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Reports and Surveys

INNOVATIVE ROBOTIC SYSTEMS

1. Robots build digitised database

At the *Forensic Science Service* laboratories in Birmingham, U.K., robots are helping to build what is claimed to be the world's first digitised database of DNA samples taken from convicted criminals.

It is reported that two machines can process 640 samples per 10 hour run. This, it is said, would usually take forty people to complete, making the new system considerably quicker than at present.

The DNA database holds samples of people who have committed a recordable offence that can be compared to blood and DNA samples taken from the scene of a crime. The DNA saliva sample comes to the laboratory on a slide, having been taken from the mouth of a suspect or criminal by the police. One robot extracts a small amount of DNA from the slide and separates it from the surrounding fluid so it cannot be contaminated. This is put on to a plastic plate that holds 96 samples, and the DNA is then copied 10 billion times to increase the sensitivity of the sample. The second robot adds a piece of artificial DNA to the sample to act as a marker. It is then put underneath a piece of DNA and resembles a ladder. This allows scientists to measure the length of DNA strands for identification purposes.

The DNA automation manager believes the new system will reduce the strain on the forensic scientists.

The robots are under strict scrutiny in their purpose-built room, since the new service has to perform without error. The Forensic Science Service have been developing both robots for nearly a year.

2. Autonomous mobile robot

Drs Yutaka J. Kanayama and Bruce I. Hartman have proposed a new method for generating smooth paths for vehicle path planning. The researchers are at the Department of Computer Science, University of California, USA. They say that the problem of finding the "smoothest path" joining two given configurations has been solved. Generally, the problem has been tackled by using two "simple" path segments. The most important issue, they say, is how to define the smoothness cost of the path. They have proposed two distinct definitions as to how to define this: the first is the path curvature, and the second is the derivative of the path curvature. The researchers used circular arcs with the first definition and "cubic spirals" with the second for "simple curves" respectively. They believe that the set of cubic spirals has several advantages when used in smooth-path planning, one of which is curvature continuity. The algorithm they have produced has, they claim, been successfully implemented on the autonomous mobile robot Yamabico-11.

The researchers have published work concerning the smooth planning of the paths of autonomous vehicles in a number of journals both jointly and with other authors. Their most recent was in *Robotics Research*, Vol. 16, No. 3, 1997, pp 263–283, but their earlier contribution to the *IEEE International Conference on Robotics and Automation* in New York, in May 1989, is also of importance.

3. Robot helicopter

A report from the United States says that a proposal to build a robot that takes to the air like a helicopter and then flies like an aeroplane is in contention for US Defense Department funding. Called *Eagle Eye* it was designed to take off from a small area such as a ship's deck. Once in the air the rotors would be able to switch to helicopter mode at any time. The robot is 5 metres long, 4 metres wide and 1.5 metres high, with the rotor 2.5 metres in diameter and the undercarriage retractable. It is claimed that the 750 kg robot can carry a payload of 90 kg at a top speed of 230 mph and cruise at 185 mph. *Eagle Eye* has already flown successfully on many tests where it was controlled remotely using simulator screens and information from a video camera aboard the robot. It is, however, claimed that the robot is highly automated and its control system allows it to operate without continuous input by an operator. the robots are being developed by *Bell Boeing* who are also producing an even more sophisticated robot called *Remote Bold Eagle* which has a more complex system and which does not require a human operator at all. If successful in their bid for funding, these robots will take to the air around the new millennium.

4. Reading's Only Genuine Endurance Running Robot

Reading's only genuine endurance running robot is called *Rogerr* and is the product of Professor Kevin Warwick and his colleagues at the University of Reading (UK).

It was recently billed to appear as a robot runner in a half-marathon held for some 1000 human runners in Bracknell, Berkshire. If successful there would have been no doubt about a place in the *Guinness Book of Records*. Unfortunately, despite worldwide interest especially from Japan, the robot, because of some earlier erratic behaviour was not deemed, by the race organisers, to be a safe entrant. It was reported that this behaviour was due to the influence of the Sun which Rogerr thought was another entrant. The robot may yet reappear on the race scene to earn his designers a place in the world's headlines if not amongst the marathon winners.

5. Robot Mower called Robomow

The benefits of research and development in robotics has now led to the design, production and marketing of a number of devices that have in many cases revolutionised approaches to horticulture and to agriculture. What must be

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of great interest to the researchers and developers of such systems is the way in which so many current products now incorporate the results of their endeavours. Many are now routinely advertised as being: intelligent, automated, user-friendly, eco-friendly and with many more characteristics that were initially designed for the robot in the factory workplace. In the current garden season in the United Kingdon, for example, the new *Robomow*, described as an intelligent, automatic cordless lawnmower is available for under £1000. It is described as having the properties of an estabished robotic device developed for travelling over the production floor. It is said to be so sophisticated that it need only be set up and then left on the lawn to get on with the job of grass cutting. It is also claimed that it recognises and avoids obstacles such as garden furniture, needs no grass box to store cuttings as it mulches and recycles them. It can, the developers say, be put away with one and and its battery re-charged.

Just as in one type of production mobile robot it needs its region of activity to be defined. This is done in the conventional way by placing a wire connected to a small generator powered by two miniature batteries, around the edge of the lawn or area in which it is to be confined.

The "intelligence" comes from the well-known technique of allowing the robot mower to build up a map of the lawn area which includes any obstacles. This is noted when it encounters an obstacle and it calculates the size so that in future it is able to divert to trim the grass behind it before returning to the main cutting route. Its last task is to cut around the lawn edge.

This particular machine therefore incorporates many of the design features of the conventional mobile robot.

It is being marketed in the United Kingdom by *Friendly Machines*, Thame, Oxfordshire.

6. A robotic system for drug development

A new robotic system for creating and testing new drugs has been outline by its developers: The Technology Partnership (TTP) of Cambridgeshire, United Kingdom. The development of even more advanced systems combining the use of computer systems and robots is also under way.

Three systems, *Haystack*, *Myriad* and *Acumen* are being developed to bring automation to the whole process of drug design and development. *Haystack* is a computer-controlled storage system which is currently available commercially. In essence it is a store cupboard that has the capability of informing robots of the locations of each chemical that might be required in a new compound.

Myriad is a robotic system in which the ingredients of a potential drug can be mixed. This consists of the computer and robotic equipment that is linked into a database of existing and defined compounds.

This will allow the computer to be set up in a chemist with the task of looking for chemicals that are likely to have an effect on particular diseases. This information can be displayed on a screen so that the chemist can suggest ways, in an interactive fashion, in order to create new drugs.

Acumen, finally, is a more advanced robotic testing system which would monitor results and decide what a compound may need to make it more effective. The system would be able to order its associated computers, that were designed to control the earlier stages of the process, to mix a slightly different batch of chemicals and then to prepare them for new tests.

The three stages will, of course, merge into one process which has a degree of recursion in that when the first drugs are designed and produced they enter a process of successive improvement and testing. The automated process could then continue until the system has reached a stage where a compound has been produced that the chemists believe should be subject to final investigations and trials.

It should be noted that when the trials drugs are ready the equipment is sufficiently automated to deposit samples into test tubes. The developers can then observe that the reactions they have planned, do take place.

Although this is a great advance in the technique of producing drugs the system currently can only give a very general picture of what is taking place. It still requires humans to examine the test results and evaluate them. Scientists are only too well aware of the side effects of drugs and that extensive testing and licensing are essential before they are marketed and used.

In this project the Technology Partnership has been joined by the well-known pharmaceutical companies SmithKline, Beecham, Merck and Pfizer.

LASER LIFT-OFF

Nasa's Marshall Space Flight Centre, Huntsville, Alabama and the Philips Laboratory, Kirkland Airforce Base, New Mexico, USA have been jointly engaged in a test of a new laser lift-off system. This provides a unique method of propelling objects, initially into space. The system involves using a laser to heat the air beneath a space capsule, the air then expands rapidly, launching the capsule. Such a technique has obvious applications in space. It would, for example, provide an alternative means of launching satellites. Called the Lightcraft experiment, the principle has already been demonstrated, researchers say, in the laboratory. Now the latest test involves firing the system outside.

The project is being carried out at the Nasa Centre under the title of: "Beamed energy propulsion research". The project manager, Dr Jonathan Cambell describes the effect:

> "The force of the lift-off is determined by the power of the laser and the nature of the capsule's underside. It is a marriage between optics and propulsion."

For the laboratory use the laser is only 10 kilowatts, but for the experimental test at the White Sands Missile Range in New Mexico, it will be 15 times more powerful. A project spokesman says that:

> "The underside of the capsule is mirrored and contoured to allow the laser energy to focus on a small volume of air, and it takes just a few milliseconds to get the capsule airborne. The great thing about laser propulsion is the fact that the system is on the ground. A lot of the weight and volume of rockets is dedicated to propulsion. If we can leave that on the ground we only need to lift the payload. A great deal of our work at Marshall (Nasa's Space Flight

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Centre) is devoted to pushing down the costs of getting into space."

It has already been pointed out by many scientists that provided powerful enough lasers become available the only propulsion costs invovled would be the electricity bill for powering them.

Scientists have yet to harness the full potential of the power and versatility of laser systems. Many laser experiments, particularly those associated with military systems are already in being. If Nasa scientists are successful in adapting the concept for space then, as with so many other space-orientated projects, there are almost certain to be "spin-offs" into many other application areas. If successful there is the possible use for laser propulsion in:

- Shifting payloads around in space
- boosting vehicles or satellites to 40,000 ft at six times the speed of sound (Mach 6)—the laser could be focused on a pocket of fuel, creating additional thrust.

Although the project is still in its experimental stage and has, Nasa, says, cost only about $1 million, the developers will continue to build systems capable of propeling small objects to increasingly high altitudes. The immediate aim is to fire a small capsule to an altitude of at least 0.5 kilometre in the next year. Efforts will then be made, the project team say, to focus on the goal of getting a picosatellite, probably weighing less than one kilogram, to sub-orbital altitudes. Funding is, as usual, the problem so the project aims remain modest for the team, but inevitably, such are the possibilities of laser-propulson systems that early successes in the current experimental tests would soon change the funding situation.

MICROCHIPS WITH LIVING BRAIN CELLS

It has been reported that brain cells have been successfully grown on microchips. At the *New Orleans Conference* (October 1997) it was reported that brain cells had been grown on a microchip to create a "simple brain". The idea being that it would assist scientists to study how the brain works and how it might be possible to connect computers to living nervous systems. The obvious potential in, for example, linking the human nervous system to the powerful computer systems that are being developed, is enormous. This possibility has been already the subject of intense research activity worldwide. Some of the pioneering work has been carried out in Germany by Professor Peter Fromherz and others. At this conference scientists from the University of California USA described how a "neurochip" had been developed.

Dr Michael Maher from the University of California at San Diego said that:

> "The neurochip that is being developed is a device for growing rat neurons in a silicon chip. One day it could help to restore vision, reconnect nerves or control an artificial limb. The neurochip has electrodes set inside small wells etched into the silicon. Individual brain cells are placed into each cage growing extensions called neurites that make contact with neighbouring neurons. The chips must be kept sterile and infection with bacteria and fungus is a constant danger."

To avoid infection Dr Maher has the cells bathed in tissue culture medium which was specifically designed to maintain the survival of brain cells. Dr Maher also reported the results of his experimentation, he said that:

> "The neurons survive two to five weeks. We are working to improve that but it is long enough to do the experiments we have planned. We can monitor the network. We can also stimulate input by selectively stimulating any cell in the network."

There are electrodes in the chip which are capable of detecting the electrical activity of the cell. In his report to the conference Dr Maher said that the team had performed a series of experiments to perfect the design of the chip, and to show that it works. They have shown, he said, that "cells survive in the chip and that we can communicate with the neurons in the chip."

The team has ambitious plans to experiment and study the various effects produced by the electrical activity in the cultured neurons and, it is hoped, learn more about brain processes and the way in which information can be stored.

MIMICKING NATURE

Researchers involved with the science of mimicking nature, have produced many successful "spin-offs". Perhaps the most well publicised is that of the most successful product *Velcro*. This was produced as a result of observing the way pollen stuck to plants. Other examples quoted in this section in past issues have outlined how studies of nature have helped scientists with their researches and in the development of new materials and technologies.

A recent report from the UK Defence Department now outlines how the sea cucumber, which is well known as *béche-de-mer* and consumed as a delicacy in China, has properties that could be harnessed to make combat aircraft faster and more manoeuvrable. Indeed, it has been suggested that the sea cucumber could, perhaps, one day, do more for combat aircraft than the developments in avionics and mechanical engineering of recent years.

Sea cucumbers it seems, can become hard or soft at will, with the help of the natural magnesium and calcium ions found in sea water. What researchers have now found is that it may be possible to adapt the sea cucumber's body changes to structural materials. For example, it is suggested that a jet aircraft, using these properties, could go soft in flight, thus providing maximum flexibility. The aircraft wings could even face forwrd, thus creating entirely different aerodynamics. This could lead to the development of aircraft that could travel further and at much greater speeds.

The research and development of this and other innovative ideas is being carried out at the UK's Ministry of Defence Evaluation and Research Agency (Dera), situated in Farnborough, Hampshire. The work has been given the name aero-elastic tailoring. The head of the Dera department concerned with polymer composites and smart materials, Dr Paul Curtis, predicts that:

> "the imporance of the sea cucumber project is such that a

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demonstration of the new technology could be ready in three to five years and a practical version flying in ten years."

A study of the sea cucumber has shown that it is a marine invertebrate that has a soft cylindrical body, which can vary in size from $\frac{3}{4}$ inch to $6\frac{1}{2}$ feet long, and is between $\frac{1}{2}$ inch and 8 inches thick. Its characteristic behaviour is that when threatened it wedges itself into a crevice and stiffens its body so that predators cannot extract it.

This study of the creature has convinced scientists involved with smart materials projects that human-made materials could also be made to stiffen at will. This hard/soft capability could have many uses in the world of technology.

Professor Paul Curtiss says that:

". . . the idea was to develop a material that would have varying stiffness providing greater manoeuvrability for jet aircraft. Combat jets would have special computers that would dictate automatically when the structure of a fighter jet should stiffen or become more malleable by changing the chemical materials, depending on circumstances."

The development of smart materials and smart structures is now receiving a great deal of support worldwide and there is no doubt that the study of nature and, in particular, of creatures and creature habits can provide much information for technologists.

NEURAL SYSTEMS

1. Advanced Uncertain Reasoning Architecture (AURA)

Both industry and academia have again combined in a UK project and important advances in enabling intelligent systems to perform complex reasoning quickly and reliably on large volumes of uncertain data have been made. The *Advanced Uncertain Reasoning Architecture* (AURA) project was discussed in *Impact 1997*, the UK Research Council IT Update. It was completed at the University of York's Department of Computer Science, and was funded by the Engineering and Physical Sciences Research Council (EPSRC). In its Impact Research File, published as an information technology update, the EPSR has published more details of the project which was conducted by the partnership of the University department and British Aerospace (BAe). The initial aim was to develop real-time aids to help military aircraft pilots make decisions using incomplete and confusing data from many sources.

Dr Gordon Semple, Technologist Advisor in BAe's Mission System, R&D Group says in this report that:

"AURA's remarkable success in knitting together theoretical and electronics advances has resulted in a generic technology that goes far beyond our original cockpit support objectives, which were fully met."

The research report on the project also indicates that research is under way in using AURA to improve address matching for the Post Office in the UK. It also sees great possibilities for an application in molecular database searching for Glaxo Wellcome, the pharmaceutical company. In addition, further applications are also envisaged for BAe.

Dr Jim Austin of York's Advanced Computer Architecture Group says that AURA has demonstrated that:

"methods based on biologically plausible neural networks can be very useful in many hard processing tasks to which they had not been previously applied".

It has already been reported that the prime objective of the research team was to use neural technology more effectively for symbolic reasoning. It is accepted that the main activity in neural networks and their applications have concentrated on more continuous patterns of knowledge. The team believes that the pre-processing of different data types was a major piece of work in AURA. This is done by converting lexical tokens representing symbolic information into binary patterns suitable for neural networks based on Correlation Matrix Memories (CMMs). CMMs are, we are told in the project report, relatively simple neural networks that encode relationships using binary (on-off) synapse connections rather than real numbers. They can be trained much faster than other neural networks. AURA processes tokens by techniques developed from the Advanced Distributed Associative Memory (ADAM), created at the University of York originally for image processing. Both ADAM and AURA are constructed around CMMs. The EPSRC report also explains that:

"Specially-built low-cost AURA hardware, called PRESENCE, can process binary neural networks over 200 times faster than standard workstations. AURA's rapid reasoning is further enhanced by its flexible new method for partial matching. AURA employs industry hardware and software standards throughout."

It was the EPRSC's Architecture for Integrated Knowledge Manipulation Systems (AIKMS) programme that funded the AURA project. The council's *Neural Computing: The Key Questions Programme* will continue to pursue the work of aplying AURA with large numbers of CMMs for molecular databases.

Plans to continue AURA research are being made and these, we are told, will include collaboration with industry.

More details of this work can be accessed on the Web Link:

htt://dcpul.cs.york.ac.uk:6666/acag/nn/aura.html

2. New Surveillance System

A new surveillance system that can identify a wanted criminal or a missing person from a crowd captured on a security camera is about to complete its first trials. If successful the system has great potential in many application areas, but it will most certainly transform the use of closed circuit television.

The system is based on advances in artificial intelligence (*AI*) and research in image and vision systems. Several prototype systems have been introduced that are capable of image recognition which was regarded as an important part of, for example: human-interface and safety-critical studies.

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Throughout the world closed circuit television (CC-TV) systems have been used for security and many other applications where images need to be monitored. In the United Kingdom such systems are being increasingly used to combat crime. These systems have cut street crime in the UK by up to 50%, but they have had to be monitored by security personnel who have to view many screens at one time. It has consequently been almost impossible to pick out an individual from the many thousands who pass the cameras. Now a British company has developed a computer that will continually watch CC-TV images and instantly recognise any face it is asked to look for.

The system is called Mandrake and it uses the recent advances in neural network technology. In effect, an ordinary computer is programmed to act as a network of simple cells mimicking the human brain's operation. It can be taught the tasks it has to perform in the same way as a human brain is shown how to perform a particular procedure. It can also, like a brain, learn from its mistakes. Unlike the human brain which in most cases has a limited capacity for storage and recognition, the Mandrake computer can be shown hundreds of thousands of facial images which it is able to recognise rapidly. It does this by identifying key features which in turn it is able to recognised from the faces that appear on a CC-TV image.

The system has been developed by Software & Systems International, Slough, UK. The system team is headed by Philip Bowe and Patrica Oldcorn. The developers say that:

> "The computer has been trained to concentrate on just the parts of the face between the top of the eyebrows and the bottom of the chin, and from one temple to the other. It ignores hairstyles, facial hair, glasses and jewellery and turns what it sees into a simple template that captures the essence of the face."

This template is then used by rapidly comparing it with a library of face images stored on the comuter and once found the machine will immediately alert the security staff.

The main feature of the Mandrake system is its human-like ability to cope with many different views of the face that has been isolated. It is claimed that it can recognise the same face from different angles. Philip Bowe says that:

> "Mandrake recognises a face very quickly. It can compare what it sees with what is in the image library at around 250 images every second. And it isn't fooled by disguises. If you are wearing a beard, we'll spot you. If you are in drag we'll spot you."

Demonstrations and live tials have been held and many applications have already been suggested by the police and anti-terrorist services. One trial has been held at a football ground where the crowd was scanned for known trouble-makers. Plans to test the system in searches for missing persons, particularly children, in a particular area are being undertaken.

PLASTICS DISEASE

Reports from across the world indicate that plastic materials have been subject to degradation. Called by the media "plastics disease", it has shown itself to be, in the main, age related. The decay in materials that have for so long been considered indestructible is worrying scientists and manufacturers are also concerned at the long-term viability of their products. This decay is reported to cause plastic materials to drip a sticky substance, give off a vinegary odour and to flake or crack. Some examples given include tractors built in Scotland, UK in the 1920s and the steering wheels of 1960s Morris Minor motor cars. Even clothing, such as dresses made from rayon, a synthetic fibre, covered with sequins is affected. In the National Museum of Scotland, Dr Anita Quye has reported that a dress by Norman Hartnell has its sequins flaking away. It turns out, she says, that there are synthetic fibres too. Studies to counter the decay problem have been undertaken by the University of Strathclyde's Chemistry Department, and other organisations including the Engineering and Physical Sciences Research Council (EPSRC). Dr Quye is reported as believing that:

> ". . . old plastics, some of which were made some 130 years ago, were affected in different ways, depending on their composition. The studies have focussed mainly on cellulose nitrate, a plastic used to simulate tortoiseshell and ivory."

Already, it would appear, X-ray fluorescence analysis has shown that degradation is linked to the level of sulphur impurities. Zinc oxide, used in some plastics such as fake ivory, helps to protect the plastics. The scientists are now studying the conditions that trigger the process. In the case of museum exhibits safe environmental conditions for plastic are sought and ways of detecting whether the decay is likely to occur. In France and in the United States, these problems are being investigated. In particular, in America the Smithsonian Institution has found problems with the rubbers and polyurethane foams used in space suits. One recommendation is to keep them at a sub-zero temperature in oxygen-free chambers.

Although the problem is currently that of museums and those responsible for keeping historical items, concern about the plastics disease has prompted various bodies to look at modern paints such as acrylics and resins to see, for example, whether artworks are at risk. Modern furniture, modern synthetic fibres are also the subject of investigations. We are told that what has currently been revealed is, perhaps, the tip of the iceberg, and that chemical reactions in plastic materials, that were always considered to be everlasting, need to be investigated with some urgency.

PROCESS SOLUTIONS

A United Kingdom company has recently outlined a programme of research and development in process management undertaken, jointly with a University department. The company ICL has established a leading position in providing business process management solutions with the assistance of knowledge gained through its involvement in a variety of research collaborations. Each of these collaborations is of great interest to management in the world of business and industry which sees the need to provide support for process improvement initiatives.

ICL announced recently that a "Process Solutions Group"

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had been established to bring together its capabilities for supporting business process management solutions. Its service includes a Process Design Studio which helps companies to turn business-level process concepts into effective operational systems. The group report that:

> "In tailoring solutions to specific business contexts, the group can draw on many methods and tools. These include the ICL *ProcessWise* family, whose Integrator was identified in 1995 by the prestigious US Gartner Group consultancy as the first product to support process management and coordination across many business processes.
>
> The foundations which ICL has been able to exploit in products like ProcessWise were laid by an EPSRC/DTI Alvey research project that set out in 1984 to investigate Integrated Project Support Environment (IPSEs) for large-scale software developments. Called IPSE 2.5, it was managed by ICL and included Manchester University and the Rutherford Appleton Laboratory (UK)."

The Director of IPSE 2.5, Professor Brian Warboys, currently Head of Manchester University UK's Computer Science Departmen has recalled that:

> "As the project progressed, we realised we were developing generic approaches, such as for process modelling, which could be applied effectively beyond software engineering to any business activity."

ICL also gleaned important new process management knowledge on two other UK Alvey projects: *Persistent Information Space Architectures (PISA)* and the *Introduction to Process Technology (IOPT)*. Recently, ICL has worked on the *Integrated Cooperative Workstation (ICW)* in the *Computer Supported Cooperative Working Programme of the EPSCR/DTI*.

In this programme partners undertook research into activities such as Rapid Application Development (RAD) methods and the interworking of multiple process management and workflow tools and technologies. ICL currently report that its process research collaborations include:

- Support for the *Compliant Systems Architecture Project*—this involves bringing together pioneering work at Manchester and St Andrews Universities (UK) on business process management, operating systems and evolutionary large-scale "persistent" application systems.
- Participation in the new *Systems Engineering for Business Process Change Programme* supported by the UK's Engineering and Physical Sciences Research Council.

The Principal Consultant for the ICL ProcessWise, Jane Searles, was reported in the *EPSRC Newsletter for the IT & Computer Science Programme* (June, 1997, p. 8) as acknowledging that the:

> "collaborative trail from IPSE 2.5 has been an extremely productive journey, with our academic partners illuminating the route with their invaluable and varied innovative thinking and background knowledge.
>
> This has greatly helped ICL to fill out its vision of process thinking to encompass all relevant technical, business and social dimensions. For example, it has assisted us to play a prominent role in the development of relevant industry standards, such as the Dynamic Systems Development Method (DSDM) for RAD."

ICL believe that it has maintained close collaboration with important UK Universities on process work and much mutual benefit has been gained. Professor Warboys believes that:

> "a fruitful way of building on this type of collaboration will be for academia to take the initiative in showing proof of novel concepts by building new applications. For instance, computer science students at Manchester have built a system which gives access to ProcessWise over the World Wide Web."

Web links for these research collaborations are:

- *ICL Process Solutions*: http://www.process.jclnet.co.uk

ROBOTICS AND AUTOMATION WORLDWIDE

1. AUSTRALIA

Members of the Austalian Robot Associaton (ARA) voted in favour of changing the Association's name in 1997, and now it is changing its rules to incorporate this and other changes, reflecting the Association's expanded focus. Following the final approval by the membership the name will be formally changed to: *Australian Robotics and Automation Association Incorporated*.

Automation Statistics. A survey by the ARA estimates that 250 robots were installed in 1996, 17% more than the 214 robots estimated to have been installed in 1995, bringing Austalia's robot population at the beginning of 1997 to 2517 units. This figure, the report says, represents accumulated sales and the Association has no way of knowing how many of these 2517 robots are still in use. Once again it is noted that following the International Federation of Robotics and the United Nations Guidelines, only devices having three or more axes are counted as robots in these statistics. It is significant to note that the ARA survey indicates that 244 of the 250 robots installed in 1996 were imported and 6 were locally manufactured.

The value of the Australian market place estimated by the ARA report grew from $25,000,000 in 1995 to $31,136,555 in 1996, a 25% increase. It should be noted that this value included the price of the robot itself and all ancillary equipment and services provided by the robot supplier or sub-contractor to the robot supplier in connection with each robot installation. It does not, however, include the cost of equipment or services provided by the customer or other parties. The survey also indicated that arc welding was the main application of robots installed in 1996 accounting for 81, some 32%, of the 250 robots installed. The second leading application was palletising and packaging, accounting for 20% of the installations. This was followed by spot welding (11%) and miscellaneous materials handling, some 10%.

Research and development attracted four robot installations with two robots for education.

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It was significant to note that manufacturing motor vehicles continues to be Australia's leading industry sector in terms of robot usage. This was shown by the report which stated that 57, or some 23%, of the 250 robots installed in 1996 were in this sector.

Both the sectors food/beverages/tobacco manufacturing, and the manufacturing of fabricated metal products accounted for 17% of installations in this period. The industry sector—manufacture parts and accessories for motor vehicles, now regarded as a distinct sector, claimed 10% of the robots installed in 1996. We are told, that an aggregate total of 95 robots, some 36% of all robots added last year, were installed for manufacturing transport equipment; this includes cars, car bodies, car parts and accessories, and other transport equipment.

Installation Trends. The ARA estimates give a good indication of the trends in the pattern of robot installations in Australia. In relation to the number of robots added in the period 1990–1996 the distinct increase and growth in numbers were from 153 (1990), to 154 (1991), but down to 118 (1992), and then an increase to 145 (1993), wih a continued increase to 156 (1994), to 214 (1995) and to 250 (1996).

It will be recalled that the World Robot statistics published by the United Nations and the International Federation of Robotics estimates the world robot population at the beginning of 1996 to be 650,000 units, an increase of 6% from the year before. It estimated Australia's robot population to have grown by 3.6%. This compared with the USA (16.1%), Germany (13.3%), Singapore (49.8%), Korean Republic (45.9%), and Japan (2.7%).

2. JAPAN

The Japanese company Toto in collaboration with the University of Tokyo scientists have produced what is described in a recent report as a self-cleaning window that never mists up, by using a new technological approach. They are reported to have produced glass that is covered with a thin film of titanium dioxide. When it is exposed to sunlight the ultraviolet radiation alters the microstructure of the film creating a surface on which both water and oil spread freely instead of forming droplets. Consequently, the scientists say, the surface is easily wettable acting like a dish in washing-up water and the rain can therefore easily wash off any dirt. The development is the work of Dr Akira Fujishima of the University of Tokyo and a team of scientists.

The team has tested their work and claim that when they left various materials coated with titanium dioxide outside for six months they remained much cleaner than the same materials without the film.

Further research in this innovative approach has been completed by Dr Adam Heller of the University of Texas at Austin, USA. He has demonstrtated that particles of titanium dioxide could act as catalysts in the sunlight helping to destroy any organic matter such as dead insects.

Potential applications for this new technology are many with the most immediate being concerned with glass products such as windows in high rise buildings and domestic and industrial glazing. Car manufacturers are particularly interested in the use of these techniques for vehicles' windscreens etc.

3. UNITED KINGDOM

A report on Information Technology innovation from the UK's Engineering and Physical Sciences Research Council, details some of the important and collaborative Safety Critical Systems (SCS) programmes that have been supported by the Council and the UK Department of Trade and Industry.

The knowledge gained in the six-year EPSRC/DTI Safety-Critical Systems (SCS) programme, which ends in January 1998, is being made available to as wide an audience as possible. The SCS report says that:

> "About a hundred academic and industrial organisations participated on 32 Safety-Critical Systems projects, which covered a comprehensive technology agenda and a broad range of industry sectors concerned with improving the safety of computer-based systems. A total of about £28.4 million has been invested in the projects by the EPSRC, the Department of Trade and Industry and industry."

According to the report this has been a substantial programme by any standards and some impressive work has been done in it which will be of much value to many managers, users, and developers of critical systems.

Detailed information about the SCS research and workshops is now available on a Web site maintained by Augusta Technology Ltd. This also offers guidance on key safety issues and links to sources of help. A book is also available which has drawn together the many threads of the programme's work. Other planned publications include information packs containing advice gleaned from the programme and a report on the systematic evaluation of the programme. This evaluation is being carried out by Gordon Hughes, the Director of the Safety Systems Research Centre at Bristol University, UK. It will be partly concerned with the extent to which the programme has met its objectives and produced high quality academic research that has been exploited by industry.

The EPSRC is continuing to support work in this area through the responsive mode. In addition, it is reported, a new programme in Critical Systems is under development.

The Web sites that can be accessed for more information are:

Information about SCS:
http://www.augusta.co.uk/safety/
SCS Book:
http://web.ukonline.co.uk/Members/mike.falla/digest.htm
Workshop Report:
http://www.iee.org.uk/PAB/wic.htm

SOFTWARE & HARDWARE ADVANCES

1. Hardware—New generation computer chips

The development and marketing of computer systems has now reached a point where the advances are so rapid that it

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is again becoming almost impossible to make a choice of systems. Some businesses and commercial concerns may be happy to change their systems in the short term but many individuals and organisations expect to keep theirs for a 'reasonable time'. Like the manufacturers of motor cars systems have to change and be made to appear at least upgradable. The advent of the new chip Pentium II is yet another example of a highly desirable advance that encourages us to change our existing machines. It has been much publicised and we have been told that the chip is some 50% faster on most measures than the *Pentium* or *Pentium Pro*.

Reports say that it contains 7.5 m transistors together with 544 KB of memory and is capable of running at 200,233 or 266 MHz. It also, reports say, includes the new MMX technology which will have the advantage of speeding up video and graphics facilities. Further increases in speed are produced by its use of parallel processing. It is also suggested that because of its new edge-connection plug to the printed circuit board, which incidentally is said to be easier and more robust than fragile pins, the ability to upgrade is in jeopardy because it would appear that there is no way of substituting the new chip for the previous generations.

The new chip is now appearing in the latest computers from AST, Hewlett Packard, NEC and IBM. Machines incorporating the new chip are priced at some £2000 to £2,500. The speed-up of these computers is dramatic and the computer press reaction is almost one of alarm that such power is now becoming available often to users who will certainly never make use of it. Even so many of the operations will be enhanced to the point where anything slower will be regarded as unacceptable by the new generation of users with their ever widening range of applications. Future users of these chips will see the potential for a possible 50% increase in running time for many complex and previously time consuming algorithms that perhaps required much sorting and searching of data. The speed-up of graphics and video will also be a particular bonus for those with demanding applications.

2. Software—creating "softer and more forgiving" computers

There was a dramatic change in the development of computers some two decades ago when someone coined the term "user-friendly" to describe what they then considered to be a computer system that had a much improved interface. Now we await another term that encompasses the new "understanding" computers that are being designed.

The software company Microsoft has initiated a new £50 million project with the University of Cambridge, UK, to create a "softer and more forgiving" breed of computers. The involvment of the US company with Cambridge University has been much publicised and is the result of a search by the American firm for a viable overseas research centre. Not only does the choice of Cambridge affect the university itself but also the local companies who are now part of an attempt to produce a new "Silicon Valley" in the area around the town. Microsoft are reported to be investing £10 million in local companies in pursuit of this goal.

Microsoft are reported to have outlined tasks it would want the 40-strong Cambridge team to pursue. These include that of making computers "more understanding" of the owners' needs. A spokesman for the company said that:

> "Computers still have an arcane structure. We see them being softer, more forgiving, having some degree of common sense."

The new research base started work in August 1997 with an initial staff of 25 which will grow to 40 during the first five years of its activities.

This is therefore an innovative initiative which is a new venture for the successful US company or Cambridge University and its locality, and for computer users of the future who may see computers that have been described as having a "heart" and "feelings".

VIRTUAL REALITY

1. Virtual Reality (VR) for the Fire Services

It is with no surprise that we read that Virtual Reality Training programmes are being designed for fireservice training. Nigel Finlayson, the Chief executive of the Fire Service College (UK), reported that fire officers are now using virtual reality to help them tackle real life blazes. The session was given at a *Computers in Personnel and Training* conference held recently in London UK and organised by the Institute of Personnel and Development (IPD) and the Institute of Employment Studies (IES).

The Chief Fire Officer said that:

> "We have started to train officers using an interactive virtual reality programme where they take on the role of the commanding officer during a fire. The whole exercise happens in real-time, so reactions are tested as realistically as possible and there is no way of changing your mind once a decison has been made. The program, *Vector*, uses external factors such as the weather, time of day and amount of traffic en route to the fire for added realism, as well as additional stresses such as casualties or fire engines breaking down. Traditional training has concentrated largely on the classroom and practical training exercises. Academic case studies require a lot of imagination and full-scale practical exercises are extremely expensive and can only train one officer at a time to be in command."

Vector is used in conjunction with traditional methods for the 5,500 officers in the UK who need training every six months. It is based on educational theories and research and is deliberately designed to measure what the officers learn against national Fire Service standards.

The program has been developed by the Fire Service College in the UK and computer company Colt VR. By definition, real life incidents are out of control and we have been looking at using computers for years as a realistic way to prepare and train our officers for them.

He argued that the most important aspect of virtual reality training is not high-quality graphics and sophisticated extras but whether the skills learnt through the program can be translated to real life.

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2. Virtual Reality for Medical Applications

Reports from researchers and developers world wide outline the exciting new techniques involved in using Virtual Reality (VR) for medical purposes. By creating a virtual reality image they claim to have lessened the risk of operations for both patients and the medical staff involved. In the UK at London and Leicester Universities, a three-dimensional image of the patient's body is displayed so that it will act as a guide for the surgeon's instruments. Producing such a picture will provide an aid to surgeons in a number of different operations. At first Dr Peter Bell of the University of Leicester says, the method will be used to repair aneurisms, weaknesses in the aorta which can burst with fatal results if untreated. The repair can be made using keyhole surgery which, of course allows for the operation to take place without the patient's chest being opened-up, and the consequent trauma. One problem is that the patient has to be X-rayed on the operating table which can, of course, lead to everyone present being exposed to regular doses of radiation. Dr Bell, working with Dr Gus Alussi of the University of London has, however, developed a new technique that requires only one X-ray by a body scanner before the operation and which is then used to create a screen image of the topography of the body and the position of the aneurysm. The aneurysm can be quite long, as much as seven inches. For its repair a fine metal mesh, called a stent, has to be inserted to reinforce the weak point.

At a recent meeting of the British Association the research team forecast that:

> ". . . within a year, surgeons at Leicester Royal Infirmary will be able to guide the stent into position by watching the 3D image. The stent will be inserted through a small incision in the groin and its position at any moment mapped on the virual image of the patient."

Professor Bell also told the meeting that:

> ". . . the main advantage would be to reduce radiation exposure, but the operation could also be cheaper and more accurate. The first trials of the image system will be during conventional open-chest surgery."

At the same meeting a laser scanner that can make 3-D images of the body in a matter of seconds was also demonstrated. The device used was developed by Suncan Hynd Associates and 3-D Scanners with the University of Surrey UK.

The scanner, we were told, was originally designed to produce better fitting artificial limbs and other body parts, but other applications such as checking the healing of wounds are emerging. It may well be used to direct radiotherapy and so provide a more precise and effective treatment.

TelePower PROJECT

The innovative TelePower system allows control to be applied to energy consumption in both the domestic and business environments using remote facilities. The system, it is claimed, is unique and has been designed for applications involving individual households or even the national utilities. The European Comunity through its Eureka programme has encouraged projects that are user-friendly and provide systems where human users can remotely contol what is happening in their homes or in their place of work. This can only be an encouraging trend in a technological age. In this EU project it was decided that the effective management of power systems was to be the main aim, thus not only providing the convenience of monitoring the function of a system but also proving a saving in precious fuel resources.

As a result, the first *TelePower* systems are going on-line across Scandinavia to help manage energy consumption. Called EU 1499-TELE-ON it aims at:

- Providing wireless communications for remote energy usage control
- Suitability for both individual households and national utilities
- Providing low-cost improvements in energy efficiency and management.

The three-year project involved Norway, where *Cresto Technologies AS* participated, and Sweden with Edstroem Komponent AB taking part. The project was completed in 1997 and the report of the success of this national and international power control service was published by the project sponsors in the *EUREKA NEWS No. 37, 1997*. The report says that:

> TelePower is a flexible, low-cost and user-friendly system which allows its users to "control their energy usage from any place at any time via their telephone. For domestic and business users, it offers a simple way of remotely controlling electric, oil and gas fired heating systems, water heaters and air conditiners.
>
> For utilities, however, it represents a more responsive way to manage energy demand and provide customers with new types of services such as 'time-of-use' tariffs. The benefits are obvious: more efficient energy usage and a healthier environment."

It also outlines the form of communications that has been incorporated in the system and describes the telephone control, that is a key feature.

The TelePower system was developed by the two participating companies with a project launch in January 1995. Cresto Technologies AS is an independent developer of hardware and software systems with experience in the fields of energy conservation and computer telephony integration while Edstroem Komponent AB manufactures and sells temperature control systems. They describe the system as having two parts:

> ". . . a Central Station, which is operated by any telephone supporting DTMF (tone) signalling, and the TelePower switches. These incorporate a paging chip, so they don't require a telephone connection, and are installed on the site to be controlled. Users can control them—thereby activating household appliances, altering room temperature or controlling ventilation systems—simply by following the Central Station's instructions and pressing the keys of their telephone."

One of the developers of the system, Dr Rivenaes says

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that:

> "But it has a much wider scope than the individual user. One of the key advantages is that the system can be used both by the general public *and* by the utilities. The utilities industry is interested in improving energy efficiency through load control and demand-side management. To do this they often develop their own broadcasting capabilities and systems. Tele-Power eliminates this investment because switches with the same code can all be simultaneously activated or deactivated through one phone call to their Central Station."

The EUREKA Report gives details of the system and indicates the costs involved. The estimated cost was 0.8 M ECU (Million European Community Units). At 35,000 ECU (European Community Units) a Central Station is, they claim, a relatively low cost investment. The costs are reduced because, the report says:

> "FINNET, Finland's largest private telephone company with fifty per cent of the mobile market, has already bought a TelePower Central Station while Cresto Technologies has signed a contract to supply several thousand TelePower switches for the whole country over the next five years. Cresto Technologies have also installed a parallel Central Station in Norway which also covers Sweden. After Scandinavia, Cresto Technologies aims to start marketing the system across Europe and has similar plans for the US market."

Dr Rivenaes writes in the EUREKA Report that:

> "We are confident that our system is competitive. We did an international patent search. Our software combination is unique—nobody else offers the same interactivity. The response from users aged between 8 and 80 has been overwhelming. Our new energy service is flexible, smart, good for the environment and industrially relevant."

Details of this National and International Wireless Power Control Service can be obtained from:

World Wide Web site: Http://www.telepower.no

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