote market prices for the 8250 and 8350, launched just six months ago. (Computer Weekly, 29 October 1987)

IV. APPLICATIONS

Academic networks

Still in its infancy, the European Academic and Research Network (EARN), a computer communications network, is now embarking on enforced independence without the comforting support of computer giant IBM. EARN must learn to live with the potentially disastrous tariff policies of some European telecommunications monopolies, earning at least enough income to replace the $15 million provided by IBM over the past four years. Director Dennis Jennings is confident that EARN will stay the course.

Since 1984, EARN has connected more than 2,000 computers in 20 countries, largely with the help of IBM's determination to overcome wildly different standards and attitudes in the host countries. The network now includes Israel, Côte d'Ivoire and Iceland. All members are also connected to US research institutions through BITNET, a US computer network.

EARN's success is measured by its growth. In the Federal Republic of Germany, for example, EARN traffic has doubled every 10 months since the beginning. The Federal Republic of Germany data lines, which carried 2,400 bits per second (b.p.s.) at the outset, have been largely replaced by lines carrying 9,600 b.p.s. and may soon be upgraded to 64,000 b.p.s., already available in many other European countries.

But who will pay the costs when IBM support runs out at the end of 1987? EARN directors decided at Nice in May to adopt the "BITNET model" to fund the lines connecting the various countries. Under that scheme, each user pays for the line leading to its neighbour; the members share the cost of one line to the United States and the other line is paid for by the Federal Republic of Germany.

Because of huge discrepancies in the cost of the international lines, however, several countries are considering shifting their lines out of high-priced areas such as the Federal Republic of Germany and Switzerland. The United Kingdom, for example, is contemplating a shift of its lines from Geneva to Montpélier, France. The Federal Republic of Germany may lose all but one of its five international data lines because its charges are so high. These shifts are not expected to hurt EARN's performance.

Nor do most countries expect difficulty with the transition to self-management. Networks such as SWITCH in Switzerland, JANET in Britain, SURF in Holland and REUNIR in France will continue to belong to EARN. The only problem will be convincing funding bodies to give support to the network. EARN director Dennis Jennings is confident that all countries have established a source of funds, at least for 1988.

One obvious area for improvement is in EARN's carrying capacity. European researchers are envious of the new US network NSF net operating at 1.544 megabits a second. In Europe, Jennings says there are "no plans" to upgrade EARN beyond 64,000 b.p.s.

One of EARN's most important tasks in the transition is to tell whether demand justifies such massive increases in capacity. In some fields, such as computer-aided design, the need already exists; but in areas like the humanities demand will depend on how well EARN can sell itself. (Nature, Vol. 328, 27 August 1987)

UK cargo movement threatened by chaos

The world of import and export could be turned upside down unless computer systems around the UK are rapidly modified to cope with new trade procedures from January 1988.

From that date new documentation will be needed to accompany all international freight movements. Cargo processing is now highly computerized in the UK so unless a long chain of computers is modified in time importers or their forwarding agents will have to resort to manual paper systems. This will hold up cargo at air and sea ports where delays could severely damage their businesses.

"We are very concerned that there are a significant proportion of UK traders who are not sufficiently prepared," said Douglas Tweddle, assistant secretary of HM Customs & Excise Inspectorate Division at the recent Worldfreight exhibition, which is the industry's major annual get-together.

Delays could be considerable. In the days before electronic customs entries, clearance of cargo at Felixstowe port took 24 hours. Today with direct trader input clearance takes four hours.

Customs is concerned that it will be swamped with work if electronic processing fails, and air and sea ports will become congested. "Customs & Excise does not have the resources to deal with everything manually," says Tweddle.

The changes are part of a plan to standardize trade procedures between EEC countries. A new tariff for classifying goods will become standard and the Single Administrative Document will replace the different forms used at present. (Computer Weekly, 29 October 1987)

Paralysis treatment hits the market

Several years ago, a potential breakthrough in the treatment of paralysis aired on 60 Minutes and was the theme of a TV movie. A team at Ohio's Wright State University had demonstrated that electrodes fired by computers can cause paralyzed muscles to move, raising hopes that people with spinal-cord injuries might walk again.

Now, Computerized Functional Electrical Stimulation machines are being manufactured and marketed by Therapeutic Technologies of Alpha, Ohio. Paralysis victims pedal the exercisers; a micro-computer receives feedback from sensors in the machine and controls the electrodes' firing.

Two systems are available. The $36,500 REGYS I (Rehabilitation Exercise Gym System) is most commonly used in hospitals under a doctor's supervision. The $18,800 ERGYS I, which is suitable for home use, can be controlled by a handicapped person. The company has sold about 125 ERGYS machines after nearly 18 months on the market, and about 65 REGYS models since December 1984.

The machines have not taken off as quickly as Therapeutic had hoped. Because the technology is so revolutionary, insurance companies have been slow to approve treatments using the machines, says a company spokesman. In response, Therapeutic set up its own office to process insurance claims. The company expects better acceptance of electrical muscle stimulation as more insurers are exposed to it. (High Technology Business, September 1987, p. 11)

AIDS database available

A database covering documentation on AIDS (Acquired Immune Deficiency Syndrome) has been produced by the London Bureau of Hygiene and Tropical Diseases. The database, which is available on Data-Star, contains bibliographic citations and abstracts. Its main source of information is the joint collection of journals, proceedings, reports and books of the Bureau of Hygiene and Tropical Diseases and the London School of Hygiene and Tropical Medicine, which publish over 1,100 journal titles world wide. Subject areas include the control, transmission and treatment of AIDS and other related human viruses.

The database, however, suffers from a chronic shortage of funds, and expansion plans have had to be temporarily shelved.

For further information on the AIDS database, and how to access it, contact either: David Simmons, Bureau of Hygiene and Tropical Diseases, Keppel Street, London WC1E 7HT, UK (TP+44-1-636-8636); or Daniele Scherf, Data-Star, Laupenstrasse 18, 3008 Berne, Switzerland. (TP+31-659-630)

Information source: Information World Review, No. 13, March 1987. (ACCIS Newsletter, 5 September 1987, p. 2)

Informatics enters the field of pharmaceutics

A new generation of systems very similar to CAD (computer-aided design) used in industrial design, will open new horizons in chemical research and enable researchers to reproduce, on a computer screen three-dimensional figures of molecules of specific substances to be examined.

The examination of molecular structures is generally very complex. The manual reproduction of thousands of rings of a chain containing specific atoms takes a very long time, especially when the structure of the molecules of organic substances has to be modified or at least handled. Such models can be constructed fairly quickly however when software, especially designed on mainframes, is used.

Another advantage offered by computer applications is that of being able to store the data concerning the creation of these new substances as well as other information (such as experimental data, description of the properties of the substances under examination or of other similar substances, the results of clinical tests, etc.) thus facilitating their analysis.

In the area of genetic engineering, in particular, new computerized instruments are being quickly developed and integrated in order to help separate and automatically identify complex molecules, such as those which make up the DNA chain. The processing and storing of data enable the researchers to conclude experiments in a few hours which would have otherwise required months.

New computerized systems are used ever more frequently by pharmaceutical companies for the processes of fermenting, synthesizing or separating substances in order to expand production capacity and therefore the applicability of medications on a large scale. (Bulletin IBIPRESS, No. 149, 2 November 1987)

The Italian textiles sector and how it is changing

In 1986 Italy invested $US 5.5 million in computerized tools and systems for product on control and management. This figure is expected to increase an average of 28 per cent in 1987-1988. Automation is moving into more and more sectors and is gradually revolutionizing the world of textiles. It is no longer the simple, tedious and manual tasks that are being automated today but also the more intelligent ones. The computer is as involved in production and design as it is in the finished product and its distribution. For some major textile firms the computer system is already a genuine production technology vital to the daily running of the firm.

Applications are multiplying in the field of textile production control and these systems are developing considerably both in the spinning and in the weaving processes, etc. Costs, on the one hand, are cut enormously and businesses have become fully aware of the enormous benefits that are to be had from knowing analytically how production is progressing. Production control also offers other possibilities of using informatics with the development of software for production planning, for making the best use of resources as well as for real-time stock management.

Computer-aided design is one of these technological innovations of importance to the textile sector. The advantages, economic and strategic, derived from the possibility of creating designs and variations of the same in the shortest possible time and at a reduced cost are such that a mass distribution of this type of system is expected.

As far as manufacturing process control systems are concerned, a constant effort is being made to find new sensor devices which may be capable of making certain textile characteristics objective and controllable, a task which previously required the evaluation of an expert. (Bulletin IBIPRESS, No. 150, 8 November 1987)

Monsoon dating depends on Cray

The project to achieve accurate forecasting of the arrival of the Indian monsoon season - which would be of great value to India's farmers - is falling behind schedule. And Indian scientists say the reason is the United States' refusal to supply the supercomputer they want.

The joint India-United States monsoon forecasting project is already five years old and the need for a supercomputer to deal with the enormous quantity of data that has accumulated was recognized in 1984. After a study of the programme's needs, Indian scientists at the Meteorological Department asked to purchase one of Cray's top models, the X-MP-24. The US side responded by offering the Cray X-MP-14, a slightly less sophisticated version, even though the original choice had been made after consultation with the US State Department.

Political analysts in New Delhi believe that the possibility that India might use the supercomputer for defence research, or even that the technology might reach the Soviet Union, had alerted hawks in the US State Department and the Pentagon. The State Department points out, however, that India is the first country to be offered a machine as advanced as the X-MP-14.

An Indian technical mission is now once more re-evaluating the project's needs to see if they can make do with the Cray X-MP-14. If not, they may have to consider the purchase of a Japanese or even a Soviet supercomputer, although opinions so far are that neither country produces a computer to match the Cray. (Nature, 6 August 1987, p. 463)

Supercomputers come down to Earth

When a bicycle hits a Volkswagen Golf car the outcome may seem obvious. Not, however, if you are an engineer trying to design a car that mitigates the effects of such a calamity. Until recently, the answer to questions like this could be found only by running a bicycle into a car and filming the results.

The test would normally only be done once and it would probably take a few weeks to set up, record and analyse. Supercomputers, computers tuned to perform the millions of stress calculations involved in such a problem as quickly as possible, enable the collision to rerun again and again at different speeds and angles.

The trouble is that computers capable of reproducing an event like this cost between $5 million and $20 million (about £3 million to £12.5 million). Until now, only large organizations such as oil companies, nuclear research establishments, weather bureaux and the military could afford them.

The picture is changing. Cheaper supercomputers are being mass-produced. Last week, Control Data of the US brought out an air-cooled number-cruncher based on the same technology used in its larger machines, but costing less than $1 million and without the cumbersome liquid-nitrogen refrigeration required by the bigger machines. Although the computer is 27 times slower than Control Data's most powerful machine, it is still a supercomputer, according to the American Department of Energy.

The computer's central processing units consist of a single printed-circuit board with 240 chips on it, arranged on 44 different layers. Cooling, to 77° Kelvin, doubles the performance of the chips.

The ETA 10 P and ETA 10 Q computers are the first supercomputers that can be operated as though they were ordinary business machines. The trouble is that supercomputer applications are being held back by lack of software. The 312 different supercomputers currently in use share few programmes. Some 70 per cent of the software available has been specially produced for individual machines.

Suitable programmes are in such short supply that the behaviour of the Scram jet, a craft intended for use within Earth's atmosphere and outside it, is being modelled by a programme originally designed to study gas flows in space. (This first appeared in New Scientist, London, 22 October 1987, the weekly review of science and technology)

CAME comes to construction

Computer Aided Materials Evaluation (referred to as CAME) represents a growing service to the construction industry, primarily because of the technical advances and cost reductions made in the manufacture of small or micro-computers and their associated equipment. CAME systems can be used extensively for the manipulation and analysis of both existing and generated data, quality and test control, modelling and life predictions.

A paper presented to the UK Institution of Civil Engineers by N. Greig, an Executive Officer with Harry Stanger Ltd., and N. Trigwell, Technical Director of Testwell Ltd., outlines the general principles of such CAME systems, paying particular attention to materials and data manipulation, analysis and data acquisition as well as test control methods.

Materials manipulation and analysis is studied from four basic standpoints: evaluation and data modelling; statistical analysis; quality assurance and quality control.

Computers can be used to perform a very valuable function in evaluating the effects of constituent properties on the end-product, the statistical analyses of the test results and all aspects of quality control. The source of the data fed can be obtained either from standard tabular material or from specific test results. However, a prerequisite for the design of such programmes is a sound understanding of the underlying materials technology and service conditions.

The purpose of an application may be either to optimize cost or to ascertain such characteristics as strength, drying shrinkage, heat evaluation etc., and, since innumerable factors may affect the end result, the possibilities are far too extensive for meaningful evaluation by manual methods.

In the case of a concrete mix, for example, the aggregate (source grading, shape, texture, porosity and durability), the cement (type, content, source, composition and strength), the water (content and impurities) and the admixture (dosage, performance and composition) represent only a fraction of the potential variables. Others include the effect of temperature, mixing, transportation, placing, compaction, quality of workmanship and curing. Such variables also cover the possible constraints in meeting the objective functions of durability, strength and workability of the concrete.

In the area of statistical analysis computers come into their own by their ability to rapidly manipulate numbers from an initial set of entered values. Typical examples are: probability testing; establishing characteristic values and component variability; setting production targets and equation solving.

Regarding quality assurance and quality control, in comparison with manual methods computers can cut costs and time as well as facilitating preventive action by shortening the control cycle. Corrections can be more detailed and larger sources of data can be included. CAME's most important feature is that data can be used, stored and retrieved to greater benefit than the primary purpose.

The section of the paper dealing with data acquisition and control systems embraces the principles of data acquisition; CAME and control systems, test specimen, testing devices, data recording and analysis and finally, verification.

Data acquisition by manual methods can be best illustrated by the use of an example, say, measuring deflection in a test pile. The procedure involves fixing dial gauges in position; regular visits to site; reading gauges; recording data seen and calculating, or translating, the readings into units of load and settlement versus time.

Computerized data acquisition follows a similar routine but replaces the optically read dial gauge with electronic sensors. The converted digital signal is interpreted by the computer and transferred to an assigned memory for storage.

CAME is also an invaluable tool for controlling and monitoring tests designed to obtain data on the endurance of materials. The testing systems used comprise the test specimen, the testing device, data acquisition, a control system and the final recording and analysis of the data obtained.

The test specimen plays an obvious role and care in design is necessary if realistic results are to be obtained. An important factor to take into account is the inherent material variability which will determine the number of test samples required to permit confident use of the test results. It is also essential that the test device has adequate mechanical stability and is suitably protected from any corrosive, or hostile, media.

Control systems use the data acquired to compare and adjust the test parameters according to the criteria established in the programme. Simple starting and stopping of such functions as water spraying can be controlled through digital input/output lines. Another advantage of CAME systems is the capability of the computer to collect and store data in readiness for analysis at the conclusion of the programme.

A system of verification must also be incorporated. This means that the programme must permit checks to be made for any illogical occurrences which imply that the calibration of any analogue or digital conversion system is as important as the calibration of the sensors themselves.

The paper continues with a review of performance evaluation in which it is stated that, in order to construct a satisfactory structure, it is necessary to understand how material properties may be affected by fabrication techniques and exposure to the conditions of service. The design problem of materials selection, it says, requires a knowledge of the necessary mechanical properties; the envisaged constructional processes; the achievable level of quality and the predicted service conditions.

That life prediction of a structure, an important part of performance evaluation, can be obtained by two possible routes. In both cases details of the significant service conditions are essential.

Given this knowledge using the first route, life can be predicted testing the materials used in a manner which accurately reproduces the service conditions but on an accelerated basis. The degree of acceleration practicable is limited by the dependence of the primary mode of degradation on real time.

The second method of predicting service life is to take the same set of service conditions and then add the material data concerning the relevant properties and resistance to environmental factors plus an analysis of the particularly sensitive areas. By combining these three inputs through cumulative damage models, service life can then be predicted. In both cases though it must be emphasized that the reliability of the result is obviously entirely dependent on the accuracy and validity of the input data.

The growth of CAME system has been made possible for two reasons - the reduced cost of micro-computers and their increased capability. The authors consider it to be a fast-moving and exciting technology. Engineers, they say, can look forward to more reliable and comprehensive materials data derived from the use of this technique. (African Technical Review, September 1987, pp. 31-32)

Microcomputers in construction

... With the advancement of micro-computer technology and related software, computers are quickly becoming one of the newest and most valuable tools in construction. Not only can they aid in bookkeeping duties, word processing and accounting, they can also be of great help with design, bidding, inventory and management of construction of projects. It is becoming an essential tool for a contractor in all phases of a construction project. It will not be considered optimistic to state that within a few years the computer will be as important to an Indian contractor as a concrete mixer or a truck. ...

The smaller construction firms, previously unable to afford mainframe systems, can now start utilizing these modern management techniques for a modest investment in equipment and programmes. For the large construction companies who probably have mainframe systems already in use, the micro offers the opportunity for a more competitive means of project control on small- to medium-sized projects.

Another unique advantage of a micro is the capability of stand-alone operation with no need for a processing link with any other system. For a construction project this stand-alone ability of the micro is perhaps the most important advantage of all regardless of remoteness of construction site or type. ...

When we talk of using computers as a tool in sophisticated modern project management techniques and systems, computerized scheduling using the critical path method analysis is generally recognized as the first and most useful of our modern project management tools.

In addition computers can be used in other operational project management functions such as material tracking, cost control, work measurement etc. Today several software vendors have packed together all the different functional programmes to give a complete project control system, which offers the project manager computerized control over all his functions.

Computerized project scheduling is today a practical and financially viable option for virtually every construction project, thanks to the rise of more flexible and powerful micro-computers and corresponding software which has already ended the domination of large computers in project management. Today because of relatively low cost and ease of using micro-computers as compared to large mainframe computers the benefits of computer scheduling can be realized. The benefits or advantage of micro-computer-based project scheduling is the comparative ease with which schedules can be updated to reflect actual performance, change orders or the potential impact of additional work on the original programme. It is not that project scheduling cannot be done using manual methods. At the initial stages of setting up the network it does not take long but the problems really start when you have to update the schedule. ...

The complexity of the job and the usefulness of updates really determines whether it is worth using a schedule. If one creates a single programme and sticks to it right through the job, then it would not be worth putting it on the computer. Updating is where you see the benefits of computerization.

Many versatile project-scheduling software packages are available today, intended for either planning short-term high-intensity projects, or use by senior management in preparing project outlines or scheduling large projects involving more than 50,000 activities. Besides project scheduling many sophisticated packages allow you to do other planning and cost-control functions, like resource planning and levelling, progress cost reporting, baseline time and budget comparison etc. Listed are some of the popular integrated project management software from micro computer in the order of their ease of use and sophistication: Pert master, Microtrack, Quicknet, Plantrac, PMS II and Primavera Project Planner. Some Indian software companies have also released their software for project scheduling like Wipro's Instaplan, SPA's Pert etc.

Almost all of the above listed software generate standard required reports and graphic networks.

Perhaps one of the biggest areas in which a computer can help a contractor is in project estimating which is, of course, time-consuming and often a less than totally accurate procedure. This is exactly the kind of work at which a computer can excel.

The two biggest benefits from computerized estimating are productivity and accuracy. Once a particular system becomes familiar, a bid can be prepared in half the time or less than it takes using manual methods. This can result in increased productivity which in turn can bring more work for the firm, either because estimators will have more time for fine-tuning so their success ratio improves, or simply because they can bid more jobs. Accuracy is greatly enhanced. Not only are mathematical errors eliminated, but the more sophisticated systems greatly reduce the prospect of omitting an important cost item or making errors during take-off of materials.

Depending upon the complexity and purpose, construction job estimating can be categorized in two categories: one, estimating using spreadsheets, and two, estimating using speciality software.

Most people today are familiar with spreadsheets. Today they are widely used for accounting, financial modelling, decision analysis and other applications, but they can be also used with fairly good success in estimating construction work. Spreadsheets such as cisicalc or integrated spreadsheet data base programmes like Lotus 1-2-3 form the cheapest computerized estimating packages. They may be all that will be required by firms bidding a relatively small number of contracts, for which schedule of quantities are available, or by firms that subcontract a significant portion of their work-load. An electronic spreadsheet quickly recalculates the rows and columns of figures when a single item is changed, for example - an estimator can quickly see how a changed masonry work rate, or a variation in subcontractor's price, affects the overall bid.

In the simplest form spreadsheet estimating can be used in the final phase of tender preparation to access different pricing options. As an estimator becomes familiar with working with spreadsheets he can easily develop worksheets that he uses regularly and fits his needs. These worksheets are generally called "templates". These templates are built up with cost information and calculation instructions, are stored in floppy disks or hard disk, recalled when needed and fitted out with figures for the job under consideration.

The advantage of integrated spreadsheet data base software is that a large quantity of information including the spreadsheet template and current cost information can be stored in the data base and easily retrieved by the spreadsheet programme without juggling disks.

This form of computerized estimating lacks the power and sophistication of the specialist software, but is cheap, flexible, and requires a relatively short learning period.

The other category that estimation software falls into is the specialist construction cost-estimating software. Most of these software use integrated data bases to store information on structural components and item costs. These programmes claim a certain level of flexibility allowing the estimator both to define the items in the data base (catalog) and design its operating method to confirm with his or her own estimating practice. The more powerful programmes allow an estimator to prepare assemblies of regularly used structures, saving time spent repeatedly entering similar information. Reporting capabilities of the programmes vary tremendously, but most will produce at least a bill of materials for the project being estimated. Some can break these reports down into basic labour, material, equipment and subcontract reports, and location details, aiding resource allocation and materials ordering when construction proceeds.

Estimation using speciality software can be a little more expensive than spreadsheet estimation. The cost of estimating software in the US varies from under $500 for basic spreadsheet, to well over $5,000 for the most powerful programmes and their related hardware. Some of the very popular estimating packages that are used the world over are Estimator, Quick-Est, Estimator II and Estimating Pro. Recently, some Indian software companies have also released speciality estimation software in the market which can be looked into.

Virtually all the estimating software on the market today is designed to run on computers with MS-DOS operating system used on the IBM personal computers and the so-called compatibles, while some programs are also available for computers using CP/M and other operating systems. ... (The Economic Times of India, 23 July 1987, page IV)

Feats of clay

Thirty years ago the Potteries was a clearly identifiable region in the Midlands, a handful of towns clustered around Stoke-on-Trent. Almost all the potteries have now been taken over by just a handful of firms, principally Royal Doulton and Wedgwood.

Royal Doulton has been in the Potteries for at least two centuries but has been a relative latecomer to information technology, getting its first computers in the early 1970s. Today its principal system supports 100 on-line terminals at a dozen different sites - formerly the factories of the smaller firms it has swallowed up over the years.

Running on an ICL 2966 mainframe, the system provides all the stock control, order processing and sales systems for the 12 locations. A DEC Vax 11/780 runs the financial functions such as ledgers and payroll. Royal Doulton uses little packaged software on its mainframes. Head of group management services Roger Williams says that the firm had to develop its own stock and order processing sytems as it could not find anything suitable.

He has a staff of around 50, split roughly half and half between development staff and computer operators. All are based at the company's premises in Stoke-on-Trent. The machines are up 24 hours a day, seven days a week, providing on-line systems during the day and running batch housekeeping work overnight. The development staff is managed by three project managers, each in charge of eight people. ...

The department has recently converted from the DME to the VME ICL operating system for its new ICL Series 39 mainframe. This is used exclusively by Royal Doulton's retail division for warehouse, stock control and point of sale systems. ...

Royal Doulton also uses a large number of micro-computers as end-user systems, mostly the ubiquitous IBM-PC and some PS2s, in its 12 factories. The 60 micros run mostly packaged products for control of production work and factory performance monitoring. ... (Computer Weekly, 10 September 1987)

Sensors detect where lightning strikes

Certain systems using networks of sensors have been developed both in the United States and Europe in order to locate where lightning strikes and to better understand this phenomenon.

One of these systems, designed by the firm Meteorage-Franklin, has just been installed on French territory. The sensors record the long magnetic waves which are emitted each time lightning is produced between a cloud and the Earth, and measures the polarity and the intensity of the electrical field created by the lightning.

They are also capable of locating, thanks to the American software, the point on Earth where the lightning has struck with ion of from one to three kilometres over a field of 300 kilometres.

This data can be very useful to, for example, forest rangers or fighters. Already in the United States firefighters are using this type of system in order to keep them immediately informed on areas of the forest where lightning has struck and where a fire is therefore most likely to start.

Over the next few years, the various statistics collected on the location of lightning will enable data to be provided on where lightning most often strikes and therefore enable decisions to be taken on setting up new installations which are particularly geared to this phenomenon.

Constant surveillance and observation of the lightning is completely new in France and will certainly provide meteorologists and environmental specialists with new knowledge. (Bulletin IBIPRESS, No. 143, 20 September 1987)

A part of Switzerland is computerizing its land register

Siemens' Sicad system, an information system for graphic applications in the field of energy distribution, measurement and planning, has just been chosen by four municipalities in West Lausanne for the computerization of its land registry plans.

This system is made up of a 7530 computer with 6 mb central memory and 0.4 mips power. The computer has a telecommunications processor to which two graphic stations and alphanumerical terminals are connected.

This infograph system contains all the necessary instructions for cartography, the land register, the consolidation of land holdings, the distribution of energy and regional planning.

It will take several years to introduce the different data into the system but once the basic land register is digitized manually it will be very simple to update and the time to retrieve the data or carry out reconnaissance will be reduced.

Through this system, the land registers can be kept continually updated, efficient and complete. (Bulletin IBIPRESS, No. 142, 13 September 1987)

Laboratory instruments

Time was when the test and measurement needs of almost every engineer could be satisfied by an analog oscilloscope, a handful of meters, some signal sources, and the like. These laboratory instruments still do yeoman's duty on many a designer's bench and in the field, but newer gear such as logic analysers, digitizing scopes, and arbitrary waveform generators are crowding them. Now many more types of laboratory instruments are competing in a market where growth is slowing.

While the slack user demand that pervades the electronics industry is a contributor to the slowdown, the driving force is new technology that demands new kinds of T&M equipment. As users invest more and more money in computer-aided design and engineering systems, automated test equipment and other development and test systems, laboratory instruments have been left in the lurch. These developments will continue to shrink the traditional laboratory instruments' share of the overall T&M market. Moreover, increases in future spending on all forms of conventional T&M equipment - including the newer gear such as digital analysis systems - will be small compared with spending on factory automation networks and other new forms of T&M systems.

In other words, laboratory instruments are being squeezed into a smaller share of the overall market and are beginning to experience relatively low growth rates. Yet, some of the old line instruments are bouncing back, rejuvenated by new technology: the oscilloscope is the prime example.

In the billion-dollar scope sector, two strong growth paths have emerged, both reflecting technological advancements. The first includes instruments with band widths well above 100 MHz, which is the performance needed to keep up with continuing increases in semiconductor-chip performance. The second is in digitizing oscilloscopes. Digitizers - also known as digital-storage scopes - are better suited for advanced development work because they store waveform data and can process, recall, and compare this waveform data. For instance, some new models contain fast-Fourier-transform processors to operate in a spectrum-analyser mode.

For scopes under 100 MHz, the focus of the competition is price, and low-cost models are moving into the market in force. Much the same kind of price competition is shaking the market for logic analysers, the other instrument widely used to debug microprocessor systems. There has been little incentive to push analyser performance above 100 MHz, a speed that suits most microprocessor system development. However, several companies have pushed beyond 100 MHz to meet the requirements of systems being built with today's very fast emitter-coupled-logic chips and the parts emerging from the Pentagon's Very High-Speed Integrated Circuits programme.

Laboratory instruments also are evolving into multifunction units that are in themselves small T&M systems. Another important force for change is the application-specific IC. ASIC designers have been using logic analysers and other conventional instruments to verify the functionality and performance of prototype chips. But since that is cumbersome and time-consuming, high-end logic analysers are evolving into larger, smarter digital analysis systems for developing ASICs and multiprocessor systems. And the need for software commonality from the laboratory, through factory and field testing, is being addressed by a variety of test systems, as well as by instruments based on the personal computer. ...

Last autumn, Hewlett-Packard Co. reached a single-shot bandwidth of 250 MHz in a new digitizing scope series, the HP54111. Other scope makers will be hard put to keep up, because the Palo Alto, California, company developed bipolar flash converters that digitize at 1 megasample/s, gallium arsenide track-and-hold circuits, and a 1-GHz surface-acoustic-wave oscillator.

Another laboratory-instrument powerhouse, Tektronix Inc., of Beaverton, Ore., pushed its proprietary charge-coupled-device technology into the multigigasample-a-second range. CCDs can capture faster single-shot transients than conventional digitizers. However, they do introduce a readout time delay where flash converters do not. Tektronix uses CCDs in the digital models in its 11000 family of 1-GHz scopes, which also includes analog units. These scopes expand to 12 channels, with 8 selectively displayed - twice as many as previous scopes. David White, the Tektronix marketing manager for laboratory instruments, says such instruments have a bright future in ASIC development work because they can be used to tune CAE simulation models by feeding back high-resolution parametric and pin-to-pin skew measurements to computers.

Added functionality is also winning converts to digital storage scopes. Recently, Prime Data, a San José, California, market researcher, looked at the competition between analog and digital scopes. It found that, while analog scopes still outsell digitizers 2:1, their annual growth rate has dwindled to about 2 per cent, compared with 26 per cent for digitizers. Analog scopes have higher real-time bandwidth at any price/performance level, and they save the cost of flash converters, recording memories, and other high-speed digital circuits. But because digitizers store waveform data, their users can look at waveforms before trigger events, as well as after, and can compare stored waveforms and process the stored data.

Digitizers are capable of bumping other instruments, such as spectrum analysers, off the test engineer's bench. A new portable unit, the 4094, from Nicolet Instrument Corp., Madison, Wis., uses plug-in modules to run at bandwidths from 100 KHz with 12-bit resolution on up to an equivalent bandwidth (with repetitive-input sampling) of 500 MHz at 8 bits. It does spectrum analysis and math processing at 5 MHz and has disks for data collection and post-processing analysis software.

Another digitizer that competes with spectrum analysers is the 9400 from LeCroy Corp., Spring Valley, New York. This multichannel portable has a built-in FFT processor that displays time- and frequency-domain spectrums simultaneously. FFT resolution is 1 mHz at 50 MHz and, with repetitive inputs, equivalent bandwidth is 125 MHz.

One sign of the times is that HP's new catalog contains no analog oscilloscopes whatsoever. It declared its analog models obsolete last year and replaced them with competitively priced mid-range digitizers.

Both HP and Tektronix have gone to new user interfaces with uncluttered front panels, many automated functions, and menus that pop up on the screen. HP's models can make and display many complex measurements automatically, and HP says its colour-co-ordinated displays save the time users would generally spend sorting out waveforms and measurement data. Tektronix offers an infrared touch screen on the 11000 series: point a finger at a waveform and parameters are displayed automatically; tweak a knob, and that part of the waveform zooms up in size.

But with the bulk of the scope market still under 100 MHz, major producers are also striving to drive prices down on these products. Philips Test & Measuring Instruments Inc., the Mahwah, Jew Jersey, subsidiary of Philips International NV, last year challenged Tektronix in the low-priced analog scope market with 50-MHz smart analog scopes designed for mass production. The PM3050 costs $1,245 and the PM3055, with a dual time base, costs $1,345. Philips claims its prices undercut those of Tektronix's 2200 series by as much as $150. And the no-frills scopes made by Kikusui Electronics Corp. of Japan cost still less: the 60-MHz COS5060 lists at $1,185.

That kind of value engineering is also going on in the logic-analyser market, where growth of only 2 per cent to $207 million is expected this year, compared with 9 per cent and $202 million last year. For example, David Blakemore, vice president at Arium Corp., says his seven-year-old Anaheim, California, company has come up fast to rank among the top five in market share because its ML4100 series provides 90 per cent of the functions needed in logic analysers at prices ranging from $2,995 to $5,850: half to a third the price of analysers with all the bells and whistles.

Moreover, today's low-cost models often give the same 100-MHz performance on timing-analysis channels as most of the more expensive models do. So to compete in the laboratory market, the leading companies have made their high-end logic analysers smarter. Among other new features, HP and Tektronix now offer system performance analysis, a system-optimization aid. Also, HP's 200-MHz HP1631 series has two digitizing-scope channels to measure electrical parameters and process the data. And some units from Gould Inc.'s Design & Test System Division analyse noise margins and compare tolerances. The Cupertino, California, division also has a 500-MHz unit, the K500, with a built-in analog channel that is aimed at supercomputers.

Moreover, laboratory-quality logic analysers have reached the performance that advanced semiconductor devices demand. Both Tektronix and Outlook Technology, Campbell, California, have 2-GHz machines - high enough for timing analysis of 500-MHz chips. With input sampling similar to that in digitizing oscilloscopes, Outlook reaches 100-ps resolution in its T-100 scope.

One reason sales of conventional instruments have been flattening out is that today's new multifunction instruments, such as universal counters, make it less necessary to build rack-and-stack systems for bench work. In these new boxes, microprocessors co-ordinate functions that used to take a rack of instruments and an IEEE-488 bus controller. The new breed of arbitrary waveform generator, for one, is smart enough to replace noise generators, function generators, sweep generators, and the like, at frequencies from dc into the rf range.

Stimulus and analysis instruments will be integrated, too. John Battin, president of Wavetek Corp., San Diego, California, sees instruments that operate as frequency generators and spectrum analysers replacing the usual combination of sweep generator and network analyser. But do not discount conventional spectrum analysers yet. Sales are forecast to grow another 12 per cent, to $280 million, this year, according to the Electronics 1987 US market report.

Laboratory-instrument makers also are responding to the verification requirements of ASICs and multiprocessor systems. To test these, high-end logic analysers are evolving into digital analysis systems with large numbers of stimulus and analysis channels. The Atlas system from Dolch Logic Instruments Inc., San Jose, California, expands to 192 channels, and as many as 64 channels can analyse at 300 MHz. And Tektronix's newest DAS 9200 runs at rates from 20 MHz on 540 channels to 2 GHz on 160 channels, and it can have as many as 1,008 stimulus channels.

Recently, too, several new small ATE systems dedicated to ASIC verification have borrowed technology from logic analysers. Although ATE-like ASIC verifiers are too big to fit on a bench, they are designed to be used by the same engineers who develop ASICs and to test prototype chips with the same test patterns and vectors as the engineers' CAE systems. For instance, Hilevel Technology Inc., Irvine, California, builds an ASIC verifier around a logic analyser and a high-speed bit-slice bipolar processor. The Topaz series has 288 pins, and its test channels multiplex from 25 to 100 MHz. A new file-conversion package allows test software to be shared by CAE, ASIC verifier, and large IC testers.

In another development, sparked by the need for software commonality, board testers once seen only on the factory floor are going into laboratories and out into field-service depots. For example, Fluke recently introduced the 9010, a programmable tester that is smaller than most logic analysers. The 9010 operates with in-circuit emulators or miniature bed-of-nails test heads and was designed for troubleshooting boards rejected by large board testers, says Hugo Drave, manager of Fluke's manufacturing and R&D marketing group. But, he adds, it is also being used in laboratories, where board designers can programme it to run debugging tests, then pass the programmes on to troubleshooting technicians in the factory and in the field.

Another fast-developing trend that is changing the face of the laboratory-instrument world is the personal computer. The IBM Personal Computer and the flood of new instruments that interface with it let users take advantage of both the extra processing power of the PC family and all the engineering and test software developed for it. Recognizing a fait accompli, the Institute of Electronics and Electrical Engineers has set up committees to standardize the PC bus, the PC-AT bus, and BIOS, the basic input/output system for computers using Intel Corp.'s 80286 16-bit and 80386 32-bit microprocessors. (Reprinted from Electronics, 5 February 1987, pp.88-93, copyright 1987, McGraw-Hill Inc., all rights reserved)

Computer-aided design zeroes in on chemical engineers' needs

The news in computer-aided design (CAD), as far as chemical engineers are concerned, is that, as the available hardware gets more powerful and less expensive (and thus more widely used), software firms keep making progress in the development of integrated packages for Ch.Es. They are also extending their programmes into such new areas as 3-D design.

CAD software designers are accustomed to speaking of the purely conceptual designs or simulations as the "front end" of CAD. At this end, new process flowsheets are created and tested for process chemistry, and energy and mass balances. In stepwise fashion, CAD packages then move data to drafting packages that generate piping and instrumentation diagrams (PIDs), fabrication isometrics and equipment sizing, and from there to actual construction or fabrication blueprints - the "back end" of CAD.

Along the way, materials/inventory-ordering programmes can evaluate a design to specify the number and type of pipes, valves, reactors and other equipment, and run capital-cost summations of these. Linking this scheme is the Engineering DataBase Management System (EDBMS), another software package that accepts programme inputs (or direct inputs from design engineers), stores the data and transmits these to the next programme.

In chemical engineering applications, programme integration would eliminate costly and error-prone rekeying of data by hand, and would free the engineers' time to perform more design runs and checking of designs.

Integration, however, is not quite here yet for Ch.Es. On the other hand, in electronic engineering, where integrated circuits or printed-circuit boards are generated, or mechanical engineering, where metals or other materials are fabricated into such shapes as airplane wings or automobile crankshafts, this integration is farther along, probably because there are more engineers at work in these fields, and because the applications are of a more specific nature.

For example, a company called Structural Dynamics Research Corp. (Milford, Ohio) - one of many existing vendors in its field - says it already has 2,000 users for its I-DEAS, a commercial package for mechanical design that does solid modeling, static and dynamic stress analysis, and automated drafting. The output can even be transferred to numerical-controlled milling machines for fabrication. By comparison, Simulation Sciences has a user base of 900 for an elaborate simulator system called PROCESS, which must be customized to integrate with drafting or equipment-inventory programmes.

In chemical-process design, there are many more types of design problems; the market is not easily characterized from the point of view of a programme vendor. Various companies have developed separate parts of process-design CAD systems, and are now working to link the output of their programmes to other inputs. Except for a few cases, such fully integrated programmes are not commercially available.

One integrated programme on the market is Designmaster - a package from Chemshare Corp. (Houston) that contains modularized programmes that perform some engineering drawings; it runs on various minicomputers, such as Digital Equipment Corp.'s VAX/6800. Another example is CHEMCAD from COADE (Houston) - a division of McGraw-Hill, Inc. This programme combines a process simulator (formerly known as MicroCHESS) with two-dimensional drafting, but the drafting is limited to process flowsheets and the simulator is primarily intended for distillation and heat-exchange applications. CHEM-CAD runs on the PC AT from IBM (Armonk, New York) and other compatible hardware.

Last summer, Combustion Engineering, Inc. (Stamford, Connecticut) announced that it was joining forces with ICI (London) and Duke Power Co. (Charlotte, N.C.) to commercialize Provue 3D and Isogen, a pair of tridimensional process-plant design programmes originated by ICI.

Central to the potential integration of the various CAD programmes is the EDBMS concept. Database programmes are among the most essential computer applications programmes, used in everything from airline reservation systems to physical-property compilations.

However, general-business database systems are not well suited to engineering applications, because the types of engineering data are much more complex. ...

Prodabas, an EDBMS market by ProsysTech, Inc., (Florham Park, New Jersey) is derived from work that has been going on for over a decade at CadCentre, a research organization in Cambridge, England. It has been integrated (in a test version) with the PROCESS simulator of Simulation Sciences, as well as with the Aspen simulator of Aspen Technology, Inc. (Cambridge, Mass.). Peter Winter, president of ProsysTech, Inc., says that it is already in use at several major petroleum and chemical companies, and runs on IBM and DEC-type minicomputers.

Another EDBMS effort is already under way at the Center for Computer Aided Process Engineering at Washington University (St. Louis). This centre is sponsored by the US National Science Foundation and a growing number of industrial clients. Operating through a company called EOS Corp. (St. Louis), the centre has commercialized an EDBMS called Cadre, plus related software.

A couple of years ago, as the personal computer was beginning to make an impact on engineering, much debate centered on whether it could ever be considered powerful enough for heavy-duty CPI computer-aided design. To a large extent, the controversy has died down, partly because the computing power of PCs has risen substantially, especially after the introduction of the PC AT from IBM. The machine has been bought by thousands of design, project or operations engineers, to serve many different purposes. As a result, many of the firms that had developed CAD packages in mainframe or minicomputer environments have now adapted their programmes to the PC. For example, Simulation Sciences' PROCESS runs on the AT/370 (an upgraded version of the AT); and Design II/PC, from Chemshare, now runs on the AT.

Even so, organizations where intensive CAD operations are carried out frequently depend on the minicomputer or "supermini" now commercialized. Vendors of this equipment include IBM, Intergraph (Huntsville, Ala.; the system uses Digital Equipment computers), GE Calma (Santa Clara, California), Apollo Computer Corporation (Chelmsford, Mass.), Computervision Corp. (Bedford, Mass.), Applicon (Ann Arbor, Michigan), and Prime Computer (Natick, Mass.).

A primary distinction between the micro and the mini is the latter's use of 32-bit central microprocessor chips; most PCs are limited to 16 bits as the nominal size of a chunk of data that can be processed at any given moment, but this distinction is expected to fade as the widely heralded introduction of an IBM PC-type machine using Intel Corp.'s new 80386 microprocessor becomes a reality. The 80386 is a 32-bit microprocessor, and is the latest extension of the microprocessor in the original PC - the 8088 chip. Although IBM itself is giving no indication of how soon the new hardware may be available, it has been reported that Intel is offering the chip to PC manufacturers, and that Compaq Corp. (Houston) - a leading maker of IBM-compatible PCs - is already developing such a machine. ...

Generally, PCs are limited to, at best, a resolution of 640 X 350 picture elements (pixels - the dots on the screen that make up an image). Most minibased systems have 1,024 X 1,024-pixel screens, which offer a much better display of the image.

One software programme that has greatly enhanced the utility of PCs for engineering CAD is Autocad, from Autodesk, Inc. (Sausalito, California). Although not tailored to chemical engineering applications, Autocad's flexibility and power have made it a leading engineering PC package, with 50,000 units already in operation in the US.

Because it is a PC programme to be used on low-cost PCs, Autocad is especially useful for small companies. One example is Buda Equipment and Controls, Inc. (East Syracuse, New York), a four-year-old supplier of custom water- and wastewater treatment systems.

At present, Autocad does only two-dimensional (or simulated three-dimensional) drawings, although there is talk of a true 3-D system in the works. Another company, Cadtrak, is already on the marketplace with a 3-D system called Plant*Trak, tailored to process-industry and mechanical drawings. ... (Chemical Engineering, 1 September 1986, pp. 14-17)

V. COMPUTER EDUCATION

Computer-based learning

At the same time as educationalists are putting renewed emphasis on the teaching of basic skills at school, new information technologies are making their presence increasingly felt in the classroom. OECD's Centre for Educational Research and Innovation recently brought together governmental policy-makers and senior researchers to discuss the issues raised by these developments. 1/

In a world of constant and accelerating change, children as well as adults are expected to learn and relearn, to train and retrain throughout their lives. Above and beyond the three Rs (reading, writing, 'rithmetic), that entails devoting greater effort to the teaching of so-called "higher-order thinking skills", or "metacognitive skills", which signify the power of reasoning, the ability to analyse and synthesize, and the capacity for critical thinking, problem-solving and communication. While these skills have of course been taught implicitly in the past, they have never received the attention they deserve.

Unfortunately, the resources and skills for that sort of teaching are not to be found in all schools and in all teachers. At the same time, falling school rolls, as a result of declining birth rates, combined with a concern to limit public expenditure, have led most governments to curb outlays on education since the middle of the 1970s. Schools in all OECD countries are being asked to do more and more while their resources are being rationed. The new information technologies may help to fill that gap if they can enhance the effectiveness of teachers and facilitate the learning process.

The availability of ever-cheaper computational power has the potential to do just that, provided that the user has a clear understanding of what he wants his computer to do. Up to now, computers in schools have been used mostly to emulate a variety of teaching practices, but not necessarily the most important ones. The teacher's most valuable role is to coach, criticize and encourage, but such activities are hard to describe with precision and hence difficult to simulate, so until recently they have tended to be neglected by educational software developers.

Considerable progress is now being made in understanding the learning and thinking processes. Psychologists, computer scientists, specialists in artificial intelligence, linguists and philosophers have contributed to the creation of a science for studying, understanding and improving the educational process. This cognitive science is beginning to stimulate the development of intelligent computer systems that can assist the learning process by interacting directly with students on an individual basis.

Similarly, techniques are being developed to assess the reactions elicited by computers in the classroom and their actual effects. If teaching methods can be analysed sufficiently to develop computer programmes that reproduce, even partially, the behaviour of good human teachers, then computers could be used not only for teaching pupils but also for training teachers. This potential should be particularly attractive to those countries which face teacher shortages or whose teaching corps varies significantly in competence.

One of the main factors determining the diffusion rate of computer technology at both the local and national level is the perceived cost-effectiveness of these tools. While hardware costs have decreased considerably, those of quality educational software remain high, but computers can only be realistically and fairly evaluated if studied in schools where

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1/ Information Technologies and Basic Learning: Reading, Writing, Science and Mathematics, OECD, Paris, to be published.

the "critical mass" of computer-based learning (CBL) has been reached, in terms of access time for the students to the equipment, availability of appropriate software and the number of teachers trained to use computers. 1/ Such schools are still the exception to the rule.

Good educational software must be identified and documented, and it must be demonstrated and evaluated in real school settings. Too often educational innovations are tested in "ideal" conditions, with the risk that they may fail when applied in an ordinary school environment.

Computers can be of great help to schoolchildren when it comes to learning the closely-related basic skills of reading and writing. Beyond that, the student can manipulate scientific notions and back up his arguments with simulated examples. He can present graphic summaries of his treatment of mathematical problems and discuss the results with teachers and fellow students instead of simply being told whether he is right or wrong.

When it comes to the reading process, one possible approach is to try and develop models that combine concepts of cognitive science with aspects of the individual teaching method. As Norton and Resta explained: "The traditional curriculum has tended to view the reading process as the accumulation of discrete bits of information and the mastery of specified, often sequenced, skills believed to add up to a whole. Conversely, gains in achievement made by those using problem-solving and simulation software suggest reconceptualizing the reading process as fluency with cognitive and problem-solving strategies." 2/ It thus seems possible that computers could help children learn to read through the use of integrated software, videodisc/compact disc technology, speech reproduction and recognition, networking and multi-media communication.

Changes are needed in the way children are taught to write, since little actual instruction on this subject takes place in most schools (about one hour a week on average in many OECD countries). Studies of the writing process have shown that the linear model - pre-write, write and rewrite - does not correspond to reality. The writing process is recursive, in fact; there is no straight line from conception to completion. It is composed of five stages: conceiving the idea; organizing one's thoughts; composing; editing and revising the text; and obtaining feedback on the result. Several software programmes have been designed to help with these different stages of the process and available assessments of their usefulness are encouraging. Information technologies may also be more widely applicable in the context of writing instruction by affording new environments for communications, such as electronic mail systems which enable the student to address a large, real audience.

Computer technology is already proving very helpful in the teaching and learning of scientific and technologial concepts. A great number of "drill and practice" programmes exist in physics, earth science, technology, chemistry, ecology, biology and medicine, but now some more sophisticated software is appearing which develops higher skills in the student. This may be of the problem-solving type, of which there are interesting examples in the fields of chemistry (such as for calculating the number of atoms released in a reaction) and mechanics (for calculating speeds and angles after an impact, for example). Or they may entail the use of databases and above all simulation for demonstrating dangerous (in chemistry) or impossible experiments (nuclear reactions, the movement of projectiles on land or in a gravitational field, for instance).

Mathematics can be hard to grasp for the many students who lack the capacity for logical thinking and deductive reasoning. Here too there are a number of software programmes that can help, starting with drill and practice programmes for teaching elementary arithmetic and ranging up to tutorial, simulation and exploration programmes. In the near future, spreadsheet and graphics programmes could be in extensive use in schools. As in science subjects, a basic task of computers could be to detect and analyse students' errors and misconceptions. This diagnostic capability could be especially useful for both teachers and cognitive scientists.

An inescapable conclusion can be drawn from examining the role that information technology could play in teaching basic skills and in better understanding the associated cognitive processes: it necessarily involves a fundamental reassessment of aims and pedagogical methods. When computers are introduced into the educational system in sufficient numbers and with the appropriate software, they can make a major contributon to the efficiency and effectiveness of teaching. However, they do not manufacture knowledge, they cannot fully explain things and they cannot motivate in an enduring manner. They cannot replace the teacher nor substitute for personal interaction, which is the essence of the educational process. They are merely tools that can be utilized to achieve a variety of effects and objectives.

Radical policies and approaches may be needed to derive the full benefit from computer technology. It has to be accepted by the teaching force. Above all, it has to be introduced on a sufficient scale to make a significant impact. If only a half-hearted effort is made because of an unwillingness to provide the necessary resources, then the result, if any, will be of marginal benefit and could possibly lead to frustration if not outright rejection on the part of the pupil. While a few schools have acquired sufficient hardware and software to improve their teaching and learning processes, the general situation in OECD educational systems is still one of limited investment in information technology. (OECD Observer, October 1987, pp. 23-25)

Information technology for the disabled

Information technology has only just begun to scratch the surface of what can be done to help students with disabilities to study. COMET, the Concerned Micros in Education and Training project, was set up in 1984 to award grants to purchase microcomputers, monitor needs, create a resource and information bank and increase awareness of the new technologies' potential for disabled students. A seminar was told about special keyboards with fewer keys which make operation easier for students with severe physical disability and about software, still at an early age of development, which uses the equivalent of speed writing - telex-like codes, such as BL for balloon. There is already a microprocessor speech recognition device which translates the words of the profoundly deaf into widely intelligible

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1/ New Information Technologies: A Challenge for Education, OECD, Paris, 1986.

2/ P. Norton and V. Resta, Investigation of the Impact of Computer Instruction on Elementary Students' Reading Achievement, Educational Technology, Englewood Cliffs, N.J., 1986.

speech, and increased control of computers by speech for the visually handicapped is becoming available. There is an integrated computing environment for the blind: the operator enters text in the usual manner to produce large print Braille or speech. With the voice recognition equipment spoken phrases can be used to select programme functions or input text. A document reader accepts an entire page of text which can be edited and output as speech or Braille. It means a complete speech system is now available with an unlimited vocabulary. The National Bureau for Handicapped Students hopes to help people through its campaign to have guaranteed funding for communication aids for students with special educational needs, a provision which is automatic in other European countries. (The Times Educational Supplement, 3 April 1987, p. 37) (Reprinted in Microcomputers and Microprocessors, British Deputy High Commission, British Council Division, Bombay)

Low-cost software for French schools

By deciding to reactivate the four-year-old "Informatics for All" (IPT) programme, the Minister for National Education has just announced his intention to redefine the informatics training provided in schools by establishing new combined licences, aimed mainly at aiding the software industry.

The teaching establishments will be able to purchase software at reduced prices and the educational software industry will be motivated by this new type of licence. The special purchasing procedure will consist in the Education Ministry buying the rights for two years' use of the software and paying a large lump sum upon the signature of the contract.

The Ministry has earmarked FF 70 million for the purchase of software, 60 per cent of which should go to teaching establishments in order to help them purchase the software products of their choice. A first wave of combined licences for 22 software products, some of which are direct competitors, has been negotiated with the French or American publishers. A second series will follow within the next few months, pending the indication by the teachers of their specific needs.

Besides wanting to create a true educational software market, the objective is to avoid mixing topics. It is up to the teachers to reflect on the use of informatics in the different subjects, make proposals and select the software which best suits their needs while the Ministry will give the final directives and define the framework of action.

The State, which refuses to be a software manufacturer, has already launched a competition for programmes and has received 300 proposals. Approximately 30 are expected to receive the national educational label. (Bulletin IBIPRESS, No. 147, 18 October 1987)

VI. SOFTWARE

United Nations receives computer software to produce documents in Braille

The American Impact Foundation and the National Federation of the Blind of the United States of America have donated Braille translation software to the United Nations that will enable computers in the United Nations system to produce Braille documents in English or Romance languages.

The software accepts computer text files and translates them into Braille characters. A small printing device must be attached to the computer to produce documents in Braille. Braille is an embossed dot reading system used by millions of blind persons around the world.

Margaret J. Anstee, Director-General of the United Nations Office at Vienna and Head of the Centre for Social Development and Humanitarian Affairs, which is the global focal point for the United Nations Decade of Disabled Persons (1983-1992), said "this donation of Braille translation software will allow United Nations bodies and organizations to take the first steps in providing blind persons around the world with equal access to their documentation. On behalf of the United Nations, I would like to thank the American Impact Foundation and the National Federation of the Blind of the United States of America for their very generous donation."

The American Impact Foundation is a private, non-profit, charitable organization involved in an international initiative against avoidable disability, sponsored by United Nations agencies. Its Executive Director, Harold Snider, said "as a blind person myself and, as an administrator of an organization which is concerned with United Nations projects to avoid disability, I am very pleased that United Nations agencies will now have the ability to produce documents in Braille by computer."

The National Federation of the Blind is the oldest and largest organization of blind persons in the United States with affiliates in every State and over 50,000 members. The Federation developed the Braille translation software being donated. Kenneth Jernigan, Executive Director, said "the United Nations system, through the United Nations Decade of Disabled Persons, is having a significant effect on the lives of blind people in developing countries. It is only right that we should do what we can to give blind persons equal access to printed documents which contain polices that may affect them." (United Nations Information Service, 28 October 1987)

Software for Intel's 386

The Intel 386 has well and truly arrived and no microcomputer manufacturer worth its salt has failed to develop a 386 machine.

But 386 software is a different matter; there is very little purpose-written 386 software on the market. One reason, of course, is that microcomputer software is not written for processors, but for operating systems, and there is hardly a single 386 operating system available. Even IBM's new OS2 is designed more for the 286 than the 386.

What is the 386 going to do for microcomputing? Is it merely a souped-up 286 that will drive existing DOS productivity and graphics programmes even faster; or is it just another processor that will allow multiuser systems to attach more users to a single machine?

The answer can be found by looking at the effect of the 386 on operating systems rather than on hardware and applications software.

One interesting anomaly is that the 386 may do little for MS-DOS, but much for the DOS market. The reason is relatively simple. A move to OS2 will require that MS-DOS applications are either abandoned, or run under DOS emulation within OS2. It is likely that the market will refuse to abandon its DOS investment.

But a single DOS application on a 386 machine makes little sense. A better solution would be DOS multitasking; but multitasking OS2 cannot multitask DOS. As Digital Research's Paul Bailey points out, "C-DOS 386 will do a much better job of multitasking DOS applications than OS2 ever will, because OS2 was written for the 286 while C-DOS 386 takes advantage of 386 facilities."

This gives the ironic possibility of a scenario in which arch-rival Digital Research provides the 386-based operating system for Microsoft's MS-DOS applications. Anything else would be wasteful.

As Barry Forrest of Altos comments, "It is the media that describes the 386 as a graphics workstation driver - but that is like trying to shoe-horn a Porsche engine into a mini."

The arrival of the 386 could provide an unexpected boost for C-DOS on the super-powerful 386-based stand-alone PCs.

But what of the multiuser operating systems? What will the 386 do for Unix? Will it, for example, provide the final push to propel Unix into full market acceptance?

Tony Heywood of Redwood thinks that it will, but that it should not be so. "For Unix," he comments, "the 386 is a non-event - it is just another chip capable of yet more processing in a faster manner.

"But it is no more powerful than its competitors; it will just be more successful because of the relationship between IBM and Intel.

"One of the first machines to run Unix," he explains, "was from Zilog running the Z8001. This ran at 5.5 MHz, and was essentially a one Mbyte machine, but it performs with up to 16 users better than many of the new 386 and M68020 machines.

"Unix performance has relatively little to do with the power of the processor - which has had ample power for some time - it has more to do with the attendant architecture, the speed of the bus, the discs and I/O." For example, the Ensign 386/100 from Metcom can in theory support up to 100 users. This is made possible by using additional M68020 processors to handle the I/O for the 16-user expansion boards.

But one thing that Heywood agrees with is that "the 386 will hasten the demise of MS-DOS. It has far too much power for the MS-DOS limitations".

Despite the theoretical irrelevance of the 386, in practice it will have an undoubted effect on the Unix market. "We have to recognize," says Forrest, "that the 386 is a substantial step forward - it will allow machines to do a lot more than ever before. In the past, the biggest and most valid criticism of Unix has been that it is too resource-hungry. Well, the power of the 386 makes this irrelevant."

It is often forgotten that the 386 does not simply represent raw power; it is also a very versatile processor.

Patrick Sutton, marketing executive at Convergent Technologies (UK), says, "The 386 provides very high speed processing, but we selected it for our new range more for its functionality than its speed.

"It combines true multitasking with access to more than one base of aplications software in a powerful distributed processing environment, and we are now able to offer concurrent CTOS/WM and MS-DOS without the need for additional hardware."

Alasdair Macgregor, product marketing manager at NCR, takes a similar view.

"One of the major reasons we selected the 386 for our top-of-the-range PC916," he says, "is its variable speed, which ranges from 4.77 Mhz up to 16 Mhz. NCR is a major supplier in the rapidly growing communications marketplace, and this variable speed feature is particularly useful in networking and time-dependent applications."

Such versatility leads Forrest to isolate five major areas that he believes will be significantly affected by the 386:

- The greater power will allow the existing PC generation to handle more complex models and data more efficiently;
- More sophisticated software tools will become available to a wider range of staff;
- Sophisticated software previously available and viable only on minicomputers and mainframes will be available to even the smallest companies on desktop systems;
- Complete families of workstation-like products covering specialist areas like CAD, POS and process control will be developed;
- The 386 will be used to develop multiuser departmental systems as viable alternatives to networked PCs and minicomputers.

"The multiuser capability and enormous power of the 386," explains Forrest, "will enable the market to expand within the traditional multiuser market for the foreseeable future, while peripheral developments in networking and communications will be the cornerstone of future information processing architectures based on network multiuser systems.

"Only the availability of network application software is preventing the market moving in this direction today."

But there is, of course, a body of multiuser networking software already available on the critically acclaimed UK BOS operating system.

BOS, like C-DOS, is one of the few operating systems that can already claim a genuine 386 implementation.

Ron Wheelhouse, chief designer at BOS Software, fervently believes the 386 should not be relegated to the role of a powerful DOS-based network server.

"Such central file servers," he explains, "are subject to failure and often get bottlenecks in the data access. They are not the local area networks of the future. For example, BOS/Lan already uses distributed data access rather than central file servers.

"But even here, although the 386 may accelerate the speed on BOS/Lan to some extent, it will have no overwhelming effect."

So there we have it. The industry view is that the Intel 80386 processor is an excellent and powerful microprocessor but it is not going to change the nature of microcomputing.

It is going to do the same as before, but more and faster. The strongest general belief is that it should not be used with MS-DOS; whether as a mighty powerful PC or as an MS-DOS network.

As Heywood puts it, "OS2 and Unix will probably be the main beneficiaries". OS2 because the 386 will be powerful enough to bridge between PCs and minicomputers, and Unix because the 386 power makes the Unix need for excessive resources irrelevant. (Source: Computer Weekly, 8 October 1987)

Software for composites design

Software of increasing versatility is needed by designers who use composite materials. A recent workshop organized by the British Plastics Federation showed that software developers are responding to the needs of industry.

The complex nature of composites means that it is not easy to describe their behaviour mathematically. Designers are presented with the challenge of performing an accurate structural analysis of anisotropic, laminated materials. Work is being done in many establishments to develop software systems which will do this. A recent workshop, organized by the Advanced Composites Group of the British Plastics Federation, brought together users and designers of software from educational establishments and the composites industry.

ESDU International (formerly the Royal Aeronautical Society Data Service) demonstrated a software package called Failure Analysis of Composite Laminates (EDSU 2033). The user-friendly system, which is designed to run on the IBM PC, analyses laminates of up to 200 layers using the Puck Modified failure criterion, in which longitudinal tension or compression are treated separately from transverse, direct and shear stresses. Thermal loading can be applied as a linear distribution, or incrementally to each layer.

Loadings are applied sequentially until a matrix failure occurs in a particular layer. At this point, the matrix properties for that layer are set to zero and the analysis continues until the load which causes matrix failure in all layers is reached.

Another package which was demonstrated at the seminar was PIGS (Pafec's Interactive Graphics System), a finite element pre- and post-processor, which runs on an Apollo 32-bit computer. The PIGS mesh generation system uses the standard Pafec on-screen menu systems to select a series of node or element generation options. It is also possible to use geometries which have been developed on other Pafec modelling and draughting systems, by inputting them directly into PIGS. To analyse composites however, the system needs extra laminate analysis software.

A range of coloured, shaded and illuminated options is available on PIGS to display the model and applied loads. At the post-processing stage, an animation option is also available to display stresses, deflections and vibrational modes.

The engineering design consultancy ETA demonstrated a general-purpose finite element analysis system called Fesdec. The software has static, dynamic and thermal capabilities and runs only on Hewlett Packard desktop hardware. Although it can handle composite materials, Fesdec, like the Pafec system, requires a separate laminate analysis programme to evaluate material properties. These properties can be entered as the individual values of shear modulus, elastic modulus and Poisson's ratio for the system; or they can be entered as an inverted stiffness matrix.

As might be expected from a desktop system, mesh generation is via co-ordinate entry rather than interactive graphics, and the output stress/deflection graphics are limited.

Coala and Lamanal are two other systems which are similar in function and operation. Coala was developed by, and is available from, the Cranfield College of Aeronautics. Lamanal was developed by Ray Butler, a former Cranfield lecturer who now has his own consultancy business, Severn Consultants.

Coala, designed to run on an IBM PC or compatibles, can analyse a maximum of 200 layers and 50 different ply materials in a laminate. Laminate layup and individual layer materials are input either in free format form, or by the pre-processor. The software evaluates laminate stiffness and compliance matrices, and calculates the laminate equivalent elastic and physical engineering constants.

The final part of the programme allows the input of an unlimited number of mechanical and non-mechanical loads, then carries out a ply-to-ply strength/failure analysis against the common failure criteria and ascertains the probable in-plane mode of failure. This latter part of the package is obviously not as rigorous as the more specialized ESDU programme.

Lamanal runs on the IBM PC, DEC Vax, Apple II or CBM 64-SK computers. It was covered in depth in Advanced Composites Engineering, Winter 1986.

Think Composites France is a software users' club which supplies packages which are tools for materials and structures design. Members also receive a copy of the book Composites Design, by Dr. Steven Tsai. Software is available to run on both the IBM PC and Apple Macintosh.

Tsai's programme Mic-Mac is an integrated micro-macromechanics analysis package, with a spreadsheet format. There are specialized spreadsheets for pressure vessels, tubing, beams, thin-wall construction and hybrids. Seven representative composite materials, and the possible addition of a new material, are incorporated into each spreadsheet. The rules for defining the factor of safety in terms of the limit and ultimate strengths are also included.

When operating on an IBM PC, the Mic-Mac spreadsheets require Lotus 1-2-3 as support software and an 8087 processor. On the Apple Macintosh, the spreadsheets can be accessed through Microsoft Excel.

Another software package offered by the club is Genlam 3, which provides a point stress analysis of laminates. Results are in the form of stiffness and compliance matrices in both absolute and normalized units, engineering constants, ply stresses and strains in both ply and laminate axes, and strength ratios at the top and bottom of each ply group. The strength ratios are based on both the intact and degraded matrix material, from which the design rules on the limit and ultimate strengths are applied.

At present, Genlam 3 is dimensioned to handle 5 materials, 10 ply angles, 40 angle-material combinations, 5 loads and 200 plies. The limits can be increased by changing the dimension statement and recompiling the routine.

Lamrank 4 does laminate design by rankings, where laminate ranking is based on limit or ultimate strength. The material, cure temperature, moisture content and multiple in-plane loads are inputs for the laminate selection. The system can include any family of sub-laminates consisting of 2 to 10 plies, and 2 to 4 arbitrary ply angles, so that 1,000 laminates can be examined systematically improvements over a quasi-isotropic laminate i. computed and the required number of plies to sus... the specified loads are provided. The criterion for strength is based on a ply degradation factor defined by the user, from which the first and last ply failures can be defined. The limit and ultimate strengths of laminates can be determined from a selected safety factor. (Source: Advanced Composites Engineering, September 1987)

"Rusting" computer software

The idea that software can "rust" is a strange one. However, a recent report has highlighted the potential dangers of rusting software: whole software systems have now become such objects of mystery that the staff employed to run and develop them do not understand their internal workings. The problem arises from maintenance - the euphemism software engineers use to describe any changes to a software system after it is put into operation. There are two reasons for maintenance. First, errors will be discovered which were not found during development. Second, there will be modifications due to changes in requirements. It is this category of change that seems to be causing trouble. It is estimated that 70 per cent of all resources expended on computer projects involved maintenance and that the majority of this effort went on adapting systems to changes in requirements. For economic reasons, a software developer will modify an existing system rather than implement a system from new. Unfortunately, the process of modification can degrade it quite dramatically. A system contains chunks of programme called modules. When it is first developed its architecture is clean and well designed: interfaces between modules are simple and the processing that is to occur in a module is straightforward. However, when maintenance starts the nature of a software system changes. Usually, low-grade staff, unfamiliar with a system, are used for maintenance. Changes are made so randomly that soon the processing in each module becomes complicated, the documentation of a system becomes scrappy, and, in some cases, wrong. This results in a system architecture becoming increasingly baroque. The effect is analogous to rust or metal fatigue. A new approach to software development is required. Developers should realize that software, just like plant and equipment, depreciates in value in that further changes tend to be more expensive. At selected times when the complexity of a system becomes too high, work on enhancing the system in order to adapt to change should be stopped and effort be put into restructuring. What is being asked is to devote resources to a software system, not in order to increase its value immediately, but in order to invest in the future where the effect of restructuring would mean lower maintenance costs. (The Independent, 1 June 1987, p. 15) (Reprinted in Microcomputers and Microprocessors, British Deputy High Commission, British Council Division, Bombay)

Software failure

By far the greatest threat to business now is failure of the software. Of the 74 cases documented over the past two years, 30 were caused by software failure, against 13 by fire. Only 12 software-generated disasters were identified in the whole of the previous decade, a mere quarter of the 47 caused by fire. That is a startling change. The altered proportions may result from increased use of packaged software - this may fail or just not cope with the job demanded of it. But it could also come from growing sophistication: the computer is given harder tasks, more is demanded of the system, and users know more about what to expect and have a better idea of why they are not getting it. The report warns though that as more companies come to be ever more reliant on electronics they will have to be increasingly careful about how and what they buy. Vigilance is needed even more after installation because people tend to believe what a computer says. Since many companies would grind to a rapid halt without their computers and lose large sums of money lacking debtor control information, it is at least sensible to find out how vulnerable the system is and make contingency plans for failure. (The Daily Telegraph, 11 May 1987, p. 20) (Reprinted in Microcomputers and Microprocessors, British Deputy High Commission, British Council Division, Bombay)

This software robot fixes systems - while they're running

With computer systems growing more pervasive and complex, maintenance is a mounting headache - especially as networks rope together more unrelated brands of equipment. Finding and fixing problems too often turns into a finger-pointing contest among vendors.

But suppose there were a robot technician residing in software that could worm its way freely through the system, periodically "exercising" the diagnostic programmes provided for each piece of equipment. Imagine that this software robot is "smart" enough, when it discovers problems, to run the applicable repair routines. Command Technologies Inc., a Boston startup, claims its SoftRobot software does this and more. For example, if a hard disk crashes, the SoftRobot might move data to another system, restart the first drive, and restore the data. The programme, says Command President Franco Vitaliano, "fools the system into thinking that a person is doing the work". As a last resort, the system summons a human. SoftRobots, which cost about $2,500 for workstation-level systems, are being evaluated by a dozen computer companies. (Reprinted from the 7 September 1987 issue of Business Week by special permission (c) 1987 by McGraw-Hill, Inc.)

Programming languages

Future programming language standards will ensure that there are suitable facilities for handling non-English character sets, including large character sets requiring multibyte representation.

The decision reflects the growth in recent years of the importance on the IT scene of Japanese and other East Asian suppliers. Japan in particular has been pressing for languages to provide support for kanji characters, and the People's Republic of China is beginning to take a more active part in standard activities and was represented at the Washington meeting. In addition to those two, there were delegations from the US and Canada and from eight European countries.

Several of the European countries pointed out that current standards for most languages support properly only the English language; many European languages, even when based on the Roman alphabet, have accents or special letters. They have managed to cope, with some difficulty, but this new initiative will help them too.

Possibly some people in the English-speaking world will be a little put out at what they might regard as yet more evidence of Japanese influence on the computing scene. However, another way of looking at it is that at least it offers some scope for competing in the domestic Japanese market.

Whatever one's view, the committee agreed that the issue had to be faced and the commitment had to be made, though no one was under any illusions about the magnitude of the task.

The first language to be affected by this is likely to be Fortran. The Fortran 8X revision will be for public comment in the autumn - the IBM and DEC objections having been outvoted in the US - but both the Ansi and ISO Fortran committees have already discussed the matter and detailed study is being undertaken of how alternative character sets might be included in the final version, without waiting for the outcome of the public review.

The following summarizes the largest developments in other areas:

Ada: The working group is to produce two reports, one on issues and questions which have arisen concerning the Ada standard, the other on uniformity of Ada implementations.

Although the US Department of Defence is renowned for taking a hard line (no subsets or supersets) on the question of dialects, it is becoming clear that even the limited degree of implementation-dependence the Ada standard does allow is still harming portability and undermining the value of standardization.

It was agreed to support the Ada group's proposal to develop in Ada/SQL binding.

Basic: At present two standards for full Basic exist, ANS X3,113 and ECMA-116. They were developed together, and as far as language features are concerned, the main difference between the two is that the Ansi standard contains some extra features.

However, the two have rather different subsetting structures and conformance requirements. It was agreed to resolve this potential conflict, since both approaches had advantages, by allowing either subsetting and conformance strategy in the ISO standard, and using the Ansi standard, being the fuller one, for the language definition.

Implementations would have to state to which levels or options they were claiming conformance. Programmes conforming to the ISO standard would be portable between implementations supporting any higher level or optional features used, whichever of the two subsetting models any implementation used.

The ISO standard would describe the subsetting and conformance differences, for which a working draft already exists.

Cobol: An addendum to the Cobol 1985 standard is being prepared which will resolve identified ambiguities and correct errors which have been detected since its publication.

Lisp and Prolog: Working groups have been set up to develop ISO standards for Lisp and Prolog. The Prolog standard will be based on the British and French work, already well advanced, and the convenor will be Roger Scowen of the National Physical Laboratory. The convenor of the Lisp group is Christian Quenniec of France, who has played an active part in the Eulisp project.

The first major problem for the Lisp working group is what to do about the Ansi development of a standard for Common Lisp, which the people concerned seem determined to push through regardless both of opposition abroad and of the agreed aims and principles of standardization.

Posix: A further working group has been set up to bring the work already in progress in IEEE into the international arena. The next IEEE draft will also be put forward as a draft proposal for an ISO standard, and the present draft (version 11) has already been circulated for comment.

The new working group is also to make contact with the Operating System Command and Response Language (OSCRL) group, and a joint meeting of the two now seems likely to occur some time in the new year.

The committee indicated its willingness to consider other work in this general area.

PL/I: Another problem of differences in standards was not so much solved as legislated away when PL/I was discussed.

The two standards envisaged in this area have been full PL/I and the general purpose subset. The intention had been to produce a revised full PL/I with a corresponding revised subset.

The trouble was that, while the revision of the subset had been prepared and was ready to go to the final stages, that for full PL/I had not been completed and work on it had stopped - indeed, the original full PL/I standard (ANS X3.53, which ISO 6160 endorses by reference) had recently been reconfirmed.

Despite this there was a clear need for a revised subset standard - except that, as various national bodies had pointed out, it could no longer properly be called a "subset"!

Neither withdrawal of the full standard nor updating it were, for various reasons, viable options. Hence the committee adopted what someone called "the minimal effort form of damage limitation" by renaming the subset standard "General Purpose PL/I". For most PL/I users this will become the effective useful standard, the older (and now incompatible) full standard remaining only for historical reasons.

New projects: Another language which has been around for a long time is Simula. It has a relatively small but dedicated band of users who need its specialised facilities, but has never reached the necessary threshold of active support to achieve international standardization.

Now, however, Sweden, in collaboration with Norway, has produced a national standard (in English!) and intend to submit the finished document again.

There is now what is called a "fast track" procedure to enable such local specialist standards to achieve international status if they are widely accepted. The committee thought that this was the preferable route to take, rather than the lengthier normal procedures which led to the ISO endorsements of, for example, the Ansi Cobol and Fortran or the BSI Pascal standard.

Other languages on which national standards have been started were announced by the US (Forth) and the UK (Vienna Development Method). If the users in other countries are interested, now is the time to notify the fact (to their own standards bodies).

Yet another project under way in Ansi, and actively seeking international collaboration, is a form interface management system (FIMS).

Based on a screen management system considered for Cobol, but now made language-independent, this is a language-oriented "human-machine interface" standard which, when in place, will be able to be used from various languages by suitable "language bindings".

For historical reasons, much re-invention of the wheel goes on in language standardization. Suppose two years ago, the first standard in the languages area had been, not Fortran (1966 version), but a generic functional standard for, say, ordinary input-output.

Then all the many subsequent language standards could have referenced that one and specified bindings so that Basic could have its PRINT, Pascal its writeln, etc.

How many person-days, or -hours, or -years, would that have saved? (Brian Meek, assistant director of the Computing Unit at King's College, London, in Computer Weekly, 8 October 1987)

Software takes the pulse of nerve disease

Medical and computer experts in Britain and Denmark have developed a computer programme that will help doctors to diagnose muscle and nerve diseases, plan tests and report on the results. Experts in this field of medicine, called electromyography, can diagnose disease with machines that use electrodes to measure how fast electrical signals travel along a nerve, for example. In a healthy young person the signal would travel at around 50 to 60 metres per second. If the speed is slower it indicates that something is wrong.

For less skilled doctors, interpreting the results can be difficult. Now the research team, which is funded by the European Esprit programme, has developed an expert system - a piece of software that is capable of containing enough knowledge to take in information from the medical equipment that measures the electrical characteristics of nerves and muscles, and to generate a likely list of diseases.

The next version of the system will also help doctors to plan what tests they should make, plan further tests depending on the results, and write reports afterwards.

The current prototype system deals with a limited set of 10 muscles, 3 nerves and about 20 different diseases. The final version will be able to diagnose the whole range of human muscle and nerve complaints, coping with about 300 nerves, 300 muscles and around 500 diseased states.

The project team involves workers from the software house, Logica and the National Hospital in Britain, and from Computer Resources International, Judex Datasystems and the University of Aalborg in Denmark. (This first appeared in New Scientist, London, 8 October 1987, the weekly review of science and technology)

Users, vendors team on expert systems

Dissatisfaction with off-the-shelf expert system offerings and a desire for packages that are customized for specific applications has led some of America's top corporations to join artificial intelligence vendors in the development of expert systems software. The craving for expert systems is so great that even though the products these companies are developing today may one day be sold to their competitors, it hasn't stopped them from avidly pursuing the technology.

While there's nothing new about users and vendors seeking close ties, or about users developing in-house applications, it is unusual for a technology and its makers to depend so heavily on customer input. In the case of AI, however, users and vendors agree that despite the risks, joint development is the only way to go.

Vendors' development efforts differ. Some choose to have the end user take an equity position and participate in running the vendor company. Only a handful of firms appear interested in that level of involvement, however. Most users prefer a more hands-off relationship, whereby they invest in the technology, not the vendor.

In the latter case, users usually pay the vendor up front and must be prepared to expend manpower and management time. Many of these experimental projects receive little, if any, funding from MIS, though. Instead, corporate management usually makes the decision to fund the project separately and agrees to reassign valued employees to it (anywhere from three to 15 employees, companies report). ...

But to most end users, the technology's great promise is still just that: a promise. Few have had much experience with expert systems. One of the attractions of these kinds of agreements is that in return for providing funding for the development project and insight into how their industry works, companies get extensive training with expert systems as well as a system fine-tuned to their needs.

Beyond the expertise, companies believe they benefit by receiving an expert system earlier than their competitors will. Artificial Intelligence Corp. (Waltham, Mass., USA) consortium members will get a prototype version six to 12 months before a commercial product is released, plus approximately six months of on-site consulting by AI Corp. personnel. That amount of consultation is not the norm for AI Corp., says company chairman Larry Harris. He estimates that with the future commercial version, customers will receive considerably less assistance, probably amounting to 10 days of technical support and a one- to two-week class.

In some cases, though, companies don't have to worry about competitors. Sometimes, if an equity investment is made, corporations may limit to whom the end product can be sold. That was a standard provision agreed upon by Teknowledge Inc., Palo Alto, in return for funding from such companies as Procter & Gamble Co. and FMC Corp., in Chicago.

In the majority of cases, however, competitors find themselves working with the same vendor. One essential is the protection of what is viewed as proprietary knowledge (e.g., in underwriting, each insurance company weighs factors differently); and users are demanding and receiving the final say as to what is released in a product.

Despite their enthusiasm for the projects, a certain wariness remains. These companies are working with, and even defining, prototypes with no guarantee of success. ...

From the vendor side, the risks are few and the potential rewards great. Artificial intelligence has a long way to go toward commercial acceptance and these alliances are crucial. Learning how to merge AI products with, for example, DB2 or IMS databases is invaluable to the vendors. (DATAMATION 1 September, 1987 pp. 18-20) (Reprinted with permission of Datamation[r] magazine[c], copyright by Technical Publishing Company, A. Dunn and Bradstreet Company, all rights reserved)

Arianna and Diana for Italian industry

Two new expert systems for industrial automation, Arianna and Diana, have been set up by the Italian groups Pirelli and Montefibre, respectively. The two systems are considered to be among the most advanced technological applications for programming and production control.

Pirelli, the Italian tyre production group which transfers know-how and sells equipment to the developing countries, has created the Arianna system for programming the production of its range of tyres, for cars and for agricultural machines.

The Montefibre chemical group is also in the process of testing out an expert system which, once in operation, will be capable of controlling the planning of the whole production process. It will be of real help in the qualitative and quantitative choices demanded in each phase of this cycle, in strict connection with market trends, thus favouring a more flexible reply to its needs.

Diana, as the system is called, will become operational by November and will be divided in two parts: one covering the codification of the planning data and the other covering the method for identifying the optimal solutions on the basis of sales forecasts and available resources. Using Diana, the whole production reorganization process can take just over 48 hours.

According to estimates, the overall cost of this project, once it is in full operation, will be paid off within a year. (Bulletin IBIPRESS, No. 146, 12 October 1987)

Expert system for scheduling Alitalia flights

The Italian airline Alitalia is about to start up an expert system for scheduling flights and handling any type of emergency, and provide rational choices even in situations presenting specific technical, operational and environmental conditions.

The expert system, using the experience acquired by experts, carries out a two-fold role: that of planning the service automatically, to the extent possible, and of assisting the work of specialists in the most complex cases. It can highlight the possibility of special flights or of new routes.

The expert system creates the time-table of Alitalia's intercontinental flights, which represents 60 per cent of the service offered by the company. It then displays on video the process of creating the time-table and enables the planner to add solutions or extra elements.

The system takes as a basis information such as the draft schedules, departure days, etc. and inserts them in the list of flight characteristics and specific knowledge. These latter two categories consist of the minimum ground time, maintenance schedules, airport capacity in addition to, obviously, the needs of the air market.

The first step in planning is that of the critical factor. Once the order in which these factors should be examined is established, the system analyses the flight plan and examines the aeroplanes available. Once the first flights have been assigned only some of the departure days can be allocated at one go. In this case the expert system must find the resources for the remaining departure days by re-examining the choices made before, and either re-assigning the resources or changing the initial configuration of carriers in flight. It then redistributes the carriers to obtain a greater availability of flights or reassigns several flights to another carrier, respecting the limits of the problem, or changing the departure time or day.

The operations are not carried out in a set sequence but according to an order and a variable measure depending on the critical factor of the situation and the operating mode of the expert. This enables planning to be carried out efficiently and, even more important, ensures a maximum security of the airline's flights. (Bulletin IBIPRESS, No. 147, 18 October 1987)

Tenth world conference on artificial intelligence in Milan

The tenth edition of the International Joint Conference on Artificial Intelligence (IJCAI), the most important international event on the topic, was held recently in Milan. This conference, which has been held once every two years since 1969, was divided into three parts: presentation of papers, didactic conferences - tutorials - on the topics of greatest interest to the potential users and a workshop on the latest innovations in hardware, software and bibliography. ...

The production and management sectors world wide are becoming increasingly interested in the transformation process brought about by the development of artificial intelligence (AI). This was shown not only by the nature of the products and papers presented at the IJCAI, but also by the co-sponsoring of the event by the major Italian business groups.

The growth of AI has already been noted at other recent meetings. For example, at the conference held in Avignon (France) in May where the first expert systems already operative in European firms were presented. The American Association of Artificial Intelligence (AAAI) held in Seattle (USA) in June also showed the predominant move from prototypes to commercial products as well as the American industry's intention to increase its penetration, by enabling its numerous achievements to function on conventional computers as opposed to specialized microcomputers adapted to the Lisp language. (Bulletin IBIPRESS, No. 141, 6 September 1987)

VII. COUNTRY REPORTS

Argentina

Alcatel-Cit in Argentina

The top French telecommunications firm, Alcatel-Cit is about to sign a $US 160 million contract for the installation of 22 digital telephone exchanges in Buenos Aires, Argentina. Opposition to this project has been voiced by the German company Siemens.

In fact Siemens, who already has a foot in the Argentinian market, feels that this contract is not valid as it was not put to international tender. According to Argentinian law, however, it is not necessary for the contracts to be automatically put to international tender. Moreover, Siemens believes that the Argentinian telecommunication market is not big enough to support another competitor.

If this project is pulled off, 55 per cent will be financed by the French Government, the remainder being supported by a group of French and US banks. The conclusion of this contract would give Alcatel the opportunity of increasing its share of the market abroad, where its presence is still limited.

Siemens and NEC, in partnership with some small local companies, currently share the Argentinian telecommunication market. At a rate of 200,000 lines a year, there is considerable expansion going on and the firms already on the market, such as Siemens, do not want to take on a competitor like Alcatel.

The Argentinian market is a promising one, thanks not just to the current increase in telephone lines but to the important fact that out of the 2.6 million telephone lines in Argentina, 90 per cent of them work with electro-mechanical exchanges and most of them are obsolete. (Bulletin IBIPRESS, No. 150, 8 November 1987)

Australia

The rebuilding of CSIROnet

The most powerful computer in Australia - a Control Data Cyber 205 - is now helping scientists investigate the devastation of large portions of the country's famous oceanic asset, the Great Barrier Reef. The culprits are massive hordes of crown-of-thorns starfish that are devouring the live coral.

The supercomputer, which is front-ended by a Cyber 845, is run by CSIROnet, a one-time sleepy research institute* that now is being magically transformed by the Australian Government into a hard-edged commercial wizard. In its new guise it has to fulfil an entrepreneurial role as a revenue-producing, value-added service provider and consultant. The starfish project is a prime example of how it is linking commerce and science in an unusual but vital national project.

Divers who work under the water for two thirds of the year provide visual reports for scientists at the Australian Institute of Marine Science in Townsville on the Northern Queensland coast. Using a range of personal computers, sensitive measuring devices, and a Digital Equipment Corp. VAX 11/785, those scientists monitor the life cycles of the starfish edging down the 1,000 miles of multicolored coral that is classified as one of the world's natural wonders.

The supercomputer allows the researchers to process information up to 100 times faster than their previous equipment had. Apart from analyses that may prevent unlimited wanton damage to an important part of Australia's natural heritage, the researchers also are making a substantial contribution to the preservation of one of Australia's most important commercial assets. The Reef attracts tourist business worth millions of dollars a year.

Scientific co-operation that also assists the nation's business interests is one of the major directions for CSIROnet. For 17 years, CSIROnet was a back-room enclave for computer research and development experts of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Black Mountain, Canberra. Now, CSIROnet has been unleashed as a trading organization with the charter of an unlisted public company to sell computer services on bureau-type hardware ranging from mainframes to communications nodes. It is also developing world wide packet switching networking facilities and links between databanks in Australia and overseas.

In its new role, CSIROnet has been looking for partners for overseas ventures and has appointed a national sales force to market its products and launch its new image inside Australia. Early in 1987, David Glavonjic was named chief general manager of the organization. Glavonjic joined CSIRO in 1966 with an accounting diploma from Canberra University. More recently, he was the second-in-command to CSIROnet's former chief executive, Peter Claringbold, who retired in 1986. ...

During March, CSIROnet geared up for its first joint venture - a major international marketing deal targeted at Asia and China and involving a Hong Kong distributor, Four Seas Telecom. The product at the heart of the deal is the Ultranode, a Unix-based multiprocessor workstation for file management, data processing, and scientific computation. It also allows organizations to link various computer networks that have different communications protocols.

Hopes for the Ultranode product hinge on two recent purchasing deals with the South Australian Department of Justice and the New South Wales State Rail authority.

The Department of Justice contract, in late 1986, marked the first attempt by CSIROnet to compete in a commercial deal. It won business worth $A2 million ($1.5 million) for the data communications component of the South Australian Justice Information System (JIS). Fujitsu Australia won the contract for the mainframe hardware, valued at $A3 million ($2.2 million).

The JIS, the first system of its kind in Australia, will link the Attorney General's Department, Police, Correctional Services, Community Welfare and Labour Departments, and the Industrial Registry through a single computerized information network. It will cost about $A20 million ($15 million) to operate in its first six years of operation, but offsetting this will be estimated gains of $A24 million ($17.5 million) over the same period in the rationalization of data and the elimination of unnecessary duplication of information among departments.

The deal with the State Rail authority, worth $A3.4 million ($2.5 million), is for 84 Ultranodes from Network Automation. These will form the basis of a fully integrated communications network providing high-speed data links between three different computer systems and the many data management systems in use by the authority. Eventually, the State Rail network will also interface to the neighbouring Queensland and Victorian State Rail data networks. Over the next five years, it will provide support for more than 3,000 terminals.

These commercial deals apart, CSIROnet is also building up its commercial profile as a bureau company. Before it became an autonomous unit, CSIROnet had established an extensive computing network offering wide facilities on Control Data and Facom (Fujitsu) mainframes. These included a Facom M180 and M190 with OSIV/F4 operating systems, and a Facom M159 with VM/CMS. In a joint venture with Fujitsu, these were used to develop operating system enhancements for the Fujitsu range including a

* Established in 1963 as the computing research section of CSIRO, a government financed technical organization.

programmer's tool kit for the Facom OSIV/F4 series and a system for file transfer and batch input and output.

Although CSIROnet has this substantial base of computers to fulfil its medium-term requirements, Glavonjic believes that there is an urgent need for a national supercomputer facility. CSIROnet has prepared a draft proposal for a national supercomputer strategy that he says would rank Australia with the US, Japan, FRG, Italy, the Netherlands, and the United Kingdom. ... (DATAMATION, 1 November 1987, pp. 56-25/28) (Reprinted with permission of Datamation ® magazine©, copyright by Technical Publishing Company, A. Dunn and Bradstreet Company - all rights reserved)

China

The China syndrome

The Chinese Government, under the reforming leadership of Deng Xiaoping and premier Zhao Ziyang, is pushing ahead with its plan to modernize four key areas: industry, agriculture, the military, and science and technology. Speaking at the Second International Conference on Computers and Applications, held in Beijing in late June, the head of the China State Council's Committee for Electronics Innovation, Li Xiang-Lin, told delegates that the country "regards computers as one of the key development objectives". The hope is that the use of computers can aid the transformation of the country from a largely agrarian and local craft-based society into a major world economic power in the twenty-first century.

Li Xiang-Lin estimates that by the end of 1986, China had an installed base of 8,000 minicomputers and mainframes and over 200,000 micros. The number of LANs is still low, but it is growing rapidly. There are currently over 170,000 computer professionals in China, half of whom are involved in developing new applications. So far, Li estimates, systems have been developed covering 20,000 application programme areas.

According to a 1986 report from the US Embassy in China, over 60 per cent of the computers in China are used in transportation and industry, 17 per cent in science and education, and only 3.4 per cent in commerce and finance. The remainder is spread thinly in the cultural, health, and agricultural areas, as well as other sectors.

More significantly, the report suggests that one major reason for China's lack of widespread automation is gross underutilization of the systems the Chinese already have. "China could virtually double its computer processing by better training of its operators and the purchase and development of advanced software already available in the West," says the report. That may be underestimating the problem. Many people working in the information systems sector in China, including the Chinese, suggest that computers are being used at between only 15 per cent and 25 per cent of capacity.

Much of the technology underlying those statistics has come from foreign firms - in the US, Japan, and Europe (See figure 2 "China's Computer Imports"). Over the last 10 years, China has imported an estimated $2 billion of foreign information technology. IBM, Digital Equipment Corp., Hewlett-Paccard, Unisys, Fujitsu, Honeywell Bull, and Siemens have all had their share of those deals. IBM regards its growing business in China with such seriousness that it set up an IBM China Corp. in Hong Kong in 1984.

One of the limiting factors to technology trade now is the shortage of foreign reserves available for foreign purchases. This is largely the result of over-zealous expenditures during the first few years of the open door policy.

For a while, the Chinese thought that modernization meant having the right machines. Now they are learning that it is a systems game. China's guidelines for technology acquisition reflect the country's change of emphasis; systems must be above the level available in China, must be of practical use, must contribute to China's eventual self-sufficiency, must foster economic and social development, and must be useful for generating foreign exchange.

Not all of China's technology comes from abroad. It has its own computer traditions and is actively creating an internal computer industry, centered in Beijing and in Shanghai, much of it under the control of the newly formed China Computer Development Corp. (CCDC).

Set up in early 1987, the CCDC's stated aim is to become "China's IBM". It pulls together many of the disparate computer development and manufacturing facilities in China into one organization. The aim is to co-ordinate the country's production of machines and help ensure that the people with talent are given the right environment to work in. Cutting across the traditional hierarchies of Chinese State-controlled organizations is essential if this is going to be effective.

Thirteen factories that build the Great Wall microcomputer are part of the CCDC. Together, they produce 25,000 PCs a year. Factory Number 3, in Beijing, manufactured minis from 1965 until 1983, when it began producing 8-bit machines. Now it sells the IBM-compatible Great Wall, which it builds using Intel microprocessors and memory chips from Oki of Japan. It also makes a Motorola 6800 multiuser Unix system called the BCMS 6800. "What we would like to do is to make Digital's MicroVAX here," says Pan Tianbao, deputy chief of production at the plant.

Figure 2: China's increasing computer imports* (in $ millions)

Country	1983	1984	1985	1986
France	5.8	1.6	2.8	9.2
Federal Republic of Germany	1.3	7.3	7.1	11.1
Italy	0.4	0.8	1.1	1.2
United Kingdom	2.3	4.0	6.0	4.3
Japan	25.7	49.9	83.7	84.9
United States	35.3	77.6	154.7	189.7
Total	70.8	141.2	255.4	300.4

* All figures include computer systems, CPUs and peripherals.

Source: Official Customs Statistics.

There are now an estimated 2,600 joint ventures between Chinese organizations and foreign firms. Though not all have been successful, many foreign computer firms are looking for a stake in one particular joint venture: to build a mainframe assembly plant in China. The chances are that the company that wins the deal will also win a massive share of China's growing mainframe market.

The lack of networking hinders computer users in China in other ways. "Remote diagnostics simply is not possible here," says Siemens' Szwoch. "Users have to wait until an engineer can get to them when there's a problem."

Improvements to China's networking ability are in the early stages. On the applications side, though, there already are examples of the way ahead for China.

In the buildings of the Municipal Government of Nanjing in the Jiang-su province is one of China's more sophisticated information systems. The main application is office automation and it supports Chinese character electronic mail, Chinese word processing, and a data-based management information system. Twenty people can use the system at any time via terminals and a fiber-optic LAN.

One of the system's developers, Xue Xing, a PhD student at Nanjing University, explains that they had to start from scratch. "There are not many systems using this type of application, but it is an area that is growing very fast," according to Xue. "The trouble is getting the money to develop and install them."

Access to more advanced software tools would help cut the cost of development, and that is the goal of China's national software engineering programme. Run by Booheng Zhan, associate professor and vice chairman of the computer science department of the Beijing Institute of Aeronautics and Astronautics, the program is sponsored by China's State Science and Technology Commission and involves researchers in 13 Chinese universities and institutes. The programme's review committee, however, is not Chinese. It is made up of experts from the University of Maryland, College Park. The software engineering environment they are developing is based on Unix and written in C.

Complex software problems already have been overcome in China, particularly those connected with the major task of automating China's ideographic language - there are over 400 different Chinese character entry processing systems to choose from.

Now that the language has been automated with some degree of success, there is a base for developing administrative and office applications. Though the expertise needed to create effective systems is limited, this will change as the many Chinese students in the US, Europe, and other Asian countries - around 30,000 in 1986 - return home after being exposed to Western management methods and techniques of systems analysis. Probably the most influence on the future of China's information systems development will come from foreign companies. They will set examples, make money, and, if they want to maintain and expand their systems in China, they will probably transfer some of their know-how to their trading partners.

Both the outside companies and the Chinese are becoming aware that they have to make realistic plans to account for limitations in the use of information systems as a base for business. China, meanwhile, is beginning to focus on closing its applications gap.

If international trade is supposed to be a process of mutual benefit, then trade with China will have to be a process of mutual education for a few years. "And then," as Professor Hu puts it, "once the friendship has been established, the world will seem a smaller place." (DATAMATION, 1 September 1987). (Excerpted from an article by Paul Tate, DATAMATION's international editor and John W. Meier, an independent computer and networking consultant in Fort Worth. He has been involved with Chinese computing for eight years and has recently spent a year lecturing in China on the computer sciences.)

EEC:

Europe agrees to EUREKA projects

Research ministers from 19 European countries approved the inclusion of 58 new high-technology projects, with a total value of more than $US 800 million, in the EUREKA initiative. This is a scheme launched two years ago at the prompting of French President François Mitterand designed to link Europe's industrial and academic scientists and engineers in the development of market-oriented technologies.

The projects approved at a meeting here range from a relatively small research effort being launched by scientists in Britain and Denmark into the production of fruit flavours from plant tissue cultures, to a major 5-year, $US 60 million project involving the joint development by teams in Italy, FRG, the United Kingdom, and France of the high-speed optical transmission of telecommunications signals. Each project is funded from private and public sources.

The new projects bring the total to 165, with a value of $US 5.8 billion, the total approved since EUREKA was launched in 1985 in what many saw as a direct response to the US Strategic Defense Initiative (SDI). European politicians argue that EUREKA is needed to counterbalance civilian spin-offs from SDI for US companies.

A preliminary analysis by the EUREKA secretariat of projects launched so far reveals that the most popular fields for collaboration are in information technology (25 per cent of the projects) robotics and manufacturing (17.6 per cent), and biotechnology (13 per cent). Other important fields include new materials (12 per cent), environmental protection (8.3 per cent), and telecommunications (7.4 per cent)

One of the conclusions of the ministers at the Madrid meeting was that a special effort should be made within the EUREKA initiative to encourage greater university-industry co-operation on future projects. (Science, 25 September 1987)

IT skills gap in Europe

Education and training in Europe must undergo a profound transformation to meet the skills challenge, according to a report from the International Labour Office.

Instead of the traditional division between blue collar and white collar workers, according to the report, two new categories are emerging. Those with new information technology (NIT) skills and those without them.

The report, prepared for the September 1987 Fourth Regional Conference maintained that if Europe wants to rise to the challenge from overseas, skills development will have to play a crucial role. Unless education and training moves ahead a new polarization will take place affecting the competitiveness of enterprise and the prosperity of the nations, said the report.

"European training policy objectives remains anchored in yesterday's world ... by and large, they are conservative and inflexible, lacking aggressiveness and fine-tuning to the present labour market," according to the report.

The factory of the future, said the report, will be composed of skilled workers fully conversant with computer-aided design and flexible manufacturing systems, with non-machine tasks undertaken in rotation by operators.

The report has two major recommendations for our education and training systems. They should be flexible and foster creativity with constantly reviewed curricula to mirror the reality of the labour market.

The report concluded by saying that if schools do not react to the second industrial revolution, workers will become irrelevant to tomorrow's new opportunities, requirements and priorities. (Electronics Weekly, 26 August 1987)

India

India's soft hopes

Unlike Asia's other ambitious industrializing countries, such as South Korea and Taiwan, India has rejected the idea of mimicking Japan's success in producing low-cost hardware as a means of entry to the world technology industry. India is taking the soft route, although so far the country is finding that route hard going.

The total value of Indian-produced software last year was less than $60 million, of which $38 million was exported. In an international market where sales of a single PC package can reach a billion dollars or more, such numbers are not impressive. Even the Government's national software promotion policy, which aims to increase software exports to $300 million by 1990, is far from awesome despite the almost tenfold increase it represents. What is more, that plan is being tempered by restrictions on the use of foreign exchange (foreign money reserves held by the Government) to purchase the right development hardware.

Government and industry officials are convinced, however, that India can become a massive software and services house serving the needs of the world's user companies and the international information industry.

In one sense it already is, claim advocates of the software policy. The additional secretary of India's Department of Electronics, N. Seshagiri, who is essentially the person in charge of the country's computer policy, reports that government surveys show "Indians outside India developed $7 billion in software in 1986." He adds that there are currently almost 50,000 non-resident Indians creating software for foreign companies.

Tapping into that software potential at home is what Seshagiri hopes to do, and he believes that foreign firms, whether they are user companies looking for custom-built systems or technology companies shopping for products, will begin tapping into it too.

Some of them already have. For example, Citicorp in the US and Citibank Savings in the UK have both had applications software developed by Tata Consultancy Services of Bombay. Tata is India's largest software exporter, having earned $12 million in overseas business in 1986. Among Tata's other clients are American Express, Unisys, National Westminster Bank in the UK, the European Container Terminus in the Netherlands, Australian Iron and Steel, the New Zealand Post Office, and the Kuwait Ports Authority.

But one of Tata's most ambitious contracts is just getting under way with the Fireman's Fund Insurance Corp. (FFIC) in San Rafael, California. This deal is to help the Fund's System Enterprises subsidiary rewrite the FFIC's entire accounts receivable system.

Tony Chalmers, vice president of the subsidiary explains, "It's a very complex job and involves integrating over 20 different systems. The total project represents about 200 years of effort and will require close to 2 million new lines of code. Tata was chosen as a joint developer because we have always been impressed by their professional approach and the quality of their work. We can also benefit from the lower manpower costs when we use their development centre in Madras for some of the work."

The Fund's confidence is based to some extent on a project just completed in which Tata helped to develop a data dictionary for FFIC based on the IBM DB2 product. It is called Addict. "We believe it is the only one anywhere near completion in the world," says Chalmers, "and we intend to start selling it on the open market in the next few months."

For FFIC, Citicorp, and other Western firms, one of the most obvious advantages India offers is low labour costs. While capital-intensive hardware manufacturing is handicapped in India by severe foreign exchange and industrial infrastructure problems, the country's software industry apparently benefits from these adverse economic conditions. "India has a surplus of unemployed or underemployed scientific and technical manpower," says the Department of Electronics' Seshagiri. That manpower comes cheap. "The average monthly salary of a university graduate with specialized electronics training is 3,000 rupees ($240)," reveals J.N. Renhan, joint secretary of the Ministry of Commerce. Seshagiri adds, "Software is labour-intensive, so we have a cost-cutting advantage." Seshagiri estimates that software can be developed in India for one tenth what it would cost elsewhere.

Indian computer executives also argue that they have other points in their favour, including the use of English as the standard language in business and government sectors and a level of technical education that is higher than in many developing nations. "We have a wealth of engineers and professionals available. Other countries with so-called inexpensive labour do not have our technical expertise," claims Manohar L. Tandon, chairman of the Bombay-based Tandon Group and brother of the founder of Tandon Corp., Chatsworth, California.

India is determined to continue improving that level of expertise by expanding computer education in India. The Department of Electronics is setting up four Indian Institutes of Informatics Technology, which will make use of the National Informatics Center network (NICnet). The existing four Indian Institutes of Technology are also expanding their computer training programmes. Private institutes and industry are being encouraged to increase computer training.

The ready availability of educated, low-cost software personnel is a mainstay of India's software promotion policy, a government-backed initiative now in its first year of operation. This is the latest move in the country's five-year plan to improve the industrial and commercial structure of the country through the use of new technologies.

A central theme of the computer policy is Seshagiri's "flood in, flood out" concept. The first phase opens the gates to the unrestricted import of foreign software. Though products are still subject to a 60 per cent import duty, it is still much better than the usual 140 per cent levy applied to foreign technology wares being brought into the country. On the surface this appears to be the opposite of what India wants to achieve. How can making these Western products easier to import help increase exports of Indian software products and services? There is a plan.

The incoming flood of new software is expected to offer several benefits. Nandan Nilekani, deputy managing director of Bangalore software house Infosys, explains, "It's supposed to flood in, raise the level of expertise to international standards and the state of the art, then (Indian products) flood out again."

This goal is to be reached by several paths. First, the incoming flood should stimulate computer use and manufacturing and increase the size of the domestic software market in general. Subsequently, the plan forecasts that "import substitution" will occur with local developers creating products that are cheaper than the imported packages. If they cannot there will still be an advantage: "The imported software means we need not reinvent the wheel," explains V.K. Harindon, director of PSI Data Systems of Bangalore, a manufacturer of microprocessor-based computers and systems.

Although import substitution will not necessarily lead to exportable products, another approach might.

The improved level of expertise is also expected to attract contracts for custom-built software from major foreign companies. These contracts will all be channeled through the Government-owned computer company, CMS. The company will then break the contracts down into manageable pieces, distribute the work among domestic companies, manage the project, and, finally, supply the results to the customer.

Winning specific project contracts is the traditional way that India has run its software export trade. Usually this involves sending developers and programmers to work with the clients, a practice often described as body shopping, body export, or "fleshware" export. ...

"Software package export is the dream," confesses Pravin Gandhi, executive director of Hinditron, a local software house that represents Digital Equipment Corp. and Tektronix Inc. in India, but, he adds cautiously, "The ballgame in the US is a bloody game. I cannot see a lot of product development in India in the near- to medium-term future."

What is more, though the software policy is less than a year old, many people are already having second thoughts about it. The flood in, for example, may not be as much of a free flow as expected. "What is happening is that there's a growing fear the flood in will cause lots of foreign exchange problems, so they put restrictions on," explains Nilekani.

Even if the Western supplier does manage to get approval from its Government to export advanced systems into India - the Indian buyer is faced with internal restrictions on the import of the necessary development hardware. This is especially true of the latest models of large systems, which are scarce in the country. Though the new policy permits the import, also at 60 per cent duty, of the more expensive equipment needed to develop upscale software products, export commitments must be given in return.

For machines or systems with bundled software that are purchased using foreign exchange obtained directly from the Government, the developer must, within four years, export software worth 250 per cent of the foreign exchange used. For foreign exchange obtained elsewhere, the export obligation is 150 per cent. Similar terms are applied to leased equipment, as well as to that loaned by a customer for the life of a project.

The lack of access to the right hardware may not be too large an obstacle in the future as India develops international communications links that allow remote development.

There are other problems developing, however. Although users can import software, recent announcements appear to indicate that "if you're only a software retailer, you cannot import for stock and sale," says Nilekani.

More surprises may be in store. "There are still notifications coming out," Nilekani adds. "We're still waiting and seeing." These uncertainties about the likely side-effects of the Indian software policy on the country's local industry do not improve the confidence of Indian executives as they peddle their services overseas. But peddle them they will, and with increasing vigor.

Hinditron's outlook sums up the way most Indian software companies see their futures. Says Pravin Gandhi, "We're looking for more project contracts and recurring revenues through royalties."

Liberalized software and hardware imports will make some difference to the level of quality and appropriateness of Indian products, but there is still one inescapable problem: the geographical distance from major markets, especially the US. This will continue to hinder development of both PC packages and large-scale projects.

For PC software, the main problem that distance presents is the inability to keep up with a fast-moving market. For larger projects, the problem is access to the environment in which the product will have to function. For this reason, even companies with relatively modern hardware, such as Infosys with its in-house Data General equipment and its timesharing access to DEC and IBM machines, are often forced to export people rather than do the entire project at home. (DATAMATION, 1 September 1987, pp. 96-5/11) (Reprinted with permission of Datamation[r] magazine[c], copyright by Technical Publishing Company, A. Dunn and Bradstreet Company - all rights reserved)

Indonesia

Telecommunications in Indonesia

Approved in 1985, the Government plan will be developed over five years. At present the work is proceeding at a good pace, even though the import restrictions are making it more difficult to achieve the targets. For this reason attempts are being made to increase the import of telecommunications equipment from countries willing to give low-interest loans as well as to increase production and local assembly.

Recently, 6,000 lines have been installed in Jakarta and public EWSD switchboards providing 10,000 lines have been installed in Java. In the near future, it is planned to expand the current telephone network by 20,000 lines in Java, 24,000 in Sumatra and 20,000 in Semarang, etc.

Other methods of financing are planned for projects which foresee the launching of the first cellular radio telephone communication network in Indonesia. Last year such a system was set up on an experimental basis by a local company using Ericsson equipment. The cellular radio telephone network has at present eight radio-base stations and 18 cells to cover Jakarta and Bandung. The first phase, which designed for 10,000 subscribers is about to be finished, whilst the installation of the second phase which involves expanding the areas and the subscriber capacity is under study.

To solve the major problem of communications raised by the fact that the country has over 13,000 islands, a project was started about 10 years ago for launching satellites which can create a system of link-ups also between the most distant islands. Last September the Government approved a plan for launching, by the end of the year, the Palapa B-2P satellite. The operation will cost around $US 93 million. The previous Palapa B-1 satellite, launched a few years ago with 12 transponders, provided the country with a capacity equal to 12,000 telephone lines. (Bulletin IBIPRESS, No. 145, 4 October 1987)

Japan

Japan faces shortfall of software engineers

Japan anticipates a dramatic shortfall of 600,000 software engineers by the next decade, according to its technology ministry.

This is already presenting new opportunities for women in Japan's male-dominated computer industry, and is fuelling rapid advances in its software development technology.

Fujitsu, for example, is to recruit 20 women annually to be trained as programmers, starting this year.

But increased recruitment levels are unlikely to cope with user demands - the average applications backlog of the large-scale users in Japan is nearly three years, according to Fujitsu's Yoshio Egawa.

The software engineer shortage is one spur to Japan's Sigma which aims to develop high productivity software development environments. (Computer Weekly, 13 August 1987)

Mali

Microcomputers aid Mali businessmen

The Malian Chamber of Commerce and Industry now uses a microcomputer to carry out financial planning and analysis on a monthly basis for all of its regional delegations as well as its headquarters activities. Formerly this was possible only once a year.

A major effort has also been made over the last year to develop economic data on the activities of local entrepreneurs. The computerization of this data will eventually permit rapid answers to requests for economic statistics by foreign business people, development workers and the entrepreneurs themselves. Another database currently provides information on price indices for a variety of consumer goods. Applications such as these add significantly to the availability of key information about Mali's economy.

The ongoing liberalization of the Malian economy creates applications for the computer which promise to help local entrepreneurs take better advantage of business opportunities. With the Chamber's database system, it may soon be possible to provide quick access to information on legislative changes affecting business interests by using a list of key words and capsule summaries of legislative texts. The Chamber is also making use of the machine to conduct training workshops for Mali professionals. (Development Forum, 1 October 1987)

IT in OECD countries

The information technology (IT) industry, encompassing the whole gamut of hardware and software for the processing and transmission of data, generated total world-wide revenues of nearly $400 billion in 1986, a figure that will have more than tripled by 1995. The sector already accounted for up to 25 per cent of GNP in OECD countries by the early 1980s, and the proportion has risen since and will rise further in the future.

Expenditure on IT products is increasing faster than on any other class of goods and will continue to do so. In the United States, it is forecast that outlays on computers and other data processing (DP) equipment will rise by an annual average of 21 per cent up to 1995, and those on telephone and telegraph systems by 20 per cent. Annual spending growth for the third fastest-rising industrial product group, drugs, is projected at no more than 7.4 per cent.

Investment in IT-related sectors is also outstripping that in most other industries. US forecasts show that in terms of annual growth in total sectoral expenditure from 1984 to 1995 IT-related industries occupy four of the top five places, with the league table headed by computer hardware (8.5 per cent annual average growth) and communications services (8.1 per cent). Medical and dental instruments are in third place followed by telephone and telegraph equipment (5.2 per cent) and radio and communications systems (4.5 per cent). By 1995, the computer industry will be by far the biggest industrial investor with total outlays forecast at $62.4 billion (in 1977 dollars), followed by the automobile industry ($41.8 billion) and the three telecommunications sectors (around $20 billion each).

It is generally estimated that only 10 to 20 per cent of the potential to be derived from IT-based innovation has so far been exploited, while the rest should be realized within the next 10 years. The more rapid diffusion of IT into new products and processes will come about through cost/performance improvements in technology that is already available. Research shows that a one per cent reduction in the cost/performance ratio can lead to a 30 per cent increase in demand for an IT product. In particular, connecting data processing systems into local or company-wide networks that can in turn be linked to national and international communications systems will enhance their efficiency and economic value for the user.

IT investment forms part of an organization's long-term corporate strategy and once implemented (which may take four to five years) becomes one of the company's basic assets. From its start-up, an IT system should have a lifespan of between seven and 12 years. Over time, a company's global information system builds up into what could be described as the largest machine in the organization, just as the international telecommunications system has been portrayed as the largest machine in the world. There is a concern, however, that the world's financial markets, which are themselves riding the wave of IT-based innovation, may operate in a way that discourages this type of strategic investment.

Table 2

World production of information technology systems
Growth estimates 1986-1995

	$ billion[1]			Average annual growth %
	1986	1990	1995	
Hardware	224	353	621	12
Software	84	174	433	20
Telecommunications[2] and computing services	85	107	143	6
TOTAL	393	634	1 197	13

1. At 1985 exchange rates.

2. Telecommunications equipment solely for the public network.

Source: OECD.

IT systems not only increase productivity in the classical sense but also introduce a far greater degree of flexibility into management and manufacturing systems. Automation through programmable machine tools and robots makes batch and "customized" production both technically feasible and economically viable. IT can also make for higher quality, more "intelligent" products that have greater appeal to the consumer. Networking will facilitate interaction between users, designers, manufacturers and the suppliers of production machinery, which should not only result in better adaptation of products to customers' needs but also accelerate the innovation process.

The economic benefits of investing in IT are thus both of a quantitative and qualitative nature. Quantitative gains will arise from higher expenditure on IT-based goods and services, from the growing market for information-based services and from investment in new telecommunications networks. Investing in hardware of all kinds, from mainframe computers to desktop terminals, from robots to fibre optic cabling for integrated services digital networks, not to mention spending on software and services of all sorts, should have substantial multiplier effects, creating direct and indirect long-term growth opportunities. The burgeoning scope for new information services will cover fields such as professional and private data banks, financial transactions (electronic funds transfer and payment systems), entertainment and leisure activities, health care and education.

At a qualitative level, IT-based systems and services have the merit of being virtually pollution-free and of being useful for monitoring and helping to reduce air and water pollution. They can also be used for controlling engines, helping to lower energy consumption as well as harmful emissions. IT incorporated in robots and other computer-controlled machines can take over hazardous and dangerous (as well as tedious) occupations from human beings (such as in mining, deep-sea exploration and nuclear power plants). In a more general way, IT will bring about a transformation in the way economies operate and engender a new and more creative world. Sectors where IT is expected to make a particularly big impact are engineering and machinery, automobiles, textiles and clothing, banking, and office-based professional and personal services.

Despite the dire predictions in some quarters in the 1970s, computers have not displaced humans and added to dole queues but have actually created employment. There has been a progressive shift towards information-handling occupations. In fact, since the growing demand for information-related services has more than offset the rise in the productivity of staff engaged in these tasks. The introduction of IT systems has thus not contributed significantly to the current high levels of unemployment in many OECD countries. Between 30 and 45 per cent of the total active work-force in the OECD area is now engaged in information-handling occupations, while the information industry itself has become a major employer: in the United States, more people now work in the IT sector than in the automobile industry.

Rather than new technology causing high unemployment, it now looks as though it was too little technological progress that caused unemployment levels to rise and stay high in the 1970s and early 1980s. Unemployment seems to be concentrated in non-innovative sectors, especially those where IT has no contribution to make. It arose from a vicious circle of low profitability, low investment and low productivity growth, making employers reluctant to expand their work-forces. Since new technology is generally introduced through new investment, the conclusion can be drawn that the diffusion of IT-based process automation has, like employment, been held back by poor economic performance.

In this context, one factor tends to be forgotten: the relative prices of capital and labour affect the demand for each and may determine the application and speed of diffusion of new technology. Available data show that during the past 10 years the United States has been more dynamic in utilizing new information technology for producing innovative products and services, whereas Europe and Japan have tended (although to a lesser extent) to use IT for modernizing and automating their production processes. As a result, the American IT industry increased output and employment rapidly between 1972 and 1982, generating a steady flow of new goods and services. The relatively low number of industrial robots and programmable industrial machinery in use in the United States, together with the decline of the American machine tool industry, are in sharp contrast to developments in Sweden, Germany and Japan (table 3).

Table 3

Use of industrial robots

	Japan	Europe[1]	of which: Germany	United States
1974	1 500	800		
1978	3 000	2 000		
1980	5 500	4 000	1 255	4 500
1981	8 500	6 000	2 300	6 000
1982	12 000	9 000	3 500	7 000
1983	30 000	13 700	4 800	8 000
1984	44 000	20 500	6 600	13,000
1985	65 000	30 000	8 800	20 000
1986	90 000	40 000[2]	12 400	26 000

1. All European countries.

2. Including 3,000 robots installed in Eastern Europe.

Source: OECD/Fraunhofer Institut für Produktionstechnik und Automatisierung (IPA), Stuttgart, December 1986.

At the same time, the United States has maintained a high rate of job creation, although that should not be taken as a pointer to policies that might be adopted elsewhere. A policy geared to curbing productivity growth in order to retard investment in labour-saving production technology and stimulate employment would be open to considerable risks; the competitive environment, especially in the supply of IT products, might mean such a policy results in a lowering of living standards rather than an increase in the numbers employed.

The future diffusion of IT systems will be characterized by greater integration and interconnection, as stand-alone equipment becomes increasingly tied into networks, making technology that is already available that much more economic and productive. Only an estimated 16 per cent of currently installed IT systems have networking capability or are actually interconnected. Automated offices and factories will soon be a reality, therefore. In the factory, robots, numerically-controlled machine tools and CAD/CAM systems will be linked into Computer-Integrated Manufacturing (CIM) networks in which the various phases of design, production planning, materials procurement, machining and assembling, inventory control and sales and marketing will be interlocked in a single information processing and communication system.

Research so far suggests that IT-based innovation tends to be capital saving (and labour augmenting), unlike earlier production technologies. The argument that investing in IT systems results in more than proportionate productivity gains thus turns out to be a statistical artifact, since it merely reflects the diminishing cost of the hardware element in these systems and the differential statistical treatment of the hardware and software components (the former being counted as capital expenditure and the latter considered as current consumption). That suggests that worries about the employment consequences of the IT revolution in offices and factories is a misconception leading the policy discussion in the wrong direction.

Reducing obstacles to diffusion

Rather than trying to predict the labour market implications of computerization, policy-makers should be concerned with eliminating the impediments to the widespread and rapid diffusion of IT and minimizing the adjustment costs for those adversely affected. In general terms, there are two main areas for government action: firstly, fostering the expansion of the technology base in general and the diffusion of IT in small and medium-sized firms in particular; and secondly, ensuring the availability of a suitably trained and skilled work-force.

It is particularly in less technologically advanced countries that governments may have to support the development and diffusion of IT systems. Because it is skill intensive, IT process technology has only really taken off in a limited number of countries with an already advanced technology base and major investments in R&D. In many countries, institutional changes are taking place in market structures of telecommunications services, in restrictions on broadcasting and cabling or in protection of intellectual property rights. Finding consensus on new, or re-defining established, standards, and liberalizing regulations are important steps needed to encourage investment in IT. More generally, resistance to changes in working conditions have to be overcome, which requires both an enlightened management and a suitably skilled labour force.

In considering all the issues raised by existing rigidities and obstacles, governments may see the scope for application-oriented policies (the "technology-pull" approach) as a more efficient means of stimulating the introduction of the new technologies. This concept entails the coupling of supply-side policies to create the technological capabilities with the demand side, as distinct from pushing IT applications at the firm level only. Candidates for such large applications include new infrastructure systems, for example in transport (just-in-time delivery) and telecommunications where new services could improve mail systems currently burdening government budgets.

Some governments have adopted major programmes for encouraging broader IT use, promoting specific applications and objectives such as reducing air and water pollution or conserving fossil fuels. There is the possibility of many other applications - micro-processor-controlled engines in automobiles, expert systems for monitoring illegal chemical waste dumped in major rivers, safer electronic braking systems in motor vehicles, computerized traffic management and at a general level the creation of "smarter cities". All sorts of public services could be rendered more efficient and cost effective through the use of IT, moreover.

This kind of policy approach need not entail an increased use of public funds, since it basically involves setting specific objectives and creating an appropriate framework for the operation of market forces in a period of transition.

* * *

The IT industry could thus constitute an important engine for future economic growth, if its products are effectively exploited. However, unlike other high growth sectors (consumer electronics, for example), demand for its goods and services comes mainly from other industries and from public administrations, so that its output growth will be as much a reflection of countries' general economic performance as a contribution to it. Hence, while seeking to harness the large social, technical and economic potential offered by IT, governments cannot hope to depend on this one sector to serve as a catalyst for growth but must also continue to focus attention on general structural and economic conditions to provide a better framework for growth. (OECD Reporter, October 1987; excerpted from an article by D. Kimbel, Science and Technology Division, OECD)

Scandinavia

Scandinavia launches a transnational data network

The Scandinavian authorities are setting up what should be the first transnational telecommunications service. The joint subsidiary will be established in Sweden as a private company which will supply the data networks on an international basis. The launching of this service is to prepare the way for a similar initiative in Europe.

Sweden will own 8 per cent of the new company and Denmark, Finland and Norway will have 16 per cent each with Iceland holding 4 per cent. The company should start operating as of 1988 by which time all the countries concerned will have obtained authorization from their respective parliaments.

In setting up this service the major companies will be able to order their requirements for their private data networks from one point. They will also be able to pay for these networks at the same single point.

By moving into this field, Scandinavian telecommunications will find themselves in headlong competition with the major computer and computer services companies such as IBM, Electronic Data Systems, a subsidiary of General Motors, and Geisco, a subsidiary of General Electric of the US.

Agreements have already been concluded to exchange traffic with Hong Kong and Canada and negotiations are under way with the US. Such agreements are concentrated outside Europe in order to facilitate the discussions now taking place among the European countries for the possible launching of a similar transnational service on a pan-European basis. (Bulletin IBIPRESS, No. 142, 13 September 1987)

United Kingdom

Alvey Programme

The results of four years of work and a £350 million investment in information technology (IT) were displayed recently at the 1987 Alvey Programme conference and exhibition. All the funds are now committed and the last projects are expected to be completed by 1990.

The programme was set up in 1983 to emulate the ability of Japan to create a national co-ordinated IT drive with industry, government and academic institutions co-operating in work on the research stage, but competing later on in product development and marketing. Four key technologies were identified: Very Large Scale Integration (VLSI), Intelligent Knowledge Based Systems (IKBS), Software Engineering (SE) and the Man/Machine Interface (MMI). Systems Architecture (SA) emerged a year later as another vital element.

The Government supplied £50 million for research in academic institutions and £150 million for industry research. Industry provided the remaining £150 million. More than 100 projects were on show at the exhibition and the director of the programme, Mr. Brian Oakley, expressed his pleasure at the UK's overall progress in IT, with one note of warning. ...

The enthusiasm evident at the exhibition and conference was tempered by a concern for the future. It was not clear what, if anything, would succeed the Alvey Programme and some participants complained that their work was suffering because it was not known if funds would be forthcoming. ... (Engineering, October 1987)

USSR

USSR and telecommunications

The Soviet Union is giving a big boost to the sector of telecommunications and to commercial space programmes.

Following China's example, the Soviet Union has now launched a market campaign to sell commercial space on its proton rockets. As a result of this campaign's lack of success, the competent authorities have signed an agreement with a London Insurance broker. This company will act as an intermediary between Glavcosmos, the Soviet civilian space authority, and Western companies wishing to place their satellites in orbit on Russian rockets. The cost for each launch will amount to $US 20 million which is very competitive compared to the price set by the Chinese, $US 30 million.

As regards the Earth telecommunications sector, the Telecommunication Industry Research (TIR) has published a study containing estimates of this market's development over the next few years. According to these estimates, the expenses for procuring telecommunications equipment will surpass $US 20 billion by 1995.

The TIR have estimated that the Russian domestic market for telecommunications equipment should surpass the $US 9.6 billion of last year and increase to $US 13.4 billion in 1990 to reach $US 23.6 billion in 1995. On the basis of the plans foreseen by the Soviet Government, the cable communications networks will be expanded and renewed with the insertion of fibre optics. By 1995, 44 million lines will be digitalized for the transmission of data and images. The number of telephones will increase from the 30 million of last year to 48 million in 1990 and reach 100 million in 1995.

The results of the research have highlighted that the Soviet industry will manage to cover only a third of its needs in the telecommunications sector. The TIR therefore foresees that the Government will have to resort more heavily on imports from other countries of the East or even of the West. According to the calculations of TIR, the imports will reach approximately $US 5 billion in 1990 of which more than $US 350 million will come from western countries. These imports amounted to $US 37 million in 1984. (Bulletin IBIPRESS, No. 151, 15 November 1987)

Soviet CAD/CAM programmes and markets

... The Soviet Communist Party Congress already approved a sweeping programme of economic reform focusing on giving more autonomy to manufacturing plant managers who are expected to double their existing automation "levels" by 1990 and will hence be forced to sink or swim on their own as state subsidies are reduced. However, plants will also be allowed to retain a portion of their profits for R&D and capital investments of their own choosing and it is believed that under this system many plant managers will compete vigorously for the most advanced computers and CAD/CAM equipment that are seen as the basis of effective factory automation in Western countries and Japan.

There is mounting speculation about huge new markets and business opportunities for Western computer and CAD/CAM technology suppliers in the vast expanse of Soviet economy.

These speculations are reinforced by the fact that for the first time in history the Kremlin leaders have invited capitalist firms to set up joint ventures in the Soviet Union. They hope that such programmes will accelerate their high-technology acquisition activities and offer Western partners low-cost manufacturing facilities with huge economies of scale.

A recent book "Soviet Automation" by Dr. Jack Baranson and other sovietologists provides some unique insights into the Soviet automation scene in general with particular attention to its CAD/CAM and robotics implementation plans and problems. It also highlights political problems that the Gorbachev planners are facing in trying to implement their massive automation policies.

The Soviet CAD/CAM efforts, according to the authors, date back to the early 1970s when 40 organizations were singled out for introduction of CAD/CAM systems mostly based on second-generation BESM-6 mainframes during the 1971-1975 Five-Year Plan. This programme was accelerated during the 1981-1985 Five-Year Plan and given top priority with the objective to automate 15 per cent to 20 per cent of design work by 1985. The 1986-1990 Five-Year Plan originally called for creation of over 300 separate CAD systems dedicated to specific applications throughout the Soviet Union.

Given the fact that there are several million workers in design and production engineering at machine and instrument building plants alone these programmes appear grossly inadequate even if they are seen as development of CAD/CAM system prototypes for replication in similar applications throughout the Soviet Union. There are also unique political problems that are hindering the proliferation of CAD/CAM systems in Soviet design bureaux which typically employ 4 to 5 times more designers than in the West for performing tasks of comparable complexity and size.

CAD/CAM installations within Soviet manufacturing enterprises also threaten the traditional role of Soviet design institutes. This fragmentation of research, development, prototyping, and manufacturing functions between various Soviet organizations is perceived as a formidable barrier to introduction of effective integrated CAD/CAM systems at the enterprise level which could lead eventually to FMS and CIM levels of automation. In recognition of these problems the Soviet authorities have begun to authorize in-house R&D programmes for many enterprises and established 150 scientific-production associations modelled after typical multi-product high-technology companies of the USA.

In 1985 30 per cent of the largest Soviet enterprises with over 500 employees were equipped with their own mainframe computers many of which are still of IBM 360(RIAD) and MINSK-32 vintage. In hundreds of thousands of Soviet enterprises design work is performed using traditional manual methods and in cases where CAD systems are used relatively simple draughting is by far the most common application.

By comparison in the United States 100 per cent of comparable engineering companies operated their own mainframe computers as early as 1976. They have since supplemented these resources with thousands of personal computers, CAD/CAM workstations and sophisticated peripheral devices used in a variety of design functions in all types of industries.

The Soviets also recognized the need for specialized CAD/CAM hardware during the early 1970s when they developed their M-6000 and M-7000 minicomputers targeted for industrial automation applications. During the 1977-1978 period they also introduced more advanced units such as M-400, SM-3 and SM-4 which were functionally equivalent to DECPDP-11 minicomputers, the ISKRA-226 using WANG-2200 instruction set, and a pure native design in the form of the MAIRI-4 minicomputer. Early reports of CAD/CAM use in major enterprises claim labour and time reductions up to 95 per cent. (AMT [Ireland], September 1987)

VIII. FACTORY AUTOMATION

US robot sales rise 46 per cent in first quarter of 1987 over 1986

Gross new orders for US based robot suppliers rose 46 per cent in the first quarter of 1987 compared to the first quarter of 1986, according to Robotic Industries Association (RIA).

The trade group reported that a total of 1,365 robots valued at $106.6 million were ordered in the first quarter of 1987, up from the 1,354 units valued at $73.1 million ordered in the first quarter of 1986.

"The main challenge for the US robotics industry is to attract new customers in a diverse range of industries," said Donald A. Vincent, executive vice-president of RIA.

Shipments in the first quarter of 1987 totalled 1,171 units valued at $73.5 million, down from the 1,502 units valued at $83.0 million shipped in the first quarter of 1986.

However, the industry backlog of unfilled orders grew to 1,515 units valued at $140.5 million, up from the backlog of 1,455 units valued at $129.7 million at the beginning of 1987.

The group estimates that some 27,000 robots are now being used in the US. The US is the world's second largest user of industrial robots, trailing Japan which uses more than twice as many. (Reprinted with permission from Industrial Engineering magazine, September 1987. Copyright Institute of Industrial Engineers, 25 Technology Park/Atlanta, Norcross, CA 30092)

Trends in manufacturing*

Many designations have been proposed to describe the application of computer control in manufacturing systems, but the most general is probably CIM. In theory, CIM systems are relatively straightforward and very effective from a business point of view. A CIM system eliminates the unpredictability of human behaviour - it is therefore amenable to practical mathematical modelling, it will always behave according to theory. The raw materials for a particular product arrive at the plant as required - just on time - because their need has been predicted accurately and quickly from the immediate order book

All the pieces come together from internal processes and from external sub-suppliers, at the correct time and place, for assembly into the product. The product is then inspected, tested and packed for dispatch to the customer. Warehousing is obviously reduced to a minimum in this arrangement as is work-in-progress inventory.

This typical CIM concept bases all its planning on a regular and effective supply of raw material and the consistent performance of the mechanical and electronic devices making up the processing system. input to the computer. The specific tools, etc. required for processing time, as the raw material are known to be available and are made available at the appropriate time, as the raw material proceeds through the plant.

It tries to minimise the inevitable inputs that must come from human beings and the vagaries thereof. In the real world, however, human beings are always coming into the reckoning and this puts limitations on the perfection of all CIM systems.

In many practical production systems it has been found advantageous so far to avoid the fully integrated CIM system and settle for a number of discrete computer-controlled sub-systems that link together indirectly through a human interface. Capital costs of limited systems are substantially lower, but even more important is the faster response in dealing with system vagaries arising from human error or dilatoriness, which show up inadequacies in the system computer control.

At the lower end of this technology, discrete CNC machine tools are used to carry out specific machining functions on parts of an assembly. Some or all of the assembly operation may also be automated and carried out by robots or robot-like assembly machines. The supply of raw material or parts to these manufacturing sub-systems are called up as required by a human supervisor, who also probably has responsibility for inspection of the finished parts or sub-assemblies and for ensuring that the machining systems have the correct tools, etc. This is what is loosely referred to as CAM - computer-aided manufacture.

For many companies in Ireland this is probably the optimum extent of computer automation at this point in time. For the not too distant future, however, something more effective will be required, particularly as the number of components to be machined increases.

The next stage up in sophistication seeks to have automatic machining of a large variety of parts, needed in regular quantities, for assembly into discrete products. Typical examples would be the parts for a water pump or a driven axle. There would be the differential bowl, the wheel hubs, various covers, etc. These would require milling, turning, boring, drilling and tapping operations. Similarly, for the pumps, there would be a pump casing, the impeller, covers of various types, a shaft, bushes, seal housings, etc.

A manufacturing cell would require one or more CNC milling and turning centres, a cleaning unit and inspection unit. The raw workpieces would be clamped onto fixture blocks - often referred to as tombstones (because of the way they stand up stark and square looking) - mounted on pallets. The pallets would be moved around from one workstation to another on a conveying system in response to a computer instruction. This is the basis of what is generally referred to as an FMS - flexible manufacturing system. In such a system the machines will have very substantial tool storage and automatic tool change as demanded by the machining changes or by wear and

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* By Professor Seamus Timoney, Ph.D., D.Sc., F.Eng., Department of Mechanical Engineering, U.C.D., Ireland. (Although addressing Irish industry, his conclusions are of general interest to other similar environments. Editor's note.)

breakage in the tool itself, all of which are automatically indicated and implemented. Swarf and cooling fluids are removed in a central system and very fast rates of cutting can be maintained. After machining a steam jet system is used to clean away swarf and oil and leave the component ready for inspection. Inspection is carried out in a special station from which parts, passed as being to specification, are directed into short-term holding areas prior to dispatch to assembly.

The use of flexible manufacturing systems aims to apply the manufacturing methods of mass-production to batch manufacturing; simultaneous machining with many tools from many directions. But by maintaining batch capability instead of continuous large quantity inflexibility, faster response is possible to meet market requirements without the need for large inventory. One machine system is capable of working a variety of components of the same family. For instance, one manufacturer of diesel engines, used mainly as vehicle power plants, has over 30 different flywheel types - all of these are machined on a single FMS unit. Another manufacturer of tractors machines eight quite different components in one cell - gear box, sump, transfer box and various covers.

To implement such processes extensive high-level decisions are required:

- Components must be designed with FMS production in mind - shapes must take fixture and machining limitations into account, in addition to function and stress requirements.

- Extensive use of computer-aided draughting and design will facilitate the planning of production operations - fixturing, tool selection, operation sequencing, etc.

- Work-force educational background must be changed by new recruitment - numbers of skilled and semi-skilled operatives are quartered, at least, and those of design and production engineers are doubled.

- Plant and fixtured investment is increased fourfold, but work in progress and product inventory is reduced to one third or even one quarter. Storage space for parts is halved at least.

- FMS cells are capable of unmanned operation for long periods and should therefore be planned for at least two-shift, and preferably three-shift, operation.

The social implications of introducing AMT (automated manufacturing technology) into Irish industry are complex. Without its introduction, what little engineering manufacture we now have will face ever-increasing competition on price, on quality and on delivery. It is not possible to avoid the impact of AMT, but it is possible to benefit from it by appropriate planning. Industry, especially in the large employment area of mechanical engineering production systems, must be more and more market-oriented and in particular towards the high added-value niche markets. It is in those areas that AMT really pays off, but they do also require high levels of intellectual input and experienced engineering performance. Non-skilled jobs will decline in numbers and skilled jobs will increase, as will also, and even more so, those for mechanical engineers capable of dealing with electronic interface systems and with computer control.

At present many of the country's best graduates are being recruited for work in neighbouring EEC countries - it will be necessary to find ways of attracting these talented young people back to the country. Interesting work and a reasonable possibility of achieving a comparable living standard must be made available to them. Clearly, more and more of the nation's youth must have access to education in relevant technology if unemployment due to the introduction of AMT is to be kept under control and indeed reduced, as it can be. Better and more effective marketing and profitable products sales is the other half. In many instances, the key to both marketing and sales will aslo be the appropriate use of engineering graduates with suitable post-graduate training in these disciplines.

History shows that it is not possible nor is it desirable to hold up the progress of new technologies into manufacturing processes. The living standards in the developed world are incomparably better for the vast majority of people than were those of the 18th century. People have less arduous work and are more educated in the use of leisure - they do not always avail of the real possibilities that modern life offers in the sense of genuine human enjoyment, but that is the enigma of human behaviour, and not the fault of technology.

Unfortunately, the developed world has arrived at this point by way of trial and error - great error in many instances. The industrial revolution was a social disaster, but not due to technology - due rather to lack of thought as to what it offered in terms of human advance. It would be a pity if the same mistake were to be made today as the developed world proceeds into AMT. (AMT [Ireland], October 1987, pp. 20-22)

Flat out for flexibility

New sheet metal-working machines, of all sizes, are helping fabricators improve efficiency and quality. At the heart of these new machines is improved computer-aided manufacturing software, and innovative mechanical design.

A recent wave of innovation in fabrication machinery has conferred a new flexibility on users of sheet metal. The latest generation of machines allows economic production of smaller runs of more complex fabrications, with lower lead times and reduced design workload. This has helped sheet metal win back favour from designers who, until recently, were turning to plastics.

This new generation of machines fits in with an acceleration in the rate of innovation throughout manufacturing industry, generally giving shorter product market life, and shorter production runs, with less time available to develop complex moulds for new components and less opportunity to amortise their cost in production.

As a result, an increasing proportion of casework and fittings, particularly in the electrical, electronics and office furniture industries, is again being manufactured in sheet metal.

Sheet metal fabrication formerly required scarce, expensive design and production engineering skills. In many cases, multiple consecutive operations on a number of machines were needed. Now, virtually all sheet metal fabrication except welding can be carried out on two types of machine, and the experience required to develop components into the flat, mark out, and decide cutting and bending sequences, now largely exists in machine software.

Typical of this type of modern sheet metal-working machine is Shape Machines' Shape Rota computer-numerical control (CNC) punch press. Introduced this year, the Rota is said to be the first British-made punch press to feature programmable tool rotation, offering the ability to tackle a wide variety of work. A 25-ton capacity hydraulic machine, taking a 2050 mm x 1025 mm sheet and with the capacity to punch and nibble 6.4 mm plate, the Rota has a 20-station bi-directional turret with two tool stations.

The development which has probably contributed most to increased flexibility in sheet metal-working machines, says Shape, is indexable tooling, where individual toolstations in the turret can rotate under programme control.

On non-indexable, fixed tooling machines, cutting of irregular profiles and non-standard angles either requires special tools or a nibbling process, involving a large number of separate hits. Indexable machines allow shaped tools to be used at any desired angle. As a result complex profiles can be slit with a few strokes using standard tools.

Operations on CNC punch presses may now involve quite complex forming as well as cutting processes. Some of the features which are now regularly produced in sheet metal on CNC punch presses include: louvres; grilles; strengthening ribs; countersinks; hinge assemblies; and embossed messages.

A further development in punch press technology is the adoption of controllers with graphics and interactive software. The systems offered by Shape give on-screen draughting facilities, allowing workpieces to be designed at the machine, the CNC programmes being generated automatically from the drawing.

Input is through interactive routines with the effect of all inputs shown on the controller's screen. Colour display facilities allow tool paths and tool profiles to be shown against the background of the workpiece taking shape on-screen.

Though graphics-based controllers are easy to use and show up programming errors quickly, many sheet metal fabricators prefer to carry out programming for their machines off the shop floor. This releases the machines for more efficient use of available production time.

A desk-based programming system may also have more comprehensive design facilities, as well as permitting more convenient input of data, for example using a mouse. Systems such as Camtek's Pepe, says Shape, give powerful trigonometric and dimensioning functions with the result that programming is faster, with considerably reduced proving time.

Punching is often combined with other metal-cutting techniques to provide machines with increased performance and flexibility. In the US, W.A. Whitney of Rockford, Illinois, has combined punching with air plasma arc cutting in its 661 and 647 Plus Panelmaster machines. The air plasma cutting system gives the 661 machine the ability to cut steel, aluminium and other metals, up to 19 mm thick and at speeds of 10 m/min. This is on top of the machine's hydraulic punching and stripping facility - which allows it to cut holes up to 75 mm diameter - marking, scribing, drilling and tapping.

The Whitney machines also make use of a software package called Cimnest, which is designed to 'nest' parts on a flat sheet, and provide the capacity for companies to move to 'just-in-time' production. Advantages of the Cimnest package, says W.A. Whitney, include:

- Increased productivity and reduced machine set-up time;
- Improved material usage;
- Reduced labour costs; and,
- Increased machine flexibility.

Driving the plasma/punch press through a direct numerical control (DNC) link, Cimnest also links to computer-aided design and manufacture and materials resource planning (MRP) packages.

The construction and agricultural machinery manufacturer J.I. Case uses two Whitney machines - 661 plasma punch presses equipped with GE 2000 and 1050 CNC controllers - at its plant in Wichita, Kansas, US. Although the plant is two years away from full computer integrated manufacture, says Case, the punch presses have the ability to handle short production runs: valuable in the firm's move towards just-in-time manufacture.

At Case, the Whitney machines were brought in to eliminate a multiple machine set-up. Carrying out burning, drilling and punching on a single machine has led to lower tooling costs, reduced work in progress and stock and faster design modifications. But flexibility is the main advantage, especially with the tendency for the company now to update its designs more frequently. This, says Case, is allowing changes to be made easily until the product design 'stabilizes'. Then 'hard' tooling - a permanent machining arrangement with dedicated tooling - takes over as production volumes increase. Further advantages are gained from being able to make prototypes on production equipment, so ensuring that the final design can be manufactured economically, and from the ability to turn out part-customized products to meet customers' specific needs. In the UK, the mining and tunnelling equipment manufacturer Fletcher Sutcliffe Wild has recently installed a similar machine, as has James Howden of Glasgow for fan production. Whitney's UK representative is Wightman-Stewart, of Sowerby Bridge, West Yorkshire.

The company has also linked its Cimnest software to a combined punch press/laser sheet metalworking cell supplied earlier this year to General Electric Medical in Milwaukee, US. This uses design data from GE Calma/Apollo workstations, linked to Cimnest and scheduling software running on the company's IBM 3090 mainframe. The Cimnest software is connected to an IBM minicomputer to produce DNC instructions for the metalworking cell's GE 2000 CNC controller. This installation, worth nearly £1 million, is claimed to have halved lead times for GE Medical's production of X-ray tables and diagnostic imaging equipment parts.

Not all advanced CNC sheet metalworking installations are this expensive, however. Slough-based Rhodes Pierce-All recently launched a low-cost CNC punch press, the Spartan, which is claimed to be improving accuracy and productivity at Grade Engineering of Worthing, a sheet metalworking subcontractor. Grade produces chassis and other components for the electronics industry. The manual machines it had been using were restricting output, but CNC production has improved both throughput and flexibility.

The ability to produce small batches, or one-offs economically, says Grade, is enhanced by its use of an Apricot Xen computer for off-line machine programming. Rhodes Pierce-All claims that its machine, at around half the price of the next cheapest machine available, will offer many smaller companies like Grade the chance to benefit from CNC technology.

The key to its low cost, says the firm, is due in part to its method of locating the sheet, which is positioned against a pair of servo-driven back stops. This technique, similar to that used in computer-controlled guillotines and press brakes has, says Rhodes Pierce-All, allowed more economical construction without sacrificing speed or accuracy. (Engineering, October 1987, pp. 588-589)

More automation leads to higher flexibility

The same market forces that demand flexibility in component manufacture apply also to product assembly - manufacturers are having to deal with high product mix, low product volume or short product life. So assembly systems have to be flexible enough to handle the products for which they are designed and have a useful life after the products' death.

There is unlikely to ever be a truly universal flexible assembly system (FAS) due to constraints of product quantity, complexity and envelope size; also the broader demarcations of product classification, which are basically mechanical, electro-mechanical and electronic. In each of these areas, FAS is fast becoming a reality within several European laboratories and factories.

In this the UK is playing an active part, both in collaborative projects with other European countries and in developments initiated by individual companies. The two most far-reaching schemes are: FAMOS, for which the UK project co-ordinator is Taylor Hitec; and Project 534, managed by the Westland Group as part of the EEC Esprit programme.

FAMOS, for which Taylor-Hitec has just been awarded a further £300,000 by the Government to continue as co-ordinator, is an industry-funded programme that is hoped to attract 100 or more projects. It is part of the Eureka programme, which is regarded as the successor to Esprit; both are aimed at ensuring Europe does not fall behind America and Japan in the development and application of high technology. The justification for FAMOS is that, in the surge of technical development in manufacturing, the emphasis has been on component manufacture to the neglect of assembly, which in Europe accounts for 40 per cent of total production costs, on average. Specifically, the aim is "the realisation of advanced assembly-oriented pilot systems which are highly automated, flexible and economic".

The Westland project is concerned with developing the enabling technology to allow it to construct a flexible automated assembly cell that will permit the random assembly of electro-mechanical products within a 1/2 m cube envelope. The five-year project (due to finish by 1990) involves Westland collaboration with four other European centres with expertise in robotics, vision sensing and the human role in automation.

In fact, the University of Newcastle is also involved in a collaborative Esprit assembly venture (Project 278). Its task is to develop sensors for robots. This is an important area, because early generation robots lack the sensing skills needed for sustained use in automated assembly, particularly in poorly defined environments where individual parts are difficult to locate and orientate. The work aims at location and orientation by combined vision and tactile sensing. Vision sensing is used for distance viewing and course location of a workpiece. Tactile sensing, with the help of fibre optics in the robot's finger gripper, then determines workpiece orientation by creating a pressure profile. This research was among several interesting European projects detailed at the 8th International Conference on Assembly Automation.

A major UK manufacturer which has its own commitment to flexible automated assembly is diesel engine builder, Lister-Petter. Output of engines from its Dursley factory is equivalent to 40,000 cylinder barrels/year, in single- and multi-cylinder versions. Work has been commissioned to develop automated processes for the individual aspects of engine assembly for eventual integration into one cell.

The product mix of engines makes flexible assembly a requirement, so extensive use is to be made of robots to perform several functions on a range of components, using interchangeable end effectors and tooling. An important feature is that the cell will assemble a complete engine rather than have several engines in the cell at one time each at different stages of completion.

Research into robot-assisted assembly of Lister-Petter engines is in the hands of Bristol Polytechnic's Engineering Department. One project operating successfully as a prototype is concerned with the insertion of piston sub-assemblies (connecting rod, gudgeon pin and retaining clips together with piston) into the cylinder barrel. A second, less advanced, project concerns the correctly orientated assembly of pistons and rings.

If the choice of robot for an assembly task is not easy, neither is determining the configuration of the cell in which it is to be used. But, as the Swedish Institute of Production Engineering Research has demonstrated, false starts can result in leaps forward.

In 1984, it built its Mk 1 FAS designed for automatic assembly - where part feeding and automatic set-up between different products, it said, should be automatic. There would be automatic error recovery and it should be possible to add new products. The cell comprised four multi-axis robots (ASEA IRB 6) and two Scara types (IBM 7545) connected by conveyor for carrying palletised fixtures. Parts were fed in on feeder pallets to 10 assembly stations. The cell had certain drawbacks:

- Limited space for feeding in components meant that each robot could handle no more than five or six types of component, so system capacity was linked to the number of parts in the finished assembly.
- Components had to be fed manually into the system's feeding devices. This also drew attention to the fact that feeder magazines were component-dedicated and so could be expensive items.
- To cope with the variety of parts handled by the robots, three gripper exchange systems were needed. Gripper changing made cycle times double that of the isolated assembly times.
- To carry out one assembly operation, the robot had to select parts from three pallets, involving up to one metre of travel, which again added to cycle time.

The Mk 2 version, built to overcome the limitations, has just one assembly area served by an ASEA IRB 1000 robot on an overhead track. All the items needed to assemble a batch of, say, 80 assemblies are brought to the robot on a train of pallets carried on a looped track. The first pallet carries product-specific tools such as assembly fixtures and grippers; the second carries components that can be accurately located in the pallet; the third will carry the smaller randomly-placed parts; and the fourth will be empty for carrying finished assemblies.

For a batch of 80 assemblies, the 10 fixtures are first transferred to a second looped track which passes underneath the robot. To complete the 80 assemblies, the other pallets containing components pass around the main track eight times.

Because the two tracks run side-by-side, robot movement is reduced to a handspan. Fitting one component in succession to 10 fixtures also reduces the time spent changing grippers. For identifying and locating randomly placed components, use is made of vision using a camera on the robot's wrist.

The need and potential for flexible assembly systems are not confined to small batch production. In Europe there are already systems operating successfully in the manufacture of high-volume products which are also subject to changes in market demand. Although required in large quantities, such products can have lifetimes of only months.

In their manufacture, automated assembly has long been established as the most cost-effective approach. But product change can no longer be catered for using traditional hard automation without adversely affecting production capacity and performance.

An extreme example of high volume production, measured in millions, is found at the Danish-based Lego company. Here flexibility is to do with being able to introduce a new product quickly. This is achieved using assembly stations in standard modules which can be configured to suit.

The key module is the feeding system, which has flexibility built in by the addition of adjustable deflectors and traps, pattern recognition systems and pick-and-place or Scara-type robots. Feeders can be combined, as is done in the assembly of a miniature electrical device comprising four types of component. A pressed metal part is fed directly from an in-line punching tool, an integrated circuit is fed from a tube magazine, a miniature electric bulb is fed from tape on a reel, and some plastic parts are fed from a vibrator.

Assembly modules might be regarded as forerunners of more general-use assembly machines. Such machines will have a market with manufacturers whose low annual production volumes do not allow investment in developing their own FAS. Work currently being carried out at the Danish Institute for Product Development (IPU) suggests that general-purpose machines could make possible the assembly of a variety of products.

The institute is collaborating with three manufacturers of small volume, high variety products to establish guidelines for the design of such a system. The products include water taps, spraying equipment, valves and regulators. Annual production volumes are 8,000 to 150,000 with batches as low as one, using a variety of materials. The aim is to develop a series of system modules which can be combined with as few product-specific parts as possible to build up universal assembly cells for each of the participating companies. The layout divides between what IPU calls the general investment, those parts of the system used for most sub-assemblies, and the task-specific investment. Each cell module comprises a general-purpose four-axis Scara robot, module chassis carrying assembly equipment of which two thirds is general, plus feeder equipment comprising fixed and removable parts such as replaceable liners.

With this mix of general and task-specific components, choice can be made in the way a changeover takes place. With two companies' products, the general equipment remains in position while the task-specific equipment for holding components, grippers fixtures, feeder tracks, and so on is moved. With the third, the product types are sufficiently close to allow all the equipment to be left in place.

Probably the most important aspect of the project is that, given certain assumptions relating to running costs and usage levels, it has been possible to calculate the economics of small batch general-purpose flexible assembly machines. Return on investment was predictably found to improve as the number of types of assembly increased, until a point where the level of investment in task-specific equipment outweighed cost reduction.

The detailed figures (see table, below) show that payback in under two years is possible, justifying the argument that flexible automated assembly is practical for low-volume, high product mix manufacture. Also that one of the most attractive ways will be the general-purpose cell - within the envelope size of the machine and the constraints of product type. (Machinery and Production Engineering, 2 September 1987)

Table 4

Added product	Total assembly time [illegible]	Total [illegible]	Total [illegible]	[illegible] of units	Total pay-back [illegible]	Total [illegible] (%)
Product A	572	[illegible]	[illegible]	1	[illegible]	[illegible]
Product B	817	77000	[illegible]	1	2.7	41
Product C	1270	[illegible]	[illegible]	1	2.3	[illegible]
Product D	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Product E	[illegible]	[illegible]	[illegible]	1	1.8	[illegible]
Product F	3744	125400	71200	1	1.9	[illegible]
Product G	[illegible]	[illegible]	74000	1	2.0	54
Product H	[illegible]	[illegible]	77200	2	3.0	35
Product I	[illegible]	[illegible]	77500	2	3.0	35

Table shows how flexible automated assembly is practical for low-volume, high product mix manufacture.

Strategy for manufacturing (the UK example)

Much has been talked about in recent months about the health of the UK manufacturing industry, with often quite different and contradicting views being put across. The fact that Britain now imports more than it exports and that manufacturing industry now employs far fewer people, are often used to create a picture of declining output and overall decay.

As UK industry is now being challenged to compete more effectively in world markets, it is involved in an international race for improved product quality, lower manufacturing costs, shorter lead times, and increased responsiveness to rapid changes in market demands. Local influences are becoming less significant, as companies are having to meet world-wide standards for their products and services.

So what is the real state of manufacturing in the UK, and what manufacturing strategy does it have to adopt to remain competitive?

Manufacturing industry is now buoyant. It has emerged from the deep recession of the late 1970s and early 1980s leaner and fitter.

All the recent surveys show that all the key indicators like forward order books, output, productivity, and profitability are at all-time highs.

Output is now even growing faster than its two major competitors, Federal Republic of Germany and Japan. However what is also more important is that the environment is right as inflation is low, interest rates are falling and exchange rates are more favourable. A recent review in the Sunday Times of manufacturing industry in the UK concluded that, "Sooner or later Britain will realise that it once again possesses a successful industrial economy." This, not unnaturally, has increased industry's confidence which has resulted in higher levels of investment being forecast.

A recent Engineering Computers Survey, which is UNISYS co-sponsored, confirmed this by predicting a computer spend of £850 million against an installed base of £2,500 million.

This survey also showed that companies are looking for a tighter control of their business as there are nearly 2,000 MRP II systems and 1,500 shop floor data capture systems predicted to be installed. The explosion in CAD systems is forecast to be at micro level with 2 to 2 1/2D draughting systems, although the market for larger 3D systems is still strong (Fig. 3).

Although the survey shows there is plenty of activity in manufacturing industry, it does not, however, give any indication if these systems are being installed in the right way or for the right reasons, or whether they are actually producing the productivity gains that were expected.

Industrial automation has a very high profile in the press and on TV with articles on factories which are run without operators, and headlines describing amazingly skilful robots. There has also been a variety of government grants sponsoring advanced manufacturing technology projects over the last few years.

But why is manufacturing industry automating and what is it trying to achieve?

It is recognized now that companies have to improve their productivity every year quite substantially, in order to survive against international competition, and that their quality has to be consistent, and to the standard required. The financial pressures to reduce stocks are immense, but this has to be achieved in an environment where manufacturing lead times are being reduced, and customer levels improved.

These are the basic reasons for the drive to automate, as for most companies it is, without doubt, a fight for survival.

However, the implementation of new technology is not without its problems. In March, "Design Engineering" highlighted the fact that it has been recognized in recent years that projects involving automation in isolated areas do not usually lead either to the expected overall gains in plant efficiency, or to the benefits that computers have to offer.

These so-called "Islands of Automation" have basically been created because no long-term strategy has been formulated.

So it is not surprising that, in today's highly competitive environment, consultants like Bryer and Gaskell clearly state that if a company does not have a manufacturing strategy covering the next five years, it will most likely go out of business.

Figure 3

Manufacturing Industry

Number of Forecast Systems to be Installed During 1987

Manufacturing resource planning (MRP II)	1 874
Computer-aided design and manufacturing (CAD/CAM)	320
Draughting - 2D & 2 1/2D	1 217
Computer-aided process planning (CAPP)	320
Plant maintenance	347
Shop floor control data capture	1 426

(Source: Engineering Computer Survey, November 1986)

Business strategy

Often top management is unaware that what appear to be routine manufacturing decisions frequently come to limit the companies strategic option, binding it with facilities, equipment, personnel and basic controls and policies. The result may place the company in a non-competitive posture that may take years to reverse. So in order to ensure that a company's manufacturing capability is a competitive weapon rather than a corporate millstone, it is vitally important that a full business strategy be formulated, which should encompass five main areas, namely:

Marketing strategy: A clear undertanding must be obtained of the characteristics and the requirements of the market that has been identified by the company. It is important to also understand the market trends and what are the competitive strengths and weaknesses. It is also essential to predict the market growth potential to ensure that the general financial objectives of the company can be achieved. If this analysis of the company's target market is done correctly, the issue that will enable the production of a "competitive edge" will be clearly identified. Only when this marketing strategy has been produced can the remaining strategies be put in place.

Product design strategy: Once the marketing strategy has been clearly identified, the design constraints for the product can be defined, such as functionality, strength, quality and durability. Methods of manufacture or assembly must be taken into account as there is no point producing a product that is difficult or impossible to produce. New materials and technology must be constantly assessed to determine whether there are cost or market benefits through their introduction. Product design must always work closely with marketing and production.

Manufacturing strategy: The manufacturing strategy cannot be created until the direction the company is taking is fully understood. Only then can the basic manufacturing procedures be established and decisions taken to lay out the plans for the introduction of advanced manufacturing techniques.

Information strategy: An information strategy must then be created which allows information to flow throughout the whole business, and between any existing islands of automation. Communication standards must be defined, and how the control system will administer data, and present it succinctly to the appropriate levels of management.

Personnel strategy: Lastly, a personnel strategy must be formulated which will ensure that all management and employees are trained, understand, and are committed to the implementations of the business strategy. People cannot and must not be forgotten.

Many organizations fail because the senior management do not realize the significance of the interrelationship between all these areas. (AMT [Ireland], August 1987)

The art of survival by going small

In the early 1980s, Caterpillar, Inc., the US-based world's largest construction equipment manufacturer, recognized that their industry faced substantial overcapacity. As one result, there would be tremendous downward price pressures and intense global competition on the products it and other companies make - tractors, loaders, graders, excavators, lift trucks and the like.

"Our early forecast proved to be accurate. In fact, by 1986, average transaction prices for Caterpillar products were still at 1981 levels," the company reported last year.

So, how does the company manage to survive and operate at a profit? By closing a number of plants. By identifying which "core" products can continue to be built competitively, then sourcing "non-core" items to low-cost producers. By consolidating surplus manufacturing space. By rearranging production equipment into manufacturing cells.

Caterpillar is implementing the last two strategies at its Joliet plant near Chicago. It is committing a vast sum ($1 billion) over five years (1986 to 1990) to convert the plant and similar facilities all over the world into more efficient producers. The aim is that the gains in performance will substantially "self-fund" the programme by generating reductions in costs and inventories.

Making a control valve

One example of how a manufacturing cell at Joliet is cutting costs is in the making of a control valve that goes into motor transmissions of earthmoving graders. The cell's workhorse is a machining centre made by Niigata Engineering Ltd. (Tokyo, Japan). Previously nine different machine tools were set up to machine five components of the valve. There were 11 different material handling lift truck moves. In all, it took 40 days from rough casting to shipping the completed valve to another Caterpillar plant for assembly into a transmission.

The Niigata cell accomplishes all machining, assembly and test operations in two days - a 38-day reduction in production time. In addition to the machining centre, the cell includes a flush tank, two build benches and a test stand.

The Niigata runs unmanned for eight hours during a 24-hour period, four on second shift and four on third shift. A tool monitoring system detects tool wear. It automatically switches dull tools to spare new ones and optimizes machining cycles by varying cutting feed rates.

Machine operator and assembler-tester are in the same work cell. Quick communications between the two cell workers (assembly and test only accomplished on first shift) catches defect problems much quicker than the old method when machining and assembly/test operations were separate.

The Niigata is equipped with 120 tools to machine all five parts using 12 pallets for mounting fixtures. The parts then are deburred, flushed, assembled and tested in this one location.

Joliet cell manufacturing is saving approximately $412,000 in annual costs, says Caterpillar, by reducing the number of operations, set-up time and machine hours. More than 100 manufacturing cells are now in operation in other Caterpillar plants.

In other areas of the 72-acre Joliet plant, new equipment is being installed as part of the modernization programme. Three CNC-controlled machining centres and three CNC lathes made by Scharmann GmbH (D-4050 Monchengladbach 2, Federal Republic of Germany) will machine cylinders in a flexible machining system. When completed, it will also feature pallet buffer stations, two unload-load stations, and a rail-guided vehicle for pallet and part transportation. (Industrial World, August 1987, p. 10)

How to automate the entire plant

The word "automation" triggers visions of robots, wire-guided material handling vehicles, shop-floor computers, machining cells, computer-aided design and manufacturing, automated warehouse retrieval and storage.

Factory automation is indeed all that. Looking at it another way, it can simply be the efficient integration of process operations using today's mostly widely used automation device - the programmable controller. The key is knowing where to employ it in all plant areas, not just the process, and not just horizontally on the plant floor.

To illustrate this point, Rich Ryan, director of marketing at the Programmable Controller Division of Allen-Bradley (USA) offered a profile of a typical process plant, divided into seven major areas:

1. Raw material receiving and storage, the first area, represents the receipt of raw materials from some means of transportation (truck, pipeline, tanker, etc.) and the movement and storage of this material.

Increasing numbers of process plants are automating this section with programmable controllers. These PLCs are capable of receiving messages from a supervisory device stating that deliveries are expected for storage at specific warehouse locations. The controller can then report back to the supervisory device on how much material was actually received, when it arrived and where it was put. This holds true for liquid or solid products, in bulk or discrete containers.

Similar functions are performed to move this material to the next operation. The equipment used for these functions may include conveyors, motors, robotic devices, scales, valves and pumps - all of whose activities could be directed by the programmable controller. Analog measurements might be needed for liquids which must be kept at a fixed temperature, so temperature measurement, flow metering and monitoring devices with PLC connectivity might also be present.

For overall control of the area's activities, supervisory instructions can be downloaded from a higher level controller in the plant hierarachy. Reports can also be sent back to this device.

2. In "pre-process" - the next process plant section - materials are weighed, mixed and blended; temperatures are often maintained in some holding facility.

Equipment in the pre-process area frequently includes pumps, motors, valves, conveyors, scales, mixers, steam heating or cooling water, pumps, valves and motors. More monitoring and control of analog variables is sometimes necessary, but the vast majority of the input/output (I/O) is usually discrete. Flow rates and temperatures are monitored and controlled. Valves are opened and closed. Motors are started and stopped.

A typical automation control system for a pre-process area includes a programmable controller for the sequential logic, but with analog I/O capability for temperatures, weights and flow rates. Proportional integral derivatives (PID) loops, if any, will be handled in intelligent I/O modules or done in the main processor. A separate operator interface, apart from the main process, may be desirable here to display process variables, states of switches and valves.

3. The main process is the next area. Material is added to the reactor or processing vessel from the holding vessels. Analog monitoring and control may have to be done concurrently with sequential discrete control in the main process area.

Here the process may require pumps, motors, valves, agitators, steam heating or cooling water. Flow rates, temperature, pressure, pH, viscosity, motor speeds and air flow often must be measured and controlled.

The control system for this area will depend heavily on the requirements of the specific process. For example, if the process consists of a large number of analog I/O and PID loops, with little discrete I/O, one of the analog-oriented systems may be best suited for it, especially if it is not critically dependent on sequential logic for start-ups, shutdowns, or changes in product. Care should be taken, however, to ensure that such a system has the capability to communicate effectively with other areas of the plant, and with higher levels of management control. Where the processes involve predominantly discrete I/O, programmable controllers are a widely accepted, cost-effective means of integrating sequential logic with analog control.

4. Post-processing is the fourth area. In a typical plant there may be secondary reactions, removal of undesirable by-products or unused starting materials. Operations may include drying, pulverizing, pelletizing, and segregation of product types. Basically, post-process is much like the pre-process area in terms of I/O and logic requirements, and thus, has similar control system needs.

An example is a typical blending, extrusion, pelletizing and shipping control system. The actual process area where the material is extruded is upstream from post-process operations - very much a "process within a process". Users have found programmable controllers to be a viable choice for certain extruder-control applications. Depending on the complexity of the extrusion, one small- or medium-sized controller per machine is usually used. A larger controller manages the handling of the product, and interfaces with variable-speed drives before and after the extrusion.

5. Packaging is the next area. Depending on the state of the product (solid, liquid or gas) and how it is being packaged, there might be valves, motors, conveyors, material handling devices, scales and robots.

Packaging operations are mostly rapid discrete on-off operations, with perhaps a couple of analog measurements, but few, if any, analog control outputs. Programmable controllers are well suited for packaging operations.

6. Movement to the warehouse for storage and eventual shipment constitutes the next area. This typically involves stacking devices, robotic machines, counters, scales and tracking devices of various types. The measurement and control activity determines quantities going to different destinations. In many ways this area is identical to the receiving and inventory area in terms of its material movement, hardware and measurement devices.

Control system requirements are also similar to the first area - raw material receiving and storage: a basic configuration often includes a small programmable controller for each operation, with communication to a larger, supervisory device. The controllers, in turn, communicate with the counters, scales, and tracking devices to maintain control and information about quantities and locations of product.

7. Energy management is the seventh and final area. The control system functions to monitor and control energy usage in the plant, and to adjust overall energy consumption to minimize cost, while maintaining certain environments such as maximum or minimum temperatures.

To optimize energy management functions, a large programmable controller can easily store hundreds of different sequential routines in its memory for lowest cost operation of the plant under varying conditions. Some vendors offer complete application packages to implement this. For example, in an Allen-Bradley PLC-3 programmable controller, the following variations might be pre-programmed: eight different day types; pre-programme 365 days; 250 different schedules with five "on-off" periods; 36 cycle patterns per schedule; load shedding (500 loads) based on current demand levels - floating interval algorithm, selectable demand interval, one minute sample time, eight power demand outputs. (Industrial World, June 1987, pp. 9-11)

CIM is not the answer to all problems

Manufacturers cannot ignore the benefits that computer technology offers, but they should not expect computer technology to solve all their firms' shortcomings, either. And if they do not select the right combination of technologies from the many available alternatives, their investment may be wasted.

This warning was sounded at the Advanced Manufacturing Systems Conference (AMS '87) by Donald B. Ewalds, director, Ingersoll Engineers.

Speaking on "Strategic Planning for CIM" (computer integrated manufacturing) at the Executive Track on World Class Manufacturing, Ewalds cited the cultural impasse of trying to adapt "yesterday's factories and yesterday's people to computer control and computerized information systems".

"We're trying to overlay computer technology on chaotic resource arrangements, equipped with obsolete machine tools, and managed by executives trained pre-computer," said Ewalds.

"Many firms try to use some form of computer technology as a panacea, and that always fails. Getting the right form and combination of CIM means understanding how the elements of CIM apply to the individual firm," he added.

"Equally important, in fact essential to a successful CIM strategy, is understanding that CIM cannot make order out of chaos, but it can make major contributions after the chaos is resolved first," he said. ... (Reprinted with permission from Industrial Engineering magazine, September 1987. Copyright Institute of Industrial Engineers, 25 Technology Park/Atlanta, Norcross, GA30092)

General Motors puts Map into gear in US

General Motors has opened its first operational plant networked to the Manufacturing Automation Protocol (Map) standard championed by the company.

The multibillion dollar GMT 400 project includes Map communications systems controlling 200 robots, 1,000 programmable logic controllers and 25 minicomputers. These are linked over a broadband local area network.

General Motors has no Map-based factories operational in Europe yet, but is busy preparing for a full Map environment.

Controversy still surrounds the Map standard, with General Motors standing firm against DEC's attempts to include Ethernet as a low-cost performance option. (Computer Weekly, 13 August 1987)

Why using just-in-time is getting back to basics for American industry*

Prior to joining Outboard Marine Corp. (OMC) about two years ago, I felt that just-in-time was another fad, soon to go away. OMC, however, had committed itself to implementing the methodology. To survive in my new job, I realized that I would have to learn and master this.

Today, there is a revolution of change going on in our nation as we play "catch up". And most importantly, you as professionals, managers and IEs need to know that our very survival in industry is at stake.

What is just-in-time, and why are so many American industries and IEs and other professional people reluctant to adopt it?

Counterproductive techniques

First, just-in-time is the right way to manufacture. Just-in-time "supplies the demand" - if you don't sell it, don't build it. Getting away from this basic concept is where our American industry went wrong.

Twenty to 30 years ago, our industries and educational institutions, in efforts to lower costs per unit and maximize profits, developed methods and schooling of manufacturing techniques that were actually counter-productive to the ends that they were trying to achieve. Two examples, of many that are available, are the theories behind economic order quantities and linear programming.

EOQs, used to determine what lot sizes produce the lowest cost per unit, promoted the use of the batch and process layout manufacturing systems now prominent in a large number of American industries. These formulas assumed that certain costs such as set-up, etc., were fixed. Thus the company was justified in having to overproduce products and create the high inventory syndrome with which we live today.

What's wrong with batch manufacturing? One example I use demonstrates its effect upon customers. Early in my career, while working as a stockpicker in the shop at Cummins Engine Co., I pulled a camshaft from the shelf and sent it to the customer, "rust" and all. The part had been sitting there several months. How does this relate to the here and now? It has been reasoned that approximately 80 per cent of all layoffs occurring in our American industries are caused by this "overproduction" of non-needed parts.

Linear programming is basically a math model programme designed to show what mixture of products to build to achieve maximum profits using available resources.

Using our company as an example, such an analysis might call for building 100 V4 and 300 V6 outboard motors to maximize our facilities' profits. However, our customer demands may require 300 V4s and only 100 V6s.

US reluctant to adopt JIT

Why are American industries reluctant to join this revolution? Perhaps it is because these technologies represent change, and that is something that by nature we all tend to resist. Actually, just-in-time is among the easiest of the technologies to master, especially for IEs.

Based on simplicity and reverting to manufacturing methods that operate from "supply and demand", just-in-time requires that your entire company be set to operate and function as though it were one gigantic assembly line. Instead of using "process" flow layouts (which produce material in batches of lot sizes with plenty of work-in-process), the plants are designed using the "product" flow layout in which the product goes into the parts.

We must now become "assembly line" industrial engineers. We must look at the whole picture, not just a part of it. It is our job to make certain that the right part is in the right place at the right time. The goal is to accomplish "flow" production.

Other major, underlying principles that must be instilled within our thinking and manufacturing facilities include:

- Don't hide mistakes.
- Let workers solve problems.
- Make things simple - is there an easier way?
- Make only what is needed now.
- Continually improve the process.

Often overlooked are basic how-to's required for dramatic improvement and implementation. These include:

- Housekeeping - keeping everything in its place.
- Quality - do it right the first time.
- Uniform plant load - produce every single piece according to demand.
- Redesign process flow - turn into "product" flow, cut footage and form assembly lines.
- Reduce set-up time.

Facility design is important to just-in-time production and so is total quality control (TQC). Although JIT plant configuration and production are designed to make quality problems visible, they must not be the kind that cause major plant or line shut-downs. The problems that we are trying to make "visible" and fix are the one in 10,000 or one in a million, etc. It is Pareto's 80/20 theory all over again. This means that our incoming product from

* By James B. Byard, Outboard Marine Corp.

vendors and suppliers must be "defect" free. To achieve this quality, requirements must be accepted by vendors wishing to become "certified" who will:

- Stress and assure quality.
- Prevent shipping damage.
- Accept long-term contracts.
- Guarantee lead times.
- Have a solid relationship of trust (become co-workers).

Herein lie the positive, golden opportunities that are coming out of these technologies. Companies implementing just-in-time no longer wish to be vertical manufacturing organizations doing it all, making their own parts from scratch. Huge corporations like GMC, Ford and Chrysler only want to assemble and sell their products. They are sub-contracting more and more work to outside vendors. To those who have the resources and initiative to create their own businesses and become "certified" vendors for other corporate structures, the opportunities are limitless.

To solve the problems that manifest themselves, as mentioned earlier, a plant must always operate in the "under-capacity" mode, another just-in-time manufacturing requirement. You must have time to respond to, correct and eliminate your problems permanently from your manufacturing processes.

One more important point: any company wanting to implement just-in-time must first achieve acceptable quality levels (AQL) of incoming parts and have their vendors "certified" before modifying an existing layout or installing a new one configured for flow production. Many a frustrated corporation has abandoned its just-in-time project, usually blaming "cultural" differences, because it implemented a JIT plant layout before it solved its supplier problems. If we think about it we can see and realize the importance of this first step.

And when you have done all of this, you are ready to make your product using just-in-time manufacturing technology. (Reprinted with permission from Industrial Engineering magazine, August 1987. Copyright Institute of Industrial Engineers, 25 Technology Park/Atlanta, Norcross, GA 30092)

IX. STANDARDIZATION AND LEGISLATION

China may build a wall against copyright cheating

For years, US software companies refused to sell their products in China because it had no copyright laws. Software makers feared distributing software there would amount to legalized piracy, says Oliver R. Smoot, acting president of the Computer & Business Equipment Manufacturers Association.

Now the situation may be changing. US Government and computer industry officials are encouraged by recent signs that China will offer copyright protection for software. The first step will come later this year, when the first Chinese copyright law is expected to be approved. The law only covers items such as movies, video tapes, and records, but the Chinese Electronics Ministry is lobbying to extend protection to software. That leads some US officials to conclude that the Chinese will make major progress in that direction within two years. Until recently, they said it would take five. (Reprinted from the 1 September 1987 issue of Business Week by special permission, copyright 1987 by McGraw-Hill, Inc.)

IBM/Fujitsu deal stirs up software vendors

The world's leading software vendors are threatening to lobby US and European Governments to force IBM to give them access to its source code, in the wake of its recent deals with Japan's Fujitsu. They are up in arms because IBM's agreement with Fujitsu is precisely what they have been after for years - and are still denied.

Adapso, the leading US computer trade association will make representations to the European Community and the US Congress, and plans a broad information campaign within IBM's international user base unless IBM offers the independent vendors the same access as Fujitsu.

The deal struck between IBM and Fujitsu last month allows the Japanese firm access to IBM source code and documentation for nearly 700 key system software programmes to build competitive products.

Fujitsu is expected to have to pay IBM around $1 billion for the information.

The settlement resolved a long-running dispute between IBM and Fujitsu over copyright infringement of the MVS mainframe operating system, which IBM claimed Fujitsu had used to write its own compatible software.

Recently Jay Goldberg, chairman of Adapso, challenged IBM to explain why it will not allow other firms the same access as Fujitsu.

"It is unthinkable that Japanese software developers be given access to IBM operating systems source code while American companies that add value to IBM's products are excluded," he said. It is in the best interests of the end-user community that IBM relents, he added.

Adapso lawyers believe that the deal between IBM and Fujitsu, agreed by a group of arbitrators outside the courts, may well be "subject to attack on anti-trust grounds".

Goldberg said that litigation against IBM will be a last resort but "we will not stop until a fair and free marketplace has been established".

Marty Goetz, founder of database vendor ADR, believes that IBM intends to drive the independent vendors out of business through its policies of bundling software, such as the new PS2 database and communications manager, and supplying "object code only" with its products.

"The Fujitsu deal brings the source code issue out into the open," he said. "It shows the importance of source code to anyone who wants to build complementary products to IBM."

Goetz has been campaigning since 1983, when IBM started to introduce its "object code only" policy, for software firms to have the same access as IBM has handed to Fujitsu.

But Goetz does not believe that software firms who are developing complementary rather than competitive products should have to pay.

IBM says that the subject is "not open to discussion" but Goetz said, "We are tired of trying to talk to IBM about it. We are now looking for other ways of getting IBM to change its policies." (Computer Weekly, 8 October 1987)

Euro boss slams poor patent laws

The vice-president of Europe's biggest software company has called for a change in "inadequate" international law on software patent. "The problem is urgent because if there is no proper protection for software, there will be no incentive to produce it," said Phillipe Dreyfus of Cap Gemini Sogeti. "There should be a reciprocal international agreement for software patent, as there is for copyright." Dreyfus claims that present laws protect the individuals who write the software, rather than the companies they have developed the programmes for.

The crucial difference between patent and copyright is that patenting a project gives you a monopoly on an inventive idea no matter how it is implemented. Copyright law prevents copying of all programmes, "as it applies in relation to literary work". But you can legally borrow ideas, such as spreadsheets, and do a completely different implementation.

In the UK the 1977 Patent Act says that computer programmes as such cannot be patented. (Computer Weekly, 8 October 1987)

Britain drags copyright law into the computer age

After a decade of debate, the Government has published a bill designed to rationalize British law on copyright and intellectual property. Kenneth Clarke, the Minister for Trade and Industry, said that the new law should make Britain the first country in the world "to grapple with the problem of protecting innovation in artificial intelligence".

Since Mr. Justice Whitford reported on copyright law in 1977, the Government has produced a series of discussion documents. In this latest, and final round, there are five areas in which major changes have been made since the ministers' last contribution, the White Paper on Intellectual Property and Innovation, published in April 1986.

The changes mean that:

- The London Patent Office will remain part of the civil service;

  Britain's muddled industrial design laws will be straightened out;

- Fights in court over patents will be easier and cheaper to pursue;

- It will be a criminal offence to steal a trademark;

- Although it will remain illegal to tape records and TV programmes, there will be no tax on blank tape to compensate publishers for the unenforceability of the law.

The Copyright, Deisgns and Patents Bill is the longest in the current parliamentary session, with 277 clauses and seven explanatory schedules. Ministers will introduce it into the House of Lords within two weeks, and it should be law by next summer.

The most contentious aspect is the Ministers' decision not to give the record industry the 10 per cent levy on blank tape promised in last year's White Paper.

Clarke says that the Government recognises that the 10 million owners of video recorders in Britain will remain lawbreakers, along with anyone who copies selected tracks from a record to play at a party or in a car. "This is recognized as harmless, widespread and unstoppable," says Clarke. "It would have been a nightmare to draft legislation to legalise this without creating loopholes for criminal pirates."

Soon it will be possible for a computer with artificial intelligence software to generate artistic works. Who owns the copyright in such material? In the bill, Ministers deem that it belongs to whoever sets the task for the computer.

Following recommendations by the Office of Fair Trading in September 1986, patent agents will lose their monopoly. Anyone will be able to work as a patent agent, as long as they do not call themselves one. Inventors will have to check the credentials of anyone who now sets up in business as a "patent adviser".

Anyone whose patent is infringed, or who is accused of infringing someone else's patent, will no longer need to fight an expensive action in the High Court. Last year's proposal in the White Paper that patent actions should be judged by the Patent Office has been dropped, following objections that it would effectively make civil servants into judges. Instead, inventors will be able to fight their actions in the county courts. Because of the technical and legal complexities of patent cases, specialist judges will be appointed.

A quirk of patent law currently forces pharmaceutical companies to grant "licences of right" to their competitors for the last four years of the life of an old patent. This will now go. Ministers say that it is an unfair rule as patented drugs take years to test before sale. Firms need all the time they can get to make profits.

Trademark law will become tighter, to help protect the public against counterfeit products. If, for instance, phoney brake shoes and hydraulic seals fail, they can kill. So, for the first time, it will become a criminal rather than a civil offence to steal someone else's trademark. (This first appeared in New Scientist, London, 5 November 1987, the weekly review of science and technology)

Standardization of software houses

Computer-aided software engineering (CASE) in general, and the software workshops in particular, require - in order to be fully satisfactory - a certain amount of artificial intelligence to increase their capacity and facilitate their handling as well as standardization which fosters the portability of the instruments and tools which constitute them.

Software workshops exist for various reasons: the search for increased productivity in the elaboration of software; the growing concern for quality, arising from the presence of new applications which are increasingly vast and complex; the presence of a critical mass of software development tools which already covers all the phases of an application's life cycle; work stations with a sufficiently high performance level.

All of this has given rise to the industrialization of software production; the informaticians manage their workstations in the same way that industrial technicians use CAD-CAM (computer-aided design, computer-aided manufacturing) when they develop a new part or an integrated circuit. The new organization and the different aids which integrate the software house enable it to design, draw data flows, draft, programme, incorporate pre-programmed modules, test, link and document the new applications.

The supplier firms of software aids therefore tend to integrate in the software house different tools which were previously offered separately. The need to avoid wasted effort argues for a standardization which enables instruments to be incorporated and exchanged between different workshops. The European Community, in order to support the software industry, has defined within the framework of the Esprit programme the standard PCTE (portable common tool environment) and is financing the complementary programme pact (PCTE added common tools) which is being participated in by Bull, GEC, ICL, Olivetti and Siemens. The Eureka programme is also supporting the East programme (European advanced software technology) which groups the Finnish company Nokia, the Danish company CRI and the Italian consortium made up of Selenia, Datamat, Intecs and Sesa-Italia. ...

The popularization which began some 15 years ago of the structured programming and analysis methodologies constituted an important step in the process which led to the appearance of the software workshops. Their great economic importance was already obvious as regards the detection of errors in the earliest possible phases of design. Also, in certain "top-down" programme development techniques there was the possibility of testing during the development phase and of integrating pre-programmed modules. (Bulletin IBIPRESS, No. 143, 20 September 1987)

I. GOVERNMENT POLICIES

Informatics policy and TNCs: the Argentine experience by Carlos María Correa*

Informatics represents today a challenge and a source of concern for most countries, independently of their degree of development. Its economic and strategic importance, and the multiplicity of applications explain efforts either to dominate the technology and participate in one of the most dynamic world markets, or to orient the modalities under which the diffusion of informatics takes place.

A number of developing countries such as Brazil, India and Republic of Korea have devised and implemented informatic policies of different scope and objectives during the 1970s. Argentina started a process of defining a national comprehensive policy on the matter in 1984. This note discusses some aspects of that policy.

Background

Despite some scientific and industrial precedents,** the Argentinian informatics sector exhibited at the beginning of this decade a lack of any articulated public policy, an extremely weak productive basis, a low and dispersed effort in R&D, and a diffusion of the technology basically determined by the marketing policies of transnational corporations.

In 1984, the market for computers and peripherals was largely controlled by imports from United States' firms, either directly or through subsidiaries established in other Latin American countries. For large-size equipment, one transnational corporation (IBM) concentrated over 70 per cent of the total market, while in microcomputers TNCs were subject to the growing competitive pressure exerted by local assemblers of "compatible" PCs.

In the area of software, an incipient development could be found, which was mainly based on the production of applications for administrative purposes. A more recent study*** has revealed that 70 per cent of the software market is satisfied by imports, and that 40 per cent of the former is controlled by one transnational firm (IBM). Over 3,000 electronic engineers were identified, many of them working on activities completely unrelated to their field. Over 4,000 specialists in informatics were also available, though with a considerable disparity in the quality and scope of their formation.

Public activities in informatics were inorganic and strongly determined by supplier attitudes. Though the public sector underwent a process of informatization since the 1960s, it was characterized by serious mismanagement, excessive centralization of applications, lack of adequate information systems, unco-ordination, introduction of equipment disproportionate to users' actual needs, low standards of available software and unfavourable terms in contractual arrangements with suppliers. The lack of bargaining skills and of capacity to autonomously determine public sector demand, was one of the outstanding indicators of an unequal, relationship vis-à-vis transnational corporations.

A global national plan

On the basis of the work of a national commission,**** a global and long-term informatics policy was adopted in November 1984. It was based on two main considerations. First, the strategic character of informatics for development, due to its broad and profound impact on multiple areas. Second, the possibility to selectively enter into a field of growing economic importance and special dynamism such as the "electronics complex", that is, the industrial activities involving computers, telecommunications, industrial and consumer electronics.

The policy devised established as the main strategic objective to start a serious learning process at different levels, including in-plant fabrication, research laboratories and human resources development. This goal has been emphasized as the main underlying principle in all policy areas, including the negotiation with transnational corporations.

For the preparation of the plan, different studies and consultations were undertaken. A comparative evaluation of informatics policies in developed countries as well as in Brazil, India and Mexico permitted an analysis of the main strategies followed and their successes and failures. Special importance was attributed to improving the knowledge of the strategies of TNCs in informatics, particularly in developing countries. The assistance of UNCTC was requested for the preparation of a study on that matter, which included profiles of the main US, Japanese and European TNCs, as well as a characterization of their overall investment, technological and marketing strategies.

The main areas covered by the overall policy approved and under execution are as follows:

(a) Industrial policy: The development of a selective, competitive and innovation-based informatics industry is promoted by means of a set of

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* Under-Secretary of State for Informatics and Development (Argentina).

** By the end of the 1950s a prototype of a transistorized computer was autonomously developed at the University of Buenos Aires, while the first institute in Latin America for computer science was created in the same university in 1960. During the 1970s two projects, one private and the other official, considerably advanced the development of minicomputer technology.

*** Subsecretaría de Informática y Desarrollo and INDEC, 1987.

**** Created by Decree 1234/84 and presided by the Secretary of Science and Technology.

measures including a substantial increase in tariff protection for certain products, the granting of fiscal incentives and the regulation of foreign investments. These measures are in principle to be applied only in relation to microcomputers (and "super" micro) and some peripherals.*

The approach relating to foreign direct investments was mainly based on the search for contributions in terms of technology transfer, rather than in capital investment, in accordance with the learning objective set forth. Within the industrial promotional scheme, the establishment of wholly-owned subsidiaries was excluded. Joint ventures were viewed as a possible means to obtain foreign technology, particularly with regard to design, it being clear however, that such arrangements do not ensure per se an effective transfer of such technology.

The granting of incentives for the production of the selected type of products was subject to specific conditions as to local content, research and development and exports. The mere assembly of informatics products was excluded from national promotion. Further, in order to avoid an excessive proliferation of small-scale production, incentives were accorded on the basis of a bidding for projects.

(b) Human resources development: The upgrading of professional education was considered a crucial aspect in the approved policy. In order to improve the quality of specialists' formation, a high level institution (Escuela Superior Latinoamericana de Informática - ESLAI -) was set up, among other measures. Some programmes for the introduction of informatics into schools were devised. The improvement of skills was also promoted under a joint programme with Brasil, established in January 1985.

(c) Research and development: The encouragement of R&D is also an important element of the policy established. The setting up of an innovative industry and the creation of decision capabilities asked for an increased effort in this area, with the objective of strengthening the scientific basis and of undertaking an "imitative"** path of technological development. A national programme on R&D in informatics and electronics was organized, with an aim to particularly support and finance projects related to industrial demands.

(d) Software: The existence of possibilities almost at hand to become a significant software producer (and even exporter) has been frequently argued in relation to many developing countries (sometimes in order to suggest an alternative to entering into the production of hardware). In fact, such a possibility is not so easy to be materialized, except if qualitative changes are introduced in connection with the methodologies of development and, in particular, of marketing of computer programmes. The issues involved in the development of the software production were embraced in the framework of a special programme ("Argensoft"), which included the discussion of the legal matters regarding computer programmes' protection.

(e) Public sector: The policy regarding the public sector basically aims at: (i) diffusing microcomputers and distributed systems, as an alternative to centralized applications; (ii) emphasizing the critical importance of the information systems and of the organizational framework in which the former should work; (iii) increasing competition among suppliers, in order to avoid dominant market positions and obtain better prices and conditions for the State; (iv) ensuring the use of the public sector demand in order to enhance national industrial development. Model contracts for hardware and software acquisition were also prepared in order to obtain more balanced transactions.

India: new export policy for computer software

The computer software policy announced by the Government in December 1986 provides for single window clearance of software applications including issuance of import licences and liberal grant of foreign exchange for manpower development. The policy aims at providing a significant boost to software exports. For this purpose, exporters would be allowed to import software under OGL with an ad valorem duty of only 60 per cent, but against such imports there will be a heavy export obligation and defaulters would be liable to heavy penalties. Under the existing norms, imports of certain types of software are allowed at a higher duty of 145 per cent.

For any organization setting up an export-oriented software company and requiring import of hardware and/or software of computer/computer-based systems, foreign exchange requirement for such import may be met through any combination of the following options: (a) through the Government, (b) through NRI participation, (c) foreign exchange entitlement as a result of excess exports, (d) foreign participation, and (e) any other source permitted by the RBI. Imports under the software export scheme will have software export obligation equal to 250 per cent of the foreign exchange used under option (a) plus 150 per cent of foreign exchange under other options to be fulfilled over a period of four years.

30 per cent of excess software export earnings made over and above the export obligation can be made use of by the exporter for importing new computer systems, software and hardware sub-systems and/or augmenting his existing computer installations, and office equipment and computer spare parts. This import will have to be aimed at taking up further software exports and will be subject to actual user condition and export obligation of 150 per cent of cif value of imports. Such excess export benefit can be accommodated for a period of three years.

In addition to the sources mentioned above, the EXIM Bank of India will provide foreign exchange to software exporters for imports. The EXIM Bank facility will carry with it an export obligation of 350 per cent of the foreign exchange used for import and this export obligation will have to be fulfilled over a period of four years. A time-frame has been set for this purpose. Twenty per cent of the obligation will have to be fulfilled by the end of the second year, 50 per cent by the end of the third year and 100 per cent by the end of the fourth year. If the company concerned fails to show export performance as per the obligation, twice the amount falling short of the obligation will have to be paid by it to the EXIM Bank in rupees by way of penalty.

The procedures for clearance have been simplified. The Inter-Ministerial Committee of the Department of Electronics constituted in 1986 will function as an effective instrument for single window clearance and for co-ordination of action on all cases of software export and software development. The procedures for software exports through Earth stations/satellite links have been further simplified as follows: (i) export obligation will be determined by the Inter-Ministerial Standing Committee (IMSC) on a case-by-case basis, (ii) security and communication arrangements will be determined by a sub-committee of the IMSC, (iii) satellite links can be used only for 100 per cent export activities and all imports

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* Resolution 44/85 of Secretaría de Industria and Decree 652/86.

** The term is used with the sense attributed by Freeman, The economics of industrial innovation, Penguin, 1974.

connected with this will be exempt from duty, (iv) declaration of exports will be made in a special declaration form notified by the RBI instead of GR forms.

Software exporters will be permitted to pay commission to foreign firms/distributors/retailers for their services towards marketing, training, installation, after-sales support in foreign markets, etc. Software exporters will also be permitted to set up joint ventures and/or marketing subsidiaries and offices abroad for effective promotion of Indian software products and services in foreign markets.

Foreign exchange to the extent of Rs 5,000 per 100 man-hours of computer-related training subject to a maximum of $10,000 per year will be made available for any of the following purposes: (a) hosting foreign experts in computer-related areas from abroad subject to normal security clearance, (b) buying of consultancy from abroad in education technology in computer-related areas, and (c) improving training equipment and educational aids on OGL for captive use.

Foreign collaboration will be permitted as per provisions of FERA. Companies having foreign equity participation of 40 per cent and below will be allowed to develop software exports. Those with foreign equity above 40 per cent will be allowed to set up only 100 per cent export-oriented units.

The Department of Electronics intends to set up an Indian Institute of Information Technology (IIIT) in each of the four regions of the country.

The policy aims at capturing a substantial share of the world market where trade in computers is expected to touch $100 billion by 1990, over 50 per cent of which will be in software. The Government expects that software exports from India should be in the region of Rs 300 crore within the next two years, going up from the present level of around Rs 30 crore to Rs 40 crore. At present two big companies, viz, Tata Consultancy Services (TCS) and Tata Burroughs Ltd (TBL) account for almost 75 per cent of software exports. The liberalization of export policy should enable more companies, particularly the relatively smaller ones, to enter the export market. The industry, has however, complained that the export obligation against export-related imports is too heavy. (Economic and Political Weekly [INDIA])

XI. RECENT PUBLICATIONS

UNIDO publications:

IPCT.43 Technology Trends No. 7
The changing technological scene:
The case of the OECD countries,
by Sally Wyatt

Microcomputer applications in education and training for developing countries

This report contains the proceedings of a symposium on the use of microcomputers for developing countries held in Cuernavaca, Mexico, 4-7 November 1985. The meeting was organized by the Board on Science and Technology for International Development (BOSTID), Office of International Affairs, National Research Council (USA) and was co-sponsored by the Academia Nacional de Ingeniería (ANIAC) of Mexico. Participants came from Argentina, Brasil, Chile, Colombia, Kenya, Pakistan, Panama, Peru, Trinidad and Tobago, and Uruguay as well as the United States and Mexico. Papers submitted dealt with teacher training; educational software; primary and secondary education; special education; advanced education; and future developments.

The publication is available from Westview Press, Inc., 5500 Central Avenue, Boulder, Colorado 80301, USA (ISBN 0-8133-7488-X)

Increase of productivity in public administration: the role of information technologies

The proceedings of an international meeting held in Dakar, Senegal, 16-21 June 1986 were published in June 1987 by the International Development Research Centre (IDRC), Canada. The meeting was organized by Data for Development, a non-governmental organization and professional association with the co-sponsorship of the Government of Senegal, the Government of the USA and the United Nations Development Programme (UNDP). Participants came from Iraq, Côte d'Ivoire, Togo, India, Tanzania, Zimbabwe, Guinea, China, People's Republic of, Central African Republic, Sudan, Egypt, Gambia, as well as Sweden, France, FRG, and the USA.

Prevent system disasters

Home computers and software packages figure prominently in the latest list of computer disasters in the UK. Although managers are aware of the threats to their ability to carry on their business if their computer systems are out of action, in many cases sufficient funds are still not being made available to provide effective cover. Although computer disasters are uncommon, the total effect on a company can be devastating. Among recent examples they note the case earlier this year of a fire at the Open University. The computer and the files were completely destroyed at a cost of some £500,000. The value of the programmes and research data stored on the tapes and disks were incalculable. Back-up copies had been stored in the same room and were lost also. Television comedian Tom O'Connor found it no laughing matter when his wife put a chicken in the microwave oven, turned it on - and wiped out thousands of his best jokes stored on his home computer. The computer was being used in close proximity to the microwave: a BIS study suggests that the oven was leaking: "The waves created an intense localized force-field which could have affected the voltage on the computer's disks and erased the data held on them". A home computer proved a trial to a judge who used it to write up his ruling on one of the defendants in a heroin smuggling case. It took nine hours and he lost the lot when he pressed the wrong keys by accident.* (Financial Times, 14 May 1987, p. 10)

How to choose a microcomputer

Guardian Management Services, a computer consultancy, has produced a booklet** containing detailed checklists of what the would-be computer user needs to know and do before making a choice. The booklet does not do away with the need to seek the advice of a consultant but it does allow the businessman to assess more accurately what outside advice he needs. The computer buyer must be prepared to devote time and effort to the project. "One cost which has not fallen but has in fact risen is the cost to a small business of buying the wrong computer system," the booklet notes. Even the smallest business must meticulously prepare its responses to the checklists since the success of the computer project depends on the detail. Incomplete or inaccurate information can waste time and push up costs. The booklet details a six-stage programme leading up to the introduction of the computer system: a definition of the company's needs, an

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* Computer Disaster Casebook, BIS Applied Systems. 01-633-0866, £50.

** The Selection and Implementation of Microcomputers in the Small to Medium-sized Business. A GMS Workbook. 49 pages. £15.50.

assessment of the uses to which the system would be put and its cost, identifying suppliers, inviting them to tender, evaluating their offers and making a choice. It advises the need to start by choosing the software. The hardware is less important and will probably come from a mainstream supplier. Computer buyers should realise that if they are buying a software/hardware package, they will probably have to make compromises. Costs may be cut by choosing various parts of the system from different suppliers but this will only work if the businessman or his staff are fairly computer-literate. Low cost products may use inferior components or have poorer technical support so the cost may work out higher in the long run.

Splendid isolation is a thing of the past for British researchers

The thoughts of UK computer science researchers, both in academia and in industry, are increasingly turning to Europe as the UK Government loses interest.

To obtain support under the European Commission Esprit Programme, however, UK research groups need to enter into a collaboration with at least one overseas group. If you have been insular, but want to continue in the field of artificial intelligence research, you would do well to read this collection of papers.

The collection arises from a conference in Marseilles in 1986, and reflects the strength and diversity of the European research tradition in artificial intelligence. The UK press is full of accounts of work in the US, and the supposed threat posed by Japan, but the European tradition, in which the UK should be playing an active part, goes relatively undescribed.

The Marseilles influence is clear: Prolog, first implemented in Marseilles in 1972, is the most popular implementation language, and there are impressive accounts of natural language systems, diagnostic expert systems, learning systems, speech recognition and process control systems.

Particularly impressive was Camilla Schwind's account of an intelligent language tutoring system, teaching German to French students, implemented in Prolog, and with much to offer those wishing to teach foreign languages to English students.

The Mediterranean is a pleasant place to sit out the British artificial intelligence winter. A warning to intending Esprit suitors: visitors to Marseilles should speak French (probably the Language of God). (Advances in Artificial Intelligence: CIIAM 86 (Proceedings of the 2nd International Conference on Artificial Intelligence). Kogan Page, 1987. 325 pp. £40.) (Reviewed in Computer Weekly, 29 October 1987)

* * *

Public domain software for development by Dr. Robert Schware*

The use of computers in government agencies and university and scientific research institutions in the industrialized nations has caused an enormous amount of software to be produced. Much software has also been prepared by United Nations specialized agencies, by multilateral and bilateral donor organizations, and by international foundations. A considerable amount of this software is in the public domain and has potential secondary applications in some industrial sectors. By "public domain" I mean non-ownership, and this refers to software that is not classified or proprietary. For example, the US National Aeronautics and Space Administration (NASA) offers more than 1,100 computer programmes through its Computer Software Management and Information Center (COSMIC). COSMIC's inventory of computer programmes that have been supplied to small businesses, universities and government agencies spans a wide range of application areas, such as computer graphics, circuit design and analysis, project management, energy system analysis, structural analysis, heat transfer and software development aids. Furthermore, a portion of the available public domain software helps solve problems common to different government agencies and businesses and has been written in programming languages in such ways that minor modifications in requirements may be accommodated without too much programming effort.

This article is an attempt to provide developing countries with information on public domain software potentially applicable to their needs in order to minimize the re-development of programmes already tested and in use elsewhere. (The term "developing countries" is used as a generalization since there are different levels of sophistication in the use and development of software within and among countries.) The article does not attempt to provide an exhaustive identification and description of all the personal computer-based models and software that could be of use to firms and/or institutions. Nor does it assess the relative strengths and weaknesses of the software available.

The major benefits of obtaining public domain software for organizations and firms in developing countries are: (1) such programmes can broaden their access to a variety and number of software resources; (2) overall costs, time and use of personnel resources for software acquisition and/or development may be reduced; (3) computer programme source codes may be obtained to study programme capabilities and to modify or enhance such programmes as needed; and (4) alternative software choices can be compared before acquiring and/or developing software.

Despite these potential benefits, developing country firms and organizations may find serious problems in acquiring and modifying public domain software in the long term. Public domain software is a mixture of good programmes and bad, old and new, useful and disappointing. Many good public domain software programmes are poorly documented, which restricts their use to mostly experienced users who can quickly learn to use them correctly. Some programmes come with no warranties or customer support. The quality of the software and the usefulness of the software output can vary considerably. Results from software and models may not easily be interpreted or may require interpretation and adjustment by so-called experts. Software may not easily be adaptable to a variety of countries. Many producers of modified software systems (in both industrialized and developing countries) have had to deal with large and costly changes in the functioning of programmes. Some firms might not have sufficient resources to cover these costs and also become involved in the development of other activities, such as servicing and marketing. The basic point is that enthusiasm for acquiring and/or modifying existing public domain software should be tempered with some degree of realism.

At the outset, it is useful to provide a few definitions and to differentiate among types of programmes available in the public domain. "Software" means all programmes and routines used to extend the capabilities of computers, as distinct from "hardware" or "firmware". "Models" are software used either to explore broad, open-ended problems involving a

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significant degree of qualitative judgement (called "heuristic models"), or "algorithmic models" employed when factors central to the problem of concern are mostly quantitative and the relationships among factors can be expressed in arithmetic or algebraic form. "Available software" means software accessible to other countries (outside of the United States). In some instances, computer programmes may be restricted to domestic distribution and use for a particular period of time. The cost of these public domain software programmes range from nothing to several thousand US dollars, though most often they may cost a nominal amount to cover diskette and document reproduction expenses. "Shareware" is copyrighted software for which the owner freely gives permission to copy, but with the request that the satisfied users send a contribution for maintenance of the programme as well as to receive notices of updates.

Types of programmes

It is important to differentiate between two types of public domain software. The first generally has no formal distribution channels and is circulated among a surprisingly well-organized network of enthusiastic computer users through computer user groups and electronic bulletin boards. This type of software is part of a long tradition from the time of the first mainframe computers, when resourceful people wrote programmes to solve particular problems and to show off their programming skills. Some sources for this type of software can be found in the "Other sources" section of this article.

The second type of public domain software - referred to in the following sections - is certainly less known than the former. It is developed and made available with funding from international development agencies, governmental agencies and research institutes. These programmes are commonly prepared for submittal to agencies following set guidelines designed to encourage the development of a "software package" that is complete, well organized and "ready to use" in the public and private sectors. This means that the software package will basically consist of the complete programme source code in machine readable form, supporting documentation that presents a full explanation of the programme capabilities and the manner in which the programme achieves its objective and any additional information as merited such as sample input, output and data files. It also means that the software has been checked out and evaluated to verify the completeness and operation of the programme, supporting documentation and suitability of the package for dissemination.

International development agencies

In the process of working to promote the social and economic development of their member countries, through loan operations and technical assistance, international financing and development institutions such as the Asian Development Bank, the Inter-American Development Bank (IADB), the World Bank, the Food and Agriculture Organization and the United Nations Industrial Development Organization (UNIDO) - to name just a few - have produced both general and sector-specific software and models that operate mostly on personal computers.

For instance, the Project Analysis Department of the IADB offers its members the following models, among others: "INDUSMOD", which generates financial projections for an industrial company or project over a 10-year period; "RURAL ROAD MODEL", which simulates the economic costs and benefits associated with road projects providing access to rural areas or small villages; and "SPMOD", a financial projections model for public service institutions (communications, energy and sanitary engineering) for a period of 10 years. Many of these programmes come in English and Spanish and operate in popular environments like LOTUS 1-2-3 and dBASE III. (For further information about these and other software packages in this article see Appendix I.)

Use of models and software in the broader context of planning and decision-making is receiving increased attention in the World Bank. One model for educational planning in developing countries - the "Economies in Curricula Choice (ECC) Model" - is used to test the effects of changing policies, e.g., adding courses to curricula or increasing teacher salaries. This simulation model allows the user to study various alternative capital and recurrent costs scenarios created on the basis of a curriculum programme, which can also serve to facilitate policy dialogue.

To meet the needs of highway authorities, particularly in developing countries, the Bank has developed a "Highway Design and Maintenance Model (HDM-III)" for evaluating policies, standards and programmes of road construction and maintenance. The model simulates total life-cycle conditions and costs and provides economic decision criteria for multiple road design and maintenance alternatives for individual road links or for an entire network of paved or unpaved roads. The user of this model can search for the best alternative, by way of discounted total cost, rates of return, net present values or first-year benefits.

Evaluation and monitoring trade and industrial incentives has become an important concern of many government agencies in developing countries. "SINTIA, Software for Industrial, Trade and Incentive Analysis" is a package designed to help analyse patterns of customs duties and quantitative restrictions in a country. It can be used to provide a systematic description of the nominal protection resulting from official tariffs and other import duties. It can also be used to simulate different nominal protection structures by allowing users to make different assumptions about reform scenarios (i.e., tariff changes with or without a devaluation), import elasticities and/or the effects of quantitative restrictions on price changes.

Another World Bank developed software package, called "WHAZAN", is a programme for hazard assessment of industrial facilities to prevent future Bhopal-type accidents. A package of ten programmes for computer-aided planning and design of cost-effective water supply and waste disposal systems has been prepared jointly with the United Nations Development Programme. The programmes help designers and planners identify least-cost solutions and to examine cost implications of alternative designs performing a variety of tasks including the design of piped water distribution networks, the design of sewage collection systems, statistical analysis, mathematical optimization and financial screening.

UNIDO has developed two software packages for investment promotion applications. "COMFAR, the Computer Model for Feasibility Analysis and Reporting", is personal computer-based and designed for pre-investment studies or contract negotiations. "PROSPIN, Project Profile Screening and Pre-Appraisal Information System", is the second package and is designed to speed the flow of industrial investment funds into developing countries. PROSPIN reports are available in English and French.

Microcomputers and "appropriate" software are beginning to be seen in primary health-care programmes in developing countries. Some of the software is applicable to care providers at the "front line" of primary health care (PHC) programmes - such as the Pan American Health Organization's "Primary Eye Care Consultation Program", which provides consultation to health workers on primary treatment of problems of the eye. Other software can assist managers at the district or central levels of PHC, such as the Aga Khan Foundation's programme emphasizing integrated maternal and child health services.

US Federal agencies

The National Technical Information Service (NTIS) in the US Department of Commerce is responsible for all functions relating to the acquisition, development and marketing of computer products. These responsibilities include identifying and acquiring machine-readable data files created for the Government, creating customized packages of information and of course providing public access to more than 1,500 data bases and over 1,600 software programmes. The programmes cover a wide variety of subject areas such as energy, transportation, environmental pollution and control, industrial and mechanical engineering, biological and medical sciences and cartography. The NTIS Software Center collection includes programmes from the National Energy Software Center, which is the US Department of Energy's software exchange and information centre.

As mentioned above, the computer programmes developed for NASA projects are distributed by COSMIC. Source code is provided for each programme so programme capabilities can be studied and modifications or enhancements made. Programme documentation is also available separately for reviewing capabilities in detail. The documentation includes user instructions and a detailed description of the equations solved and the techniques used to solve them. One programme, the "Standard Assembly-Line Manufacturing Industry Simulation (SAMIS)" programme, was originally developed to model a hypothetical US industry which manufactures silicon solar modules for use in electricity generation. The SAMIS programme has now been generalized to the extent that it should be useful for simulating many different production-line manufacturing industries and companies. Programmes distributed through COSMIC are usually restricted to domestic distribution and use for a period of at least one year. Some programmes with implied military or strategic applications and industrial applications in advanced or highly competitive fields can be restricted to domestic use for longer periods.

Other sources

A computerized project analysis programme "COMPRAM" has been developed by the East-West Center and the Ohio State University to aid planners in assessing and comparing projects. The programme offers financial and economic analysis capabilities, decision criteria options such as cost effectiveness, benefit-cost ratios, internal rate of return and sensitivity analyses, such as inflation rates, scaling factors on project costs and benefits. Its strength as a planning tool lies in its ability to incorporate monetized social welfare impacts into the analysis - a perspective often ignored in financial analysis programmes.

A low-cost software project is under way at the Social Development Center to provide organizations in developing countries with a complete set of software with good documentation. The project is reviewing all of the available public domain and shareware programmes available from electronic bulletin boards and specialized distributors and choosing one best programme to be part of four sets of packages for office use, research, statistics and utilities (including small calculations, file keeping, writing notes, scheduling appointments, etc.). For example, the office package will contain the following generic applications: word processor, spreadsheet, graphics, data base manager, form generator and key redefinition. Translations into Spanish and French will be available.

Related literature

There is so much public domain software for virtually every brand of personal computer manufactured that it is often difficult to know where to begin a search for specific items. This last section provides current sources of published information, which for the most part contain public domain programmes.

Managing a nation: The software source book is a review of software for application to a wide range of national administration and management activities. The book includes software and models addressed to issues of concern at a ministerial level that are relatively long-term in perspective, policy-oriented and applicable to many countries. Multi-sector and global models modeling languages and software for rural development; energy; water; agriculture; forests; population; environment and ecology; transportation and security are included.

The Guide to Software for Developing Countries has been prepared by IBM. Its selections are divided into four major fields: agriculture, economic and social; infrastructure and physical, and administration. An Advisory Board screened submissions of hundreds of programmes in 1984 based on the utility of the programme to support development projects, proven performance in one or more developing countries and availability free of charge or at nominal cost.

The Computers in Relief and Development Newsletter provides information about software for disaster management, response and preparedness. Emergency management related software is available specifically for emergency planning, event management, resource management and administration of relief personnel.

This article barely scratches the surface of public domain software. It ends by mentioning two generally reliable distributors of catalogues and of software - Public Brand Software and Public Domain Software Interest Group - who each offer more than 1,000 programmes, including word processing, communications, graphics, spreadsheets, business accounting, math and statistics, programming languages, utilities and games. If all this seems too good to be true, the distributors hasten to add that they do not guarantee that any particular programme follows sound business practices.

APPENDIX 1. CONTACT ADDRESSES

Current sources of information are provided in this section for the software packages and related literature mentioned above.

International Development Agencies

The IADB

Project Analysis Department, Support Services Unit, Inter-American Development Bank, 1300 New York Avenue, N.W., Washington, D.C. 20577, USA for INDUSMOD, RURAL ROAD MODEL, SIMOD, and other available software packages.

The World Bank

Economic Development Institute, Education Division, The World Bank, 1818 H Street N.W., Washington, D.C. 20433, USA for the ECC Model;

Industry Development Division, Industry and Energy Department for the SINTIA package; Project Manager, UNDP Interregional Project INT/81/047, Water and Urban Development Technology Unit, for Microcomputer Programs for Improved Planning and Design of Water Supply and Waste Disposal Systems; Transportation Development Division for the HDM-III Model; and Technica International, Lynton House, 7/12 Tavistock Square, London WC1H 9LT, England for WHAZAN.

UNIDO

. Feasibility Studies Section, Division of Industrial Operations, Vienna International Centre, P.O. Box 300, A-1400 Vienna, Austria for COMFAR and PROSPIN.

Pan American Health Organization

Pan American Health Organization, Opthalmology Department, 525 23rd Street, N.W., Washington, D.C., 20037 USA for the Primary Eye Care Consultation Programme.

Aga Khan Foundation

P.O. Box 435, 1211 Geneva 6, Switzerland for the Community Health Programme. Also ask for the Report of the Workshop on Management Information Systems in Primary Health Care, which contains information about other public domain software for primary health care programmes.

US Federal Agencies

NTIS

US Department of Commerce, National Technical Information Service, Database Services Division, 5825 Port Royal Road, Springfield, VA 22161, USA for NTIS software collection.

COSMIC

COSMIC, The University of Georgia, Computer Learning Annex, Athens, GA 30602, USA.

Other sources

The Ohio State University, Department of Agricultural Economics and Rural Sociology, Room 226, Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, OH, 43210 USA for COMPRAM.

Social Development Centre, Microcomputers for Social Development, 1313 East 60th Street, Room 476, Chicago, IL 60637, USA for the four sets of packages for office use, research, statistics, and utilities.

Related literature

Global Studies Center, 1611 N. Kent Street, Suite 600, Arlington, VA 22209, USA for Managing a Nation: The Software Sourcebook.

Communications and External Programme Manager, IBM Area South, 190, Avenue Charles de Gaulle, 92523 Neuilly sur Seine, France for The Guide to Software for Developing Countries.

Computers in Relief and Development, 106 Park Road, Loughborough, Leics., LE11 2HH, United Kingdom for Newsletter.

Public Brand Software, P.O. Box 51315, Indianapolis, IN 46251 USA; and/or Public Domain Software Interest Group, 410 E. Sahara, Las Vegas, NV 89104, USA for catalogues of public domain software.

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"UNIDO general account" No. 949-2-416434
The Chase Manhattan Bank
International Agencies Banking
380 Madison Avenue, New York, New York 10017
United States of America

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