

## Reports and Surveys

### DEVELOPMENT PROGRAMMES FOR BUSINESS AUTOMATION

#### 1. Joint Venture Programme at Cranfield (UK)

The *Joint Venture Programme*, newly launched by the Cranfield School of Management, offers help to companies that are looking to expand their business in developing countries. It is claimed that valuable European Community (EU) grants are being lost, and the Cranfield initiative offers a fast track through what they describe as the bureaucracy involved in making applications for aid to develop partnerships abroad. This is particularly true of companies involved with automation and robotics who because of their intense development and marketing activities fail to take advantage not only of EU programmes that offer financial assistance, but even the help that is at hand from their own government's initiatives.

In the United Kingdom, for example, more firms are seeking new markets, particularly in developing countries with supergrowth economies and competitive labour rates. Funding is available of up to ECU 1 million (about £800,000 sterling) for companies planning to set up or expand joint ventures in Eastern Europe, Asia, Latin America, the Mediterranean region, the Middle East and South Africa.

The Cranfield Joint Venture Programme claims to be the first initiative of its kind set up to help companies in making their application for EU funds to develop opportunities abroad. It offers free assessment of eligibility for aid, help in the search for a new partner, any assistance qualifying firms may need to set up or expand their joint ventures and even assistance to complete the application form.

Companies and organisations should note that initial EU funding is available for a feasibility study and, on the successful formation of the joint venture, assistance with capital requirements and the transfer of technology and training may be applied for. The programme is self-funding within the framework of the EU funds. Those interested should contact the European Commission about the EU grants and the Cranfield School of Management about their *Joint Venture Programme* at Cranfield, Bedford MK43 OAL, UK. tel: +44 (0)1234 751122 or fax: +44 (0)1234 750350.

#### 2. European Programmes and Initiatives.

The recent EITC '96 Conference and exhibition held in Brussels in November 1996 highlighted the theme 'How we do Business in the Information Society'. It provided the occasion for those of us who are not fully conversant with the European Commission's initiatives and programmes to find out more of what is being done in the EU to recognise the impact of the information society. It not only concerns those who are members of the EU but also individuals and communities outside its borders who will be concerned with its future plans.

There is little doubt that the Information Society represents perhaps this century's greatest challenge to the business world as well as so many other sections of the modern society. Indeed, the Information Society affects all who are active in the business community, and this was recognised at EITC'96 and also by technology experts and all of us whose lives are touched by the advent of the new information age.

In the business world alone the EU has to address many and diverse themes if it is to implement new development programmes to meet the information age challenges. It has to consider how to do business in the new information society, consider the effects of the increasing use of electronic commerce worldwide, and examine the resulting developments in the electronic commerce infrastructure. In looking at

business initiatives and applications, key technologies have to be considered. Many of the major current discussions revolve around: business re-engineering, virtual enterprise, network computers, interfaces, smart cards and electronic payments systems, security for electronic transactions, and copyright management in the electronic media. One area of concern that must be addressed rapidly is that of standards for the World Wide Web. Currently, a programme of consultation and development, the World Wide Web Consortium (W3C) has been set up by industry to form standards for the Web.

Some of the topics discussed at the recent EU Information Technology Conference illustrate the concerns of the worldwide business community. They included:

- Electronic Trading – distribution and logistics
- Financing IT Innovation
- Electronic Marketing and Customer Support
- Electronic Payments
- Shared Business Processes
- Financial Markets – how to finance, nurture IT Innovation
- IT in Action – Electronic Services. Collaborative Design and Concurrent Engineering.
- Enabling Technologies – such as networking and connectivity, identification, privacy, security.
- Training and IT – The learning enterprise, new technologies for Learning.

Many major initiatives are also being considered. These involve *Urban and Regional Initiatives* as well as *Co-operative R & D in IT between the EU and its neighbours*. There is also a great debate in progress concerning what is described in brief as 'IT Trends and IT Take-up'. This, of course, produces varying views on what lies ahead, and many competing visions of the coming scenario in IT, and in particular, what the future markets will be.

#### 3. European Union's Response

Two key responses by the European Union to the changes in our society and to new technology, especially in business and industry, have been:

- *Information Society Response* – Information Society is the name given by the EU to the response to the revolution in society triggered by the rapid developments in information and communication technologies. Further details are on the Net: <http://www.ispo.ccc.be/>
- *Information Technology Programme* – The mission of the European Union's new information technology RTD programme *Esprit*, is to support an integrated programme of industrial R & D and technology transfer in information technologies, with the aim of helping to improve the competitiveness of all European industry. Further details of the initiative are contained on: <http://www.cordis.lu/esprit/home.html>.

#### 4. Internet Service for Technology based Businesses – CORDIS

Whilst we pay lip service to encouraging industry to be more competitive in the world market place, assistance in real terms is not always forthcoming. The exception seems to be the new launch of a service called CORDIS, the European Union's research information service on the Internet. This provides what can only be described as an innovation boost. The European Commission team say that innovation and opportunity are combined in this new Web service which was recently demonstrated at the United Kingdom's *Online Information 96* held at Olympia, in December last. CORDIS is now available on the new site and offers complete access to the wealth of innovation and research that is supported by the European Union. The developers believe that the new

arrangements will allow more users to take advantage of the CORDIS service and should attract many more different types of user.

One of the main aims of CORDIS is to allow the businesses and industry of Europe to benefit from the large amount of research work that is being done in Europe. It also encourages them to play their part in the drive to make European Industry more competitive in the world marketplace. By putting this information on the Web, CORDIS can give the chance for even the smaller businesses to create the partnerships that can lead to successful new products.

For many years the CORDIS information service has been providing the answers to a wide range of research and development questions:

How do I find the partners to help me develop my ideas?

What is being developed within my industry that I can use to improve my business?

How do I contact people to help me take my research to the marketplace?

By launching the service on the internet, CORDIS has responded to the growing use of on-line information sources and has provided a real commercial reason why technology based businesses should look at the World Wide Web. Further information about CORDIS can also be requested directly from: CORDIS Customer Service, BP 2373, L-1023 Luxembourg, or by visiting the CORDIS web site at <http://www.cordis.lu/> or by (Tel 00352 40116 2240, Fax: 00352 40116 2248, email [helpdesk@cordis.lu](mailto:helpdesk@cordis.lu))

## EURO-INFORMATION TECHNOLOGY PROJECTS AND PRODUCTS

When the European Commission announced the names of the twenty five companies shortlisted for the 1996 *European Information Technology Prize (ITEA '96)* in November last, they were really producing a list of products and projects that were a cross-section of current developments and that were typical of community endeavour in Information Technology (IT).

The award was organised jointly by the *Esprit programme* and the *Euro-CASE* (European Council of Applied Sciences and Engineering) and it was intended to provide recognition to innovative IT products that were judged to have excellent market potential. Those who made the final list were expected to have demonstrated creativity and good business sense in using information technology to generate growth and employment.

The full list can be obtained from the European Commission's Information and Communications Office and on the European IT Prize Home Page\*. Of particular interest to those working in automation and robotics and illustrative of the Euro-companies' contributions to worldwide R & D are:

- *MBROLA* – a high quality Speech Synthesiser (Faculté Polytechnique de Mons TCTS Lab, Belgium)
- *FaceCheck* – an integrated vision system for automatic face spotting and computerised identification of persons (C-VIS Computer Vision und Automation GmbH, Germany)
- *Gain* – a solution to advance intelligent networks with a Service Definition environment for the construction and analysis of arbitrary IT – systems. (Siemens Nixdorf Informationssysteme LOB GP, Germany)
- *Recognita Form 2.0* – a medium volume form recognition software (Recognita Corporation, Hungary)

\* For further information, please contact: DG III Information and Communications Office Tel: +32 (2) 296 65 49; Fax: +32 (2) 299 19 26  
ITEA/Euro-CASE Secretariat: Tel: +33 (1) 44 41 43 94; Fax: +33 (1) 44 41 43 55  
and the European IT Prize Home Page <http://www.itea.tm.fr/whatsn.htm>

- *Appbridge Express* – a software product which turns character based host screens into a Windows application. (Expert Edge Computer Systems Ltd. Ireland)
- *Information Broker* – an open dynamic content generation and management system to make information available over the Internet using WWW technology. (ICL Information Technology Centre, Ireland)
- *Web Educational Support Tools* – West Desktop Education™ Server – a concept to capture the best elements of instructor led training and computer based training environments (Ireland)
- *Cosmos* – an object oriented analysis and transformation technology for multilanguage software systems. (TechForce BV, Netherlands)
- *Neural Network Simulator ORKA v3.0* with Genetic Algorithm for solving classification and forecasting problems. (Arkus Electronics, Poland)
- *ArahDobby & ArahJac* – textile CAD/CAM software package for weaving (Arahne d.o.o. Slovakia)
- *ModelMaker* – a hand-held system for capturing and manipulating 3D images of objects (3D Scanners Ltd., United Kingdom)
- *Hewlett-Packard OmniGo 700LX* – a communication-centric computer that integrates voice and data communications (Hewlett-Packard Laboratories, United Kingdom)
- *TIGER* – for knowledge based condition monitoring of gas turbine and associated equipment (Intelligent Applications Ltd., United Kingdom)
- *Pathfinder* – a novel computerised taxi dispatch system (Spectronics Micro Systems Ltd. (SMS))
- *Match Box Switch* – ES-2410 – a high-performance Ethernet switch. (Cray Communications A/S, Denmark)
- *DigiFocus and the OtiSet programming system* – a fully digital compact hearing instrument at the ear, based on a new developed microchip set. (Oticon, Denmark)
- *ATKOSoft* – a med Line, set of software specialised programs for the full coverage of the medical requirements of a medical treatment provision Organisation (ATKSoft SA, Greece)

The last awards – given in 1995 went to *DigiCash B.V.* (Netherlands) for its *Ecash™* electronic cash system that allowed secure anonymous payments of small sums from any personal computer over the computer network; to *SILMAG* (France) for its fast low-cost system for the manufacture of magnetic recording heads for disk drives; and to *Vingmed Sound AS* (Norway), for its System Five ultrasound medical imaging system.

## MINUSCULE ROBOTS

Advances in nanotechnology offer the prospects of the development of minuscule computing devices and also of minuscule robots. Current advances in nanotechnology are highlighted in a report of the work of the *Nanoscale Physics Research Laboratory* at the *Department of Physics* at the *University of Birmingham, United Kingdom*. This department was set up in 1996 by Professor Richard Palmer, with the aim of contributing to the world wide research in a field that is concerned with the science of the very small. In particular, it is concerned with the development of microscopic features that could be used in computers that run on light and electronic displays. The unit of measure implied by the Greek word 'nano' is a 'billionth' and it is used in this context to mean a range of technological methods, sensors and devices that operate on the scale of a few billionths of a metre.

Silicon 'trees', each only a tenth of a millionth of a metre high, have been grown by the scientists who aim to use them to build smaller, faster computers and electronic devices. These 'trees' are regarded as the first major success of the new venture. The 'forest of trees' was planted by evaporating hot metal into a stream of cold gas resulting in clusters of some two

to 1,000 atoms condensing out. The clusters, the researchers say, were charged so that they could be sorted out by weight using electric and magnetic fields. Then a silicon surface was prepared and covered with clusters of a given size, chosen by the scientists, and with assistance from their Japanese colleagues, exposed to a chemical process that uses charged atoms to etch away the exposed silicon.

The silicon trees are only 10 nanometres across and 100 nanometres high. The researchers say that:

“The forest is not interesting merely because of its super-miniaturisation but because these structures behave in quite different way, as the quantum theory predicts bizarre behaviour at atomic dimensions. In particular, their ability to emit light changes as a result of quantum mechanics, so that they can produce visible light and be used in visual displays. Use could be found as switching elements for computers that run on light.”

It has been predicted that nanotechnology will be the world's second largest manufacturing sector at the turn of the century, with, perhaps, the computer chip industry remaining ahead.

There would be no shortage of application for computerised devices that could be developed by moving the atoms to refine or build minute structures. Nanotechnologists have already, by moving the atoms about, made the smallest switches that herald the time when microscopic computers or minuscule robots will be produced. Such devices we are told would be small enough to travel around the human body seeking out tasks such as rebuilding organs, cleaning arteries or indeed fighting and destroying alien cells. What is so fascinating about this technology is that it could be capable of producing such minute devices that they too could be capable of handling and rearranging atoms into appropriate patterns.

It may be noted that a special issue of *Robotica* (vol. 14, part 5, September 1996) was devoted to micro-robots and distributed micro-actuators developed in Japan.

## NEUROSCIENCE AND ROBOTICS

### 1. Interdisciplinary Research

Research reports from Sussex University (UK) describe the work of the university's interdisciplinary centre for neuroscience and the support received to set up a centre for computational neuroscience and robotics.

Dr Michael O'Shea and his colleagues believe that by understanding, for example, the behaviour and neurology of simple animals such as houseflies, snails and locusts, it may be possible to make great strides in the design of novel computer systems and in autonomous robots. They, like other scientists, have seen the behaviour of such simple animals as a source of great interest, if not amazement, noting how complex and ingenious the brains of even the most simple of living systems can be. Already, their work has attracted a £300,000 grant from the university for the centre to widen its interdisciplinary activities to include neuroscience and robotics. This initiative will link biologists at the centre, which is already allied to the Biological Sciences Research Council, with computing experts at the University of Sussex's School of Cognitive and Computing Sciences. Dr O'Shea the Centre's Director is quoted as saying:

“We want to derive inspiration from biological principles to help us design software and hardware solutions that so far have proved difficult to come by using conventional computational methods.”

Many institutions worldwide, have married biological concepts to computer science methodology, and are pursuing research projects aimed at producing better information systems. There is a ready market for the products of such projects. For example, in the United Kingdom British Telecom (BT) wants to use biological principles in the design of its information systems.

It is not only computer scientists who will benefit from this

interdisciplinary approach. Biologists are hoping to learn more about the nervous system and the way in which it functions by using computer modelling techniques. These will allow them to carry out virtual experiments on computers and use well defined neural networks for experiments that cannot easily be performed on animals. Projects at the Centre include:

- Researching the brain cells responsible for the rhythmic feeding behaviour of snails. A biological understanding of the neural networks involved when a snail eats is helping to create computer models that mimic the networks.
- Applying solutions developed by simple animals to machine intelligence and autonomous robots. They believe that such robots may approach, perhaps match, the ability of animals to memorise, learn, navigate, move and respond to the aural and visual world.
- Developing genetic algorithms\* to generate computer programmes for robots. The technique borrows from the theory of evolution by natural selection which argues that populations contain natural variations due to the occurrence of mutations. An iterative selection process operating on the variation of results in new generations possessing new, and it is claimed, improved characteristics.
- Detailed analysis of a simple animal like the housefly. By considering its behaviour a description was proposed of the neural architecture needed by a fly in order for it to produce its responses.
- Analysis of the human eye movements during driving, playing the piano and playing table tennis, special camera headset that monitors a person's eye movements while simultaneously recording their view and direction of gaze have been developed.

Each of the above activities have gone beyond the initial stages. Research into the brain cells of snails, it is hoped, will provide powerful insights into how a snail brain generates simple patterns of behaviour and how information is stored in their neural networks. The team of researchers, that consists of computer experts and biologists, believe that their collaboration will help them understand how evolution has solved most of the hardware and software problems that perplex them. The techniques that allow the application of the process of Darwinian natural selection to the design of computer programmes offers, the researchers believe, the possibility of creating artificial robot systems that ‘breed’ over thousands of generations to perform certain specific operations and tasks. It has been seen that simple animals manage to perform some amazing feats, such as seeing and navigating, using very few neurons. For example, houseflies have brains that are no bigger than a pinhead and yet they are able to produce rapid responses. An expert, Michael Land, who specialises in animal and human vision at the Centre is quoted as saying:

“Two flies chasing each other typically travel at two to three metres per second. Their reaction time, for example, the time taken by a fly to change direction in response to another fly's move, is about 15 milliseconds.”

Professor Land's detailed analysis of this behaviour has led him to propose the description already mentioned of the neural architecture needed by a fly in order to respond in this manner. The prediction, it is claimed, was subsequently confirmed as being neurologically correct. He has recently been awarded a £75,000 prize from Alcon Laboratories, US, the giant pharmaceutical company, for his outstanding work in ophthalmology.

The work discussed here, and in report ‘No Flies on Sussex robotic scientists’, *UK Times Higher* (1996) shows that the research is contributing to the development of ideas about the sort of neural architecture and information strategies the human brain might be using all of which can be fed into the interdisciplinary researches of this new centre. One of the most

\* Vide *Robotica's* special issue on languages and software in robotics (vol. 15, parts 1 and 2, 1997).

important tasks is to attempt to identify the processes that have been involved in acquiring these skills.

These processes when applied by simple animals have provided them with solutions which can apply in our studies of machine intelligence. Their application to studies involving autonomous robots in an obvious one, and there are reasonable hopes that this interdisciplinary approach will allow, at least, the design and production of robots with some of the abilities of the simple animal. There are, of course, many more 'spin-off' applications and the effect of this research programme on future developments will undoubtedly be revolutionary.

## 2. New Breed of Robots based on principles of nature

Whilst researchers attempt to understand and apply some of the principles of nature to automation systems the University of Salford (UK) has actually produced 'biologically-inspired' robots. The new breed of robots pioneered at the university is called *Biros*, which stands for *Biologically Inspired Robots*. The designers claim that the robots are "based partly on the rules of the animal kingdom". They see a future where "whole armies of the little machines could be used for everything from window cleaning to the decommissioning of obsolete nuclear reactors".

The *Biros* robots include the robot *Max*, who has six legs and incorporates a 'Neural network designed to learn like the human brain' admittedly, the developers say, 'to a very limited extent'. The range of robots also includes *Hector* who the researchers say 'can adjust the way he stands and walks'.

The research initiative has been inspired by the three aspects of biology:

- The survival of the fittest
- The ability to learn
- Performance of simple functions such as foraging.

The *Biros* robots are being developed by the university's Department of Electronic and Electrical Engineering who have summed up their present state of development:

.. their application as domestic robots is seen as a long way off. They could, however, work together to clean a floor or climb skyscrapers to wash windows. The ideal environment is anywhere humans cannot go, such as nuclear reactors.

Details of the project: Dr. Clive Downes, Dept. of Electronic and Electrical Engineering, Salford University, Salford, (U.K.)

## PROGRAMMING IN JAVA

At the University of Glasgow, Scotland (UK), an approach designed to assist the smooth evolution of major software systems and to facilitate program development for the Internet is under way. The university's project is called *Persistent Java* (*Pjava*) and is studying how Sun Microsystems *Java* programming language can exploit work at the Glasgow and St Andrews Universities on long-term software development.\* *Persistence* enables data values to be preserved for as long as required by a software application. The project is funded by the UK's Engineering and Physical Sciences Research Council and the funding since 1979 has enabled the teams led by Professor Atkinson and Professor Ronald Morrison of Glasgow and St Andrews Universities, respectively, to establish a well-founded approach to developing persistent application systems which can evolve flexibly over long periods.

This employs a streamlined software development environment that overcomes fundamental inconsistencies in existing programming, data management and operating systems

\* *Pjava* is also being supported by *Sun Microsystems Laboratories* (SunLabs) in Palo Alto, California USA and the Cambridge-based Laser Scan specialists in object-oriented geographical information systems. The work on *Pjava* will take place in Glasgow and Palo Alto within SunLab's collaborative research programme. This, the company say, is not linked to specific product plans.

traditions. It is based on a set of 'orthogonality' principles which allow programs to handle any type of data, irrespective of how long it needs to persist. The researchers say that:

"Orthogonal persistence should improve efficiency and quality in the software industry as a whole. For instance, it can greatly ease many complex problems faced by programmers such as difficult coding needed to specify data-handling operations for different kinds of long-term storage techniques."

*Robotica* readers may recall that research council and trade department funding in the 1980s for Professor Morrison and Atkinson led to the creation of *PS-algol*, the first language with orthogonal persistence capabilities. ICL has now re-engineered *PS-algol* as the platform for its Process-Wise Integrator. It has to be realised that in addition to supporting the construction of traditional software systems, *Java* also enables mobile program components called applets, to be exchanged across networks like the World Wide Web. Professor Atkinson says that:

"*Java* will enable programmers to use existing *Java* code very simply and reliably and it should greatly ease the maintenance for *Java* programs, while efficiently implementing all *Java*'s powerful but secure capabilities."

What the *Pjava* project offers is an opportunity to apply orthogonal persistence in an environment of critical importance on a global scale. By mid-1997 it is expected, the researchers say, that the first full *Pjava* development environment will be operational. Details of the *Pjava* project and communication to, it from: University of Glasgow Web Site:

<http://www.dcs.gla.ac.uk/pjava/>; or St Andrews University Web Site: [Http://www-fide.dcs.st-and.ac.uk/](http://www-fide.dcs.st-and.ac.uk/)

## ROBOTS IN SPACE

### 1. Robotic exploration in space

In October 1996 the US Space Agency, NASA announced plans for a robotic exploration of planets in space, working in conjunction with Russia. The joint venture is aimed at a search for evidence of organisms that may have been there some three billion years ago. Such explorations on the planets will rely very heavily on the development of robots that will be capable of collecting the vital data needed to conduct what is said to be the greatest-ever exploration of Mars. The hope, of course, is that new evidence will be provided that life once existed there.

Three separate launches have been planned to begin this new era of Mars explorations. The key task, says NASA official Daniel Goldin, when the details were announced in Washington DC, in October 1996, was the search for water which is regarded as the unifying theme of the explorations and a major requirement for life and a driver of climate. Announcements earlier in 1996 that there was evidence of the existence of microscopic life on the planet more than three billion years ago when it was deduced that rivers had cut out canyons across the Martian surface, were not the reason for the NASA programme. Martian probes, the agency say, were being planned long before this sensational announcement was made.

The *NASA Mars Pathfinder* probe was scheduled for arrival in Mars in July next. It will enter the atmosphere of Mars on a parachute, then inflate a cocoon of air bags to cushion its impact on landing. On the planet's surface it will immediately start transmitting data collected during its descent through the atmosphere of Mars. *Pathfinder* consists of a 'lander' and a 'rover robot'. It is the robot that will be sent to scrutinise the rocks and the soil of the Ares Vallis region. The normal mission life is said to be about 30 Martian days and in that time *Pathfinder* will be gathering data on the atmosphere and the surface. It will do this by storing the images taken by the rover robot's cameras and then transmitting them.

NASA has described the rover robot, which has been called. *Sojourner*, as being powered by solar cells and being not much taller than a dog. Once powered-up it stands erect and its wheeled chassis will be guided remotely by operators on earth. The robot is equipped with an 'electronic tongue' which is

capable of 'tasting' the composition of the rocks found on the surface.

In a remarkable new departure for NASA the images seen by the rover will be displayed to Internet users. They say that there will be a 20–40 minute delay for the robot's signals to be transmitted to earth.

Further Mars probes are to be launched by the US and Russia and are scheduled to arrive in September 1997. The NASA probe called the *Mars Global Surveyor* is designed to enter the planet's atmosphere using a technique called 'aerobraking' to deliver it into a low altitude, near-circular orbit over the North and South Poles. Surveyor's electronic camera will, it is claimed, be able to resolve objects as small as a car during its orbit. It will map the planet in three dimensions for a Martian year (about two Earth years), revealing the polar caps and the networks of sinuous, intertwining channels.

The Russian probe of Mars was designed to consist of an orbiter, two landers and two penetrators which were full of instruments to study the evolution of the Martian atmosphere, surface and interior. The two penetrators that were designed were shaped like darts to be spun then released to land in the Amazonis Planitia, Northern Hemisphere burying themselves some 20 feet below the surface. They were planned to remain for about 700 days to study volcanic and other aspects of the planet's geology. Russia has plans to launch a probe with a 6-wheeled robot buggy that weighs some 200 lb called Marsokhod in some five years time. All the Russian projects are now subject to review.

Robots remain our only hope of gaining valuable information about the planet. Although a NASA spokesperson Daniel Goldin, believes that one day humans may walk on Mars, there are no hopes at present of sending a manned flight to the planet. He said:

"We shouldn't be sending people until we do some reconnaissance with robots. If a clutch of technical and fiscal questions could be answered within the next decade I think we could be on Mars in the second decade of the next century".

## 2. Prototype Robot Aircraft

Last year it was reported that a solar-powered robot aircraft had reached the stratosphere in a record flight initiated by the US space agency NASA. These developments were so encouraging that NASA programmes have continued. With the aim of facilitating low-cost mission to explore the Earth's upper atmosphere it has concentrated on the study of the effects of pollutants. The solar-powered robot aircraft is a most unusual design being 'all-wing' and developed so that it can be controlled from a ground station. The aircraft is called *Pathfinder* and is but one of the several robot prototype drones that are being developed and studied by the space agency.

The first flight in 1996 was over NASA's Dryden Flight Research Centre in California (USA) and was the forerunner of a series of high-altitude tests of the robot solar aircraft which was developed by US Aero-Vironment Inc. The first mission lasted some 12 hours and the robot reached 50,000 feet, an altitude which was then claimed to be a record for solar-powered aircraft.

The robot all-wing aircraft is 98 feet in wingspan, weighs less than 600 lb and is a sub-scale version of an aircraft which will be 200 feet in span and will be able to use its solar cells to charge up fuel cells to keep it in flight at night. It has been designed and constructed so that it can move at a leisurely pace and consequently, have the potential of being able to study the upper atmosphere without disturbing it.

The goal of this NASA-industry programme is to develop drones that can operate unpiloted and in a robotic mode at altitudes, which may be up to 100,000 feet, on low-cost environmental missions that may last over 7 days. The viability of such missions have been demonstrated, a NASA spokesperson has said, proving the reliability of solar-power technology for high-altitude robot aircraft, and clearing the way

for further developments of environmental research aircraft into the 21st century. We can then expect these robot aircraft to have the capability of carrying scientific payloads and other experiments into the stratosphere. The NASA programme provides more information on the internet: <http://www.dfrf.nasa.gov/Projects/Pathfinder>.

## ROBOTIC MULTIFINGERED HANDS

If there is life in space and creatures do exist away from the earth we all think of them as versions of our human form. In science fiction the man from outerspace inevitably has a body which in effect is some version of the human body. In building robots, particularly those that are to replace the worker at the production line, designers still think in terms of head, eyes, ears, jaws, feet, legs, fingers, arms etc. in an attempt to mimic human being. Even the robot's brain is likened to the human brain and we carefully study every aspect of human movement and behaviour in the hope that it can be replicated. There is, of course, good reason for taking this course; the human is, after all a most efficient organism in many major ways.

When in many applications robots are required to handle objects, the human hand with its fingers turns out to be a particularly useful 'tool'. Consequently, studies of the hand have been exhaustive. Similarly, the function of the fingers on the hand has received equal examination. The research, however, into the composition of the fingertips and the grasping and manipulation of objects of different materials and form presents a challenge that is still only now being tackled. Indeed, some of the problems posed have only been studied in the last few years.

### 1. Robotic Fingertips-composition

There are many applications where robots have to be designed with hands or, indeed, jaws, that are capable of grasping and manipulating objects of different composition and form. For many applications soft fingers or soft 'teeth' are required as an interface for gripping and manipulation, e.g. fragile objects, odd-shaped objects. Some of the first contributions to the literature on this subject appeared in the 1970s (See "Design of a three fingered hand", E. F. R. Crossley and F. G. Umholtz, *Journal of Mechanism Machine Theory* **Vol. 12** pp. 85–93, 1977; "Stable prehension of objects by robot hands with elastic fingers", H. Hanafusa and H. Asada *Proceedings 7th International Symposium on Industrial Robots* (1977)) pp. 361–368; "Gripping surfaces for artificial hands" *The Hand* Simpson D.C. (1971) **Vol 3** (1) pp. 12–14). Many of the papers and articles published were also of interest to surgeons and the designers of artificial limbs. A more detailed and perhaps more comprehensive study has taken place in the 80s and 90s and now there is a fund of information provided in the literature.

A useful paper was recently published in *Robotics Research* (**Vol. 15**, No. 4, 320–334, 1996), which compared the construction materials available for soft robotic fingertips. The paper by K. B. Shimoga (*Robotics Institute*, Carnegie Mellon US) and A. A. Goldenberg (*Robotics and Automation Laboratory*, University of Toronto, Canada) focussed on applications that do require soft interfaces for gripping. Their article looks at the three specific problems: Impact Force attenuation; Conformability; and Repetitive Strain Dissipation. The authors say that

"... the first, the impact forces result during each instant of grasping a rigid object can affect the functioning of the fingertip sensors. Second, a hand with hard fingers cannot securely grasp objects that have uneven surfaces due to the poor conformability of the fingers. Third, repetitive strains are induced into the fingers throughout the manipulation task. If they are not dissipated, the manipulator becomes jerky, the function of the fingertip sensor is affected, and the life of the finger's skeletal structure may become short."

These researchers proceed to examine six fingertips

constructed from plastic rubber, sponge, fine powder, paste, and gel experimentally. They are compared for their ability to overcome the problems they have discussed. In producing their results they show that the sponge fingertip is the most suitable and the plastic one the least suitable for their application. For practical reasons, they say, gel is preferred over sponge. In view of these results it is recommended that future robotic hands employ soft fingers, or at least fingers with soft tips, that have been constructed out of carefully chosen materials.

## 2. Soft Robotic Fingertips – Modelling and Impedance Regulation

Shimoga and Goldenberg also present a paper in the same publication (pp.335–350) which will be of great interest to readers who wish to examine experimental results and conclusions. They publish an experimental determination of the passive impedance parameters of a soft (gel-filled) fingertip and formulate an approach to account for the soft fingertip model when controlling the overall impedance of a finger that carries the soft tip. Four experiments demonstrate the approach, each with a unique goal. They also showed experimentally how the presence of passive damping helps reduce the peak impact forces that occur as the rigid object is gripped by the fingers of a robotic hand. They also provide an excellent set of references for those who wish to continue studies in this area. Titles include: Manipulation with soft fingers, controlling the compliance of a robotic hand; Properties of human bio-materials; Control of robot manipulators; Impact control of grasping; Impact and force control; We all know that the human hand changes its grasp according to the task requirements, and researchers are now faced with the enormous and challenging task of designing and producing robotic hands that can regulate their grasp dynamic behaviour in the same way, or, of course, as we discussed at the beginning of this report develop an entirely different concept for this task-orientated function which believe to be necessary. It would appear that at least for the time being 'aping' the human is the most likely way to achieve some of the more important goals that it is hoped will be achieved in a reasonable span of time.

## ROBOTS WORLDWIDE

### 1. JAPAN

#### a. Increased Robot orders

A marked increase in orders in the first ten months of 1995 for manipulators and industrial robots was reported by the *Japanese Robot Association (JRA)*. The orders, it says, amounted to 352,819 million yen, an increase of 24.9% and exceeding the 1994 sales. Japan saw a recovery in its domestic sales during September and October of the period. In addition, this growth was coupled with an increasing export sales. The whole year's forecast by the JRA is that overall orders will reach 500 billion yen, making a 25% rise in the year.

Production, it is reported, increased during the first 10 months by 24.7% to an increased figure of 340,093 billion yen. Shipments rose 22.4% to a value of 342,599 million yen.

These increased figures were coupled with increases in the sales of individual robots for applications throughout the industrial and commercial sectors. In particular, the JRA say that the sales of robots used in welding increased to 27.4%, and the sales of electronic component placement robots grew to 29.2%.

#### b. Yaskawa progresses through its overseas markets

Industrial robots are being produced in the United States and in Sweden by subsidiaries of the Yaskawa Electric Corporation. Local production of these products is a partial shift and has been made, it is reported, by the Corporation so that the safety standards prevailing in Europe and the U.S. can be more easily

adopted. The Japanese corporation will also benefit because the move to local company subsidiaries will help them hedge against fluctuations in the foreign exchange rate.

In the US, Yaskawa's subsidiary, Motoroman Inc., West Carrollton, Ohio, was scheduled to produce ten units of welding and handling robots in 1996 and 75 units of robot controllers per month. In Sweden the subsidiary company Motoman Robotics AB, Torsås, was scheduled to produce 60 units of robot controllers per month for use with industrial robots that were made in Japan.

In Japan itself, the corporation expects to produce in the year to March 1997 about 5,000 units worth, the company say, about 30 billion yen. Half of these units will be exported from Japan. The corporation does not expect the shift to overseas production to affect the home market.

The Japanese corporation US subsidiary Motoman is also launching a class-1 compatible clean robot for export. It is being targeted at the semiconductor and liquid crystal industries. The corporation is aiming at a first year sales of some 50 to 100 units. The clean robot imports are based on the Yaskawa's K3 type of small-sized welding robot. Since 1995 the company has supplied local hard disk manufacturers in the US with approximately 100 units.

### 2. UNITED STATES

#### a. Automatic Software Installation

A US company has produced a system called *Castanet* which allows companies to broadcast data automatically through the Net to user's personal computer (PC). This will mean that installing software in the conventional way may soon become unnecessary. *Castanet* can check a PC's hard drive to see which files need updating and automatically install them on the system without the need for user intervention. Indeed, by using the tuner program on a PC the user can sign up to receive regular updates to software, games and even other services that can be sent to the users' on a daily or other timed basis.

According to a spokesman for Forrester Research in the US, the supplying companies, such as Microsoft could use the system to deliver upgrades to its office package. It is reported that a beta version of the software is available for download on the company's Net site: <http://www.marimba.com>

#### b. Sens-o-lock-US automobile safety system

When computers and sensors are linked into a system there are innumerable applications to hand. Safety is a priority in car travel and a new sensing system which functions as an in-car breathalyser can only contribute to it. A new system called *Sens-o-lock* is a US-based system that consists of a small computer linked to sophisticated sensor devices that is capable of checking alcohol levels in a car drivers breath. Depending on the level found it is able to immobilise the vehicle.

The system is installed behind the vehicle's dashboard with its sensor positioned at the end of a protruding small coil. The system is linked to the vehicle's ignition system and it is used to trigger the device. When the driver turns the ignition key a request to take the test is heard through the vehicle's audio speakers. The test is initiated by the driver placing the sensor head in his/her mouth then taking a few deep breaths and blowing into the device. The computer almost immediately, the developers say, assesses whether there is any alcohol present and provides the driver with a number of appropriate options. If there is none or only a small amount, the driver is told he/she can continue to drive and the vehicle ignition reset.

The system is also marketed in the UK by Alcohol Sensors Europe, who claim that it is more accurate than the breathalysers used by the police forces. The product has been developed in collaboration with the federal laboratories in the United States. Another feature of this innovative system is that the vehicle computer stores all the data from the tests. Company and fleet car drivers can therefore be monitored. All

drivers will have this data stored and it could act as a sort of 'black box' so that in case of accidents or any misdemeanours or other driving situations, a record is available.

### 3. UNITED KINGDOM

#### a. Water-powered robot

Reports on the progress made and the problems experienced by the University of Hull, UK, while working in conjunction with J. H. Fenner Ltd. to develop a prototype water-powered robot are featured in *Industrial Robot* 23(4), 19–23 (1996). The report discusses the structure of the water-powered robot and gives details of its drive mechanism. Its testing and evaluation are also outlined and the aims of continuing research on the project are also given.

This novel robot was designed in the UK and built to act as a test bed for water hydraulic technology. The designers believe it has potential for applications outside those targeted for water power, particularly where its large working envelope and unlimited rotations can be employed.

The robot's configuration is given in diagrammatic form in the report from the University of Hull. It shows two axes to be powered by hydraulic motors through a drive mechanism. Further axes can be added as required by particular applications. A patent has been applied for the robot (UK Patent Application No. 9124330.3). The three-dimensional structure allows the end effector of the robot to be moved to any position within its circular working area. The structure is mechanically stiff, yet it is claimed to be light. The motors and drive mechanisms are attached to the base of the robot and so do not have to be moved in space. This, the designers say, leads to a rigid structure capable of high acceleration with minimal torque. Details of the project, which has received funding from the UK Science and Engineering Research Council, are given in P. M. Taylor *et al.*, "The design and control of a novel robot structure with differential drive units", *ROMANSY '94 Conference*, Gdansk, Poland (1994).

#### b. Super-Smart Machines

Addressing the British Association for the Advancement of Science at Birmingham University UK. (Autumn, 1996), Professor Roland Burns of Plymouth University, who is a specialist in artificial intelligence, predicted that:

"Machines, even in our homes, will become so intelligent that they may become our tyrannical masters. The day is not far off when unemotional machines may decide that humans are a nuisance, and that the world could be run more efficiently without them. We may be prevented from pulling out the plug."

He also claim that domestic machines of the future would:

- replenish our fridges by learning from experience the dietary habits of their owners.
- order food from machine-controlled department stores which, in turn, would deposit it in containers outside our front doors.

He speculated further, however, by suggesting that the machine that controlled the house might then decide that 'life would be simpler if I kept the fridge empty and the doors locked'. He believes that all the efforts of industry and science were directed to making machines more intelligent; what is needed, he maintains, was a safeguard such as the science fiction writer Isaac Asimov's first law of robotics: 'No machine shall harm a human being or, through inaction, allow a human being to come to harm'.

Professor Burns added that:

"A new generation of 'smart' washing machines, cameras, and cars was coming on to the market and the ability of the machines to diagnose faults in their systems, to repair themselves, and to learn from past mistakes would continue to improve."

The danger, he believes, is when the power of the machines

would lie in their ability to make millions of decisions a second and never to forget anything. It would seem then that no human would be able to check what they were doing or planning. He sums up his thoughts by saying:

"What is most dangerous is that we have had no experience in dealing with such a technology and we will not know what to do when it goes wrong."

#### c. British consumers ignore internet hype

The Futuracom survey, which is the result of a three-year study by the University of Leeds (UK) and the advertising Agency, Ogilvy & Mather, provides data which is not very encouraging for future sales of personal computers and Internet facilities. It says that British consumers are largely ignoring the hype about the Internet and e-mail, and are shunning personal computers.

The survey was published in October 1996, and it is claimed that it is the most comprehensive of its kind. It has attracted £1 million in sponsorship from its backers who included the groups TeleWest, which is a cable group, and the United Kingdom's Royal Mail.

These first results show that just 18% of the 5,000 people questioned in the UK regularly used a computer at home, 86% of those with no home computer have no plans to buy one.

What was very surprising was the survey's finding that many consumers are reluctant to sign up for new technology because they cannot see the need for it. They believe it is too expensive and, perhaps of most importance, they are concerned that the equipment they buy now will soon be obsolete. More than half of those who have no home-computer, but who are thinking about buying one say that it is the benefits of its educational use and Internet access that is their reason for doing so. But it would appear that just 35% of the personal computers at present in UK homes are used for educating children, compared with 61% which are used for games.

Thus the image formed in Britain of an 'information society' in the making has been somewhat dented by these first survey findings. British readers will know that the UK market for the new technologies particularly in automation products and in the communications area, does not always make a rapid response to innovative systems.

## SYSTEMS & SOFTWARE FOR AUTOMATION

### 1. UK Premier for Software Products

At the UK premier showing of software products at the British Computer Society's CMSG Tools for Configuration Management Fair held in London at the end of 1996 many interesting and diverse products were on display. Included among these was the first time exhibition by the Fullduplex IT Group of *ADC/Pro (Aide-de-Camp/Pro)* which is a software configuration management (SCM) tool, and *Under Control* which is the software change and workflow management Tool. The Group say that:

"To get on top of the challenges of producing quality code in a shorter release cycle, a software development team needs a tool that makes it easy to control and manage change. *Aide-de-Camp/Pro (ADC/Pro)* is the new wave in Software Configuration Management (SCM) technology as it is the *only* SCM tool that enables a team to work with software change as a *reusable* object called a Change-Set™.

When a change is made to a project version, *ADC/Pro* captures the edits to files, their attributes, and all impact analysis and audit trail information in a Change-Set. This change object, which might be a bug fix or new feature, can be *selectively* removed, reapplied or migrated between project versions. This simplifies the complete configuration process as a release is a collection of changes made to a baseline. The tedious and lengthy process of identifying which individual file versions should be used is done away with forever."

A wide range of platforms are supported by *ADC/Pro* for

inter-operability across Windows, Windows NT, UNIX and VMS. Seamless integration to third party products such as *Visual Basic* and *Visual C++* are also available in addition to code scanners for *C*, *C++*, *FORTRAN*, *COBOL* and *Ada*. There are also links to third party problem tracking tools such as *Under Control*, *Sablime*, *Scopus* and shortly to *Remedy*.”

Further information on these software products can be obtained from: Fullduplex, Information Technology Group, Berkeley House, 49–53 High Street, Redhill, Surrey RH1 1RZ (Tel: +44(0)1737 769898 Fax: +44(0)1737 769995).

## 2. Palm-top computer becomes powerful mobile communicator

Dynamical systems Research Limited announces the launch of *SMSmail*, a Psion 3a/3c compatible software package that enables Psion users to send and receive Internet e-mail, messages and files to and from their palm-top computer using SMS.

- Send or receive SMS (short message service) and files from Psion to Psion or Psion to compatible mobile phone.
- Together with an Airmail™ subscription, *SMSmail* allows e-mail, text and Word files to be sent or received directly from the Internet.
- Allows messages of over 160 characters to be sent or received, overcoming limitations of standard SMS technology.
- Software includes Address Book and In/Out-boxes in an easy to use format for complete management of e-mails, messages, phone numbers and Internet addresses.
- Allows for ‘Smart’ messages to easily query SMS value-added information services to be launched soon such as Lottery result notification, financial information Contact: Mungo Amyatt-Leir, e-mail: [mungo@dsres.com](mailto:mungo@dsres.com); Or look at

Web sites: <http://www.dsres.com/smsmail/http://www.airmail.co.uk/>

## UK TECHNOLOGY AWARDS

The Annual Information Technology Awards of the British Computer Society for 1996 are always an important guide to ‘the state of art’ in the United Kingdom. The eleven finalists were:

- Clicker Plus – a communication aid for the disabled
- INDEX+ – an infrastructure for text and multimedia information systems
- Intelligent Prosthesis Plus – a device to help amputees
- Inter-Network Call Accounting – a tracking system for British Telecom telephone users
- MAVIS – an instrument to measure wounds
- Microcosm Plus – an IT solution aimed at archives and education uses
- Peritas Online – an online interactive Internet service with end-user training courses
- Pindar Catalogue Management Systems – a database incorporating text and graphics
- QUESTAR – a neural network analysis of sleep disorders.
- Sibelius 7 – a musical notation and engraving system
- SoftWeave – a woven fabric design system.

Details of the projects and the winners can be obtained from the British Computer Society, 1 Stanford Street, Swindon SN1 1 HJ (UK). The awards are being sponsored by: BT, Bull, Interskill, DTI, Energis, Fraser Williams, IBM, ICL, Logica, Oracle, UK Post Office and Tandem.

Professor B. H. Rudall  
Norbert Wiener Institute  
and University of Wales (U.K.)