

Innovation & Technology Transfer

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ISSN 1013-6452

Nanotechnology Small Science, Big Future

Plus:

- Women in science
- Venture capital for biotechnology
- Scheduling software for water distributors
- IRCs promote integrated waste management

and more

EUR: 85

PUBLISHED BY THE EUROPEAN COMMISSION



INNOVATION PROGRAMME • JULY 1998

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Delivering on Research's Promise

We must do more to improve Europe's utilisation of research. To this end, the 'key actions' of the new Fifth Framework Programme (5FP) have been created. Their objectives are:

- greater transparency, and more consultation with researchers, users and industry;
- better integrated, and more multi-disciplinary, research;
- real co-ordination with national programmes.

Already, early stage investment in technologically innovative SMEs is being encouraged through support to venture capital funds, in the framework of the I-TEC initiative. Furthermore, CORDIS, available free over the Internet, is now an essential tool for researchers and businesses. It offers easy access to information about research funding and results, and a means of identifying research and technology transfer partners.

In December, the Commission launched a technology transfer initiative based around its Joint Research Centre, to promote collaborative research through telematics.

During the coming months, the Commission will present a proposal for a Community Patent Regulation, to create a less expensive patenting process.

Finally, I will soon announce two initiatives designed to make it easier for women scientists to participate fully in research:

- a 'genderwatch' system within 5FP, to encourage research by women, for women and on subjects related to women;
- a network for women in science throughout Europe.

Édith Cresson

INNOVATION & TECHNOLOGY TRANSFER



The European Commission's Innovation Programme is under the responsibility of Edith Cresson, Member of the Commission responsible for Research, Innovation, Education, Training and Youth.

Innovation & Technology Transfer is published six times a year in English, French and German by the Innovation Programme. The Programme aims to strengthen Europe's innovation infrastructure and foster the application of research results to industry.

PUBLISHED BY:

European Commission, Directorate-General XIII

Telecommunications, Information Market and Exploitation of Research

Directorate XIII-D

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Printed in Belgium

WWW ADDRESS:

[Http://www.cordis.lu/itt/itt-en/home.html](http://www.cordis.lu/itt/itt-en/home.html)

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► WOMEN IN SCIENCE

The Other Half of Science

Can European science and technology really afford to do without the talents of women?

Keen not to miss "the Fifth Framework Programme's rendezvous with equal opportunities", Edith Cresson, Member of the European Commission responsible for research, education and innovation, invited scientists to debate the issue at the Women and Science Conference in Brussels on 28-29 April.

Lack of reliable data was the first deficiency, said Mary Osborn, lecturer at the Max Planck Institute in Göttingen. "In order to learn the exact position of women scientists, to compare progress on equal opportunities in different countries, and to assess the impact of European programmes, there is an urgent need to compile statistics on a pan-European basis."

It Pays to be a Man

Figures may be in short supply, but the story they tell is clear — too few women enter careers in science and technology, and of those too few reach high positions.

"In the United Kingdom, the number of women S&T graduates increased from 6% to 14% between 1980 and 1993," says sociologist Judith Glover of the Roehampton Institute in London. "But we have seen scarcely any increase in the proportion of women who find employment in their specialist field — just 13% in 1979, and

still only 17% in 1996. While most men secure management posts, most women join the teaching profession."

Those who do go on to undertake R&D projects are severely tested. As Christine Wenneras and Agnes Wold, researchers at Gothenburg University, have shown in a celebrated study in *Nature* magazine, members of the Swedish Medical Research Council displayed a clear preference for men when assessing post-doctorate projects. Among 114 cases examined in the study, the best marks awarded to women rarely exceeded the poorest marks awarded to men. Women also had to publish 2.6 times as much work as their male colleagues in order to be credited with an equivalent 'scientific ability'.

Diversity = Innovation

Could new criteria for assessing ability be found? As Edith Cresson stressed in her closing speech, "Women are more sensitive to certain things and adopt a slightly different approach to problems. This could be of benefit to science companies and a powerful factor for innovation".

This view was supported by Rosanna D'Amorio, Liaison Officer with the Italian Institut Mario Negri. "Our organisation has consciously chosen a balanced mix of the sexes," she explained. "We are convinced that women researchers have a specific contribution to make." The Institute employs 117 men and 123 women, two women and one man fill man-

"We will soon find it hard to accept that there was once a time when to be a researcher and a woman was considered an exceptional performance." - Edith Cresson at the Women and Science Conference.

agement posts, and 48% of funded research projects are led by women. □

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Equal Opportunities in 5FP

The European Commission proposes a range of measures to promote equal opportunities in the forthcoming Fifth Research Framework Programme (5FP):

■ **Implementation of 5FP will include measures to encourage women to participate in research projects, will gather figures on their participation and will give them a voice on advisory bodies and evaluation groups.**

■ **Attention will be given to research subjects of special interest to women — such as innovation, employment and relation-**

ships between technologies and society.

■ **The Commission will be setting up a European Observatory on Women and Science to monitor the implementation of measures to promote equal opportunities.**

■ **A Women and Science Network of active individuals and organisations should make it possible to co-ordinate national efforts, define joint approaches and compile Europe-wide databases.**

Investors and Biotechnologists Do Business

Venture capital is not in short supply in Europe, and nor are biotechnology innovators. But investors and researchers have difficulties getting together to do deals. The two sides met in May to tackle the problem.

Venture capitalists mingled with biotechnology entrepreneurs at the Kredietbank headquarters in Brussels on 12-14 May. The 300 delegates met to get to know each other, and if possible to do business. This was the first conference of the Biotechnology and Finance Forum (1), a joint creation of the European Commission's Directorate-General for research (DG XII) and EASD, the European Association of Securities Dealers. Its aim was to stimulate understanding, dialogue and networking between two very different worlds.

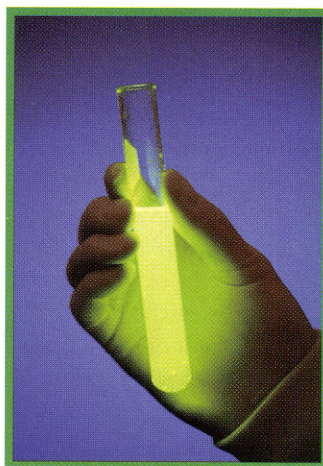
To the public, biotechnology is a mixed blessing. It leads to improvements in areas such as health and food, but raises fears of genetic manipulation. The confused legal situation over the patenting of genes (2) has reflected this ambivalence.

Yet the sector is the darling of the stock markets. Already, one third of the value of the French *Nouveau Marché* is in biotech stocks. "Biotechnology will definitely be *the* sector of the next century," says Didier Duhem, EASD's Chairman. Why is it, then, that so many ambitious researchers say 'there's no money', while so many investment banks say 'there are no projects to invest in'?

Stopping the Brain Drain

Part of the problem is the concentration of risk. Biotech start-ups are product- or technology-based companies — their success or failure usually depends entirely on one research project, whose costs are huge. The risk is highest if the product is a therapeutic drug, where success or failure may depend on a single regulatory decision. Financial markets do not respond well to such unpredictable risks. It is far from rare for a biotech company's share price to fall 90% overnight.

United States investors are much more willing to back a high-risk idea, and in the past too many European innovators have had to go to NASDAQ to raise capital. Worse still, to gain the confidence of US investors, they have often been obliged to transfer their operations, and the associated high-tech jobs, to the other side of the Atlantic



She drew attention to I-TEC, the Innovation programme's Innovation and Technology Equity Capital pilot project (3), which is actively supporting early-stage investment in technologically innovative SMEs. "Most of the scheme's 13 member funds are interested in the biotech sector, and two — totalling ECU 29 million — are exclusively dedicated to it," she said.

Europe's research networks are the envy of the world. What it has lacked — to date — is enough venture capitalists to sustain them. That situation is now improving rapidly. □

as well. If Europe is to benefit from innovation-based growth, it needs a thriving venture capital market of its own.

Europe's Investors Catch Up

Since the Investment Services Directive came into force in 1996, enabling pan-European share trading, Europe has been making up lost ground. EASDAQ is bringing much-needed liquidity to Europe, but it remains small in comparison with its US equivalent, NASDAQ.

Success is possible, and the public sector can help by making the initial show of confidence which levers in larger amounts of private risk investment. "Europe's Achilles' heel is not research, but turning it into products and services," said Edith Cresson, European Commissioner for research and innovation.

(1) See edition 1/98.

(2) A Directive on the legal protection of intellectual property rights in biotechnological inventions, approved by the European Parliament on 11 May and now awaiting final adoption by the Council, will greatly clarify the situation. See also 'Biotechnology' Dossier, edition 3/98.

(3) See 'Financing Innovation in Europe' Dossier, edition 6/97.

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■ Conference report:

[http://europa.eu.int/comm/
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► THE EURO

Are You R€ady?

It is now less than 6 months till transactions start to be conducted in euros. European companies should begin to prepare for the introduction of the new currency immediately, regardless of their size and location.

For the 11 countries which will join the European Economic and Monetary Union (EMU) in the first wave, the changeover period begins on 1 January 1999. Euro coins and notes will be introduced on 1 January 2002, with national ones remaining in circulation until 1 July at the latest. But many companies' invoices will be denominated in euros much sooner than that.

By the beginning of 1998, however, it was estimated that fewer than one SME in four had started to consider how they would be affected by the introduction of the euro (1).

The European Commission's Expert Group on Small Businesses and the Euro emphasises that it will not be in every company's best interests to make an early transition to the euro. Optimum timing will depend in particular on the attitudes of customers and suppliers. But the longer preparation is delayed, the greater the transitional costs are likely to be. This applies to all European enterprises — including those not based in one of the participating countries, but likely to trade with those which are.

Strategy

Under EMU, companies will benefit from exchange rate stability and the removal of foreign exchange transaction costs, which will stimulate cross-border trade and investment, making it easier to exploit the opportunities offered by the single market. Legal and policy obstacles to the introduction of the euro have now been overcome — the remaining chal-

lenges must be faced at enterprise level.

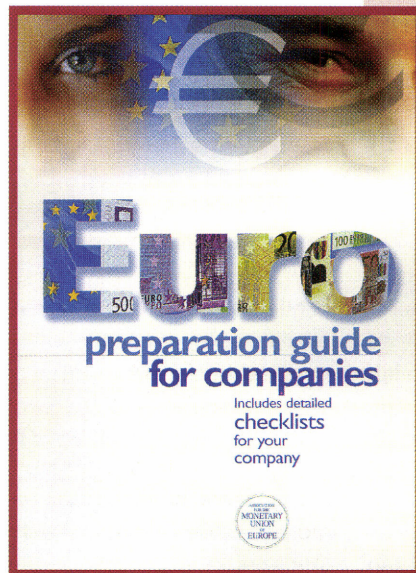
First, companies must address a number of strategic issues:

- When should they switch to the euro, and for which business functions?
- What impact will the euro have on their competitive position, and how will they respond?
- How will sale prices be converted, and how will they introduce the new prices to customers?
- How will staff training needs be met?

Second, companies must deal with the technical challenges of modifying computer hardware and software, and of redenominating their accounts.

Robert Verrue, Director-General responsible for the Innovation programme, recently co-chaired a special IT Forum, designed to assess progress in the area of company information systems, and believes that larger companies may be at greatest risk. "Companies of up to 500 employees will usually be able to buy cost-effective off-the-shelf products," he says. "The main problem is with those of between 500 and 5,000 employees, many of which have tailor-made systems which will require adaptation. These companies seem to have been especially slow to recognise the need to prepare."⁽²⁾

Finally, essential organisational tasks include comprehensive impact assessment, developing a budgeted plan for the changeover, and appointing a team to manage it.



In addition to the Commission's own materials, AMUE, the Association for the Monetary Union of Europe, has published several preparation guides for businesses, which include easy-to-follow checklists.

H€lp!

The Commission is doing a great deal to provide companies with the information they need, in accessible forms.

A dedicated web site has been established (<http://www.europa.eu.int/euro/>), and provides links to many resources. The magazine Inf€uro, produced in all 11 official languages, has a circulation of 300,000. An information programme aimed at the business community has been launched, and includes practical tools for managers. Additional planning tools specifically for SMEs will be available from DG XXIII (on paper or CD-ROM) at the end of the year. □

(1) Euro Paper: Report by the Expert Working Group "Small Businesses and the Euro".

(2) Quoted in Inf€uro magazine Number 6, December 1997

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► INDUSTRY-ACADEMIC LINKS

Business Brains

Links between academic institutions and businesses can benefit both sides, but only if each understands the other's priorities. A recent conference highlighted some notable successes.

The innovation climate in Europe is changing fast, though we still have a long way to go. We have the brains, the people and even the money," says Member of the European Commission Edith Cresson. Under the EU's Fifth Research Framework Programme, currently in preparation, an important component of this change will be to stimulate job creation and growth by capitalising on Europe's academic research.

Mme Cresson was addressing a conference in Coventry, United Kingdom, on improving links between industrialists and academics. Organised on behalf of the UK Presidency of the European Union by Coventry University Enterprises, the event took place on 14-15 May and attracted more than 100 delegates from 27 countries.

Ivory Tower? Not Here!

One way to get the most out of university research is to turn academics into entrepreneurs. Since setting up its Innovation Centre in 1986, Trinity College Dublin has produced 35 new 'campus companies'. The biggest so far is Iona Technologies, a software business begun in 1991 by three computer science lecturers and now employing 450 people. "The success of Iona alone has validated the whole spin-off process," says John Hegarty, Dean of Research and professor of laser physics.

Trinity's innovation drive began at a bleak time for the Irish economy, when academics needed to find new ways to survive. Now the economy is

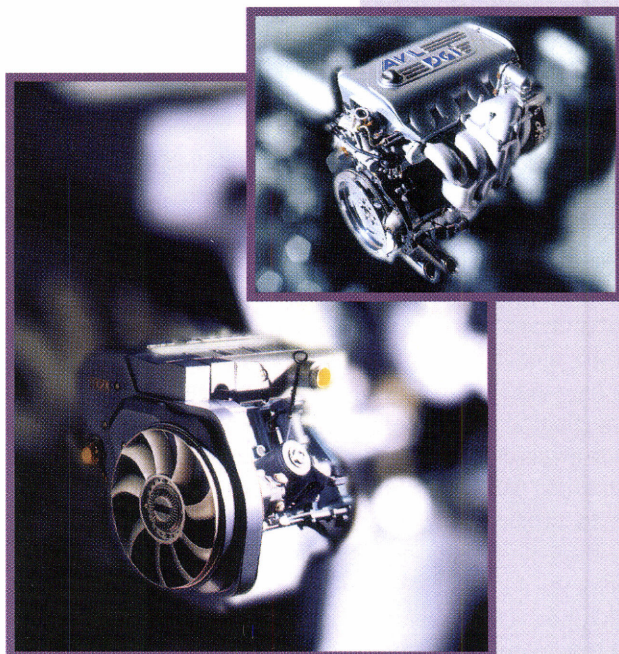
booming, and everyone wants more research space. Industrial research labs are already an important part of the Trinity formula, but the Innovation Centre wants to grow ten-fold, while preserving the qualities which have made it successful. "Informal contacts are essential, so it is important that everyone remains within walking distance of each other," says Hegarty.

When it comes to publication, academics and industrialists can have different priorities, he admits — but insists that the issue of publications has not been a problem. "Intellectual property rights are certainly a big issue, which it is important to get sorted out on day one," he says.

A World Wide Web of Research

AVL List of Graz, Austria, designs engines and power trains for the world's vehicle manufacturers. AVL has 2,200 people world-wide, spends 10% of its turnover on R&D, and is growing at 20% a year. Helmut List, the company's chairman and CEO, is also the chairman of IRDAC, the European Commission's advisory committee on industrial R&D.

One of AVL's big successes, the direct gasoline injection (DGI) engine, has involved the company in collaboration with 35 research institutions all over the world, says List. DGI engines, which offer fuel savings of up to 20%, were first tried over a century ago, but the development of a practical engine has had to wait for computer



programs powerful enough to model accurately what goes on inside the engine's cylinders. Academic support has been essential.

As well as being a good source of science, universities can offer a wider range of disciplines than might otherwise be available within the company itself. The benefits to the universities are just as clear, List says. "Most institutes today are below critical mass, so help from industry is important to them. They gain access to market information, and to real-world testing of their scientific models — normally a very expensive process." □

The computer modelling needed to design AVL List's new direct-injection engine would not have been possible without the help of researchers at universities around the world.

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Co-ordinating EU Support for SMEs

The fourth annual report on EU activities to assist SMEs and the craft sector drew attention to the measures which have been introduced since 1992 to simplify legislation affecting the small business sector, and to ensure that the impacts of new legislation on the sector are adequately assessed.

In particular, it highlighted the role of the Business Environment Simplification Task Force (BEST), set up by Christos Papatosis, Member of the European Commission for enterprise policy, in September last year. BEST has recently completed its own report.

Now the Commission is launching two new pilot initiatives designed to enhance SME participation in EU research programmes, for which it will announce calls for tenders by the end of July:

- first, a scheme to establish regional, multi-sectoral **clusters** of SMEs working with universities, research centres, technology parks and business schools, as a means of stimulating small business engagement in R&D

- second, an initiative to create 15 new regional networks of research centres and SMEs which will be telematically linked as part of the **European Technology Transfer Network**, supported by DG III, DG XIII, and the JRC

Both schemes are expected to be implemented from January 1999.

DG XXIII/B-3: K. König, Fx. +32 2 296 7558

The 1997 Report is: COM(97) 610; ISBN 92-78-27705-3

Further Progress Towards 5FP

To ensure that the Fifth Research Framework Programme is implemented as soon as possible after its adoption, the European Commission has adopted formal proposals for the specific programmes which are its components. These will provide the basis for detailed planning, which should enable work programmes to be launched at the start of 1999. The Commission is making every effort to ensure that calls can be launched at an early stage.

The Commission's proposals set out detailed objectives for:

1. four **thematic** programmes:

- Quality of life and living resources
- A user-friendly Information Society
- Competitive and sustainable development
- Preserving the ecosystem

2. three **horizontal** programmes:

- Confirming the international role of Community research
- Innovation and the participation of SMEs
- Improving human research potential and the socio-economic knowledge base

To ensure transparency and wider involvement in the management of 5FP, the Commission proposes to create new advisory groups composed of representatives of the scientific community, industry and users.

<http://www.cordis.lu/fifth/src/whatsnew.htm>

Mine Clearance Technologies

Plans are well advanced for a major international exhibition and workshop series on de-mining technologies, part of the EU's efforts to develop effective systems for locating and destroying the millions of deadly landmines which infect former zones of military conflict around the world. Hosted by the Commission's Joint Research Centre (JRC), it will take place from 29 September to 1 October, in Ispra, Italy.

In May, at the international conference on land mines organised in Washington by the US government, the Commission proposed a practical scheme for the development of new techniques designed to eliminate the need for manual de-mining, which is slow, costly and hazardous. The scheme consists of three elements — the agreement of technical standards, the establish of a network of test facilities, and accelerated pilot testing — and will make use of the JRC's facilities and expertise.

The September event will give those involved in de-mining an opportunity to see and assess existing technologies, and to draw urgent requirements to the attention of equipment manufacturers and researchers. Among other subjects, workshops will address:

- the co-ordination of national R&D efforts
- the use of geographical information systems (GIS)
- survey and detection techniques

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Taking Time out to Innovate

As part of the programme for the United Kingdom Presidency, the UK's Department of Trade and Industry (DTI), with the support of the Midlands Innovation Relay Centre (MIRC), recently staged a three-day event to promote innovation in its broadest aspects — technological, operational and managerial.

Targeting the West Midlands community of 'innovation multipliers' — businesses, universities, local authorities, chambers of commerce and development agencies — Take Time out to Innovate promoted practical ways of harnessing innovation to improve business performance. Over 600 organisations attended a programme which included seminars, workshops and exhibitions, as well as a dozen keynote presentations. Participants were also able, via satellite link to London, to take part in 'An Audience with Richard Branson', the DTI's annual Innovation Lecture for 1998.

The latest regional awards under the DTI's SMART scheme, designed to help SMEs to boost competitiveness through product and process development, were presented during the event, and brought the 12 innovative winners into contact with the IRC for the first time.

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► INNOVATION PROJECT
THE INNOVATION PROGRAMME IN BRIEF

The Innovation Programme implements the Third of the four Activities of the Fourth Framework Programme (1994-1998). Run by DG XIII/D, the Innovation Programme encourages the exchange of research information and the absorption of new technologies by European companies.

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Running Water

Constraint Logic Programming (CLP) represents a new approach to problem-solving in complex systems. CLP-based decision support software, currently being pilot-tested in Bordeaux, promises to boost the efficiency of Europe's drinking-water supply networks.

Society depends on the integrity of the pipes and cables which deliver water, power and other essential services. Yet maintenance work itself can be disruptive and costly.

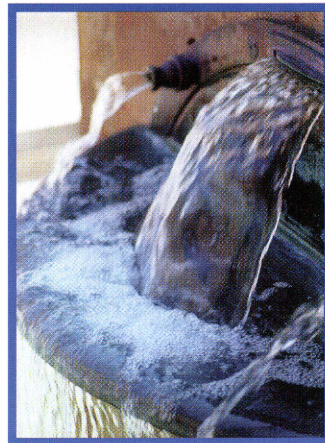
"For any water company, optimisation of its maintenance programme is extremely important," says Jordi Riera of the Institute of Robotics and Industrial Informatics at the Universitat Politècnica de Catalunya (UPC). "But this presents a hybrid problem with a combinatorial component of a very high order. The physical system is complex, with reservoirs, pumps and tanks connected to consumers by many kilometres of pipes. Supply and demand both fluctuate in ways which are often difficult to predict. And there is a limit to the resources of staff and equipment available to carry out maintenance work."

The challenge is to identify the maintenance and water pumping schedules which make best use of these resources, while preserving water quality and ensuring that as few customers as possible suffer loss of supply when work is carried out.

Potential Savings

Most water distributors face this challenge 52 times a year, programming maintenance tasks for the week ahead on the basis of current water levels and projected demand.

"Decision-making is very time-consuming," says Riera, who co-ordinates the CLOCWiSe (Constraint Logic for Operational Control of Water



© CLOCWiSe consortium

Systems) project, supported by the EU's Innovation programme. "The range of possible options is often huge. It is hard enough to find a solution which meets the minimum requirements for quality and continuity of supply. But automatic optimisation, taking into account key factors such as maintenance work, is not offered by current decision support software. Identifying the best option is almost impossible."

Optimisation is expected to improve the speed and quality of scheduling decisions. Lyonnaise des Eaux, which operates many supply networks in France and elsewhere, is the project's associate industrial partner. It is testing CLOCWiSe in its Paris laboratories and on-site in Bordeaux, and hopes the system will enable it to raise the level of service to customers, while saving energy and other costs.

New Approach

Network scheduling problems vary widely from site to site, and are highly sensitive to starting

conditions. Furthermore, complete and accurate information about the state of all system variables is rarely available.

The CLOCWiSe approach is radically different from that of traditional iterative, simulation-based packages. Written entirely in CHIP, a specialised CLP programming language, it makes active use of multiple constraints, employing techniques which home in efficiently on the few solutions which satisfy all of them. This enables it to produce integrated operation and maintenance schedules.

Riera emphasises that it is not designed to replace expert human operators, but to support them. "What CLOCWiSe does," he says, "is to identify promising strategies really fast, even under abnormal conditions."

It is based on the experience gained from an earlier system, which was developed by UPC for Spanish electricity supplier ENHER. That project, which applied CLP technology in the power industry for the first time, was successfully completed in 1996. Targeting water distribution as the next field in which to apply its techniques, Mr Riera's team was soon joined by water specialists Dr Hans Goossens of Dutch SME Delft Hydraulics and Professor Mietek Brdys of the School of Electronic and Electrical Engineering at the University of Birmingham.

"Water distribution presented an even more complex network modelling challenge," Riera recalls. "Storage plays no

part in an electricity network, and quality is not an issue. When you are dealing with drinking water, both are critical.”

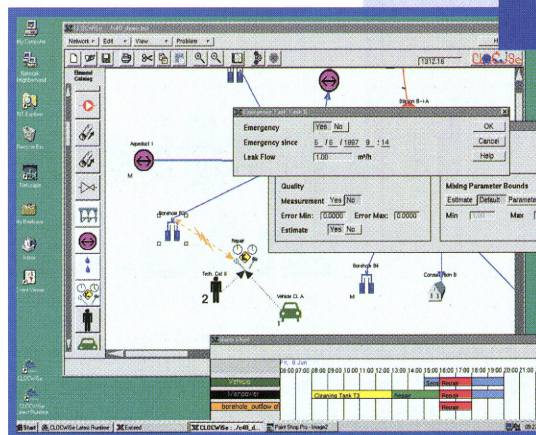
Site Licences

Following a short definition phase, the partners embarked on the design and implementation of a prototype system for Lyonnaise des Eaux. Overall software adaptation was led by Tom Creemers, UPC's own CLP expert, while the module which deals with water quality

was developed in Birmingham, and the emergency handling functions by Delft Hydraulics.

Final testing of the system will take place during the final months of the project, which ends in July. Bordeaux was chosen as the pilot site because of its particular complexity, and if CLOCWiSe succeeds there, Lyonnaise will use the software more widely. It has already taken ten additional site licences.

After the project, the partners will develop a commercial version of the software. Initially,



they will address the European market, and Delft is already in negotiation with a potential customer in the Netherlands. Ultimately, however, Mr Riera anticipates interest from water distributors world-wide. □

CLOCWiSe allows operators to specify network topology and problem elements graphically, as the basis for automated pumping and maintenance schedule optimisation.

► **CORDIS**

Uncovering Europe's R&D Riches

The ERGO pilot project aims to give Europe's R&D community easier access to research information than they have ever had before.

ERGO (1) represents a pragmatic response to a perennial problem — the near-impossibility of carrying out a comprehensive search of Europe's huge resources of research data. The web-based pilot service will soon provide a single gateway to national R&D databases via a central catalogue and an easy-to-use search form.

From July, a pre-launch version will be freely available to researchers and the general public on the CORDIS (Community R&D Information Service) server. It will initially offer access to between six and ten data collections, but the number is expected to rise to around 20 by the end of 1998. Eventually, a full ERGO service could cover more than 100.

The interface will be familiar to users of the on-line CORDIS databases, allowing searches by keyword as well as by title, and permitting the use of wild-cards and logical operators. Using a single query, it will be possible to identify relevant resources from a number of key European databases at the same time. Most of these resources are already in the public domain — although in the case of the UK, for example, ERGO will make valuable research data freely available for the first time.

The United States invests heavily in compiling and disseminating research information. The ERGO pilot will not bring Europe level with the US, but it will go some way towards closing the gap. □



The ERGO service offers powerful searching of multiple national research databases via a single straightforward interface.

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(1) European Research Gateways On-line — see edition 5/97.

Turning Mice into Gazelles

A cultural change will be needed if innovation is to become as effective a creator of jobs in Europe as it is in the United States. Three hundred representatives of the European 'innovation industry' met in Luxembourg on 18-19 May to draw up a roadmap for such change.

The conference *Innovation, creation of new businesses and jobs* tackled one of the major strands of the First Action Plan for Innovation in Europe — turning innovation into business and jobs.

Around the table were all the key players — bankers, consultants, public utility and science park managers, patent officials and innovative SMEs. On it were working papers drawn up in the wake of the initial round table held in Paris last December (1). The consultation process will be brought to a conclusion in Vienna, 12-13 November, in the presence of Dr Farnleitner, President of the Council of Ministers for Economic Affairs, and Edith Cresson, Member of the European Commission for research and innovation.

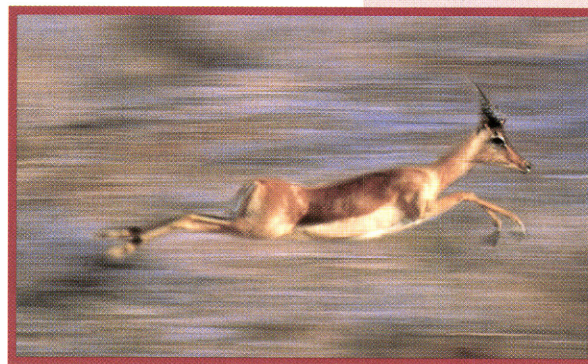
Climbing the Chimney

Why try to create jobs through innovation in the first place? The answer is that the only way to counter the labour-saving effects of technological change is to promote technology-based growth. "The demand for unskilled labour is falling," explained Luc de Soete of Maastricht-based consultants Merit. "Labour market policies that focus on training those at the bottom end of the pyramid are not going to work — the unskilled will inevitably be pushed out of jobs by better-qualified people. What we need

is 'chimney' policies which stimulate growth and suck qualified people up to jobs at higher levels."

The lesson from the statistics is that, outside the service sector, high-tech SMEs are the only firms which are creating jobs. Corporate demographer David Birch of Cognetics in Cambridge, Massachusetts entertainingly divided companies into three types — the 'elephants', which are steadily shedding jobs, the 'mice', which are quite happy to stay small, and the 4% or so of 'gazelles', which grow explosively and create four-fifths of all new jobs. Gazelles exist in all sectors of industry. The problem is, how do we persuade the 'mice' to make the leap?

The aim of 'picking winners' might seem elitist, but the positive effect will be felt by society as a whole. "Europe needs to rediscover the inventive spirit that it exported to the US in



Fleet of foot: Europe needs more gazelles.

the 19th century," said Robert Verrue, Director-General responsible for the Innovation programme, which organised the event. "That does not mean we should simply copy the American model. But one thing that we should unashamedly copy is the US venture capital system. NASDAQ raises seven times as much money as all the European venture capital markets combined."

It is clear there is still some way to go. In Britain alone venture capital firms raised 10 billion ECU in 1997 — more than

the whole of Europe in 1996. But most of it came from US sources and, disappointingly for start-ups, most was invested in management buyouts.

Innovators as Heroes

What should be done? Among the many proposals, a few priorities stand out. First, we need to make heroes of our innovators. "The stigma attached to business failure in Europe stifles risk-taking," said Birch. "You will not generate a



CORDIS

New Home Pages on CORDIS

The Innovation programme has launched two new home pages — **Financing Innovation** (<http://www.cordis.lu/finance/home.html>) and **Technology Validation and Technology Transfer projects** (<http://www.cordis.lu/tvp/home.html>) — on the CORDIS server.

As part of a progressive upgrading of the entire Innovation programme site, the

EIMS and Increasing Awareness pages have also been extensively revised, and visitors can now access information about Innovation projects directly from the Innovation programme home page (<http://www.cordis.lu/innovation/home.html>).

spirit of enterprise in Europe until you raise the social status of entrepreneurs. Kings, queens and prime ministers need to be seen spending at least 8 hours a week in the company of entrepreneurs."

Second, better links are needed between the ideas factories — universities — and business. Legislation as well as cultural prejudice currently makes it too difficult for academics to cross from ivory tower to shop floor.

Third, the balance between risk and reward must be changed. If researchers are to be coaxed into the global marketplace, they need incentives. Laws must be amended to allow them to hold stock options, a standard part of the Silicon Valley mentality.

Selling Ideas

Capital is also important, of course. The concept of the

'business angel' is still viewed with suspicion in parts of Europe, but a mentor who brings seed capital as well as business know-how is doubly valuable to a young post-doctoral student with a revolutionary idea. Till the idea catches on, public sector seed capital is often the only solution.

Later in their lives, when growing SMEs need access to venture capital, an affordable patent system is essential. Venture capitalists must be able to value businesses which have a future but no past, and intellectual property rights are usually the chief asset a high-tech start-up possesses. Yet to secure these assets, Europe's inventors have to pay much more and wait much longer than their American counterparts.

Gradually, and patchily, Europe is becoming more entrepreneurial, and there is a welcome trend towards the more

effective exploitation of intellectual property. British Technology Group exemplifies a new type of business growing up to serve innovators' needs. "BTG's business is managing patents," explains Chief Executive Ian Harvey. "Researchers, and large companies, often have no idea of the value of the intellectual property they own. Our job is to assess their patents, and find a customer for them. If we cannot sell an idea, we will create a start-up to exploit it."

BTG helps people turn ideas into profits. Europe needs more organisations which can do the same. □

(1) See edition 2/98.

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► SCIENCE FOR SOCIETY

Visions for Tomorrow

European Awareness Scenario Workshops provide a forum for people from across the community to participate in the decision making process.

Traditionally, local government decisions have relied on 'expert' opinion. Although the role of expert advisers is undoubtedly important, residents and local businesses can also provide valuable inputs. After all, they will be the ones who are affected by new policies.

The European Awareness Scenario Workshop (EASW) is a structured method that breaks the traditional mould. The workshops are run by National Monitors (NMs), who take about thirty people through the one to two day event.

Lars Karlsson, a National Monitor in Austria, explains: "The workshop process is a combination of different mod-

erated activities, brainstorming methods, construction of visions, presentations, dialogues and negotiations." The participants build a number of scenarios — or visions of the future — and evaluate them. The groups can even identify how behaviour needs to be changed, and who must take action.

Increased Demand

The workshops have come a long way since they began. Over forty European cities have used the approach and more want to get involved.

This rapidly increasing de-



EASW training in Madrid.

mand was hot on the agenda when the National Monitors met in Luxembourg this May. To release the pressure which is stretching the NM network, more people are being trained

as National Monitors, especially in countries like Austria and France, which have limited NM resources. The training allows newcomers to learn the methodology by participating. "This way, you can demonstrate how useful the system is," says Teresa Rojo who ran a training action in March.

The method is popular. "There are always more requests than places for the training actions," Mrs Rojo confirms. In the past nine months, training actions have been held in Vienna, Madrid, Kos and

Rome, and events will be run later this year in Toulouse, Brussels and Luxembourg.

Addressing the Issues

The workshop topics continually evolve as new NMs join the initiative. Early workshops focused mainly on sustainable urban living. Today, the information society, job creation, education and mobility have all found their way into the workshop forum.

Because EASW is so flexible,

it can be used to address other issues as well. Christine Ugbor of the Vienna Academy for the Future participated in the Austrian training event and is now planning two workshops. One will cover the integration of Africans into Austria and the other will look at 'Edutainment' — a mix of entertainment and education using different media.

Bernard Schneider, who took part in the same training, will use the method to explore Sustainable Village Development. "The question is to find something that lacks consensus or

where there are gaps of knowledge that are difficult to bridge," he says. "This tool offers you chances to enrich progress." □

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▶ OPET NETWORK

OPET Stretches out in the Sun

Israel, which recently joined the Innovation Relay Centre network (1), has now also become a member of the European Commission's network of OPETs (Organisations for the Promotion of Energy Technologies).

OPET Israel (OPETI) is likely to be a valuable addition to the network, extending it to a region where renewable resources, in the form of solar energy, are abundant. As well as linking energy technology suppliers and users within Israel, it will provide a channel for the transfer of advanced renewable energy and energy conservation technologies between Israel and the EU.

OPETI was established in January by a four-member consortium led by ICTAF — the Interdisciplinary Centre for Technological Analysis and Forecasting at Tel Aviv University. Its priorities span all three areas of OPET activity:

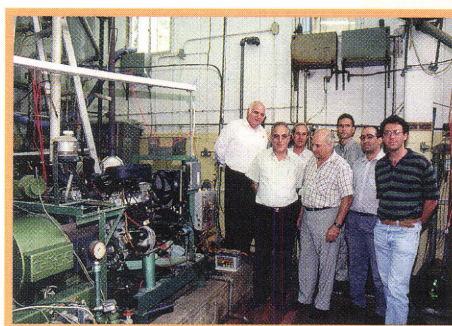
- buildings and urban areas as key targets for the rational use

of energy (RUE)

- solar and wind power, as renewable energy sources (RES)
- in the area of fossil fuels (FF), oil shales and natural gas

During 1998, says OPETI's Director, Dr Yair Sharan of ICTAF, it will establish a website (launched at the end of June), build a database of Israel's energy producers, suppliers and industrial users, and embark on a survey to identify needs which might be met by energy technologies available in the EU.

"We believe that Israel has much to contribute as well as much to gain," says Dr Sharan. As an example he cites the case of an Israeli-developed electrical fuel technology, cur-



Dr Sharan (second from left) and other members of the OPET Israel team visiting a test facility.

rently undergoing trials in Germany, which may provide an alternative power source for cars. □

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(1) See edition 2/98.

Innovation Relay Centre

Newsletter

Network on Target

The Third Annual meeting of the network of Innovation Relay Centres, held in Stuttgart on 23-24 April, confirmed the IRCs' commitment to the focused approach which has proved so successful over the past year.

"The network's members, and the regions and industries they serve, are extraordinarily diverse," says Javier Hernández-Ros, responsible for the IRC project. "Close co-operation between individual IRCs is needed if the network is to add European value to their regional work. This can only be achieved through a tight focus on the core task of promoting transnational technology transfer and participation in EU research programmes."

Mr Hernández-Ros acknowledges that the project's initial objectives were too broad. But he believes the greater focus introduced in 1997 has proved an excellent basis for improved performance.

"The annual meeting gave us a real sense of the network's increased momentum," he says. "It is maturing, and the latest results are encouraging. We want to pursue the same direction until the end of the current project in March 2000."

Regional Backing

The welcome address given by the Secretary of State of Baden-Württemberg's Economic Ministry, Dr Mehrländer, provided evidence of external backing for this strategy. Stressing the importance which Baden-Württemberg attaches to IRC South Germany as a regional window on pan-European research and technology, he said that the network was developing well, and should be allowed to consolidate its achievements. The Ministry, which co-finances the IRC, is well pleased with its investment, he said.

Among other sessions in a packed programme, delegates were treated to a summary of the early achievements and plans of the nine sector-oriented Thematic Groups, to impressive presentations by the FEMIRCs of Slovenia and the Czech Republic, and to the announcement of a new IRC initiative on innovation financing (see box, page 14).

Consideration was also given to the performance indicators which inform decision-making both at IRC and at network levels. Analysis of data from the project's first two-year phase showed

steady improvement. In the period as a whole, the network had given technology transfer assistance to 12,592 companies, resulting in 330 signed agreements. It helped 20,616 to access EU research programmes, leading to 1,438 funded projects — 32% of the proposals submitted.

Charlotte Avarello, also of the IRC unit, reported on the recent increase in promotional activities — notably the series of 'success stories' on the IRC Home Page on CORDIS, designed to illustrate the achievements of individual IRCs in the area of transnational technology transfer.

Working Late

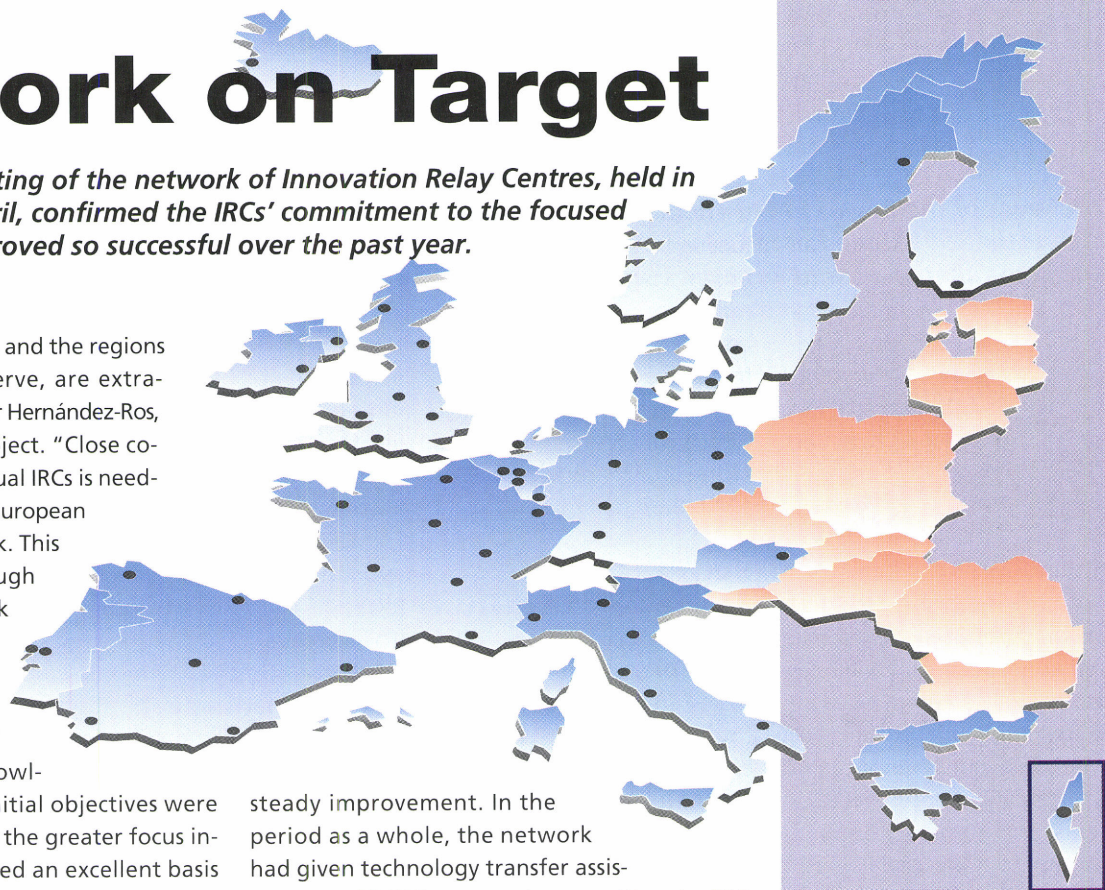
Above all, says Mr Hernández-Ros, the meeting demonstrated the project's growing strength as a network of people. "Many IRC representatives arrived in Stuttgart a day early, to meet with colleagues before the formal meeting," he reports. "And many used the free afternoon of the second day for further bi-lateral discussions. When I left, nearly 100 people were still engaged in business meetings." Such commitment promises even greater things in the years ahead. □

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THE IRC NETWORK IN BRIEF

The Innovation Programme's network of 53 Innovation Relay Centres (IRCs) spans the EU, Iceland, Israel and Norway (see map), with 'twinning' arrangements extending it to some Central and Eastern European countries (shaded in red). Each IRC is its region's window on European innovation, helping companies and research organisations transfer technologies to and from the rest of Europe and access the EU's research programmes. See the Dossier in edition 4/97 for more details.

Innovation Relay Centre

► THEMATIC GROUP

Joint IRC Initiative at ENTSORGA

The work of the Environment Thematic Group is both strategic and practical. Seventeen of its members met at the 1998 trade fair in Cologne in early May. Most took part in a parallel partner mediation event, and some shared a stand with the European Commission and local SMEs.



Until recently, industry's unwanted by-products were poured into the sea, the soil and the air as if their capacity to absorb waste was infinite. In the past few decades we have begun to understand the fragility of natural ecosystems, and industry has been forced to take greater responsibility for protecting them. Sophisticated 'end-of-pipe' technologies have been developed to enable polluters to comply with regulation of their environmental impacts.

Such technologies now form the basis of a major industry in their own right. But they will not deliver the sustainable development on which, as the Rio Summit accepted, mankind's survival depends. Today, the focus is on production-integrated waste management technologies. These go beyond treatment and disposal of residues, by permitting recycling close to the manufacturing process — within a single plant or a cluster of plants.

For business, the imperative to adopt such technologies is economic as well as environmental. Improved resource productivity is a key source of competitive advantage. Integrated waste management systems will take an increas-

ing share of the market for environmental technologies, which in western Europe alone is already worth ECU 127 billion per year.

Emphasis on Implementation

This forecast was endorsed by speakers at a workshop on the dissemination and exploitation of environmental technologies, organised by the Innovation Relay Centre North Rhine-Westphalia at ENTSORGA '98, held in Cologne on 12-16 May.

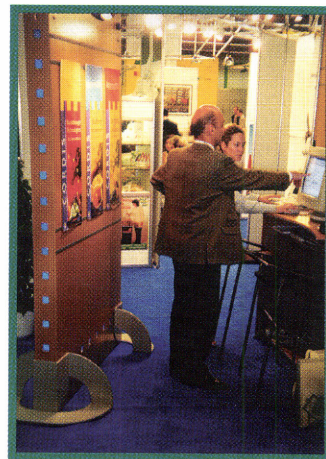
In his introduction, Dr Robert Mainberger of the Land's Ministry of Economic Affairs stressed that environmental technologies were now needed in all industrial sectors. "Collaboration across sectoral, disciplinary and national borders will be essential for rapid development and take-up," he said. "The IRC network constitutes the primary tool for building such collaboration."

Dr Christian Patemann, Director of Environment Research at the Commission's DG XII (Research), also emphasised the critical role of technology transfer. Under the Fifth Framework Programme, he said, research projects will have to involve end-users and to incorporate clear plans for industrial application.

Further presentations were made by industry associations

FEAD and EUCETSA, by technology transfer centre ITUT, and by the Commission's DG XI (Environment) and Joint Research Centre (JRC). Each expressed enthusiasm for working with the network of IRCs, 17 of which attended the seminar.

Peter Wolfmeyer, Director of ZENIT, which hosts the IRC North Rhine-Westphalia, said that the seminar had brought together key European environmental technology players for the first time, and represented a valuable opportunity to clarify their functions and capacities. In a formal meeting after the seminar, the Environment Thematic Group addressed the practical challenges of building an effective network.



© both photographs: Simon Blackley, ESN

The joint IRC-European Commission stand at ENTSORGA included a demonstration of CORDIS on-line and technology displays by six of ZENIT's client SMEs.

IRC Biotech Investment Forum

On 11-12 March 1999, with the support of a consortium of IRCs, 35 pre-selected European biotech companies will make presentations to potential investors. Aiming to produce a high number of investment contracts, the IRCs will give the companies extensive support in preparing appropriate business plans. Interested compa-

nies and investors should contact the organisers immediately.

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Innovation Relay Centre



The compactness of Heuser's waste water treatment and recycling system is a key selling-point — it is built into a unit the size of a standard container.

On a Learning Curve

ENTSORGA is an annual trade fair staged by the German Waste Disposal Industry Association (BDE). The 1998 event involved around 1,350 exhibitors, with products ranging from vehicles to deep shaft storage systems.

It also provided the venue for an international partnering event organised by ZENIT, which benefited from the experience of previous events run by other members in 1997 — at Pollutec⁽¹⁾ and at Ecotech⁽²⁾. 120 companies from 9 EU Member States, including 75 from outside North Rhine-Westphalia, participated alongside 17 IRCs. Discussions with potential suppliers, partners, distributors or licensees were opened in over 120 pre-arranged business meetings.

"We have invested a great deal of staff time," Wolfmeyer admits. "But environmental technology is a key area for the IRC. We expect the event to generate a number of high-quality co-operation projects, to which the IRC will devote considerable further effort."

These will involve companies

which are well-known to the IRC, are willing to commit management time, and have innovative technologies ready for commercialisation in international markets. "We think it is reasonable to concentrate on projects which have a real chance of success within 12 months. If this event produces 5-10 signed agreements by mid-1999, we will be very satisfied."

Tangible Results

DG XII, CORDIS and the JRC shared a stand with ZENIT and four other IRCs. "We are thrilled that the Commission is exhibiting with us," said Wolfmeyer. "It underlines our collaboration and gives a real boost to the six local SMEs which also chose to use our stand."

These typify the high-quality projects on which the IRC focuses, and two offer fine examples of integrated waste management technologies. BIOTEC GmbH uses vegetable starches to make fully biodegradable plastics for blown film and injection moulding. Ideal for agricultural and food sector packaging, its granules can be used in existing production

plant, while the products themselves can be composted after use to return fertility to the soil.

Heuser Apparatebau GmbH exhibited a compact and flexible waste water treatment and recycling system, suitable for use in the pulp, paper, corrugated paper, galvanic and textile industries. As Brigitte Heuser explains, the unit is designed to meet growing demand for integrated waste management. "In the past, companies did just enough to meet regulations on the quality of liquid discharges," she says. "Now, they view water as an expensive raw material. Our system, which allows them to reuse water, offers a payback within 3-4 years."

The IRC helped Heuser to find development partners for the new system, and is now supporting its search for distributors throughout Europe. The company held nine formal meetings as part of the partnering event in addition to contacts made on the exhibition stand.

Follow-Up

Early feedback from the partnering event was extremely positive. "We are very pleased with how it has gone," said ZENIT's Sharon Oranski. "Companies have been asking whether we plan further events, and many were impressed by the professionalism and technical know-how of the IRC representatives."

Oranski and Wolfmeyer both acknowledge that follow-up will be critical — without continued support, companies often let opportunities

lapse after a partnering event. To ensure that the meetings in Cologne lead to as many concrete technology transfers as possible, each IRC will work intensively with the most promising cases in its own region.

Thematic Group members are planning similar events at Pollutec 98 in Lyon, 5-6 November, and at Ecotech in Utrecht, 14-15 April 1999. Together, they are helping to secure the rapid diffusion of new technologies in Europe's fast-growing environmental sector. □

(1) See IRC Newsletter of edition 2/98.

(2) See page 16.

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► GOOD PRACTICE

Thorough Preparation Gives Results

The strategy of the Environment Thematic Group of IRCs is based around partner mediation events, run in parallel with major trade fairs — most recently at ENTSORGA (1). As the links between group members grow stronger, they are learning from one another.

André Roos led the IRC Netherlands team behind the ECOpartners event at Ecotech '97 last December. He does not claim to have all the answers to running partnering sessions, but he is keen to pass on his experience.

"The financial support of the Innovation programme and the Province of Utrecht was extremely helpful," he recalls. "That enabled us to offer free participation, including entry to the fair — companies only had to pay for travel and accommodation. Locating ECOpartners within Ecotech made it more attractive too, to foreign companies in particular. But it also brought new exhibitors and visitors, so the organisers helped us in any way they could."

Long Lead Time

Promotion began in July, a full seven months before the event. "That sounds like a long time," Roos admits, "but we still ended up in all-night faxing sessions to meet our deadlines. We will give ourselves even longer to prepare for the second ECOpartners event next spring (2)."

Distribution of a brochure followed the official announcement. SMEs were asked to return a carefully designed booking form, giving details of company activities, size, export turnover and R&D capacity, as well as the type

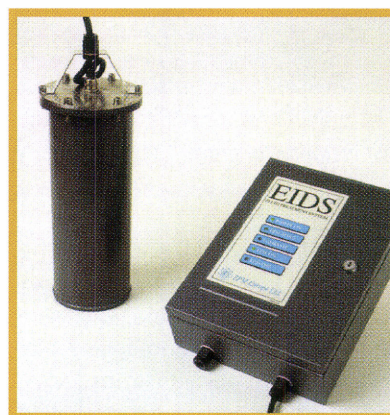
of co-operation offered or sought.

In the Netherlands, the IRC — jointly hosted by Senter and Syntens — used its own database of SMEs, and those of its local partners. But to reach foreign companies they needed the committed support of other IRCs. "At that time, IRCs tended to represent their clients at partnering events abroad. We were keen to bring together the companies themselves," Roos explains. "But to identify potential participants, and to persuade them to attend, we needed help."

In October, with just two months to go, he visited Polutec in Paris, where he joined the recently-formed Environment Thematic Group, which met at the fair. "The Thematic Group offered the perfect links," he says. "These were IRCs from regions in which environment technology was strongly represented. They did a great job in promoting ECOpartners among their SME contacts."

Personal Schedules

Eighty booking forms were returned, and the data converted into a catalogue. This was circulated to all participants, who picked up to seven companies they would like to meet. Roos used powerful scheduling software to timetable up to ten 45-minute



ZPM's Energy Interface Delivery System (EIDS), which uses radio-frequency transmission for low-cost, non-contaminating prevention of scale build-up on heat transfer surfaces (for example in food-processing plant), is likely to be more widely distributed as the result of a meeting at ECOpartners.

meetings per participant over the two days of the event.

"Each company received a personal schedule by fax a few days before they were due to travel," Roos says. "It was important to ensure that all the requested meetings could take place. But the schedules also demonstrated that the event was being professionally organised." The approach worked — 85% of the registered participants turned up, far exceeding the IRC's expectations.

Evaluation and follow-up began a few months after the event, and are still continuing. "The SMEs themselves were well satisfied," Roos reports. "We found that they had held almost as many informal meetings as the ones we arranged for them. The initial contacts made at ECOpartners have led to a French-Dutch partnership, which is running a CRAFT project under the FAIR programme, and the on-going negotiation of

a distribution agreement between an Irish SME and a British one. In addition, participants are still working on at least 30 further deals of various kinds." □

(1) See page 14.

(2) ECOpartners will be held at Ecotech '99, 14-15 April 1999, in Utrecht, the Netherlands.

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Small Science, Big Future



An emerging research field of huge potential, nanotechnology is by nature multi-disciplinary. But how well is European science equipped to straddle traditional boundaries?

Ask ten scientists to define nanotechnology, and you get ten different answers. It involves control of materials at scales from the atomic (0.1nm) up to 100nm, encompassing both ultra-miniaturisation and molecular manufacturing. Its potential contribution to commercial technologies — from microelectronics to health-care — is revolutionary. But industry is only now starting to invest in the basic research which is still needed to realise this promise.

In the past decade, new physical and theoretical tools have enabled physicists, chemists, and biologists to arrive, from different directions, at the same point — a point one millionth of a millimetre wide. Each is starting to handle individual molecules, and exploit their properties. The opportunities for sharing skills and methods, and for joint research, seem endless.

But new networks are slow to form. Differences of professional language and rigidities within academic and funding institutions present particular barriers to cross-disciplinary collaboration.

Effective research networks evolve as 'bottom up' initiatives, but the process can be accelerated. A new Training and Mobility of Researchers (TMR) project is supporting three conferences on 'Nanoscience for Nanotechnology', the first held in Hindsgavl, Denmark, on 16-19 May. A wide range of innovative work was presented⁽¹⁾, and the 90 participants swapped ideas enthusiastically, often with those from other fields. Working groups were established for six key areas⁽²⁾.

Professor Kjeld Schaumburg of the international organising committee called the conference "an opportunity to identify the European nanoscience community". He stressed the interdependence of nanoscience and nanotechnology, but warned against raising false expectations of rapid commercial results.

Industrial Orientation

How should the direction of European research be determined in a field where opportunities may not be recognised by the established disciplines, and whose commercial potential is uncertain and long-term?

Professor George Robillard of the University of Groningen is in no doubt that top scientists should work in active consultation with industrial sponsors, and free from the constraints of traditional disciplinary boundaries. Such views, not universally popular, were widely shared among the conference's younger participants.

With colleagues, Robillard is setting up BioMaDe, a nanoscience institute whose team of 100 biologists, chemists and physicists will be independent and device-oriented. "We want industrial scientists to work directly with us," he explains, "so that when we have a choice of direction we always opt for the one that is most promising from an applications perspective."

Public research funding will also play a key role in shaping European nanoscience. Under the current Fourth Research Framework Programme, the

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(1) See 'Key Techniques and Approaches' for a selection of the work presented at Hindsgavl.

(2) Materials and nano-chemistry; nano patterning; nano-sensors and biophysics; nano-scale physics; nano-instrumentation; and economic and social aspects. Information about the working groups can currently be found at <http://www.cismi.dk/nano.htm>

European Commission has supported nanotechnology through Esprit, Biotech and Brite-Euram⁽³⁾ and, in the field of electronics, through Esprit's Phantoms co-ordination action. Under the forthcoming Fifth Framework Programme, funding will continue to come from budgets for generic research within the

thematic programmes, although mechanisms for horizontal co-ordination are being developed.

COST meanwhile, which recently launched four actions covering nanotechnology⁽⁴⁾, has set up a horizontal *ad hoc* group on nanosciences to find ways of overcoming discipline-based

barriers to cooperation and synergy.

At national level, an IPTS study⁽⁵⁾ found that nine EU Member States currently fund dedicated research programmes. The German federal government, which already puts ECU 60 million into nanotechnology research, is establishing five new centres of competence.

Case Study

A Bright Idea

Advanced nanoscience research can make a rapid market impact.

In a few cases, results emerging from nanoscientists' laboratories are already shaping new or enhanced mass-market products. In two successive Brite-Euram projects⁽¹⁾, Philips and Hoechst have brought an innovative display technology to the brink of industrial production in just five years, using nano-scale manufacturing techniques.

The Light Emitting Polymer (LEP), discovered by Professor Richard Friend of Cambridge University, was one of the rival technologies which first appeared in the early 90s as potential replacements for the Cathode Ray Tube (CRT).

Sandwiched between metallic and transparent electrode layers on a substrate of glass or plastic, LEPs offered an entirely new basis for emissive displays. The electrodes could be patterned to create a matrix of pixels, and different polymers would emit light of different colours. Wall-hung colour TV seemed almost within reach.

Extended Lifetime

"Things are never quite that simple," says Robert-Jan Visser of Philips, which in 1993 teamed up with Cambridge Display Technologies (CDT), the spin-off company set up by Friend. "Before we could use the technology, it had to work reliably over a wide temperature range, with a 10-year lifetime. When we started, the typical lifetime was 10 minutes."

By the end of 1996, the PolyLED (Polymer Light-Emitting Diodes and

Displays) partners had stable polymers and electrode materials, a device architecture and a manufacturing technology. "We had shown that it was feasible to make flat, thin, high-contrast displays as bright as CRTs, running on just 2-3 volts," Visser recalls. "And CDT and

power consumption, and has to be controlled to within a few nanometres, to create a uniform film with no pinholes."

Philips and Hoechst are co-operating to launch a first range of products at the start of 1999, under a license agreement with CDT. These will be backlights and small single-colour displays for cars, telephones and other portable devices. But research continues — large, flat, colour TV screens really are just around the corner.

(1) PolyLED (BE93-7762) and LEDSPRAY (BE96-3510). The work was also supported by Esprit in the LEDFOS project.



Semi-conducting polymers and their solutions (top), a glass plate with spin-coated polymer thin film (bottom), and three operating displays (centre).

the Max Planck Institute had studied the basic physics, helping us to understand exactly how the device worked."

In LEDSPRAY, the follow-up project, lifetime was increased from 2,000 to nearly 50,000 hours — enough for a commercial product — and techniques for large-scale synthesis and manufacturing were developed. "The polymer is spin-coated in a 100nm layer," explains Visser. "The thickness is critical for

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"This is a rapidly growing market," says Bernd Kramer of the German Ministry. "We want to support the areas with the greatest market potential."

(3) See the Case Studies for examples of projects under each programme. Work has also been funded under the SMT and Joule programmes.

(4) COST actions 523 (Nanostructured Materi-

als), D14 (Functional Molecular Materials), D15 (Nanochemistry at Surfaces and Interfaces) and P5 (Mesoscopic Electronics). See the Dossier on COST, edition 6/94.

(5) 'Nanotechnology in Europe: Experts' Perceptions and Scientific Relations between Sub-areas', Institute for Prospective Technological Studies, 1997 (EUR 17710 EN).

Case Study

Flexing their BICEPS

A transnational team is perfecting the interface between three technologies.

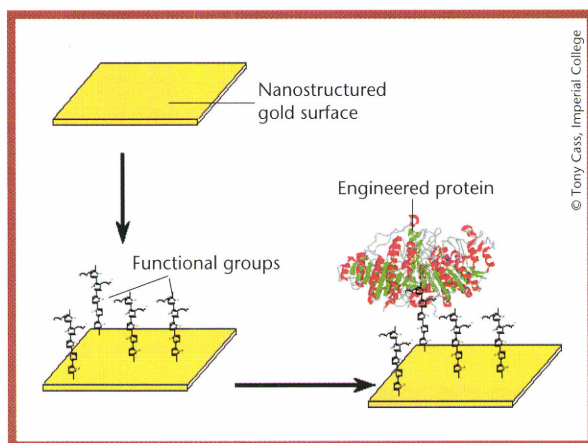
Scientific careers and scientific ideas tend to develop within well-defined disciplines — few researchers keep up with the literature outside their own field. Nanoscience offers revolutionary technological opportunities, but will require a cross-disciplinary approach. Scientists, and research programmes, must break through the traditional boundaries between one branch of science and another. Those that fail to do so will be left behind.

BICEPS — Biomolecular Integration with Composite Electroactive Polymer Structures, is one of three projects dealing with the interface between structural biology and electronics currently supported by the Biotech Programme. A multidisciplinary consortium of scientists will carry out a fundamental investigation of techniques for interfacing biological molecules with electronic devices.

"Whatever your field, structures with dimensions in the hundred micron range were conceptually no different from ones you could see on a bench or in a beaker — they were just smaller," says Dr Tony Cass of Imperial College London, the protein engineer who coordinates the BICEPS project. "But at the micro- and nano-scale things behave in radically different ways. Effects which we could ignore before become extremely significant. At this level, our separate disciplines coalesce."

Hybrid Devices

The three-year project, still in its initial phase, aims to develop a library of



BICEPS creates engineered surfaces by depositing an electrochemically polymerised film with dedicated functional groups onto a nanostructured gold film. An engineered protein binds to the polymer film through a specific molecular recognition reaction.

methods for interfacing the inorganic world of nano-fabricated metal and semiconductor structures and the organic world of polymers and biological molecules.

"We are dealing with layered structures," Cass explains. "An inorganic base of silicon or metal has simple chemical properties, but can be formed into highly complex structures. Biological macromolecules can be interfaced with such a substrate in various ways, but we are using an intermediate layer of conductive plastic, electrochemically deposited on the base. This synthetic polymer, which binds the protein molecules to the semiconductor, may also provide a channel for the passage of electrons between them."

Such interfaces are already being realised in commercial biosensors, but the BICEPS team was keen not to focus

on a single application area. "We wanted to take a broader view," says Cass. "The integration of engineered proteins and silicon-based materials will give semiconductors new biological and chemical functionality. It may also provide a means of overcoming some of their current limitations in the area of sensing. We foresee a very wide range of new hybrid devices." The project's aim is to identify generic solutions to the challenge of building and controlling the nano-scale interfaces on which such devices will depend.

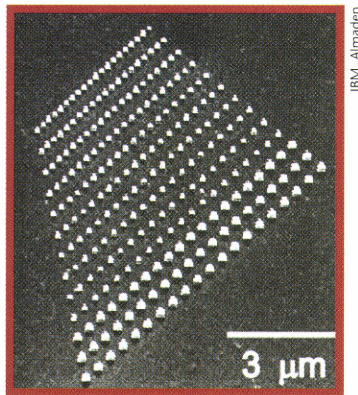
The research team's expertise covers surface analysis, physical chemistry and polymer science, as well as nano-fabrication and protein engineering. Such collaboration is extremely rare, and simply to grasp the collective capabilities of the team has been a real challenge. "We each had only a very hazy idea of what the others could and could not do," Cass admits. "But as we start to see the connections between our fields, the huge potential of such collaboration is becoming clear. We have already identified a number of other promising avenues for joint research."

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Key Techniques

These examples of work presented at the TMR Conference

Fig 1



Scanning probe microscopy — the various techniques by which surfaces are mapped at the atomic level by a scanning head — plays a critical enabling role in the development of nanoscience, allowing researchers to visualise, measure and manipulate matter at the molecular or atomic scale. Its continuing development is a measure of European competence, as well as a strategic necessity.

Anja Boisen of the Microelectronics Centre at the Technical University of Denmark is building smaller **Atomic Force Microscopy** (AFM) probes. "If you want to scan fast without damaging the surface — for example, to monitor a biological reaction — they have to be small," she explains. She worked on AFM-based data storage devices at IBM Almaden, which has developed a read-only plastic device with protrusions approximately 50nm wide (Figure 1), allowing data densities of 5-8 Gbits/cm². (Contact: ab@mail.mic.dtu.dk)

At the Institut für Mikrotechnik Mainz (IMM), Dietrich Drews is developing more efficient and accurate micromachined tips for the **Scanning Near-Field Optical Microscope** (SNOM), which characterises samples with lateral resolution beyond the diffraction limit of conventional optical microscopy. The

tips, well-suited for combined SNOM/AFM use, are fabricated on a wafer (Figure 2). The transparent cone is coated with aluminium except for the apex, forming an optical aperture around the protruding silicon nitride tip. Optimisation has since produced an aperture of 50nm diameter. (Contact: drews@imm-mainz.de)

"European nanotechnology may not be making nano-products yet — we are at the stage of building **machine tools** for the nano-industrial revolution," says George Smith of Oxford University's Department of Materials. "But it is already a profitable industry." The Optical Position-Sensitive Atom Probe (Figure 3) produced by Smith's own spin-off company, Kindbrisk, maps in 3-D the atomic distribution of elements in

Fig 2

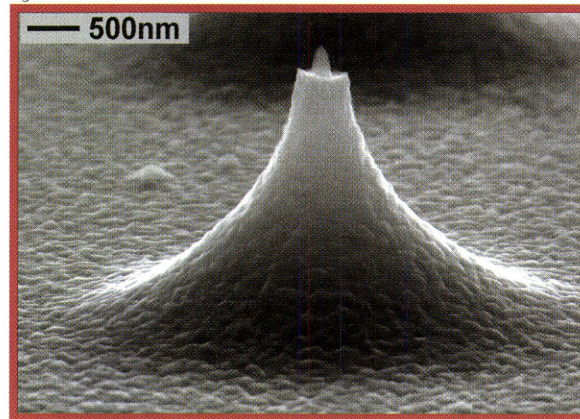
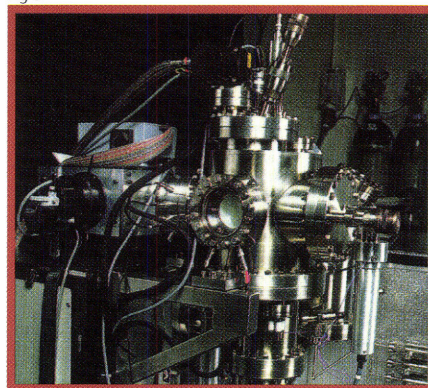


Fig 3

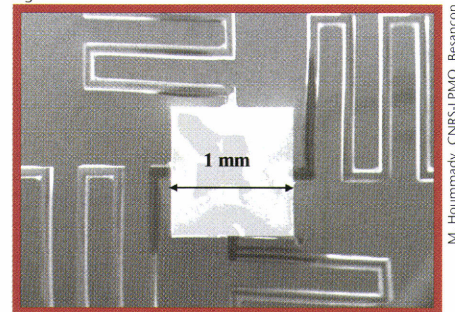


alloys, semiconductors and nanostructured materials, as an aid to systematic development. The ECU 600,000 machines are marketed to research

groups world-wide. (Contact: george.smith@materials.ox.ac.uk)

Moussa Hoummady, Andrew Campitelli and other team members at CNRS-LPMO in France have **micro-engineered** a monolithic 2-D nanoscanner in quartz as the key component of a miniature (1cm³) Scanning Probe

Fig 4



Microscope. The scanner (Figure 4) is supported by four springs, each with metallic electrodes. When voltage is applied to a spring, it stretches. Movement is detected by the spring opposite, allowing self-positioning with precision in the nanometre range. Hoummady's engineering philosophy derives from three years spent in Japan. "European science has to embrace the concepts of manufacturability and marketability," he says. With colleagues, he hopes to commercialise nanosensors and micromachines which will open up new opportunities for nano-scale science and technology. (Contact: hoummady@lpmo.univ-fcomte.fr)

Nano-diversity

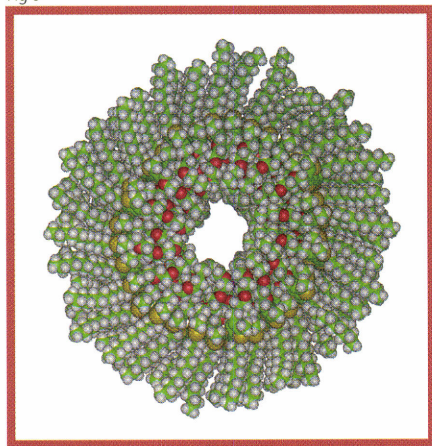
European nanoscience encompasses a huge range of research fields — stimulating, and stimulated by, novel combinations of workers, ideas and techniques.

Thomas Bjørnholm of CISMI at the University of Copenhagen has developed a polymer which demonstrates the potential of **self-assembled monolayers** (SAMs) in electronic circuits. "Nature designs molecules which self-assemble to form functional supramolecular and macro-scale structures," he says. "At last, we are learning the

ase and Approaches

Hindsgavl illustrate the scope of European nanoscience.

Fig 5

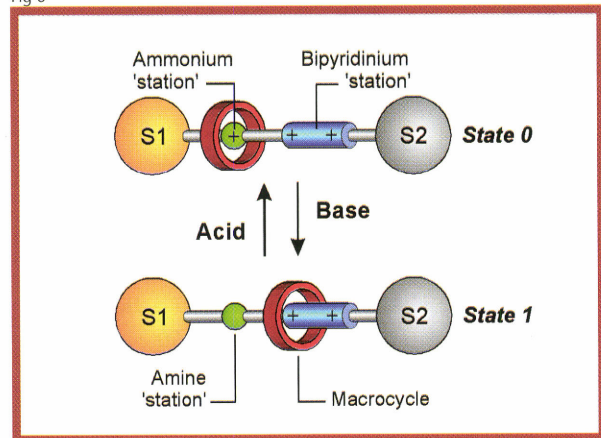


P. Shibaev/K. Nørrgaard/T. Bjørnholm, CISM

same trick." The molecules form a highly organised 2-D 'organic silicon wafer' by self-assembly. Bjørnholm envisages self-assembly in solution of 3-D micelles and tubular structures. A molecular model (Figure 5) shows a cross-section through a nanotube of conducting polymer. (Contact: tb@symbion.ki.ku.dk)

Molecular devices may lead to new forms of computing, says Alberto Credi. A University of Bologna, UCLA, and Imperial College London team has built a 2nm long molecular abacus to demonstrate the information processing potential of bistable molecular systems. The 'ring' of a super-molecule can be moved along a 'thread' between two distinct recognition sites by the addition of a base or an acid to the solution (Figure 6). Experimentally, movement is tracked by nuclear magnetic resonance (NMR), absorption spectroscopy and electrochemical tech-

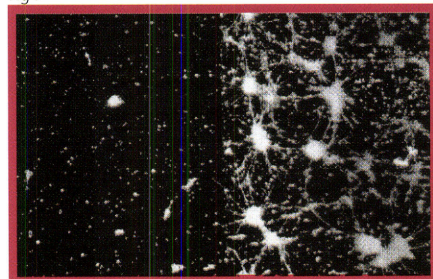
Fig 6



A. Credi, University of Bologna

niques. (Contact: acredi@ciam.unibo.it) Christiane Ziegler of the University of Tübingen has shown that artificial neural networks drawing data from networks of cultured mammalian neurons can operate as stable biosensors for the quantitative detection of neuroactive agents — including drugs such as LSD and ecstasy. The cell-electrode **bio-interface** is critical at the nano-scale. Pre-treatment with synthetic peptides has been shown to make a carbon surface more 'attractive' for nerve cell growth, improving adhesion of chicken brain cells (Figure 7 —

Fig 7



S. Kienle, PhD thesis, University of Tübingen

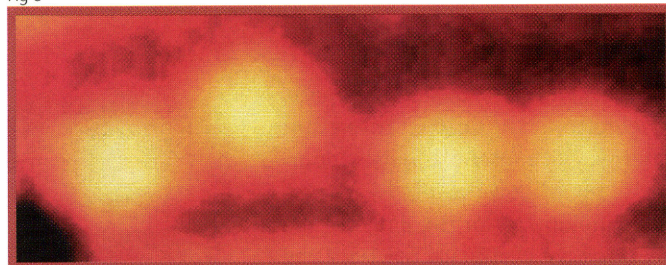
right side treated). (Contact: cz@ipc.uni-tuebingen.de)

The potential of **molecular electronics** is demonstrated by a single atom switch developed at the Microelectronics Centre at the Technical University of Denmark. A Scanning Tunnelling Microscope (STM) is used to 'flip' single atoms of hydrogen between two symmetrical sites on a hydrogen-passivated silicon surface in a controlled manner, at room temperature. Ulrich Quaade has created a four-bit atomic register (Figure 8 — holding '0100'), and speculates that the

technology may be in use commercially for 10^{12} bits/mm² data storage early in the next century. (Contact: ulrich@mic.dtu.dk)

Hannes Luyken describes quantum dots as 'boxes for electrons'. **Quantum electronics** hopes to exploit these artificial atoms for single electron transistors, quantum dot lasers and quantum computing devices. Using lithography, researchers have made dots with

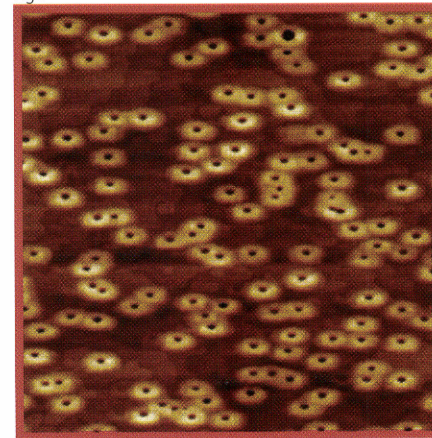
Fig 8



U. Quaade, Mikroelektronik-Centrum

around 100 electrons. Groups at UCSB and LMU München have created arrays of much smaller self-assembled indium arsenide dots, and have used single electron charging to fill empty dots with six electrons. By interrupting growth, they have also made 100nm diameter 'rings' (Figure 9) with new electronic and optical properties.

Fig 9



J. Garcia et al., UCSB and A. Lorke et al., LMU München

Case Study

Breaking the Size Barrier

Will the predicted annual doubling of the number of transistors per chip finally hit the buffers around 2010? An Esprit project is finding ways to keep Moore's Law on track.

Moore's prophecy referred to logic chips. But the density of memory chips has also grown geometrically, and they likewise face the imminent termination of this explosive increase in speed and power.

Feature sizes less than 0.05 microns (50 nanometres) cannot be resolved by optical lithography, the technology used to print circuits on today's chips. In any case, circuits this small suffer from problems of efficiency and reliability, caused by the unpredictable behaviour of electrons at the nanometre scale.

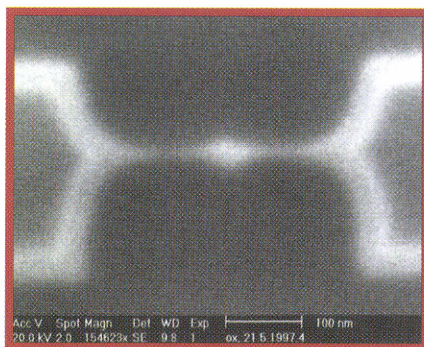
This poses a major problem for the microelectronics industry. Looked at another way, it presents a huge opportunity — for whoever is first to adopt a new technology when the limits of the present one are eventually reached. The Advanced Research Initiative in Microelectronics (MEL-ARI) of the Esprit programme aims to equip Europe to seize this opportunity. In particular, the 12 projects of the Nano-scale Integrated Circuits cluster focus on overcoming current limits to miniaturisation.

"Right now, the random behaviour which appears at the nano-scale is seen as a constraint," says Kostas Glinos of the Esprit programme. "The challenge is to find ways to exploit it."

Island-Hopping Electrons

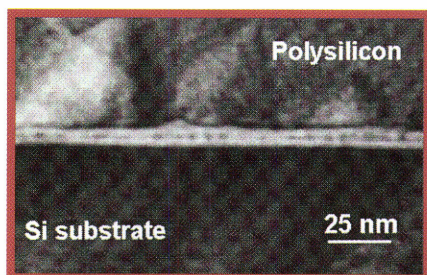
FASEM (Fabrication and Architecture of Single Electron Memories) aims to establish a technological platform for mass-production of memory chips which consume far less power than today's DRAMs, and have a capacity at least an order of magnitude greater — around one terabit per cm². Led by Dr Huguette Launois of CNRS-L2M in Bagneux, France, the project's partners are exploring five parallel approaches, all based on single electron charging effects.

In DRAM, a bit of data is stored in a capacitor, which is charged to represent a '1' and discharged to represent a



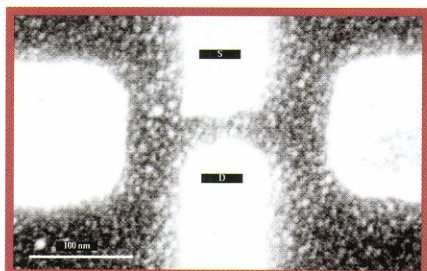
A 10nm silicon island.

Tübingen University



Nanocrystals in a silicon dioxide layer.

IMEC



Electrodes, with 1nm metallic grains.

CNRS-L2M

'0'. Tens of thousands of electrons are transferred and stored. "We are trying to do the same job using precisely controlled flows of fewer than 100 electrons," says Launois. "This relies on features just a few nanometres across. Data is written and read as tiny changes to the electrical potential in an array of these islands."

Tübingen University has created single 10nm silicon islands by lithography, etching and oxidation. The Institute of Microelectronics (IMEL) in

Athens has produced 3nm silicon nanocrystals in a silicon dioxide layer by implantation and annealing. Dr Launois' own L2M team has built a Coulomb Blockade device by coupling high-resolution lithography with the self-organised deposition of 1nm metallic islands. The Microelectronics Research Centre in Cambridge has created a polysilicon wire in which small islands are defined by natural defects. CNRS-GPEC in Marseille employs scanning tunnelling microscopy (STM) to induce the local chemical vapour deposition of metallic islands.

The project's other two partners — IMEC in Belgium and Hitachi Europe in the UK — are working on CMOS integration and system architecture respectively. "Although these devices use entirely new principles, they are the direct heirs of existing silicon technology, and fully compatible with it," Launois explains. "We want to be ready to integrate our memory into the conventional CMOS environment."

She warns that final success is still not certain, but hopes to be ready to meet the demand for high-capacity memory around the year 2010.

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► CONFERENCES

MATERIALICA 1998 **12-15 October,** **Munich (Germany)**

The first international trade fair for innovative materials, processes and applications will present key technologies in a wide range of applications.

Groups of materials, manufacturing processes, measurement and testing technology, quality and reliability strategies, and simulation technology will be on display, together with innovative developments for each stage of production. The Brite-Euram programme will show developments in materials technologies undertaken by funded projects.

The event is aimed at manufacturing and processing firms, users and service-providers in different sectors. A parallel scientific congress, *Werkstoffwoche*, will allow wider discussion of the latest developments in materials technologies.

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 Fx. +49 899 4909
 E-m. info@messe-muenchen.de
<http://www.materialica.de/>

Wanted:

Environmental Technologies **5-6 November,** **Lyon (France)**

The Innovation Relay Centres for Rhône Alpes/Auvergne and Paris/Ile de France, together with the Chamber of Commerce in Lyon, are organising a two-day 'inverted fair' on environmental equipment and technology called *Wanted: Environmental Technologies*, to take place within POLLUTEC'98, an exhibition of environmental equipment and services for industry and local authorities.

The inverted fair will concentrate on requests for technology, rather than offers, and will set up meetings between large companies looking for specific environmental tech-

nologies, and smaller companies who may have developed them. Any European company may take part.

The inverted fair uses the following methodology:

- Themes of interest and needs identified by major companies.

- SMEs present their competences in response to the needs of the larger companies.

- Larger companies select the SMEs they would like to meet at the fair.

- A schedule of meetings is given to each participant one week before the meeting.

- The meetings take place in complete confidentiality.

The Environment Thematic Group of the Innovation Relay Centres network is assisting in the preparation of the event to ensure widespread participation from across Europe.

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 IRC Rhône-Alpes/Auvergne
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 Fx. +33 4 7240 5965
 E-m. tirilly@lyon.cci.fr

Food-related research generated by the EU **18-20 October,** **Karlsruhe (Germany)**

The third Karlsruhe nutrition symposium, supported by the EU's Agriculture and Fisheries research programme (FAIR), will focus on the application of European research for safer and better food.

The symposium will consist of both plenary and technical sessions. Topics to be covered during technical sessions, subject to confirmation, will include:

- food safety and monitoring of safety aspects

- food, nutrition and well-being

- meat (a special FLAIR-FLOW contribution)

- technological methods to improve food quality

- consumer perception and transfer

- industrial demands for EU-

sponsored research

The topics to be covered during plenary sessions include:

- impact of EU programmes on industrial food research in Europe

- is innovation in the food industry market-led?

- consumer-led approach to foods in the EU

- are genetically-engineered food products safe?

Provision will be made for partner-searching for institutions interested in EU-sponsored research. Introductory presentations should be in poster format. The organisers are also seeking poster presentations on the subject 'Safer and better food'.

Contact: Prof. W. Spiess,
 Bundesforschungsanstalt für Ernährung

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E-m. volker.gaukel@bfe.uni-karlsruhe.de

European technology meeting for companies in the metalwork sector **26 November, Caen (France)**

The aims of the meeting include facilitating the creation of partnerships by providing structured offers and requests from companies and research centres, matching potential partners and providing the opportunity for meetings. These meetings will be based on offers, presented in the context of partner searching, in the following areas:

- transfer of technology backed up by a patent or specific knowledge

- transfer of skills or expertise, especially technical assistance

- industrial exploitation of products not yet in industrial production, or processes with demonstrated feasibility

The meeting is targeted at companies, laboratories, and technical centres working in the fields of:

- primary transformation of metals

- manufacture of metallic products and articles

- development of materials and services dedicated to the metalworking sector

The meeting is organised by a consortium which includes the Innovation Relay Centre Western France and the Lower Normandy Regional Council.

Contact: J-Y. Lerouilly, ANVAR

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Microsystems: Sensors and actuators for industrial applications

22 September, Besançon (France)

The aim of the meeting, organised by the Innovation Relay Centre France Centre-Est, is to foster exchange and encourage co-operation between European industrialists and researchers.

Microsystems used in production processes can be applied in many sectors of industry, and this meeting will feature sensor/actuator technologies for machines fitted with control, measuring and actuation devices. During the meeting companies and research centres with innovative technologies, interested in licensing, transfer of know-how, joint venture agreements and R&D projects, will have the chance to present their work and meet potential buyers. Opportunities will also be provided for potential new research partners to meet through pre-arranged individual appointments.

Organisations interested in participating in the meeting should send a brief description of the activities of their organisation and a clear description of the technology offered. Potential buyers will be selected and appointments arranged beforehand.

Contact: IRC Centre-Est

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CONFERENCES AND PUBLICATIONS

► PUBLICATIONS

Patents as an Innovation Tool — PATINNOVA '97 EUR 17021; ECU 49.50

The proceedings of the fourth European Congress on Patents of May 1997, which brought together patent professionals and the innovation community, have been published by the Innovation programme.

The publication contains the full text of all the presentations given at the congress, covering patents as a source of information, commercial aspects, and the use of patents as a means of protection.

An overview of the European situation, and comparisons with the USA and Japan, are also included, as are a number of case studies.

The complete text can be downloaded from the CORDIS Document Library (http://apollo.cordis.lu/cordis/EN_DOCSEARCH.html).

European Patent Office Interactive Training Package DM 450

A new CD-ROM providing

interactive training on all aspects of the European patent system, developed jointly by the European Commission and the European Patent Office (EPO), has just been published.

The package uses the latest multimedia techniques, with both text and video sequences. Requiring no special skills or training to use, it contains seven modules, covering patent application procedures, infringements and licensing, and patents as a source of information.

Contact: M. Mercier, EPO
Fx. +43 1 5212 62492

Redesigned Euroabstracts

Euroabstracts magazine, published by the Innovation programme six times a year, provides a round-up of new publications on European research and innovation. The new-look journal, which is now free, aims to make this information even more accessible and useful.

Each issue will focus on around 50 recent publications addressing strategic areas of the EU's research policy, and

will contain a major feature, highlighting related publications, and including interviews with leading policy-makers as well as background articles.

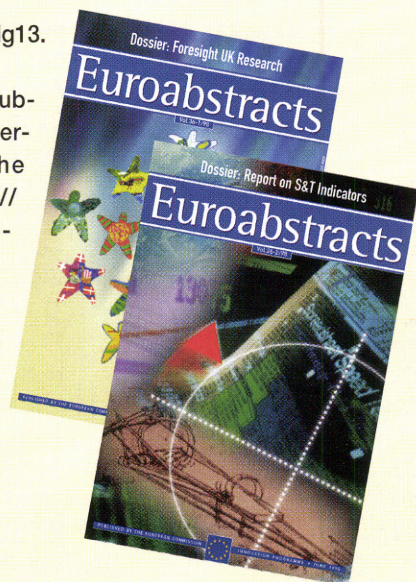
The current issue looks at the United Kingdom's science and technology strategy, to coincide with the UK's Presidency of the EU. In particular, it examines the Technology Foresight exercise, which aims to ensure British research and development addresses areas most likely to be of strategic importance to industry in the coming years.

Contact: RTD Help Desk
Fx. +352 4301 32084
E-m. rtd-helpdesk@lux.dg13.cec.be

Euroabstracts is also published in a browsable version available on the CORDIS website (<http://www.cordis.lu/euroabstracts/en/home.html>).

NOTE

Publications are free unless otherwise stated. If specific contact information for obtaining a publication is not supplied, and there is a price listed in ECU, then the publication can be purchased from the sales and subscription office in your country of the Office for Official Publications of the European Communities (Eur-OP). Addresses can be found in most EC publications, on the WWW (<http://eur-op.eu.int/en/general/s-ad.htm>) and by contacting Eur-Op (fax: +352 2929 42759).



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