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Progress and doubts

Science and Society

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Science and society - A European debate

New action to raise awareness

A new activity designed to raise public awareness of science and technology has been launched under the Improving Human Potential programme. It allows the European Union to provide much more systematic support to organisations and institutions trying to bridge the gap between EU-level science and the public, through regular calls for proposals. The most notable initiative aimed at the general public is the European Science and Technology Week which has been running since 1993. Through it, the Commission has supported events held in the Member States with the aim of raising public awareness – especially among young people – highlighting, in particular, the European dimension of research. Following the first call for proposals, published in 1999, the projects selected for the next European Week, to be held from 6 to 12 November 2000, will be launched in February.

Three other types of activity can also receive EU support: the creation of thematic networks for the exchange of good practices between European partners; the organisation of round tables on European research priorities; and the production of scientific and technological information aimed at the general public, by electronic or other means.

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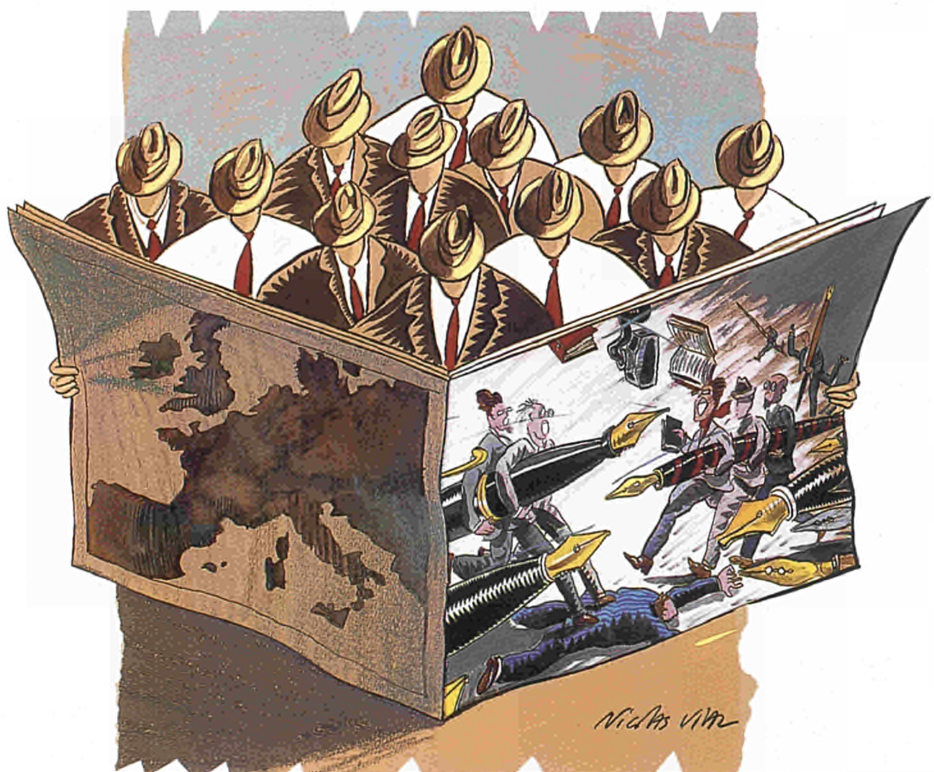
Nobody would deny that science is part of European culture or that its communication and perception, and the power it can wield, merit increasing attention at a European level. In a global economy, in which wealth is increasingly linked to the acquisition and use of knowledge, European countries have no alternative but to develop their intellectual resources together. Yet, curiously, many European universities complain that new generations of students are shunning many science subjects.

Furthermore, the major political issues raised by and confronting science - in such fields as bioethics, the environment, health and energy - are already European. Many of the debates between scientists who must make decisions on questions with political implications are already held at a European level daily.

Democratic control over the links between science and power, and the understanding and acceptance of the resulting options by citizens, thus extend far beyond the national sphere. The dissemination of knowledge, and the promotion of science and its understanding by the public in general are fields in which the European Union must play an active part.

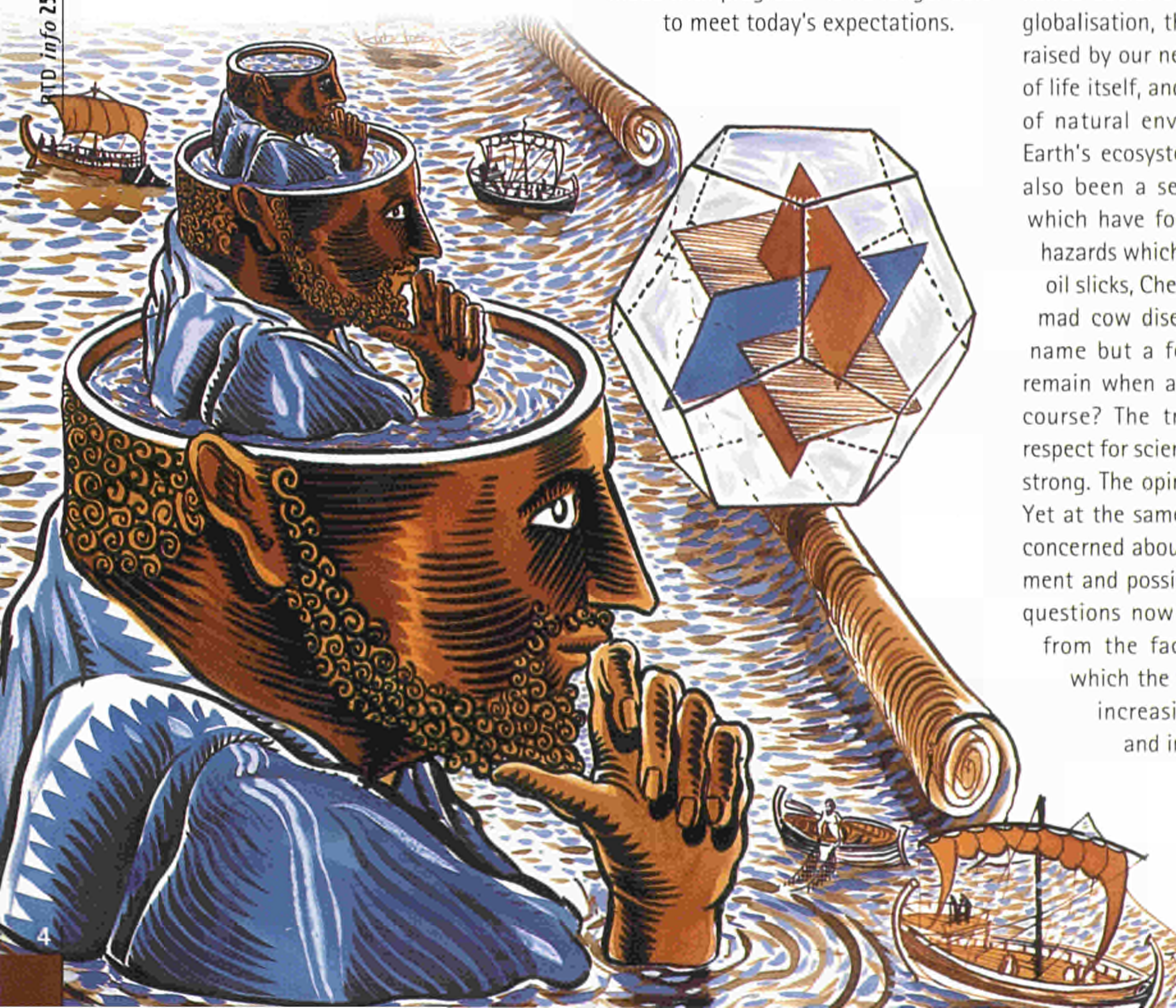


Progress and doubts

Despite developing at ever greater speed and playing an increasingly important role in our daily lives, is science destined to elude public understanding? What democratic control can be exercised by the societies it is transforming? And how do scientists view the gulf that divides them from their contemporaries?

Is public opinion mistrustful of science - perhaps increasingly so? Two approaches to this key question, which will help determine the course of the 21st century, can be found in Europe. Anglo-Saxon and Nordic countries talk in very practical terms about public understanding of science or raising awareness. In others, the Latin countries in particular, the emphasis is on the lack of scientific culture. These two approaches, with their many variants, seek to achieve the same objective: renewed dialogue between science, which is having an increasing impact on society, and society, which is finding it increasingly difficult to exercise effective control over science.

The desire for the widest possible dissemination of a culture and understanding of science is as old as science itself. Ever since the Enlightenment, scientific knowledge has been transmitted through the introduction of general education and the continuing tradition of a culture of popularising its major advances. However, this model - which has patiently laid the foundations for collective confidence in science as synonymous with progress - is no longer able to meet today's expectations.



The rise of technoscience

Over the past five decades or so, the rate of progress in technoscience - born of the marriage between science and technology - has really taken off. In the process, some of the initial public enthusiasm seems to have suffered, to the detriment of the general belief in the systematic benefits of scientific developments which prevailed until the mid-20th century.

The origins of this uneasiness are linked to the radical nature of developments such as the microchip, the blows dealt to established social structures by technological globalisation, the serious ethical questions raised by our new mastery of the processes of life itself, and the worrying deterioration of natural environments - if not of the Earth's ecosystem as a whole. There have also been a series of dramatic disasters which have focused the spotlight on the hazards which technosciences can bring - oil slicks, Chernobyl, contaminated blood, mad cow disease, the dioxin scandal, to name but a few. What constant values remain when a whole civilisation changes course? The traditional fascination and respect for science - and hope in it - remain strong. The opinion polls clearly show this. Yet at the same time the general public is concerned about the new powers, development and possible excesses of science. The questions now being raised stem in part from the fact that the knowledge on which the technosciences are based is increasingly specialised, complex and impenetrable.

A European forum on the Web

In December 1999, the Human Potential programme launched a discussion forum on the subject of Science, Technology and the Public, open to anyone seeking to participate in this crucial debate.
www.forum.europa.eu.int/Public/irc/dg12/impstpub/home
(NB: this address is case sensitive; "Public" must have a capital P.)

Recommended reading

From 1994 to 1999, the European Commission lent its support to the Euroscientia forum which has organised almost 20 conferences and debates bringing together experts from all fields to discuss the historical, ethical, cultural, socio-economic and political issues raised by science and technology.
Several in-depth reports on these meetings have already been published or are about to be published. Of particular interest in connection with our theme of Science and Society is a volume on *Science and Technology Awareness in Europe: New Insights* (ISBN 92-828-4384-X). To obtain a copy, as well as for a full list of publications, please contact:
Annette Paternostre, Research DG
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Up to the scientists

Faced with these expectations and questions, it is clearly up to the scientists to act. Some have understood this; in the United Kingdom, for example, science centres and museums, television science programmes, the world of publishing, and schools renewed their science education and communication activities long ago. The movement has spread, and today - albeit to varying degrees - all European countries are making an effort in this direction.

But are these attempts to catch up through the intelligent dissemination of knowledge enough to allay today's growing concerns over scientific developments? Is not the very association of the words culture and science, as used by some, itself undermined by a fundamental paradox? "Although science lies at the heart of technology and technology at the heart of culture, there is no direct connection between science and culture; in fact science is increasingly alienated from culture," observes Jean-Marc Lévy-Leblond, an uncompromising questioner of the meaning of contemporary science.[1] "Scientific knowledge, even classical scientific knowledge, is not part of common knowledge. Its conceptual advances and intellectual implications are increasingly foreign even to culture professionals [such as artists, writers and philosophers]." This raises two simple questions: "What is the use of knowledge which is ever less common? What is the point of continuing to reason without the reasons being clear?"

The need for a critique

Perhaps the problem of communicating science is the result of its own cultural isolation, of the way it sees itself as an edifice of knowledge without responsibilities. It would then be for scientists to question the place of science in society and to attempt to explain it - as many are doing - and not to analyse the problem behind closed doors but in the public forum. One of the major challenges facing science is to help free itself from the burden of being sole arbiter of the social problems it raises.

Steve Miller, a lecturer at Imperial College London, has been studying the problems of communication between science and society with great scientific rigour for years. A pragmatist, he calls first and foremost for a genuine critique of science. "Carrying out social, cultural and historical critiques of science does not equate with being 'anti-science'. Scientists themselves should be part of the questioning process. Analysing the practices of science and scientists - how scientists conduct their arguments, how concepts develop within the limitations of individuals and the society in which they operate, how policy issues affect and are influenced by research - can not only be helpful in deepening general public understanding of science, but also beneficial to scientists wanting to know how they got where they are, and where they might be going."[2] ■

(1) La pierre de touche - La science à l'épreuve... - Editions Gallimard, collection Folio/Essais - 368 p.- ISBN 2-07-032933-X
(2) A protocol for science communication for the public understanding of science - www.ucl.ac.uk/sts/whatson/scied.htm

The third circle

Many scientists believe that journalists fail to do justice to their work. Many journalists believe that scientists are poor communicators. But at the end of the day, it is the public - the "third circle" reached by the media - who suffer from this communication breakdown. Which is why a number of avenues are now being explored in an attempt to renew links between researchers and journalists.

How is scientific knowledge communicated? In concentric circles, like the ripples sent out when a stone is thrown into water, simultaneously widening and losing their intensity and precision.

The first circle is from scientist to scientist, knowledge first being recognised within the peer group. Nature, Science and other publications play a vital role is this "blessing" of new knowledge and discoveries.

Then the second circle. Through specialised publications, lectures, colloquia, conferences and expert studies, scientists spread the word and help guide politicians in their choices. On the borderline between an informed and a more general public, they also publish their ideas on the Internet, where they are debated, interpreted and even discovered by those for whom they were not primarily intended.

Mass science?

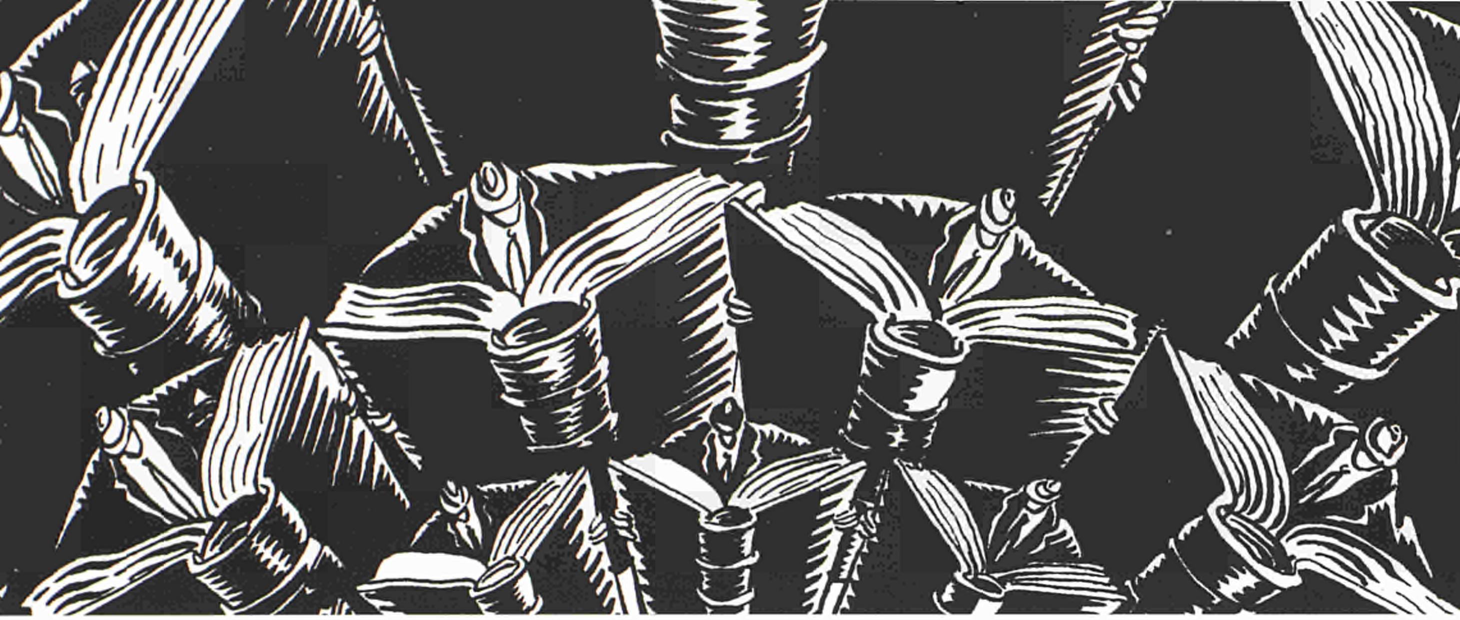
Finally the third circle, where researchers no longer exercise control. In La médiation connaissances scientifiques et techniques[1] Bertrand Labasse notes that, once they have completed their formal education, people acquire knowledge mainly via the mass media, either directly or indirectly.

The reason millions of people tried to witness the eclipse last August is because it received such media coverage. In this case an astronomical event served as a driving force for communication. But many other events are passed over in silence. "Science sells when it refers to something unknown or myste-

The media and their audience

Obviously there are different media and journalists, each with their own readership or audience. But when opinion polls indicate that the public is "very interested" in scientific questions, what does this mean? Are not visitors to science museums, the readers of science journals, and the viewers of specialised television science programmes in fact precisely the same people? We know that science sells. Science supplements can boost the sales of European dailies by 20 000 or more.[1] But what is the profile of these readers? A large audience means mass media (primarily television), but programmes and publications which attract a large audience or readership are more concerned with entertaining than educating. Perhaps an indirect approach is called for. "One could well imagine, for example, a skiing magazine publishing articles on the physics and chemistry of snow, tribology, or the physiology of effort and of altitude," suggests Mr Labasse, while pointing out that "an invisible barrier often separates this type of information from that which makes up the normal diet of these publications."

(1) Survey carried out in 1991 by Pierre Fayard for the University of Poitiers and the Cité des Sciences et de l'Industrie covering about 20 national daily newspapers in the principal European countries.



rious, to a miracle of technology such as in the field of space, or to something which affects people in their daily lives, such as health, ageing and food," explains Paola De Paoli Marchetti, president of the European Union of Science Journalists' Associations (EUSJA).

In the case of the eclipse many journalists did a remarkable job in informing their public. But in many other instances, scientists are far from satisfied. Of the 800 researchers interviewed for the purposes of the Hypothesis[2] report, more than half deplored - in order of priority - the ignorance of journalists, their misleading statements, their tendency to collectively latch on to the same thing, and their recourse to unreliable sources.

The enthusiasm - or alarm cries - of the press can be expressed in eye-catching headlines designed to boost sales, but in most cases these are not in fact the work of science journalists but of the sub-editors who have the job of adjusting the tone to comply with the wishes of their editors. Science journalists - like journalists in general - are often subject to constraints of time and space which leave little room for reflection. Subjects are also imposed on them, with pressure from lobbies and sometimes hastily arranged press conferences at which it is easier to find a marketing director than a researcher. Journalism is not always an easy job. It involves reporting the facts and the doubts, accurately presenting the thoughts of researchers and their detractors and explaining the benefits and risks of a particular discovery, while all the time being careful not to take sides or influence the public and remaining above the fray, so as not to misinform. "Science is the world of hypotheses, in which one never speaks of truth, but suggests half-truths," is how Ms De Paoli sums it up.

The most frequent criticism aimed at journalists (as a whole) is that of misinforming their readers. "In the case of sciences, this misinformation can be due to the enthusiasm of researchers who perhaps do not always express themselves with sufficient prudence. The press speaks of results when it is in fact a matter of hopes," notes the EUSJA president. "Scientists themselves can also overemphasise certain elements in order to obtain media coverage which will make it easier to secure the funds to continue their research," believes Ms De Paoli.

Changing hats

Could these reservations and negative feelings on the part of researchers, which have been confirmed by many surveys, be the result of a mutual lack of understanding of the other's job? In which case, in order to improve the communication of science, would it not be wise to start by improving relations between researchers and journalists? "There must be constant dialogue between scientists and the media," continues Ms De Paoli. "Researchers must understand that the journalist is an interface between the scientific community and the general public, and also between researchers in different fields. But perhaps, to get a researcher to express his or her views clearly, a journalist has to ask the right questions. And for that, a journalist must know the subject, which is not always easy, especially as knowledge must be continuously updated."

There have been a number of attempts to establish closer contacts between journalists and researchers. In Germany, the Max Planck Institute plays host to around ten European journalists a year and initiates them into laboratory work. A number of European universities (Barcelona, Trieste, Strasbourg, Paris, Grenoble, Belfast, Dublin, Cardiff, London) also offer specialised courses in science communication. The Unione Giornalisti Italiani Scientifici awards grants to professionals under 35 who submit a project which is useful for their professional development.

The EUSJA, with members from 22 countries, makes a remarkable effort in organising workshops with researchers, laboratory visits and fellowships for young science journalists. It also promotes the continuous updating of essential knowledge and exchanges between journalists (this year between Slovenia and Ireland). These training visits are organised in Europe, the United States and Israel. The next meeting will be attended by around 20 journalists from different countries who

(1) This report was produced at the request of the European Commission's Research Directorate-General in June 1999 and can be consulted at the new " Science, Technology and the Public" forum, launched by the Human Potential programme www.forum.europa.eu.int/Public/irc/dg12/impst-pub/home (NB: as noted earlier, this address is case sensitive; "Public" must have a capital P.)
(2) Hypothesis, Science and Media survey: Final results, Milan, 1995.

will first travel to Italy to visit the Trieste science park before continuing to the Ljubljana science park, where they will be able to talk to scientists from disciplines as diverse as astronomy, telecommunications and biology.

Conversely, the British Association offers Media Fellowships to scientists seeking to spend one or two months with the editorial team of a newspaper or TV station. Milan University 's faculty of pharmacy also runs a postgraduate course for scientists whose job involves communicating scientific knowledge - those who work in pharmaceutical laboratories, for example. Journalism, too, is a profession with its own very particular skills.

The obligation to inform

Although bridges have been built to facilitate science communication, does this mean that scientists, however unwillingly, must break their silence? Under certain national legislation, in France for example, the dissemination of scientific knowledge is now one of the key missions of scientists, along with research and education. Many European universities and leading laboratories also employ communication officers who organise open days, distribute brochures and are generally responsible for assisting journalists in their quest for information.

A number of proposals aim to systematically broaden the dissemination of research results, such as the suggestion that scientific articles and doctoral theses be accompanied by easy-to-understand summaries. Going considerably further, the Wolfendale Committee[3] believes that the receipt of research funds should imply an obligation to communicate research findings to a wide public. Do scientists see such measures as an imposition? "This type of incentive would certainly be one of the most effective in developing science communication," believes Bertrand Labasse, who adds that the idea warrants further consideration at European level. "On the one hand, it would quickly remove the still very strong taboos on the subject, as a scientist who communicates his findings would no longer be

The Web, the new marketplace

"The Web has the power of a new international community of individual consumers. Clearly scientists have a role to play in this," comments Robert Cailliau, one of the key figures in the invention of the World Wide Web at CERN, the European laboratory in Geneva (CH). A communication medium which was dreamt up independently of any institutional needs, the Web was first developed by and for scientists in the spirit of a totally free exchange of knowledge (very much the exception in a world where communication has become primarily a matter of economics and finance).

Its success soon led to the general public gaining access to what had become a universal communications tool - and to a potential revolution in their access to science. But amidst this whirlwind of messages, how can the Internet user, however expert, distinguish genuine scientific information - as credible as that contained in reference publications edited by scientists themselves - from erroneous or deliberately misleading information?

And can the Web lead to new forms of democratic debate on science? "Nobody can answer this fascinating question at present," admits Mr Cailliau. "CERN is launching a new education division this year with the aim of rethinking the way we communicate with the public. It is a difficult task as the various domains of scientific and technological knowledge are becoming increasingly interdependent - a fact which distinguishes them from the world of culture. Also, scientists are not the only participants in the debate. There is knowledge, but there are also applications. Those who apply the knowledge - industry - must do something very similar if the debate is really going to get off the ground."

viewed by his colleagues as an attention-seeker, but simply a researcher going about his job. It could also cause many scientists, especially those working in areas which do not usually receive much media attention, to seek new ways of communicating their work.

"Just like teaching," adds Mr Labasse, "if not more so, popularisation is like a mirror to the mind - it makes you take a fresh, and often very rewarding, look at your own beliefs and actions." ■

(3) Committee to Review the Contribution of Scientists and Engineers to the Public Understanding of Science, Engineering and Technology, whose report was published in London by the Office of Science and Technology in 1995.

AlphaGalileo, the cyber-agency for the scientific press

Compared to the impact of science communication networks in the United States, European research is suffering from a confidence crisis. This has long been evident in the media, where news about US laboratories often dominates.

AlphaGalileo seeks to provide a patient and constructive response to this lack of visibility. The initiative was launched in the United Kingdom in 1998 by a handful of science information enthusiasts from the very active British Association for the Advancement of Science, the Council for the Central Laboratory of Research Councils and the Novartis Foundation.

"By improving the image of research in the European media, our aim is to help the younger generation understand that research opportunities in Europe are just as good as the much vaunted opportunities which too often attract them to the United States," explains project manager Peter Green. The network also aims to demonstrate to Europeans and the rest of the world the often underestimated wealth and diversity of Europe's scientific and technological capacities. The challenge for AlphaGalileo is twofold: to convince the European research world to use this platform to improve the communication of its activities and its results, and to convince science journalists to take up the information resources it provides.(1) By December 1999, 14 months after it was set up, the pilot phase had clearly been a success, with 700 research bodies approved as contributors of information and 1 260 European journalists registered (free of charge) as regular users. The site, which can be navigated in five languages, now contains almost 2 000 press releases covering all the major scientific and technological fields. But despite receiving over 300 000 visits in just over a year, AlphaGalileo faces an uncertain future.

www.alphagalileo.org

(1) AlphaGalileo offers a very efficient automatic e-mail alert service.

Bridge the gap now

A high-energy physicist who has held senior posts for many years at CERN, the Joint Research Centre and in Portugal - where he has been Science and Technology Minister since 1995 - José Mariano Gago is also a long-standing campaigner for scientific culture. As president of the European Union's Research Council, he speaks here of the European dimension to raising public awareness of science, a goal clearly set out in the objectives of the EU's "Improving Human Potential" programme.

> "It would be a mistake to limit European science policy to allocating money for research"

Many people are increasingly concerned at the deepening gulf between those with a command of science and those to whom it remains a mystery. Are you worried by this divide?

José Mariano Gago: I do not totally agree with the idea that there is a growing gulf between science and the citizen. History tells us precisely the opposite and that relationships between science and society were much more difficult in the past. It is the actions of enlightened scientists, philosophers, teachers, and trade unionists which, since the end of the 19th century, have helped bring the two closer together. The desire to promote science education for everyone has radically transformed education, in Europe and elsewhere, and today the sciences are a major element in the compulsory school curriculum just about everywhere.

As for technology, this has never been so present or so accepted and desired by society. We have come a long way from the fears raised by the first railways! I therefore believe that the gap is closing, even if many problems undoubtedly remain.

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"It is the practice of science - experiments conducted by the pupils themselves - which, in the context of democratic education, can make a real contribution to scientific culture."

Although science is being taught and technology is accepted, our age does not seem to be one of scientific culture, does it?

The principal question to my mind is indeed the acquisition of scientific culture by the citizen. This is very limited because opportunities for the genuine acquisition of scientific culture in most people's daily and professional lives are also limited.

Paradoxically, one of the main reasons for this is that the technology incorporated in the most common products is hidden and requires no explanation. People have to be able to use a mass-produced product with their eyes closed, otherwise it would be a specialised product destined for a small market.

How can this paradox be overcome?

By creating situations which make it possible for the public to be more closely involved in the practice of science and technology. First of all, this involves education and relaunches an already long-standing debate in connection with science education, namely the role that should be granted to practical and experimental education. In certain countries with a more empirical tradition, such as the United Kingdom, it is prominent, but less so in countries whose cultural awareness is based more on written texts. But it is the practice of science - experiments conducted by the pupils themselves - which, in the context of democratic education, can make a real contribution to scientific culture.

Another approach is to establish closer links between scientific institutions and industry. This twinning can provide opportunities to update teaching staff, to make direct contacts between scientists and engineers, and to transfer new laboratory techniques to schools. Although common in the United States, this approach is the exception in Europe.

Do you think the public wants to deepen its scientific knowledge?

All the surveys carried out on this question, in Europe and in the United States, show that while people very much want to increase their scientific culture, they often do not know how to go about it. Look at public health and environment controversies such as mad cow disease, dioxin and GMOs. These are creating a genuine desire for knowledge among the general public and also provide excellent opportunities for collective learning. This type of debate will increase in the years to come. We will not only need a very strong component of scientific and technical expertise, but also a whole information network - schools, science centres, Internet sources - fed by the scientific community in order to inform the public and provide science education.

The creation of science centres, which promote interactivity, is one recent response to this information need. This new style of museum has made it possible to implement a type of informal scientific education which has attracted a new audience.

And do you believe Europe's scientific community is aware of its responsibility to educate?

Increasingly so, yes. But while it is ready to play such a role, it must also be assigned its tasks. For this there must be closer contacts between the world of science and research; and the politicians. This dialogue must be part of the ongoing debate on science and technology education and the role this could play in the future of employment.

There can be no science policy without a major element devoted to society's scientific and technological development and the conditions which create it. It would be a mistake to limit European science policy to allocating money for research. The scientific and technical culture of the population is a major problem that has long been absent from the European political agenda. It is a deficiency that must be quickly corrected. I believe it would be money well spent to allocate some European funding to scientific exhibitions, science programmes on TV, science press agencies, and actions to promote science communication.

Does the Portuguese presidency intend to launch any initiatives of this kind?

We will be stressing the role of scientific and technical culture in creating new jobs, and the importance of new factors of competitiveness in the so-called knowledge and information society. What does the information society mean if not society's adoption of the information technologies? As to the knowledge society, this not only covers the development of research but also, and perhaps above all, society's appropriation of the results of research and its processes, in particular through scientific and technological culture. This implies political initiatives in terms of training, education, and the media. It is a European question. Among other things, we must agree on the level of basic skills to be acquired by all pupils and students and the contribution of European science to the information society.

The real problem, at Union level, is the virtual absence of a structured dialogue between scientists and political institutions. But before such a dialogue - for which the scientific community is ready - can be initiated, European policy must first set clear objectives. ■

Controversies such as mad cow disease, dioxins and GMOs are creating a desire for knowledge among the general public and also provide excellent opportunities for collective learning.

Experts in the dock

The public has two perceptions of science. On the one hand are the true scientists - engaged in research - and on the other the scientific experts, summoned to sit on bodies which take policy decisions in the fields of health, diet, the environment or industrial priorities. And while they are all too often viewed in a negative light, disagreements between experts are also an excellent means of communicating the implications of science.

Too often working behind closed doors, their integrity called into question, and sometimes displaying a strange mixture of impotence and doubt (as in the thorny issue of mad cow disease), experts are most certainly not perceived as respected scholar-scientists by the general public. But, in fact, they and the researchers are the self-same people. An increasingly large part of the scientist's work today consists of contributing to expert opinions, on the basis of which decisions are taken with implications for society as a whole.

Science surpassed

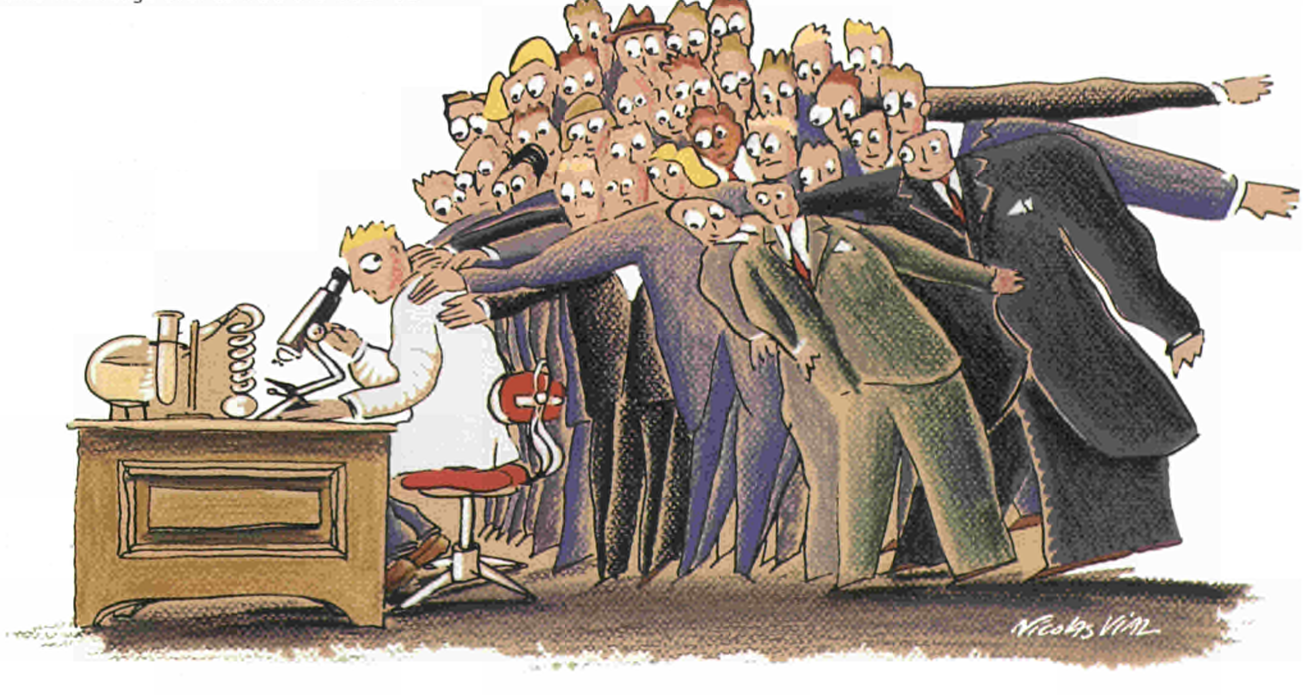
When a scientist leaves the laboratory to sit on an expert panel, he or she enters another world, and is asked to contribute his or her knowledge to help other people make choices. The problem is that no scientific knowledge ever confers the label "scientific" on the decisions taken in its name. Because science is never static, and is increasingly complex, it simply authorises an expert to state: "This is what I think, on the basis of what is known."

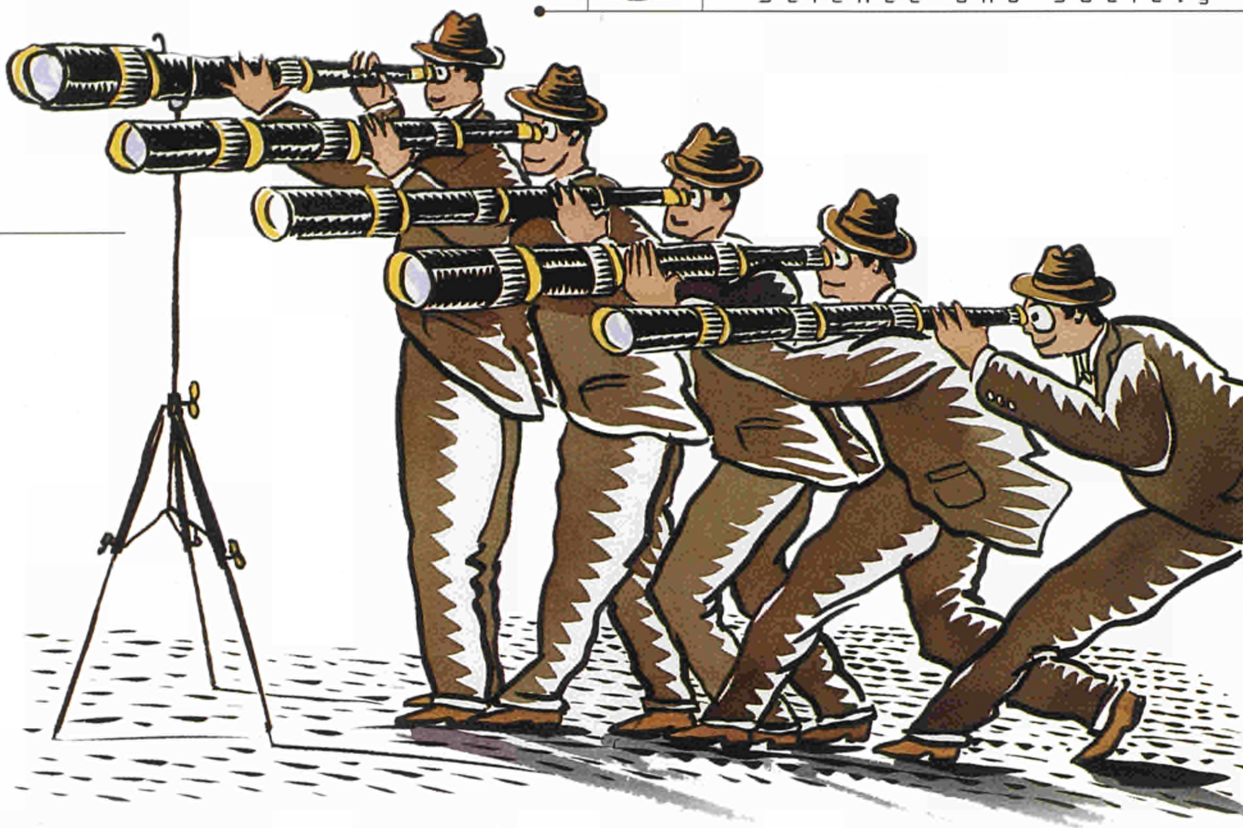
"The act of giving an expert opinion inevitably goes beyond the limits of [a scientist's] own knowledge," writes Philippe Roqueplo, a sociologist at France's CNRS and an expert on these questions.(1) "Why? Because they do not have the answer to the question posed ... This is the paradox the scientist faces when asked to act as an expert. Despite any gaps in their knowledge, they are obliged to provide the full knowledge of the facts requested by the politicians.

"Hence the conflicts between experts. These conflicts are of a totally different nature from controversies between scientists, which are in fact nothing but the collective exercising of a methodical doubt. In the case of an expert opinion, the conflict stems from the subjective beliefs of the various parties, especially as these are complex questions directly linked to major political choices. Nuclear energy, the mad cow affair and genetic engineering are all issues on which it is an illusion to believe you can be neutral! ... An expert opinion requires scientists to express convictions which exceed their real knowledge."

The legal model

The debate-dispute between the experts can become a genuine tool for dialogue between science and society - provided it becomes public and avoids the confidentiality and obscurity which is too often the





rule. But the difficulties of organising this "democratisation" of public, expert, scientific opinion are far from being solved. Mr Roqueplo would like to see a mechanism based on a legal model and a confrontation between experts which is similar to that between opposing counsels in a court of law.

In order to persuade the judges or decision-makers, the lawyer-experts would analyse the facts, build an argument which they could defend and - the key point - look for contradictions in the arguments of the opposing party. It is then not they who would decide, but the decision-making judges or juries who represent the public and who, like all spectators, would have formed a favourable or unfavourable opinion of the summing up.

Mr Roqueplo would also like to see research bodies and scientists set up a permanent public forum for the delivering of expert opinions. In many fields these are increasingly having to convene - after the event - in 'crisis sessions', their findings often likely to be met by incomprehension among the general public. So why not ask the world of research to make its expert evaluation before the event in the many sensitive fields where science and technology have a major impact?

"Expert opinions must be able to build on each other; in a sense, an expert opinion should always be prepared before the problem in question arises. I am aware that this proposal may seem extreme, but it is nonetheless what society expects of the scientific world. And I do not believe society is going too far, in particular because science and technology have become risk factors."

(1) Entre savoir et décision, l'expertise scientifique. Published in the Sciences en question collection by INRA publications (French Institute for Scientific Research) ISBN 2-7380-0713-9.

The end justifies the beginning

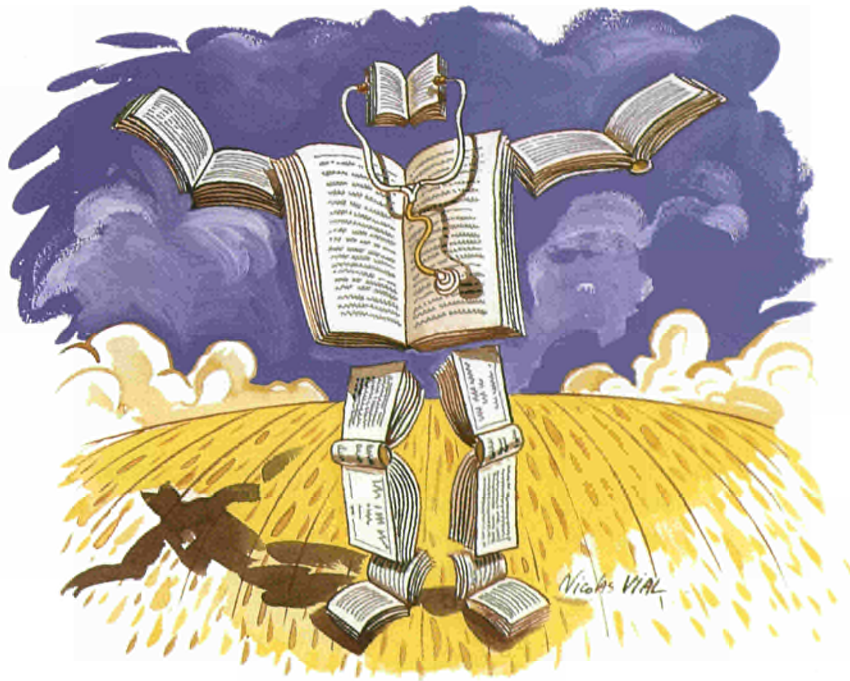
"More and more, the strategic time for a product is not the time of its launch but of its discontinuation. What is going to become of it when it is no longer needed? That is the increasingly important question," believes Mr Roqueplo. CFCs are no doubt the most famous example of this. Their popularity was due to the fact that they were inert, did not react with anything and were chemically ideal for many immediate applications. But this inertness was the reason for their build-up in the stratosphere where, at a temperature of minus 50°, they were reactivated. They then displayed a remarkable ability to destroy the ozone layer which protects the Earth from UV radiation. The lesson to be learned is that no technology can be launched without taking into account its future obsolescence. This changes the whole logic of innovation, which is no longer driven solely by the desire for increased economic power, productivity gains, or the launch of perfectly targeted and innovative products. This logic, says Mr Roqueplo, "is increasingly justified by the constraints which new regulations concerning product disposal, or new behaviour by consumers aware of the problems disposal causes, place on companies. It is no longer simply the laws of the marketplace which operate between manufacturer and purchaser, but also the actions of the regulatory authority and the fact that the purchaser not only acts as a customer but also as a more-or-less well-informed citizen."

Maintaining "technonature"

The Intergovernmental Panel on Climate Change (IPCC) - a body with its origins in the UN climate convention drawn up following the Rio summit - is an example of such a public forum for expert opinion. Its mission is not to undertake research [(2)] but to relay information. The IPCC regularly - and publicly - evaluates the stock of knowledge about climate change as a basis for policy decisions. Sometimes accused of being a lobby for climatologists, the IPCC is not a body which speaks with a single voice, and those with opposing views are perfectly free to express them.

The debate on climate change provides an excellent example of the challenges facing the expert scientific opinion today. "In a sense, the way technology has rendered nature artificial has produced a technonature which must be maintained by society, and that is the new situation," explains Mr Roqueplo. "There is a kind of technological saturation of nature which is starting in return to affect our existence ... Any malfunctioning at any level in nature becomes a political problem and it is interesting to ask why." ■

(2) There is a specific structure for this at the international level: the IGBP (International Geosphere-Biosphere Programme).



"Common sense" has its say

The idea of consensus conferences - renamed citizens' conferences in France - originated in Denmark. It was first launched in 1987 at the initiative of the Teknologiråd - which advises the Danish parliament in assessing scientific and technological options. The process involves bringing together a panel of between 10 and 20 ordinary people and a team of experts, over a three-day period. The experts must explain a controversial scientific or technological issue with implications for the future of society to the panel of laypersons and answer their questions. The citizens involved then draw their conclusions and make recommendations which are published and debated in the press. Before the conference itself, the selected citizens will have met over at least two weekends during which they will have studied documentation on the subject and prepared their questions.

The experiment, with its emphasis on open debate, has already been repeated about 15 times in Denmark[(1)] and has since been tried in the Netherlands, the United Kingdom and France with very positive results. The conclusions reached by citizens' panels of this type do not claim to express public opinion as a whole. But they do open up the democratic debate on science more than most opinion polls, by contributing a valuable "common-sense" opinion which is independent of the intellectual or material interests of those directly involved in scientific or technological progress. Such opinions reflect a very careful and in-depth consideration of the issues raised and of the expectations and fears of those who no doubt form the majority. These conferences receive extensive media coverage in the countries in which they are held and mark a very interesting new development in communicating science and the democratisation of the issues it raises.

(1) They have considered such diverse subjects as agricultural and industrial genetic engineering, genetic engineering on animals, applications of knowledge acquired from the human genome, artificial reproduction, air pollution and the future of the private car.

Showcases for science and technology

In their different ways, traditional science museums - with permanent collections, displayed in a historical context, and thematic exhibitions - and educational, interactive "science centres" are encouraging a more and more diverse range of people to explore the various fields of scientific knowledge - and their applications.

Over the last century or more, the mission of science museums has been to conserve, to educate and to transmit knowledge. During the last 20 years, "science centres", born of a new technological context, have been highlighting a more lively and interactive approach to the acquisition of scientific knowledge.

"The educational component - that is the transmission of scientific knowledge - is more developed in traditional museums, whereas science centres create emotion and the desire to know more," explains Walter Staveloz, manager of the Ecsite network. "But over the last few years there has been a twofold movement. The science centres are tending to return to the original approach by highlighting the object - the historical object or collection which creates its own emotion. And the museums, which have realised that visitors are no longer satisfied with simply looking at the contents of a showcase, have incorporated interactive techniques into their presentation."

Varied visitors...

Despite this, whether it's lifelong learning, cultural tourism, virtual - thus more informal - education, or traditional teaching, science museums and centres continue to offer complementary approaches and are proving increasingly successful. Vienna's Technology Museum, for example, founded in the 19th century, has just welcomed 100 000 visitors in the space of two months having "modernised" its presentation and broadened its activities.

Schools are particularly frequent visitors. "Children are born into a world of images, while teachers have learned through writing. The science museums and centres provide them with an alternative learning space, one presenting a new form of communication as well as reliable content. Some of them coordinate all their educational projects and draw up documents adapted to their national education system," says Mr Staveloz.

"Jeux de Lumière" (Light Games) exhibition at the "Cité des Sciences et de l'Industrie"

... and diverse debates

For the public as a whole, museums are a source of information on contemporary technological and scientific developments. Their websites too are often a rich source of information, presenting valuable knowledge, referring visitors to specific documentation and sometimes offering genuine discussion forums. "Can museums fulfil this role as public forums for debate?" wonders Paul Caro, scientific affairs manager at the Cité des Sciences et de L'Industrie in Paris. "This role involves entering into technical explanations and evaluating them - and many of us already have a presentation of basic information suitable for the general public. To be honest, I do not really see which other institutions could take on the responsibility of bringing democracy to technology. It will probably be a difficult step for museums to take, as they will be laying themselves open to criticism and controversy, but it will be a way for them to be part of contemporary society." ■

Museum network

Ecsite (European Collaborative for Science, Industry and Technology Exhibitions) brings together 240 science museums and centres in over 35 countries (Europe, the United States, Latin America, Australia, Asia, Israel) which together attract more than 25 million visitors a year. The network provides an area for the exchange of information and experiences as well as cooperation on joint projects. All members are accessible on the Internet from Ecsite's own website.

Contact **Walter Staveloz**
Fax: +32-2-647 50 98
wstaveloz@ecsite.net
www.ecsite.net/

Open forum

RTD info is pleased to launch a double-page forum. This regular feature will provide a flexible and informal platform for reports, thoughts, opinions and statistics which we believe warrant a wider audience. The forum is designed to be an invitation to discussion and debate, and a place for ideas - with which we trust our readers will keep us well supplied.

[Contact: Michel Claessens – Fax: +32-2-295.82.20 – michel.claessens@cec.eu.int]

Footnote

Klaus Ammann, Director of the Botanical Gardens at Berne University, recently gave a lengthy interview on the subject of GMOs to the French monthly La Recherche (November 1999). It included this remark: "Many researchers pursue their work in a vacuum, without paying any regard to its future impact on society. Many scientists are in fact technocrats of science and are not interested in the real world at all."

A deliberately provocative comment? We invited Dr Ammann to explain further. Here is his reply:

"Science has a lot of geniuses and genius is often linked to a very great capacity to concentrate on a precise subject. Excessive specialisation - especially when it leads to recognition - results in a research approach founded on experimentation which is too reductionist, which erases the complexity of the environment. Recent hypotheses on the monarch butterfly (1) seem to me to be a good example. In this case a laboratory experiment led to conclusions which could never have been drawn from research conducted in nature, where the monarch is not endangered at all. Experiments are of course necessary, in molecular biology for example, but researchers must maintain a certain distance from their work. Many still believe in the notion of exact science without taking any philosophical or epistemological considerations into account. It was to this kind of scientist that I was referring, not to the many researchers who carry out excellent work - such as in the field of health - which is of great use to society."

(1) According to an article published in the May issue of Nature magazine, pollen from transgenic maize resistant to the insecticide Bt affects the caterpillars of the monarch butterfly.

Personal Opinion

Did you say "sustainable"?

The use of the adjective "sustainable" in many different contexts can cause the scientist seeking clear definitions to raise a number of questions. A convenient and flexible term, it initially relates to sustainable development, a world project designed to respond to a particular crisis affecting the idea of progress. In aiming to integrate environmental, social and economic aspects, this project appears both ethical and rational. But the simple mention of the term sustainable is clearly not enough to meet these conditions. Apart from the possibility of simply "re-labelling" in order to jump on the bandwagon, there remains the matter of defining the implications of this criterion.

Sustainability is not a sufficient condition, or necessarily a desirable one. Neither the environment nor societies need necessarily conserve all their elements. The desert is sustainable for example, but that does not make it an ecological model. Historically, marked divisions in society have proved sustainable. On the other hand, any innovation is essentially a change compared to an initial situation.

However, we cannot fail to recognise in the current stress placed on sustainability the search for a counterbalance to the rapid and profound changes we have been witnessing at the turn of the century. Our world is the scene of growing interactions leading to instability. Every day we must turn our attention to a rapid succession of subjects. Fashion and, in part, politics, are governed by the desire to

Figures

■ **Research expenditure** - In absolute terms, the EU spent more than €135 billion on R&D in 1997, less than the United States (€168 billion) but more than Japan (€107 billion). This expenditure increased by 14% over the past decade, compared to an increase of 21% in the US and 35% in Japan. Germany, France, Italy and the United Kingdom account for three-quarters of the EU's research effort. But the Nordic countries are particularly active, Sweden devoting 3.8% of its GDP to research, Finland 2.8% and Denmark 2.1% (compared with the European average of 1.9%). The private sector accounts for 63% of research expenditure across the EU, universities and research centres 21%, and governments 16%. The proportion varies from country to country: in Sweden 75% of research is funded by companies and 4% by the state, in Portugal 22% by the private sector and 24% by government. At the regional level, the Ile de France leads in absolute terms, spending more than €11.4 billion (1996), but in relative terms some regions of Germany are ahead, with Bavaria in first place spending 4.72% of its gross regional product.

■ **Health** - 75% of the world's population consumes 15% of the world's medicinal products. Out of more than 1200 new medicines introduced during the past 15 years, only 11 are for the treatment of a tropical disease.

■ **Inventiveness** - One of the measures of a population's creativity is the number of patents per million active persons. According

move on to the next thing. As the new century begins, our societies are asking questions about their permanence, and also the permanence of our constructions, of our techniques, of forms of life.
Faced with these deep-rooted trends, which are not without their risks, sustainability gives the opportunity to call matters into question. But it can only do this if it asks research questions rather than presenting itself as a response which it is not.

Edwin Zaccaï, co-director of the Centre for Sustainable Development Studies at the Université Libre de Bruxelles.
ezaccai@ulb.ac.be

Clippings

■ **Bureaucracy** - "What is needed in Europe is not a new bureaucracy to deal with research infrastructure, but for science ministers and funding agencies to start thinking in terms of European solutions, and acting accordingly." *Nature*, 4.11.99.

■ **Time** - "To deny time is to create a genuine paradox which is damaging to our understanding of the world and how to live in it." Ilya Prigogine, winner of the Nobel Prize for Chemistry 1977, *Le Soir* (B) 17.11.99.

■ **Diseases** - "There are approximately 3 000 [diseases] which all involve genes the disturbance of which is in itself enough to trigger an often serious illness. Yet these diseases only affect 0.5% of the total population. In other words: economically speaking they are of no interest to anyone. Whether we like it or not, the public system is a market system, and it is just as expensive to develop a medicine for a rare disease as for a common ailment: an average of 3 billion francs [460 million euros]. The result is that no government wants to invest in research into rare diseases." Daniel Cohen, geneticist, Genset, *Le Monde* (F), 23.11.99.

■ **Collaboration** - "There is a ridiculous amount of paperwork involved and I'm sure much of the suspicion about Europe is about the cost of the bureaucracy. But my feeling is that anything that creates collaboration is going to be very positive for both Europe and science as a whole." Sir Harold Kroto, winner of the Nobel Prize for Chemistry, *The Times* (UK), 24.9.99.

■ **GM crops** - "More scientific research and monitoring of the effects of GM crops and food are needed, but research may never resolve the uncertainties, so decisions on how much uncertainty to accept is essentially a political judgement." Robert Grove-White of the University of Lancaster, *The Times* (UK), 22.10.99.

■ **Discoveries** - "Today, discoveries are the result of cooperation between many different players, often from outside the field of research." Rémi Barré, director of the Observatory on science and technologies, *Le Monde*, 12.10.99.

■ **Women** - "Research on the subject of women used to be met with amusement, it was a bad career move. Today it has almost become the bread and butter of university researchers - and so much the better if that means that their work is finally going to be taken seriously." Dora Mahfoudh, president of the Association of Tunisian women for research and development, *Le Monde*, 13.10.99.

Letters

Jean-Claude Charry, national representative for actions to restore mountain sites (F), wrote to make a number of points in connection with the article "Defence against the white fury" (*RTD info* 24).
"The risk index (1 to 5) is determined per massif (Mont Blanc, Pyrénées ariégeoises); it is information intended for managers of services (communications, skiing areas) and people practising winter sports in a natural environment; these people interpret the index and the accompanying explanation locally (valley, site, route), in order to evaluate a risk level which then determines the decisions they take.
"Consequently, there cannot be a direct and automatic link between the issuing of an index 4 or 5 and the implementation of measures to evacuate a population, as could be inferred from your article. Your article also describes preventive evacuations as unnecessary and false alarms ... your journalists misunderstand the principle of precaution ... Finally, I regret that your article calls into question "the local planning officials" who are described as being "too intent on encouraging the development of tourism", a suggestion which is based on polemics and which has no place in a scientific and technical publication."

We do not in any way claim that preventive evacuations are unnecessary. We wrote that they "prove to be unnecessary", that is, after the event. As to the role of local officials, we would point out that we in fact say that "The local planning officials were often accused of..." We are not making our own accusations, but alluding to articles which have appeared in the press - after having referred to the sometimes exaggerated media coverage of these events.

to this criterion, Bavaria leads the European Union (1012), followed by the Stuttgart (942) and Stockholm (759) regions.

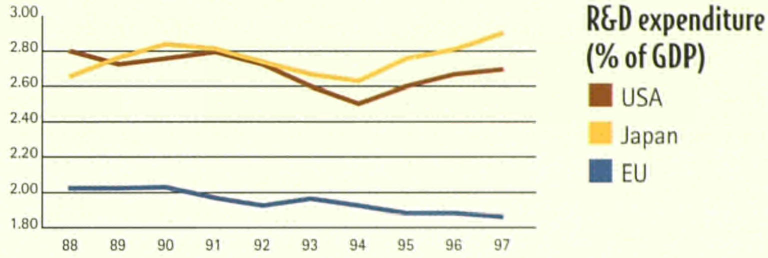
■ **Physical sciences** - Physics is attracting fewer and fewer students in Europe: in Germany there are only half as many as in 1991, while in the United Kingdom numbers have dropped from 553 (1993) to 181 (1998). This trend means it is not going to be easy to replace university lecturers when you consider that 30% of physics lecturers and 28% of chemistry lecturers at British universities were aged over 55 in 1996/97 and will be retiring before 2007. Physics is being ignored in France too, where, more generally, the number of science students as a whole fell from 150 000 to 125 000 between 1995 and 1999.

■ **Choice** - Three-quarters of young Irish people say they do not want to work in the science and technologies sector, which are seen as fields that are both boring and difficult. The country is set to see an annual fall of over 2000 in the number of engineers, technicians and computer scientists by 2003 - a deficiency which, to be corrected, would require an increase of between 17% and 24% in the number of young people opting for careers in science and technology by that date.

■ **Paper** - According to researchers at the Worldwatch Institute (USA), 20% of all the trees felled worldwide are processed into paper - a material which accounts for almost 40% of the solid waste produced by certain countries. The paper industry also accounts for 20% of total industrial energy consumption.

News in brief

Paving the way to a stronger European research area



At a time when the development of a knowledge-based society is promising increased opportunities, a number of indicators reveal a worrying trend in European research. The EU as a whole invests just 1.8% of GDP in research, compared with 2.8% for the USA and 2.9% for Japan. In 1998, European research expenditure was 60 billion euros less than that of the USA, compared with 12 billion euros less in 1992. Europe also records an annual trade deficit in high-technology products of some 20 billion euros. Finally, researchers represent only 0.2% of European industrial employment, compared with 0.7% in the United States and 0.5% in Japan. It was these alarm signals which caused European Commissioner Philippe Busquin to present a communication to the Council and the European Parliament in January 2000 recommending a more integrated and less compartmentalised approach to European science and technology. "National research policies and Union policy overlap without forming a coherent whole," the document points out. "If more progress is to be made a broader approach is needed than the one adopted to date. The forthcoming enlargement of the Union will only increase this need."

Strengthening the European research area in this way will require a policy aimed at promoting:

- the emergence of centres of excellence which are better recognised and more accessible, to researchers both in Europe and in the rest of the world;
- the interactive networking of research players leading to the creation of genuine virtual laboratories;
- greater coherence between the activities and major infrastructures of national and European research;
- an environment which encourages more investment in research and innovation;
- increased employment opportunities and mobility for researchers, including an increased role for women, encouraging young people to pursue careers in science, and highlighting the European dimension of scientific careers;
- common social and ethical values in the face of changes in science and technology;
- the introduction of flexible, "variable geometry" programmes at a European level;
- the synergies of "dual-use research" in certain areas, giving rise to applications in both the defence and civil sectors.

In future issues, *RTD info* will be returning to the wide-ranging debate which this communication seeks to instigate - particularly via the Web address below.

http://europa.eu.int/comm/research/area.html

Ten priority actions for the Information Society

In order to help all parts of society - citizens, enterprises, administrations, schools, etc. - to enter the digital age, the European Commission has launched a new initiative: eEurope - An Information Society for All. "Europe has already successfully accomplished historic projects such as the Single Market and the euro. There is no reason not to take the political step of producing a similar dynamic forward-looking response to the Information Society," explained Romano Prodi, presenting this project on the eve of the Helsinki European Council. Ambitious objectives to be very quickly realised have been set in 10 priority areas which include education, health, transport, e-commerce and "government online". By the end of 2001, researchers and students must have fast Internet access via a network linking universities, research centres, higher-educational establishments and vocational-training centres. By then work should also be completed on developing common specifications for chip cards giving access to applications requiring a high level of security. Traffic management and information systems should also be in place in the road and air transport sectors by 2002-2004. Finally, a pan-European venture capital market should be operational to launch innovative and fast-growing enterprises using the new information technologies. This initiative - which promises to stimulate employment - is to be discussed at the special European Council in Lisbon on 23 and 24 March.

http://europa.eu.int/comm/dg13/index.htm

The common core of genes

In December 1999 the journal Nature reported that the sequencing of the 37 million DNA base-pairs of chromosomes 2 and 4 of the plant Arabidopsis thaliana had been completed. This ambitious project was carried out by US laboratories and some 30 European laboratories supported by the EU's Biotechnology programme as part of a vast international effort for scientific cooperation, in which Japanese laboratories also participated. The sequence analysis revealed the presence of nearly 8000 protein-coding genes - almost a third of the total number of genes in plants - which will provide a remarkably rich source of material for genetic research, not just on plants but on other organisms too, including man. The surprising discovery is that genes from the plant world have much more in common with human genes than with other organisms.

First launched in 1994 at the initiative of European scientists, the complete genome sequencing of Arabidopsis (about 100 million base-pairs in the three remaining chromosomes) could be completed by the end of this year.

europa.eu.int/comm/research/press/1999/pr1412en.html

Science against doping

Research is spearheading the fight against doping. But what are its priorities? And what means do the athletes and representatives of sporting bodies, the doctors and the courts envisage using in combating this scourge? In 1998 and 1999, the Hardop project, under the aegis of the International Olympic Committee and the European Union, sought to take stock of a situation which affects amateurs and professionals alike.(1) They identified two deficiencies: the lack of cooperation between the various circles concerned and the absence of the necessary international harmonisation in terms of legislation, the attitude of the sporting authorities, laboratory checking techniques, etc.

It was to provide this kind of link, and to implement harmonised procedures and standards that the IOC and the EU decided to set up a central body charged with conducting the fight against doping at an international level, complete with a reference laboratory.

As far as research is concerned, this new body will, among other things, serve as a scientific and technological watchdog which (in cooperation with fundamental research and industry) should make it possible to stem the "advances" in developing these banned substances. This is research which extends far beyond the world of athletes and corresponds to the concerns of society as a whole.

The results of the Hardop project are also published in a report entitled "Harmonising the ways and means of fighting against doping in sport", which can be consulted on-line.

europa.eu.int/comm/research/smt/hardop-en.pdf
eddie.maier@cec.eu.int - Fax: +32-2-295 82 20

(1) See the article in *RTD Info* 23 (Sept. 99)

The European research on line

Departments/Programmes	E-mail	Web addresses
Commissioner Busquin's home page	research@cec.eu.int	europa.eu.int/comm/commissioners/busquin/
General information	research@cec.eu.int	europa.eu.int/comm/research/
Framework programme	research@cec.eu.int	europa.eu.int/comm/research/fp5.html www.cordis.lu/fp5/
Quality of Life and Living Resources	quality-of-life@cec.eu.int	www.cordis.lu/life/
Information Society	ist@cec.eu.int	www.cordis.lu/ist/
Competitive and Sustainable Growth	growth@cec.eu.int	www.cordis.lu/growth/
Energy, Environment, Sustainable Development	eesd@cec.eu.int	www.cordis.lu/eesd/
Nuclear Energy	eesd@cec.eu.int	www.cordis.lu/fp5-euratom/
International Cooperation	inco@cec.eu.int	www.cordis.lu/inco2/
Innovation/Participation of SMEs	innovation@cec.eu.int research-sme@cec.eu.int	www.cordis.lu/innovation-smes/
Human Potential	improving@cec.eu.int	www.cordis.lu/improving/

Calls for proposals: overview

Deadlines 2000

QUALITY OF LIFE AND MANAGEMENT OF LIVING RESOURCES (www.cordis.lu/life)

KEY ACTIONS	FEB	MAR[2][3]	APR	MAY	JUNE	JULY	SEPT	OCT[2][4]	NOV	DEC
Food, nutrition and health		15						11		
Control of infectious diseases								11		
The "cell factory"		15						11		
Environment and health		15								
Sustainable agriculture, fisheries and forestry		15						11		
The ageing population and disabilities		15								
Generic research										
OPEN CALLS [1]	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**
Training: Marie Curie individual fellowships			12					11		
Research training networks	1									
SME Measures (exploratory awards / cooperative research)			26				13			
Accompanying measures	10				12			11		
Support for research infrastructure		15						11		

(1) Call published on 6/3/99 - (2) Call published on 15/12/99. For the two deadlines of 15/3/2000 and 11/10/2000, the fields of research included in the various key actions and for generic research are specified.

USER-FRIENDLY INFORMATION SOCIETY (www.cordis.lu/ist)

KEY ACTIONS	FEB	MAR	APR	MAY[1]	JUNE	JULY	SEPT	OCT	NOV	DEC
Systems and services for the citizen				10						
New methods of work and electronic commerce				10						
Multimedia content and tools				10						
Essential technologies and infrastructures				10						
Cross-programme themes				10						
Future and emerging technologies [2]				10						
Research networking				10						
OPEN CALLS	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**
Future and emerging technologies [3][4][5]	Open until 15/9/2000									
Support measures [5]	Open until 15/9/2000									
SME Measures (exploratory awards / cooperative research) [6]			26				13			
Intelligent manufacturing systems			1							

(1) Call scheduled on 8/2/2000. Indicative closing date - (2) Proactive initiatives - (3) Open sector - (4) Evaluation at least every 3 months - (5) Call published on19/3/99 - (6) Call published on 16/3/99

COMPETITIVE AND SUSTAINABLE GROWTH (www.cordis.lu/growth)

KEY ACTIONS	FEB	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
Innovative products, processes and organisation		31[1]					15[4]			
Sustainable mobility and intermodality		31[1]					15[4]			
Land transport and marine technologies		31[1]					15[4]			
New perspectives for aeronautics		31[1]					15[4]			
Generic research		31[1]					15[4]			
Measurements and testing research		15[2]-31[1]					15[4][5]			
Support for research infrastructure		15[2]-31[1]					15[4][5]			
OPEN CALLS [3]	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**
Training: Marie Curie individual fellowships		22					18			
SME Measures (exploratory awards / cooperative research)			26				13			
Accompanying measures		15					15			
Intelligent manufacturing systems			1				15			
Expressions of interest on research needs					15					

(1) See periodical call published on 15/12/99 for the fields and types of action concerned - (2) See targeted call Measurements & Testing and Infrastructures published on 15/10/99 - (3) Reception deadlines for call published on 16/3/99 - (4) Periodical call scheduled for 2/6/2000 - (5) Targeted call scheduled for 15/4/2000

ENERGY, ENVIRONMENT, AND SUSTAINABLE DEVELOPMENT (www.cordis.lu/eesd)

KEY ACTIONS	FEB[1]	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
Sustainable management and quality of water	15									
Global change, climate and biodiversity	15									
Sustainable marine ecosystems	15									
The city of tomorrow and cultural heritage										
Cleaner energy systems, including renewables				1[2]						
Economic and efficient energy for a competitive Europe				1[2]						
Support for research infrastructure	15[3]									

(1) Call published on 18/11/99 (2) Indicative date, to be confirmed with the launching of the call (3) Environment and sustainable development only

Periods for which deadlines have not yet been decided; these will be published in future calls.

Legends

Submission deadlines (for specific research actions)

Batch evaluation dates (for open calls)

For the latest information on calls for proposals and calls for tender, see: www.cordis.lu/fp5/src/calls.htm

Deadlines 2000

OPEN CALLS [1]	FEB	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
Generic research	15			Next selection scheduled for 16/4/2001						
Training: Marie Curie individual fellowships		22		Next selection scheduled for 21/3/2001						
SME Measures (exploratory awards / cooperative research)			26				15			
Accompanying measures	15			Next selection scheduled for 15/2/2001						

(1) Call published on 20/3/99.

NUCLEAR ENERGY (www.cordis.lu/fp5-euratom)

KEY ACTIONS [1]	FEB	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
Nuclear fission										
OPEN CALLS [1]	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**
Generic research										
Support for research infrastructures										
Training: Marie Curie individual fellowships					14					
Other training actions [2]		27					25			
Accompanying measures		27					25			

(1) Call published on 20/3/99 - (2) Special courses, research training networks, cooperation with countries outside the EU.

INTERNATIONAL COOPERATION (www.cordis.lu/inco2)

CALLS BY COUNTRY GROUPS [1]	FEB	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
States in pre-accession phase							15[2]			
Copernicus 2							15[2]			
Mediterranean partners (INCO-MED)										
Developing countries (INCO-DEV)							15[3]			
OPEN CALLS [4]	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**
Accompanying measures				Evaluations every 4 months						
Fellowships for Japan		1								

(1) Call scheduled for 15/3/2000 - (2) Accompanying measures: increasing awareness and training - (3) Research projects, concerted actions and networks on selected themes. - (4) Call published on 27/3/99 except for group of emerging economies and industrialised countries for which call was published on 6/8/99

INNOVATION / PARTICIPATION OF SMES (www.cordis.lu/innovation-smes)

OPEN CALLS [1]	FEB	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
SME Measures (exploratory awards / cooperative research) [2]			26				13			
Economic and technological intelligence projects [3]		2				2			2	
Innovation projects							15[4]			
Awareness and assistance actions in the field of IPR and in the field of Innovation finance										15[5]
- Pilot action: Europe's patent academia - accompanying measure: directory of EU start-ups										15[5]
Pilot projects related to access to private finance							15[4]			
- Innovative regions in Europe Network							15[4]			
- Regional Innovation Strategy projects in NAC										

(1) See CORDIS for calls for proposals and calls for specific promotion and encouragement actions - (2) Call published on 1/4/99 - (3) Call published on 23/4/99 - (4) Provisional deadline for a call scheduled for 15/06/2000 - (5) Provisional deadline for a call scheduled for 15/09/2000

HUMAN POTENTIAL (www.cordis.lu/improving)

OPEN CALLS	FEB	MAR	APR	MAY	JUNE	JULY	SEPT	OCT	NOV	DEC
Research training network [8]									4	
Marie Curie individual fellowships [1][2]		15					13			
Marie Curie industry host fellowships [3]					15					
Marie Curie development host fellowships and training sites [4]				Next deadline: 16/5/2001						
Research infrastructure: cooperative networks and exploratory workshops [5]	15									
High-level scientific conferences [1]	1									
Awards for first-class research [9]		17[10]			29[11]					
Raising public awareness of science and technology [6]			15							
S&T policy strategy: thematics networks [7]								5		
S&T policy strategy: studies [2]		Open till 2/6/2000								
Accompanying measures for the programme [8]		Open till 28/6/2002								
KEY ACTIONS	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**
Socio-economic knowledge base		15								

(1) Call published on 2/3/99 - (2) Individual fellowships, return fellowships, experienced researcher fellowships - (3) Call to be published on 15/02/2000 (4) Call published on 11/6/99 - (5) Call published on 15/11/99 - (6) Call published on 15/1/2000 - (7) Open call on 16/6/99 - (8) Call to be published on 15/6/2000 - (9) Call published on 1/12/99 - (10) Descartes Prize - (11) Archimedes Prize

Diary

- *Women and science* - 3-4/4/2000 - Brussels (B) - Conference bringing together scientists and public decision-makers to debate the conclusions of a report drawn up by a group of experts on the under-representation of women in science.
- *Enlarged ministerial conference on the information society and knowledge* - 10-11/4/2000 - Lisbon (P) - Wide-ranging discussion forum organised by the Portuguese Presidency of the EU.
- *TERENA European Conference* (Association of European Academic and Research Networks) - 25/5/2000 - Lisbon (P).
- *Photovoltaic solar energy* - 1-5/5/2000 - Glasgow (UK) - Organised by the Joint Research Centre.
  pv.conf@jrc.it
  www.wip.tnet.de/pv00.htm
- *Eureka meets Asia* - 23-27/5/2000 - Macao (China) - The second Europe-Asia meeting (the first was in 1998), focusing on technologies for sustainable development.
  Isabel Caetano - Agencia de Innovação (P)
  icaetano@adi.pt
  www.adi.pt
- *CRIS-2000 - Knowledge at work - research information for society* - 25-27/5/2000 - Helsinki (FI) - The fifth such event, organised by the Innovation & Participation of SMEs programme, will be looking at innovative approaches opened up by the Internet for creating and disseminating research information. The CRIS-2000 Cybercafé will be opening in preparation for the event.
  cris2000@hut.fi
  www.hhut.fi.misc/cris2000
  ww.cordis.lu/cris2000
- *Official opening of Expo2000 (and the EU pavilion)* - 1/6/2000 - Hannover (D) - see box *Tunnel of Visions.*
  www.expo2000.de/englisch
- *First world conference & exhibition on Biomass for Energy* - 5-9/6/2000 - Seville (E).
- *Beyond the genome: understanding and exploiting molecules and cells in the 3rd millennium - 18th International Congress of Biochemistry and Molecular Biology* - 16-20/7/2000 - Birmingham (UK)
  info@iubmb2000.org
  www.iubmb2000.org/
- *EurOCEAN 2000 - the European Conference on marine science and technology* - 29/8-2/9/2000 - Hamburg (D)
  klaus-guenther.barthel@cec.eu.int
  europa.eu.int/comm/research/envsc/eurocean.html

The Mediterranean and climate change

Six years of research, 1 000 days at sea collecting and analysing data, more than 300 scientists from 53 laboratories in 13 countries (Europe, Morocco and Tunisia), and Union support of 10.8 million euros. Since 1994, the ambitious Mediterranean Targeted Project (MTP) has brought together leading experts in marine sciences and other disciplines from throughout Europe. They analysed data obtained during research voyages, conducted laboratory experiments and developed mathematical models to understand the complex processes which govern and shape this enclosed sea and to discover how its ecosystems are formed. They studied deep-water temperature changes and salinity, the increase in nutrient levels due to human activity in coastal zones, the density of plankton and marine fauna, and the levels of pollution with heavy metals such as lead. Evidence of the Chernobyl disaster was also found in the high levels of Caesium 137, especially in the Northern Adriatic. A 3% increase in phosphorous (waste from human activities) leading to an increase in eutrophication (and consequently an increase in certain algae) was found in the coastal zones of the Western Mediterranean. The scientists also discovered (by means of simulations of the Eastern Mediterranean Basin) the determining role of phosphorous (and not nitrogen) in the growth of phytoplankton. One of the main sources of the phosphorous in this region is Saharan dust.

The Mediterranean also proved to be an excellent indicator of the climate changes which affect its temperature, salinity, deep-water currents and marine productivity. The Mediterranean's strong sensitivity make it of great value as an indicator, warning of the likely effects of climate change on the world's oceans in general. The MTP project has in fact already served as a model for similar studies in other parts of the world, especially the China Sea.

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More resources for risk capital

Set up in 1997, the MET (European Mechanism for Technologies) invests in venture capital funds which support the creation and development of high-tech SMEs in Europe. Managed by the European Investment Bank, the MET is allowed to acquire minority shareholdings (maximum 25%) and has already invested 85 million euros in 19 funds. But with an allocation which has just been doubled, this is only the beginning. Following the decision of the EIB Board of Governors it will have 250 million euros to invest.

Research in Switzerland

You are looking for European project partners... Find one in Switzerland! This is the title of the leaflet issued by the Swiss Federal Office for Education and Science (OFES) addressed to EU researchers seeking to present projects in response to European calls for proposals. This leaflet as well as full details on Swiss scientific institutes and companies with research capabilities can be obtained by consulting the websites or from the e-mail address below.

www.admin.ch/bbw/formulare/pc5ch-e.pdf
(brochure in English)
www.admin.ch/bbw/infonetz/f/entry.html
(website in French - no English available at present)
claude.vaucher@bbw.admin.ch

Two new European scientific prizes

This year the Improving Human Potential programme launched two, new, top-level scientific competitions to stimulate and highlight the added value of cooperation between European researchers - whatever the field of science or technology, economic and social sciences included. The Descartes Prize will be awarded to collaborative research involving at least two EU Member States (or one Member State and one country associated to the Fifth Framework Programme) and resulting in highly significant scientific or technological progress. Winners can receive financial support of as much as 50 000 euros per research team, either for disseminating the results or pursuing their work further. Closing date for applications: 17 March 2000.
The Archimedes Prize is for research carried out by students who, as part of their predoctoral university course, have developed original scientific ideas or concepts likely to make a significant contribution to progress in European science. The competition will award nine prizes - three of 60 000 euros, three of 50 000 euros, and three of 40 000 euros - to fund the continuing scientific career of the winners. It is open to students from the Member States and FP5-associated countries. Closing date for applications: 29 June 2000.

www.cordis.lu/improving/src/hp_calls.htm

Publications

Due to lack of space, the publications mentioned below are limited to a few recent titles likely to interest a relatively general public.
Readers with specialised interests should consult the Internet for more complete lists and updates of the Research DG's publications, especially those concerning the scientific results of projects supported by the Commission. See the site:
europa.eu.int/comm/research/pub_rtd.html
For a more extensive look at all European Union publications, we recommend the Office for Official Publications of the European Communities (EUR-OP).
eur-op.eu.int/general/en/index.htm

- *Marine research and policy interface - Links, interdisciplinary cooperation, availability of results and case studies - European Commission* - Research in enclosed seas series-6 - ISBN 92-828-5902-9 - eesd@cec.eu.int
- *Interlaboratory Studies and Certified Reference Materials for Environmental Analysis - The BCR Approach* - P. Quevauviller et E. Maier - Elsevier - ISBN 0-444-82389-1 - *growth@cec.eu.int*
- *Research and Technological Development in Europe - 36 examples of projects (series II) - EUR-19075* - A new popularised publication presenting projects supported by the Union in all fields covered by European research - Currently available in French only (English and German editions available shortly) - *research@cec.eu.int.*
- *Assistance for FP5 Proposers* - Special edition of CORDIS Focus Magazine - December 1999 - *innovation@cec.eu.int*
- *Academic/industry interfaces:* Optinet - G. Degenaars et al - EUR 19068 - *info-sales-opoce@cec.eu.int*
- *New possibilities for accessing the capital markets for biotech SMEs* - K. Menrad et al - EUR 18908 - *info-sales-opoce@cec.eu.int*
- Efficiency of psychotherapeutic treatment of eating disorders -Project report - EUR 19212 - ISBN 92-828-7436-2-30 - *info-sales-opoce@cec.eu.int*
- *Standards, measurements and testing: some examples of successful projects* - Project examples - growth@cec.eu.int
- *Greenhouse gases and their role in climate change: the status of research in Europe - Proceedings of conference* - EUR9085 - ISBN 92-828-7437-0-116 - *eesd@cec.eu.int*
- European Union - Latin America: scientific cooperation in the 90's (3 vol.) -ISBN 92-828-7832-5-560 - ISBN -92-828-7833-3-280 - ISBN - 92-828-7834-1-348 - *inco@cec.eu.int*
- *Similar concerns, different styles? Technology studies in Europe* - volume II - Project report - EUR 19102 - ISBN 92-828-7262-9-96 - *info-sales-opoce@cec.eu.int*

Tunnel of Visions: EU research at EXPO 2000

The EU Pavilion at Hannover's EXPO 2000 (1 June to 30 October) will illustrate how the European Union is working to address the challenges of the 21st century, especially those related to the Expo's triple theme: Humankind, Nature and Technology. Through an interactive experience, in which they travel from the past into the future within the imaginative virtual environments of the Time Shuttle, Euro Disc and Galaxy Walk, visitors will come to appreciate the EU's rich history and unique character. Scientific research funded by the EU will be a recurrent theme throughout the pavilion, with a special emphasis in the Galaxy Walk's Tunnel of Visions, where visitors find themselves with stars overhead and a glass floor that gives the illusion of endless space beneath. Among the wide range of themes presented will be climate and biodiversity; fighting fraud; standards for safer construction; preservation of cultural heritage; natural and man-made risks; applications of satellite earth observation; solar energy; nuclear medicine; energy efficiency and a "city of the future" demonstrating the EU's goal of sustainable mobility.

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Strata - The strategy laboratory

How is it possible to govern a society - in the sense of steering a moving vessel - increasingly shaped by developments in science and technology? This question of strategy - in terms of investment in growth sectors, the orientation of education systems, the development of new infrastructures - is one which political decision-makers are putting to the world of socio-economic research with increasing insistence.

Under the Fourth Framework Programme, Etan (European Technology Assessment Network) launched the first European initiative to develop communication between the world of politics, and scientific and technological expertise. Members of the nine working parties analysed and drew up guidelines for action on subjects such as the technological challenges posed to European competitiveness by globalisation, the ageing population, climate change, the role of women in research, the importance of intellectual property rights, the impact of research and innovation on employment, etc.

A reinforced dialogue

This dialogue between the decision-makers and the experts receives a further boost under the new Improving Human Potential and the Socio-Economic Knowledge Base programme, in the form of a new activity called Strata (Strategic analysis of specific political issues). The initiative is based on two types of action.

• Support in setting up and developing thematic networks, based on four major lines of enquiry (see box) selected at the time of the Commission's regular calls for proposals. Five networks, approved in 1999, are thus in the process of being set up. These will analyse the scientific input to public policy and regional development, the socio-economic effects of public RTD policy, the influence of the innovative strategies of multinational companies, and the redefining of research policy goals in the light of evolving knowledge. The next call is scheduled for 15 March 2000.

• Support for measures designed to provide concrete assistance in setting up and operating these Strata networks, such as the organisation of conferences and seminars, the creation of knowledge bases, the management of Internet forums, etc. As these are open calls, proposals can be submitted at any time and will be evaluated within three months at most.

The first accompanying measures

Three initiatives of this type will receive support from Strata in 2000. A series of workshops entitled Europolis will bring researchers and decision-makers together to draw up scenarios for the future development of European science and technology policy, and the institutional changes to be proposed in this field by the year 2010. The Adept (Advanced digital European policy think-tank on innovation) initiative will look at how to provide access for Europe's innovation policy-makers to the new digital means of communicating and consulting knowledge in this field. Finally, another series of workshops will look at the practical benefits of "Science Shops" in informing the general public and businesses on scientific and technological matters.

Building on the experience acquired with the Etan pilot initiative, the Commission will continue to set up groups of experts on subjects of interest to political decision-makers, in particular on the links between research and other policies - at the regional, national, European or global level - and on the management-of-change in science and technology as they are faced with new needs. ■

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www.cordis.lu/improving/src/hp_sstp.htm

Strata: the four fields of enquiry

• Science and technology policy in the face of European and global integration of systems of governance.
• Links between research and other policies in the European institutional environment.
• Change management in the approaches of science and technology policy.
• Cooperation in science, technology and innovation: new needs and new opportunities.

2001, a new European space odyssey

Telecommunications, television, transport, management of natural resources and the environment, security... Today, a growing number of activities are based on space technologies as the whole sector undergoes a radical restructuring and becomes increasingly market oriented. The time has therefore come to implement a "European space strategy" based on increased synergy between institutions, agencies, research centres, industry and users.

Forty years after the launch of the famous Soviet Sputnik, a constellation of artificial satellites of all nationalities orbits the Earth. Their day-to-day applications include weather forecasting, telecommunications, navigation, environmental monitoring and security.

With the successful launch of the XMM-Xray scientific satellite - a powerful tool for observing X-rays in the cosmos - Ariane 5 entered its commercial phase and is now one of the world's most powerful satellite launchers. But pressure from the competition is set to increase.

The commercial era

Technological progress has made space not only a part of the information society but one of considerable commercial importance. For Europe alone, this industrial sector represented a turnover of more than 5 billion euros in 1997, 60% of which was generated by telecommunications and rocket launcher production (most notably Ariane). The new satellite systems are also the key to gaining access to fast-growing equipment and services markets, such as town and country planning and transport. They provide a vital source of information for many civil applications as well as for implementing European policy in the fields of agriculture, fishing, the environment, defence and security.

According to Herbert J. Allgeier, who is Director-General of the European Commission's Joint Research Centre (JRC) and responsible for space coordination, it is therefore essential that Europe "win its independence in the face of the US offensive - conducted in the name of national security - to control space and information systems. The space race of the Cold War years is no longer the driving force behind this rapidly restructuring industry; it is now principally concerned with the launch of new commercial services and gaining market share. In the era of the global economy and the information society, the European Union must show real initiative if it is not to be overshadowed by US domination in this sector, which is growing in economic and strategic importance. It is foolish to believe that the EU can control its information, electronic commerce, security and transport systems without mastering space technologies."

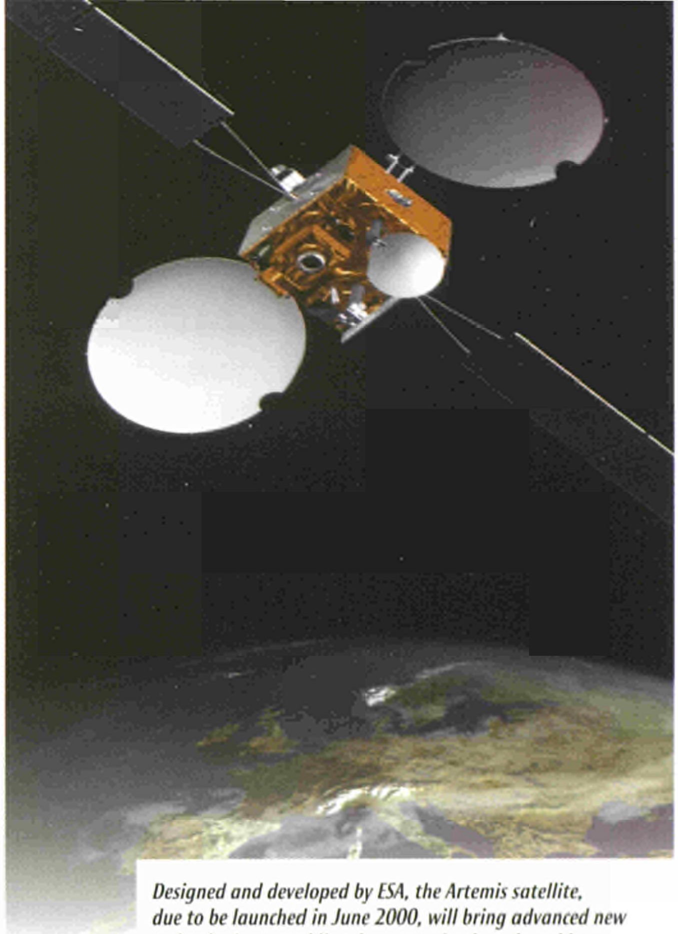
Hence the joint initiative launched by the Commission and the European Space Agency (ESA), with the support of the 15 Member States, to strengthen the coherence of the European approach to space by the end of this year,[1] through cooperation with the national space agencies and industrial partners.

A strategy for space

"We need to create the foundations of a new strategy, not for space, but for space applications," continues Mr Allgeier. "Coherence must come from increased cooperation between the various players, while taking into account the fact that space activities must meet the threefold needs of society in general (including commercial interests), security, and international cooperation on technological developments with scientific aims - the international space station, for example."

For any of this to be possible, Europe must retain an independent launch capacity. Although the success of the Ariane rocket launcher is well known, the pressure from the competition is considerable and prices can be expected to fall by 50% over the next few years. It is therefore essential to pursue research and development programmes if Europe is to remain competitive and retain operational access to space.

"Where Europe wants to position itself in the space sector is also a political question," observes Mr Allgeier. "The European Union is an appropriate level for preparing an overall space strategy. For a long time the sector was only of interest to governments, via national space agencies and ESA, but now it interests an industry seeking to meet new commercial requirements. Public-private partnerships are possible. It



Designed and developed by ESA, the Artemis satellite, due to be launched in June 2000, will bring advanced new technologies to mobile telecommunications, based in particular on inter-satellite data exchange.

is up to us to facilitate consensus on applications which serve both the common good and commercial enterprise."

To this end, the Commission has set up a consultation structure with the Member States, the space industry, ESA and the Western European Union. A Space Advisory Group is responsible for overall strategy and policy, while a second high-level advisory group is responsible for developing dialogue with industry. Identical structures have also been set up in the specific sectors of satellite navigation (EGNOS - European Geostationary Navigation Overlay Service - and Galileo), telecommunications (Satellites Action Plan) and environmental monitoring.

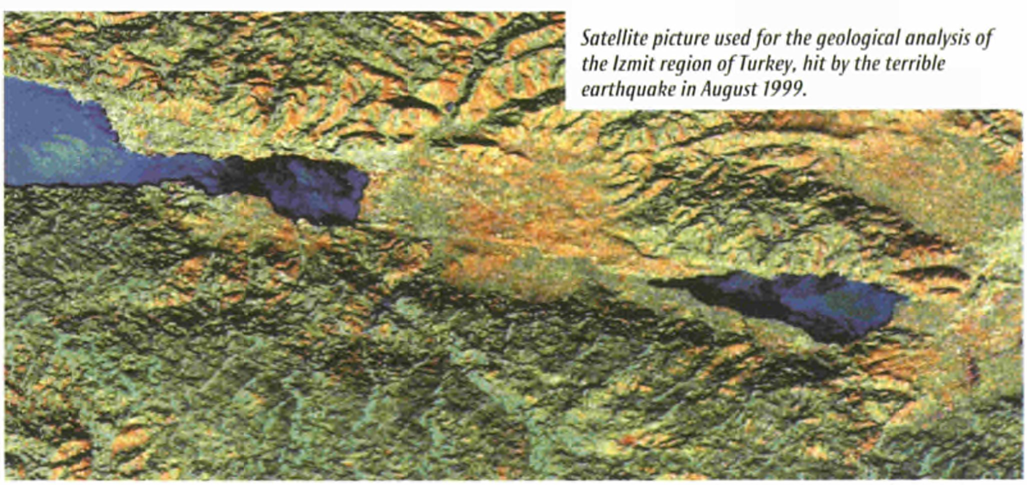
The role of European research

"For the past 40 years, through ESA and the national space agencies, Europe has invested some 150 billion euros in research and development in order to establish a highly effective space industry,"[2] points out Mr Allgeier. "Everyone must do what is necessary in their own field in order to support the European objectives of their sector. At the JRC, the Institute for Space Applications has acted as project manager in developing satellite observation services for agriculture, coastal zone management, environmental monitoring, and the evaluation of risk and damage linked to natural disasters."

In the telecommunications sector, 65 million euros have been invested in the EU's ACTS and Esprit programmes and new priorities set for the Fifth Framework Programme, in particular to promote the interoperability of terrestrial and satellite communication systems. The principal challenges lie in broadband multimedia systems and personal communication systems by satellite (S-PCS), the latter a sector in which Europe has demonstrated its know-how by gaining progressive acceptance of both its standards and its technologies for GSM, UMTS (GSM's successor), ATM (broadband transmission) and ADSL (high-speed transmissions via ordinary telephone lines).

A similar approach to that currently used for navigation with Galileo (see opposite) could provide Europe with a global service to monitor environmental parameters and help limit the effect of natural and man-made hazards. ■

(1) Towards a Coherent European Approach for Space, Commission working document, SEC (1999)789, final, 7 June 99 (europa.eu.int/comm/jrc/space/approach 99/ index_en.html).
(2) In 1998, government investments in the space sector amounted to 4.7 billion euros compared to 5.4 times that figure in the United States (25.8 billion euros). See 1998 State of the Space Industry Report (www.spacebusiness.com).



Satellite picture used for the geological analysis of the Izmit region of Turkey, hit by the terrible earthquake in August 1999.

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Galileo: the challenge of autonomy

The European Union's Galileo project for a global navigation satellite system is crucial to European independence and competitiveness.

In the 1980s, the United States developed the satellite navigation system known as GPS (Global Positioning System), initially for military purposes. Interest in its civil applications grew quickly, and today GPS - replaced, in certain areas, by the Russian GLONASS system, also of military origin - is used for navigation by an increasing number of sailors, aviators, hauliers, taxis and car drivers.

A system made in Europe

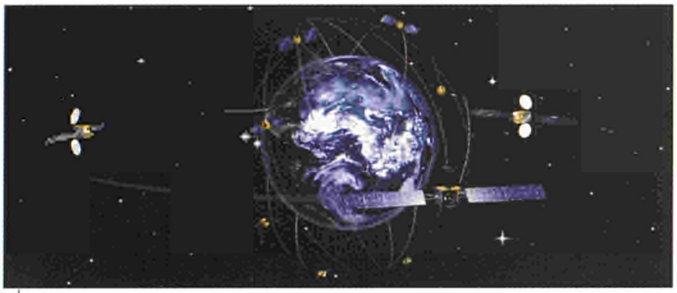
"Europe's dependence on these two external, military systems over which it has no control places it at a disadvantage," explains Matthias Ruete, director of the Trans-European Networks for Transport programme. "Their links with defence priorities provide no guarantee of development and dependability for the future. But this future is crucial in determining the development of an integrated European transport sector. Added-value services and equipment linked to the growth of navigation systems could represent a market worth 35 billion euros in the next decade and generate large numbers of skilled jobs."

This is why the European Commission proposed the ambitious Galileo project. This new navigation system for civil transport will be developed industrially with the Union's support and in close cooperation with the European Space Agency (ESA), which, by 2008, should have sent a constellation of some 24 GalileoSat satellites into medium Earth orbit. The total investment is estimated at 2.7 billion euros.

Green light

Last June the Council of EU Transport Ministers gave the Commission the go-ahead to launch project definition studies. These will be financed by the Fifth Framework Programme, with the aim of completing the Galileo definition phase by the end of 2000.

"Four contracts providing global support of 37 million euros have already been signed with European industry," announces Mr Ruete. The largest - worth 29 million euros - is the GALA programme with more than 70 participants coordinated by Alcatel Space and focusing on the system's architecture and global specifications. The other three concern the definition of the service (GEMINUS), integration with EGNOS (INTEG) - see box - and standardisation (SAGA).



The constellation of GalileoSat satellites will circle the globe from 2008, providing Europe with a positioning and navigational system which is autonomous and interoperable.

The Commission has also set up the GNSS-2 Forum (bringing together users, government bodies, universities and industry) to analyse the project's legal, institutional, technical, financial and security/defence aspects, as well as user needs, while ESA has embarked on the technical definition of the space component and ground-based systems, to be carried out by a consortium of 50 contractors, led by Alenia Aerospazio. Supervising these tasks will be a committee chaired by the Commission consisting of representatives from the Member States and ESA.

The development phase should start in 2001, partly financed by the EU Trans-European Networks for Transport programme and ESA, and partly by private and public-sector partners. The Commission is at present drawing up the framework conditions for such a partnership and, given the size of the investments, plans to create new sources of revenue, such as specific charges for certain specialised services. ■

A two-stage advance

The initial GNSS (Global Navigation Satellite System) phase of Galileo is run by the European Tripartite Group (Commission, ESA and Eurocontrol[1]) and aims to develop and implement the EGNOS (European Geostationary Navigation Overlay Service) system by 2002. This will use geostationary satellites to increase European coverage. Phase two (GNSS-2) will develop and implement the Galileo satellite navigation system, giving Europe its independence while ensuring continuity, compatibility and interoperability with existing systems.

(1) Eurocontrol is responsible for validating the system's conformity with civil aviation requirements.

Helping SMEs enter the communication age

Broadband communication systems offer a real possibility for fundamental change in the way that distributed organisations interact and inter-company transactions are carried out. But their use has to be tailored to SME capabilities and needs.

The latest information communications technology, already used by large companies for a number of years, is based on broadband communication - 155 Mbps (megabits per second) ATM (see glossary). This allows high-speed transmission of large volumes of data - such as pre-press documents, CAD engineering drawings, multimedia packages and video signals - and can significantly enhance business efficiency and competitiveness. So far, however, its high cost and a lack of suitably structured applications have inhibited small companies from using the technology.

Bourbon - the BrOadband Urban Rural Based Open Networks project - was therefore set up in 1995, supported by the EU's Advanced Communications Technologies and Services (ACTS) programme, to develop a means of providing SMEs with cost-effective, scaleable access to such advanced capability. Its ultimate objective was to stimulate their full involvement on a European scale by facilitating the adoption of new means of reaching global markets. The project was coordinated by Lake Communications in Ireland and involved partners, mainly research institutes, from nine EU countries. The results of this applied cooperation, enabling European SMEs to enter the Information Society fully, were featured at last November's IST '99 conference in Helsinki.

Understanding SME business processes

As Aimo Maanvilja, Research Director of the Helsinki Telephone Company (HPY) and a leading participant in Bourbon, observes, "Service development is simple when you are dealing with one major organisation, but the diversity of needs in SMEs demands more complex solutions. We really have to understand each customer's business processes."

To achieve this, it was necessary to explore both user-focused and technical issues. At the start, the partners had a clear vision of the benefits that SMEs could derive from broadband communications. However, they recognised that the facilities must be easy to use, as smaller organisations would generally not be able to employ specialist IT support personnel. Scaleability would also be important, to allow users to take advantage of future innovations without needing to make major investments in their own internal systems.

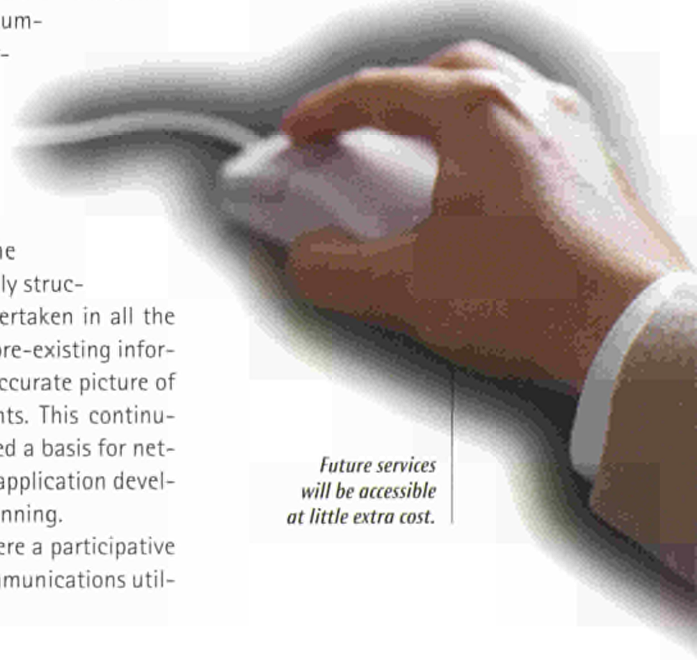
The expense of using the 155 Mbps ATM broadband communication facilities available in 1995 presented an initial barrier to the involvement of SMEs as full programme partners. They were therefore included as associate partners, with whom field trials could be carried out in a number of test areas in different countries.

Shared experience

As a first step in the process, a series of carefully structured interviews was undertaken in all the test areas, to collate any pre-existing information and establish an accurate picture of users' specific requirements. This continuously updated input formed a basis for network integration studies, application development and field-trial planning.

The trials themselves were a participative exercise involving telecommunications utilities and service providers, together with some 20 SMEs. Commercial and pre-commercial heterogeneous broadband ATM/IP (Internet Protocol) and ISDN networks were employed in Ireland, Finland, France, Austria, Germany, Scotland, Italy, Greece and the Netherlands. These supported user access at a variety of speeds using ISDN, xDSL and optical links.

Learning together gave the SMEs hands-on opportunities to discover the potential of the new technology to solve their particular problems. The organisation of national SME user-groups also provided valuable forums for the exchange of ideas and experiences. And with environments varying from country to country, collaboration enabled the providers themselves to gather valuable insights into requirements for the longer-term introduction of generic services with the flexibility to meet differing needs.



Future services will be accessible at little extra cost.

"Service development is simple when you are dealing with one major organisation, but the diversity of needs in SMEs demands more complex solutions. We really have to understand each customer's business processes."

Impact in Finland

In the Helsinki region, which was the major test location, a laboratory test network, pre-commercial pilot networks and commercial network services offered by HPY and its associate companies were all utilised - with IP access speeds ranging from 64 kbps (ISDN) to 155 Mbps (ATM).

The graphical industry was selected as a key target for the trials. Because personnel expenditures represent by far the largest cost element for companies in this sector, there was real interest in any services that could increase the efficiency of production and project management.

Understanding the meaning of digital media, telecommunications and IT in their business processes has encouraged the users to become networked. HPY is already seeing a potential revolution in print production methods for the national media. Material for publication can now be assembled and supplied in digital form rather than as conventional films. This eliminates time-consuming pre-press procedures and has speeded up the overall process dramatically.

Equally important was the possibility for advertising agencies and reproduction houses to charge broadband communications costs to specific jobs, in the same way that they have calculated film costs in the past.

Net tools for toolmakers

Another test area was in Ireland, involving a group of SMEs located in the north-western county of Sligo, a major manufacturing area and the country's tool-making centre.

The selected companies, active in the production of injection moulds for the plastics and die-casting industries, were linked via the Bourbon ATM ADSL network. Their in-house activities extend from software development and tool designing on 3D CAD/CAM systems, to manufacturing, metrology and testing. This frequently entails collaborative working, much of which could be conducted over the Internet using broadband communication. Employing PCs equipped with 25-Mbps ATM network adapters and, in some cases, video capture cards, it became possible to hold virtual meetings and run shared AutoCAD applications - as well as enjoying rapid and sophisticated e-mail, audio and video services.

Although the full speed of the ADSL connections is available in one direction only - the reverse path functions at 640 kbps - this was more than enough to demonstrate the advantages of the underlying methodology.

"Our approach to service development under Bourbon has been to propose an innovative solution, seek the customer's views, refine the service offer - and price - and, if necessary, try again until we reach a satisfactory conclusion," explains Aimo Maanavilja. "This is not just user-friendly, but positively user-centred: an excellent example of fitting technology to customers' needs." ■

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Glossary

ADSL: Asymmetric digital subscriber line (or loop)
A digital telecommunications technology designed to allow high-speed data transmission over the existing copper telephone lines between "clients" and "servers". ADSL is much faster than ISDN (for example) and offers rates of up to 9 Mbps when receiving data and up to 640 kbps when sending data. It can handle voice, data and compressed broadcast video

ATM: Asynchronous transfer mode
A broadband telecommunications standard which integrates voice, video and data and offers bandwidth on demand. It functions by establishing a fixed link between two points when it starts transferring data - making it easier to track and bill data. It is seen as the key to activities such as video on demand. ATM can be carried over traditional copper telephone lines, coaxial and fibre optic networks.

ISDN: Integrated services digital network
This international communications standard makes it possible to send voice, video and data over both digital and normal analogue telephone lines at speeds up to 64 kbps. The Euro-ISDN standard allows full transparent interworking between all European countries.

xDSL: Digital subscriber line
An emerging family of similar techniques and devices including ADSL, and other DSL technologies.

Reducing traffic jams, pollution and accidents

These three objectives are central to the European Union's policy on road transport and thus the focus of its support for scientific and technological cooperation in this field.

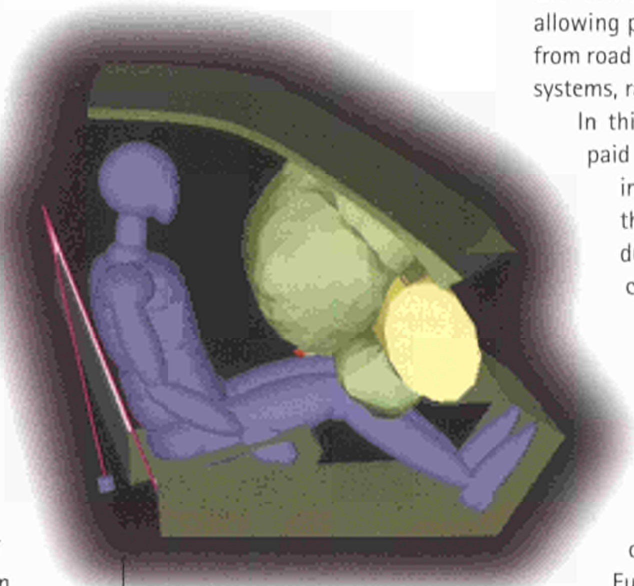
Europe's road transport has increased dramatically over the last two decades. Between 1980 and 1997, the number of private cars in the EU rose from 100 million to 170 million, leading to a 62% increase in the volume of traffic (measured in passenger-kilometres). In 1998 alone there were 14 million new vehicle registrations - a 7% increase. The lorry and commercial vehicle fleet grew from 10 million to 19 million over the same period, with a 90% increase (in tonne-kilometres) in the goods transported, and road transport now accounts for 73% of the EU's freight volume.

With the European transport system as it stands at present, there are no signs of individuals or companies turning away from road transport, and traffic is continuing to increase at the rate of 2% a year. This is producing two major problems: traffic congestion (at a cost equal to 2% of Europe's GDP) and increasing pressure on the environment; despite lower fuel consumption and cleaner fuels, road transport accounts for almost 25% and 50% of man-made CO_2 and NO_x emissions respectively.

Also, despite significant progress in road safety, the roads continue to be by far the most dangerous form of transport, with an enormous social and economic cost: 45 000 deaths and over 1.3 million people injured in the EU every year.

The European agenda

The aim of the common transport policy is therefore to make sustainable road traffic part of a new global approach to ensuring the mobility of people and goods.[1] To achieve this, it is essential to understand the economic, social and behavioural factors which underlie present road transport conditions.



Simulation of knee protection studied at the TNO Crash-Safety Research Centre in Delft (NL).

New technological resources in the fields of telematics, vehicle and infrastructure safety, and environmental protection also provide valuable tools in helping to regulate the sector and minimise its negative impact. These areas formed the three major lines of inquiry and innovation at the centre of some 40 road transport projects under the first Transport research programme which was launched in 1994.

Managing demand

One essential need is to regulate the demand for road transport. The Dante project, for example, aims both to seek strategies to reduce the demand for movement and to promote "intermodality" - meaning the combination of technical solutions allowing passengers and freight to transfer from road vehicles to urban public transport systems, rail, or sea.

In this area, the European Union has paid particular attention to developing a policy based on the "cost of the road", encouraging the introduction of various toll and flat-rate charging systems linked to the real marginal cost of the increase in traffic on major infrastructures or in urban areas. This economic dimension to the cost of road transport - which must be compared transparently to the cost of other means of transport - is a key area of European research.

The Eurotoll project, for example, has studied and defined how specially adapted toll structures would better regulate the flow of traffic, and looked at the resultant socio-economic effects, including how the new source of revenue could be used to maintain and improve infrastructure. These studies were carried out for public authorities and road network operators in ten European urban areas.

At the same time, researchers on the Extra project have stressed the social impact of charging for road use. Such a policy must offer sufficient incentive while remaining fair and balanced. In particular, charges must not discriminate against the most disadvantaged or exceed a level acceptable to them.

Managing information

Recent developments in communications and telematics also permit increasingly intelligent traffic management of the road system as a whole (and of intermodal connections). It is not just the vehicles, but the infrastructure itself which is now "communicating".

Inter-European cooperation developed under the Force project, for example, has enabled millions of drivers in whole areas of the EU to receive automatic and constantly updated multilingual information on traffic problems in their vicinity, via the RDS-TMC (Radio Data System-Traffic Message Channel) function on their car radio. Meanwhile, the Tropic project has explored every aspect of large-scale traffic management using VMS (Variable Message Signs) systems which are positioned along major roads and in urban areas to inform users in real time of the local traffic situation.

Safety first

And road safety? Between 1991 and 1997 there was a 22% decrease in the number of deaths and a 9% fall in the number of those injured on European roads. Major differences in national road safety levels,[2] calculated per number of inhabitants or vehicles, provide clear proof that progress is possible - and at several levels. In the field of passive vehicle safety, the Dutch national research institute, TNO, possesses advanced equipment and know-how for the simulation of the effects of accidents on bio-authentic models. TNO coordinated the Adra project which was designed to improve the safety standards of systems such as airbags in the event of head-on collisions.

Two European towns are experimenting with lanes reserved exclusively for car sharing. In Leeds (above) the average vehicle occupancy has increased from 1.35 to 1.45 people per vehicle as a result. In Madrid, forecasts indicate an occupancy as high as 1.8 per vehicle during rush hours.

But safety depends - perhaps above all else - on driver behaviour. Excessive speed is a major component of the danger on our roads. The Master project made an in-depth study of the impact and (non) observance of European speed limits, and the acceptability of new measures by users - in particular the introduction of automatic speed limiters (possibly remote-controlled) on vehicles. With the same goal, the Escape project studied the effectiveness of policies to increase police speed-checks and fines.

Finally, the quality of the road infrastructure is a key element in road safety. The Dumas and Promising projects are active in urban environments analysing strategies to protect other road users - motor cyclists, cyclists and pedestrians. An essential factor in passive safety on motorways is the state of the roads which, in turn, is linked to road design and the wear resistance of surfacing materials. The various projects working in this area also take into account the need to cut the cost of infrastructure investments and maintenance, as well as to reduce their impact on the environment. ■

(1) The Fifth Framework Programme is particularly concerned with transport efficiency, safety and respect for the environment under the *Competitive and Sustainable Growth* programme (Key Actions: Sustainable mobility and intermodality, Land transport and marine technologies) and the *Energy, Environment and Sustainable Development* programme (Key Action: The city of tomorrow and cultural heritage).

(2) According to a 1997 survey of the two neighbouring countries, there are approximately 1 350 deaths a year amongst Belgium's 10 million inhabitants, compared with 1 150 deaths a year for the Netherlands' 14 million inhabitants - a difference of almost a factor of 2 in relative terms.

All about Transport research

The Extra initiative is charged with disseminating the results and information of the various Transport research projects supported by the Commission. In addition to providing extensive details and contact references on the 40 or so projects supported in the field of road transport - about 10 of which are referred to in this article - the Extra website gives full details of European research in air, rail and sea transport and their intermodal integration. Extra also publishes a newsletter: *Transport Advance.*

europa.eu.int/en/comm/dg07/extra/

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Joint research, mutual benefits

Over the last five years the European Union has been weaving a web of scientific and technological cooperation agreements with some of the world's most important and dynamic centres of research. This is designed to increase the exchange of knowledge and know-how between the industrialised countries and with the emerging economies.

The globalisation of technological know-how is playing a determining - and often ground-breaking - role in the internationalisation of trade and finance. Within this process, those involved in the industrialised countries and the emerging economies represent both potential scientific partners and trade competitors for Europe.

It is against this background that the EU is developing its new policy of international research agreements under the Confirming the international role of Community research (INCO) programme. The opening up began in 1994 when an agreement was signed with Australia.[1] This was quickly followed by agreements with the United States and Canada and, since 1996, the EU has also been party to very active links in the field of science and technology with Israel, through an association agreement.[2]

Three agreements have been concluded with emerging economies, too: South Africa (1997), China and Argentina (1999). Two others are currently being explored with Brazil and India.

Mutual interest and equity

"The spirit behind the implementation of these agreements is based on the clearly understood mutual benefits of balanced scientific and technological cooperation," explains Nicholas Newman, who is responsible for relations with industrialised and emerging economies at the Commission's Research DG. "In particular, they guarantee the equity of this external cooperation by establishing rules governing intellectual property and the right of mutual access to the results of joint research."

The agreements provide scientists in the signatory states with a framework for participating in the various projects supported by the Union, whether this is specific research areas or all the thematic research of the Fifth Framework Programme. In return, European researchers are given access to the scientific and technological programmes in the countries in question.

This freedom to participate in the activities of the Framework Programme does not mean, however, that non-European partners are eligible for financial support from the EU - at least not those from industrialised countries; US, Canadian and Australian partners have to self-finance their project participation. Under the terms of the agreements, this rule also applies to European research partners who must finance their participation in projects run by those countries.

The situation is somewhat different for emerging economies with developing country status. Quite apart from any scientific and technological agreement, this status affords them access to the substantial financial support provided by the EU's INCO research programme, which has a five-year budget of 210 million euros for research linked to development. China, Argentina and South Africa have thus already chalked up 56, 41 and 35 participations respectively (with European support) in specific INCO projects in developing countries (see table).

There is also a budgetary allocation under the Fifth Framework Programme granting European funding for accompanying measures such as the financing of international meetings, analyses and information activities to promote partnerships, which are essential to the effective implementation of the major INCO agreements. "Their aim is both to make European and international actors aware of the benefits of cooperation and to identify obstacles to the process," concludes Mr Newman. ■

(1) This agreement between the EU and Australia was renewed in 1999.

(2) This differs from a cooperation agreement since the country pays into the programme which then funds its participants.

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International S&T cooperation agreements signed by the EU*

(Fourth Framework Programme - 1994-1998)

	Year of signing	Participations in European projects under specific programmes	Participations in projects supported by the INCO programme
Industrialised countries		**375**	**41**
Australia	1994	34	1
Canada	1996	50	3
Israel (association agreement)	1996	245	37
USA	1997	46	0
Emerging economies		**10**	**132**
South Africa	1997	7	35
China	1999	2	56
Argentina	1999	1	41

* Excluding association agreements and specific cooperation with the New Independent States of the former USSR, which are not included in this table.

Powered by the Australian sun

Australia's worldwide renown in solar technologies is being placed at the service of a European project to develop photovoltaic cells, led by Spain. An example of an international research partnership based on a genuine mutual interest.

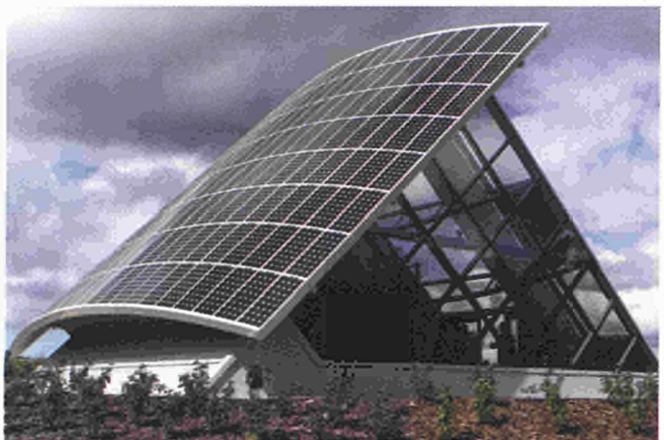
The Australian sun beats down with such force that the country's preeminence in photovoltaics - the conversion of sunlight into electricity - should come as no surprise. Much of the country's expertise is focused at Sydney's University of New South Wales, where Professor Martin Green's Photovoltaic Group has notched up more world records than any other.

The first records fell in the early to mid-1980s, when Professor Green and his colleagues used lasers to embed metal contacts deep inside a crystalline silicon PV cell. This patented technology has already been commercialised at BP Solarex's manufacturing plant in Madrid, which produces cells with a 17% conversion efficiency - the highest in any commercially produced cell. The PV Group, meanwhile, has led the field ever since, pushing up efficiencies to the most recent record: 24.5% in 1998.

Constant improvement

"It's a constant process of improvement," explains Professor Green. "Over the years we've adopted photolithography from the microelectronic industry to pattern cell surfaces, experimented with different sorts of cell backing and dopants and worked on various processing techniques."

The transfer to Europe of this high-level know-how lies at the heart of the participation of Australian researchers in the Transgen project, supported by the Joule programme, via a partnership led by BP Solarex and the Madrid Polytechnic University. The collaboration is aimed at PV cell characterisation and couldn't be simpler: BP Solaraex sends partly processed silicon wafers to the PV Group for experimentation, while one of Professor Green's postgrads recently spent a few weeks in BP Solarex's laboratories.



The roof the "G8 summit" building in Birmingham is covered in BP Solarex's PV Cells, produced as a result of cooperation between BP Solarex in Spain and Australian researchers at the University of New South Wales in Sydney.

They aim to transfer some of the PV Group's newer patented technologies to the Madrid plant, particularly a new sort of metal contact layer on the back of the cell. According to Tim Bruton, Director of BP-Solarex's European Technology Centre, "We are hoping to push our cells close to the 20% mark without substantially increasing production costs. This could double or even triple our production. It's still early days, but we're getting good results in both Australia and Europe. We have the building blocks - now it's time to integrate and optimise."

The cost challenge

Both scientists are adamant that the key to widening the use of PV power is to increase production levels to reduce costs. Mr Bruton, author of a study for the Joule programme in the mid-1990s, recommends "an intense but relatively short subsidy programme to grow the industry until it produces around 500MW per year worth of cells. This would drive unit production costs down to the point where the industry would be self-sustaining and subsidy free. For the moment PV remains locked out of the mainstream power industry, and we continue to fill the atmosphere with greenhouse gases." ■

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A combined effort

The more uniform the meadow, the poorer the yield. Such a hypothesis - one that could lead to a reversal of the increasing trend towards monoculture - has just been confirmed. This is thanks to the painstaking work of an extensive network of European researchers who have observed, measured and compared the effects of biodiversity and the consequences of its loss across the full range of European climates and latitudes.

From top to bottom :
The crop, before weighing.
A way of controlling the insect community.
Measuring productivity.
Measuring dead leaf decomposition.

"If a plot of land is planted with just one type of grass, and a similar site is sown with a variety of species, a greater number of plants and a higher grass weight can be harvested in the latter case," observed Charles Darwin. This belief seemed to be contradicted by the development of industrialised monoculture as a guarantee of increased production. "Despite the results of the forced techniques of modern farming, our instincts continued to tell us that biodiversity had an impact on the total resources of ecosystems and that this simplifying agricultural model did not apply in reality. But this had never been confirmed. We wanted to demonstrate that, in a rich community of species, different varieties spontaneously occupy a particular niche and use resources differently, with the result that a mixed field produces more than a monoculture," explains John Lawton of the NERC Centre for Population Biology (CPB) at the Imperial College of Science, Technology and Medicine, coordinator of the Biodepth project and Chief Executive of the UK's National Environmental Research Council (NERC).

Mini-meadows under the microscope

Some 50 researchers attached to 11 universities in eight European countries worked on this vast project, the first one of its kind. The results were published in the US weekly Science in early November.[1] The field of observation consisted of 480 sites each covering 4m^2, located along two major axes running diagonally across Europe, one from the north-west to the south-east (Ireland, United Kingdom, Germany, Switzerland, Greece), and the other from the north-east to the south-west (Sweden, Portugal). This was an attempt to cover the continent's different climates and latitudes.

"A major factor in the success of the Biodepth project was the highly cooperative and collaborative team spirit between all the partners", explains Philip Heads, who is responsible for the project's administrative coordination. "I am sure that the diversity of knowledge and technical skills played a part in increasing our research findings. All these people, from senior scientists to research students, made important contributions to this European project and, by sharing, we generated an enormous amount of learning and understanding, both scientific and cultural." The teams observed, measured and analysed the effects of biodiversity - and its absence - over a three-year period (1996-1998). It was a meticulous operation. The field sites were first sterilised to eradicate all plant life and therefore guarantee the purity of the experiments. Each site was then planted in a specific way, ranging from a single species to a varied mix. The same sowing methods were used in every case, care being taken to ensure the same seed density in all the fields. The seeds sown had been harvested the previous year from a pool of native species. Their combination was determined with reference to strict criteria of biodiversity, taking into account not just the number of species but also the functional groups to which they belong - legumes, grasses or herbs.[2]

From germination to decomposition

The CPB studied 66 field sites, each one sown very differently (some of them contained a variety of species, others were devoted to monoculture). In the interests of scientific rigour, each configuration was repeated twice, and comparisons made with control sites that had not been manipulated. An identical method was used at each site. With a maximum biodiversity of 32 species in the same field, the researchers used 200 different combinations. This scientific experiment - the most extensive of its kind anywhere in the world - was particularly interesting because it was conducted across an entire continent.

The plots were carefully weeded throughout the experimental period, retaining only those species originally sown. The total process was studied, from germination to decomposition. Productivity was measured, the vegetation was weighed on maturity, soil samples were taken, insects listed (like other animals, they have a mutually dependent relationship with the plants), the plant decomposition and dead leaves analysed, and the soil humidity and water retention measured.

Biodiversity = productivity

In terms of productivity, the results were convincing. The researchers estimate that productivity falls by an average of 80 grams per square metre each time the number of species is divided by two. The absence of one of the functional groups results in a loss of 100 grams per square metre. "We showed that a more diverse community has better productivity without adding fertiliser. No doubt the plants are better able to absorb the nitrogen. There is therefore less nitrate in the water, which has a beneficial effect on human health," comments Professor Lawton.

The benefits of biodiversity are more than quantitative. A loss of biodiversity upsets the ecosystem as a whole. Plant resistance and health is reduced. Insects decrease in number and variety. Invertebrate populations change, resulting in potentially negative impacts on soil chemistry and the recycling of mineral elements. Researchers recorded these effects at all the field sites, despite differences in climate, soil type and plant species.

Complementarities

The Biodepth project also indicated the importance of complementary niches within a rich plant community. Different species occupy a particular niche and use different resources. Some plants draw on nutrients near the surface, ☞

Biodiversity and Biodepth on-line

The total number of living species on Earth is estimated at between 5 million and 50 million, but fewer than 1.5 million of them have been classified, among which are 360 000 varieties of plants and micro-organisms. Between 50 and 300 plant and animal species become extinct every day. Although the figures are approximate, it is clear why both scientists and the general public are growing increasingly concerned at this progressive impoverishment of the natural world.

Researchers working on the Biodepth project have set up a particularly user-friendly and educational Internet site on the subject. Among other things, visitors to the site can find out exactly what is covered by the notion of biodiversity. First used by Walter G. Rosen in 1985, the term is much more than a quantitative concept. It refers simultaneously to diversity of species, genetic diversity (of genes within a single species) and ecological diversity, as well as interactions between the three. The importance of biodiversity in regulating carbon, oxygen and water cycles and its fundamental role in adaptation processes and restoring balances after natural disasters or major climate change, for example, is clearly explained. The site also presents information on Biodepth, including its scientific bases and results, clearly demonstrating the added value of European research in this field.

http://forest.bio.ic.ac.uk/cpb/cpb/biodepth/contents.html

Experimental site at Silwood Park (UK) - Demonstrating the fundamental role of biodiversity.

whereas others take their sustenance from deeper down in the soil.

When grouped together, these different species can therefore use more nutrients in total - such as nitrogen or phosphorous - than if they were planted as a monoculture. This is why biodiversity is so important to the food chain and why the concept - as obvious as it may seem - has major implications for agriculture. Complementarity is the indirect result of competition between species.

"Imagine two football teams," suggests Asher Minns, Public Understanding of Science Officer at the CPB. "Team A has 11 players who are each skilled at playing in a different position, while team B has players who are all good at playing in exactly the same position. Which team will perform better on the field? Team A offers a more diverse range of skills, with players able to use different specialist tactics, and therefore should win. The problem is that it is technically easier to demonstrate this complementary mechanism in football teams than it is in plant communities."

Interactions

In addition to the notion of complementarity, which explains the quantitative results obtained, there are a number of other hypotheses relating to the beneficial effects of mixed plant communities. One notion is that of positive interactions by which one species effectively "encourages" a different species and is thus in itself a factor for biodiversity. In extreme situations, such as drought, one plant can create shade that helps a new plant to become established. There could also be other types of very specific mutually beneficial interaction.

"But the beneficial effects of biodiversity revealed by the Biodepth project may be no more than the tip of the iceberg," believes Michel Loreau, Professor of Ecology at the Université Pierre et Marie Curie (Paris VI), and responsible for developing the mathematical theories and models used in the Biodepth project. "We want to conduct experiments of the same type, this time studying the impact of biodiversity in an environment which changes over time. By subjecting a site to different phenomena, such as drought or freezing, fire or added nitrogen, we will try to show the importance of biodiversity under these conditions and also its potential significance in the event of climate or environmental change, for example."

By artificially creating heat or cold, European researchers will therefore be able to improve their knowledge of complementarities and interactions between species in order to better identify the true implications of biodiversity - a biodiversity shown by their research as playing a fundamental role in a living organism's ability to adapt. ■

(1) Plant Diversity and Productivity Experiments in European Grasslands, Science Nov 5 1999: 1123-1127.

(2) Legumes fix nitrogen in the air, unlike grasses and herbs.

From stock farming to crop farming

The superiority of diversified meadows, demonstrated by the researchers on the Biodepth project, is certainly of significance to the management of Europe's approximately 60 million hectares of grasslands, one half of its total farmland. "Our research results could be applied directly to the production of cattle fodder," believes John Lawton. But what about arable farming? The technical constraints of this sector are dictated by the demands of economic production and, for reasons of processing and mechanisation, monoculture has become necessary in a single field. "Modern intensive farming practices have resulted in a loss of biodiversity, coupled with other problems of pollution and eutrophication," adds Andy Hector of the CPB at Imperial College, Ascot (UK), the principal author of the article published in Science. "Our results show, however, that if we want to reduce these nuisances by reducing the impact of fertilisers and pesticides, intelligent management, which takes into account the number and type of species used, could also play a positive role in terms of agricultural production." Biodiversity is a major factor in the complex food chain. "Biodepth has done more than simply demonstrate the benefits of non-intensive farming to the environment," points out Michel Loreau. "Our own energy depends on plant productivity, and we are in the process of reducing the vital energy which lies at the base of the food chain."

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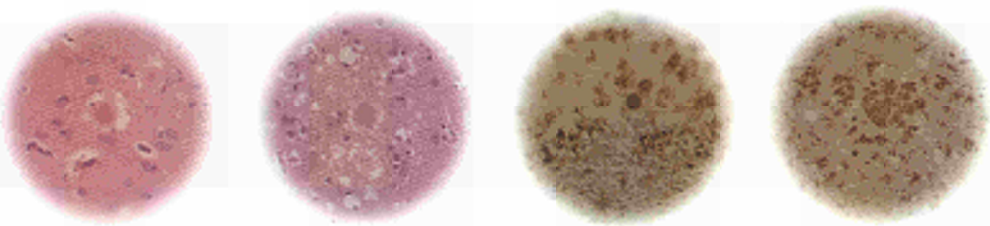
On the trail of the mystery prion

The European Union is currently funding over 40 research projects seeking to investigate and eradicate mad cow disease. Scientists with the targeted research action on TSEs (transmissible spongiform encephalopathies) are pursuing a wide-ranging investigation to unravel the mysteries of the prion, the new type of infectious agent which continues to baffle scientists. RTD info looks at some of the twists and turns in the long path to knowledge.

The neurodegenerative phenomenon triggered by transmissible spongiform encephalopathies - so called as under the microscope the infected brain tissue is seen to be full of tiny holes, like a sponge - was first identified many years ago, in man and in animals. These diseases, which are always fatal, lead to a loss of motor control followed by dementia and sometimes paralysis.



These microscopic images of human brain tissue were presented in 1996 by Robert Will and the co-signatories of the famous article in The Lancet which sparked the British mad cow controversy. They reveal the similarity, and also the distinct differences, between the ravages of two types of TSE. The first photos show the results of kuru, a disease identified in 1957 in certain tribes in New Guinea who ate the brains of human corpses; the last two come from patients infected with the new variant encephalopathy attributed to transmission by contaminated beef.

18th-century beginnings

The earliest reference - that of scrapie in sheep - dates back to 1732. But it was not until two centuries later, in 1938, that it was shown to be transmissible. In man, the disorder known as Creutzfeldt-Jakob Disease (CJD) was first identified in 1920, but was only linked to scrapie in sheep at the end of the 1950s. Other, more rare, TSEs have also been identified in man: Gerstmann-Straussler-Scheinker syndrome, inherited fatal insomnia and kuru. The latter was discovered in the 1950s among a tribe living in New Guinea and, interestingly, a link was discovered between its transmission and a funeral rite which involved eating certain organs of the deceased. The number of cases fell sharply after this practice was banned in 1955.

Neither Creutzfeldt-Jakob Disease - with a very low incidence of just 0.4 per million inhabitants - nor scrapie (which was thought not to be transmissible to man and without any real economic impact on sheep farming) were the subject of intense research before the BSE crisis. Although a number of indicators pointed to infection by a slow virus, no viral particle could be identified as the culprit. Research carried out in the 1970s even showed that the transmission agent did not necessarily contain genetic material, which was contrary to established thinking on the transmission of infectious diseases. On the other hand, epidemiological surveys showed that the disease could also include a genetic element, either in the form of transmission within a family or sporadic mutation in certain individuals.

The 1980s: alarm signals

It was not until the 1980s that new and serious fears emerged of the possible infectious transmission of Creutzfeldt-Jakob Disease in man. New treatments using the growth hormone from human pituitary glands were identified as having caused several dozen cases of CJD world-wide. This risk was eliminated in 1986 when a growth hormone produced by genetic engineering was introduced.

But that same year an event occurred which was to have very serious consequences: the appearance in the United Kingdom of a new TSE affecting cattle: BSE or mad cow disease. The epidemiological study soon showed that the production of cattle feed which incorporated elements of animal origin could explain the transmission of scrapie in sheep to cows and thus BSE. Although measures were quickly taken to stop the epidemic at its source, it is now known that errors were made which allowed new centres of infection to develop.

What is surprising from the scientific point of view is the lack of reaction from specialists to this hypothesis of the virus crossing the species barrier. In the two centuries since scrapie in sheep had been identified, non-transmissibility had remained the accepted dogma. It was another 10 years (1996) before a concluding sentence in the article published by Scottish researcher Robert Will and his team, describing a new variant of Creutzfeldt-Jakob Disease (nvCJD) in the United Kingdom, caused media uproar: "That [this previously unrecognised variant of CJD] is due to exposure to the BSE agent is perhaps

the most plausible interpretation of our findings."(1)

The (re)discovery of the prion

A fundamental hypothesis first formulated in the 1980s by the American Stanley Prusiner, who went on to win a Nobel Prize for the work in 1997, soon came to the fore again. He theorised that the transmission of TSEs took place via a simple protein, the one which constituted the fibrillar deposits found in infected brains. This new kind of infectious agent, which Prusiner described as a prion (proteinaceous infectious particle), acts on an ordinary protein found in the body, PrP, but only after a change in conformation. Proteins, in fact, consist of a linear chain of amino acids in a particular spatial arrangement. A change to this spatial arrangement upsets the physico-chemical properties of the protein. It becomes hydrophobic, aggregates and resists the normal mechanisms by which it breaks down. Consequently, it accumulates in the brain and causes neuron destruction.

The infectious nature of the disease apparently comes from the ability of this modified protein (either alone or in association with other unknown elements) to trigger the conformational change in the normal PrP protein present in any organism. This change has a genetic character involving mutations in the PrP protein gene. But this atypical mechanism raises a number of questions, and even doubts. The European Research Group on BSE - set up by the European Commission and headed by Charles Weissman, one of Europe's leading prion specialists and currently with the department of neurogenetics at Imperial College London - was charged with looking at these questions when the mad cow crisis broke.

European science at battle stations

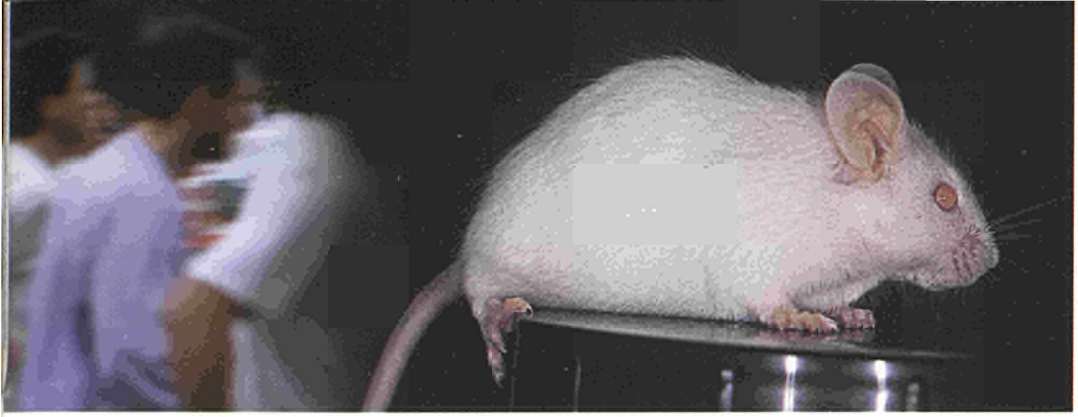
Two groups of questions were identified. The first is linked to the practical aspects of BSE. Has it really been transmitted to man? How can the risk of transmission be estimated? What tissues are infected? How can methods of diagnosis, inactivation, treatment, etc. be developed? The second group concerns fundamental research: the nature of the infectious agent, mode of multiplication, method of pathogenesis and transport, specificity, susceptibility factors, etc. It is on these research subjects that the Commission launched its action plan and allocated a budget of 50 million euros.

"Progress is slow, as always in research, and the projects initiated in 1998 are not going to have any very visible results for

An enigmatic infectious agent

What is a prion? We do not know. To date, the physico-chemical characteristics of the abnormal protein have prevented its total purification. Its precise structure is not known and the infectious preparations with which laboratory animals are inoculated also contain lipids, sugars and nucleic acids. "It is very probable that the protein is associated with the infectious agent," explains Dominique Dormont. "It is probable that the protein is the infectious agent itself, but we have no certainty of this." Nor is there any certainty regarding the normal function of the PrP protein in the body as genetically modified mice do not react when it is suppressed.

Without a clearly identified and isolated agent, the risks of BSE being transmitted to man are difficult to estimate, and the precision of diagnostic tests is limited. Infection by a prion does not cause any immune reaction - it is impossible to detect antibodies; the prion has no known genetic material - and the absence of nucleic acid makes it impossible to use modern methods of genetic amplification to detect it. That leaves the preparation of antibodies directed against the PrP protein - a number of rapid tests already developed and in the process of being validated within European projects are based on this technique. But the antibodies also recognise the normal protein and the most effective test to date detects at best 1 000 to 10 000 infectious units in the brains of cattle, a threshold far too high to expect to diagnose the infection much before the first clinical symptoms appear (BSE has an incubation period of five years). Under these conditions, there can be no direct or immediate transfer to human medicine of the results of initial research on molecules which are able to increase survival in animal models of the disease.



From sheep to cows, from cows to mice, and including man: the species barrier is a notion that no longer holds up.

five or six years," explains Dominique Dormont, a French researcher who is a member of the Standing Committee of the European Research Group on TSEs. Nevertheless, the action plan has already brought some significant results to someone who has been working on the subject for more than 20 years. "European projects," she says, "are making it necessary to better define the objectives of cooperation. They force the partners to meet regularly and to work more quickly than in the case of informal cooperation." Maria-José Vidal-Ragout, TSE project manager at the European Commission's Research DG, also makes the point that "The calls for proposals have attracted laboratories which had not specialised in prions before but which possessed valuable expertise for their study."

"We are already seeing concrete results in epidemiology, since these projects began first," continues Ms Dormont. "The methods of diagnosis are now the same throughout Europe. These are the best available and nowhere in the world has such outstanding TSE monitoring. Supporting this epidemiology, a European network now links all the European laboratories working on prions, thereby permitting links between human and veterinary medicine. This is important when you consider that bovine encephalopathy has been transmitted to man."

As the symposium organised by the European Commission in Tübingen last September illustrated,[2] European mobilisation makes it possible to accumulate an impressive amount of knowledge rapidly. "Once we have finally identified the infectious agent, other developments will quickly follow," concludes Ms Dormont. "The techniques of molecular biology will make it possible to move very quickly. We will be able to work on detection tests without having to formulate a dozen hypotheses, assess the prevalence of the agent rather than that of the disease, etc. But that does not mean that all the problems will be solved, and prolonged research will remain necessary. The only way to solve a public health problem such as spongiform encephalopathies is through advanced fundamental research." ■

(1) R G Will, J W Ironside, M Zeidler, S N Cousens, K Estibeiro, A Alperovitch, S Poser, M Pocchiari, A Hofman, P G Smith, A new variant of Creutzfeldt-Jakob disease in the UK, The Lancet 1996, 347: 921- 25.
(2) Characterisation and diagnosis of prion diseases in animals and man, Tübingen symposium, 23-25. 9.1999.

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A universal mechanism?

The prion phenomenon is not limited to TSE in mammals. "Prion mechanisms" are known to be involved in a number of "mutations" in yeast and certain fungi, which break Mendel's laws of genetics and have been known for over 20 years. In this case, conformational changes are found in proteins that are transmissible and independent of gene expression. Yeast lends itself much more easily to experiments in molecular biology, biochemistry and genetics than TSE animal models. One of the projects selected under the action plan, Maintenance and transmission of yeast prions: a model system, aims to use this yeast model to determine and describe the universal nature of the prion mechanism. It is coordinated by the University of Kent, with partners from French and German laboratories. Its results will contribute to our understanding of both the TSE infectious agent and its transmission mechanisms.

Brain drain or brain gain?

The flow of European scientists to the United States, long feared by politicians, is real, according to an on-going Joint Research Centre study. But provided the scientists eventually return, Europe may actually be the winner in this "circulation of brains".

Two routes account for most movements of scientifically trained personnel between countries. First, post-graduate or post-doctoral students frequently go abroad to complete their studies, and many stay to begin their professional careers in the host country. Second, increasing numbers of private-sector research managers move to overseas posts as employees of multinational corporations.

Sami Mahroum of the JRC's Institute for Prospective Technological Studies (IPTS) has been studying the international migration of scientists since 1998.(1) Although he says that it is hard to be sure exactly how many are in the US at any one time, there is little doubt that more European scientists cross the Atlantic to study or work than American ones.

"This is the case at every level, from students up to senior scientists. But that does not necessarily mean that Europe is the loser. Students who go to the US to study gain international experience and expertise which will enrich the scientific community in Europe when they return later in their careers." The only real danger is that they settle there permanently.

Promoting positive mobility

According to Mahroum, Europe should not face this challenge overcautiously but should instead actively promote the international mobility of scientists. "In most European countries, it is still much harder for a non-EU scientist to get a work permit than it is for a non-US scientist to enter employment there," he says. "It is often argued that any easing of immigration rules for highly skilled non-European personnel will reduce the number of job opportunities for the very people Europe wishes to retain."

In fact, according to Mahroum, the effect of such resistance to the globalisation of the labour market for scientific and technological staff is precisely the opposite of the one intended. Excluding foreign scientists starves Europe of the skills it needs to complement and strengthen its native capacity, and makes it impossible to develop the centres of excellence where the best scientists want to study and work.

"There is no evidence that America's liberal immigration rules for highly skilled staff has led to the displacement of US citizens," he explains. "But it has been an important factor in creating the centres of excellence which are now drawing star scientists from Europe, India and China.

It is a virtuous circle. Star scientists, though few in number, are critical to the movement of staff. They tend to go where the best facilities are, and their reputation attracts the best young talents," Mahroum says. "If Europe is losing its star scientists - and there is some evidence that it is - then this is likely to accelerate the outflow of other research staff."

In his opinion, as well as relaxing immigration rules for senior scientists, Europe should therefore strengthen both public- and private-sector support for the development of European centres of scientific excellence. ■

(1) See his article "Europe and the Challenge of the Brain Drain" in the IPTS Report, no. 29 (ISSN 1025-9384; €5).

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How many? How long?

In 1995, 100 000 non-US science and engineering students were enrolled in US universities. In 1996, 75 225 highly skilled personnel were granted permanent visas to the US - of whom 20-30% came from Europe.

About 50% of all Europeans who finish their PhD studies in the USA stay there for some years afterwards.

Of the Europeans who completed their PhDs in the US in 1995 (all subjects), 19.5% have become naturalised citizens, and a further 13.3% permanent residents.

Of the 7 638 EU professionals granted permanent US visas in 1996, 81% were executives and managers, 15% engineers and scientists, and 4% doctors.

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