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Towards a European Research Area

An urgent need

European research has some obvious and well-publicised weaknesses. But it also has its strengths, and it needs to do more to make the most of them. This is why, in January, European Commissioner Philippe Busquin launched the idea of creating a genuine European Research Area which would amount to much more than simply allowing national and Community policies to run in parallel. The initiative triggered a wide-ranging debate, in the member states and beyond.

In this issue Philippe Busquin takes stock of the current state of this debate and looks ahead to the next stages in implementing this new facet of the Community's research policy.

As luck would have it, two recently completed European projects have produced very significant and relevant results.

The first (see p. 7) compares the national research support policies of 12 European countries. The differences - and the similarities - among them highlight both the benefits and the deficiencies of the current European research system.

The second (see p. 10) allowed around 200 experts to analyse the technological and social challenges Europe is going to be facing by 2010. In addition to mapping the Union's strengths and weaknesses, the project's conclusions stress the handicap caused by the pointless fragmentation of Europe's research efforts.

In a context where the engine of growth and progress is technological dynamism, the creation of a European research area is becoming more than an accepted priority. It is an urgent need. ■

'Research activities at national and Union level must be better integrated and coordinated to make them as efficient and innovative as possible, and to ensure that Europe offers attractive prospects to its best brains.' With these words, the Lisbon European Council of March 2000 gave the green light to the new approach to the European Research Area. Commissioner Philippe Busquin explains the meaning of this new political direction.

You took over the European research portfolio in September 1999. In January, at your initiative the Commission launched a wide-ranging European debate on this new strategic dynamic to create a genuine European Research Area. What was the reason for this initiative?

Philippe Busquin: It is a response to a situation which I believe should be cause for concern. Scientific and technological development is clearly the engine for economic and social growth, and in particular for creating new jobs. Europe has one of the best research capacities in the world. But a lot of indicators show that we fall a long way short of our major competitors in the dynamism stakes. I will cite just one: our research expenditure has fallen to 1.8% of GDP compared to 3% in the United States and Japan.

There is one circumstance which both aggravates this weakness and in part explains it. European research is fragmented. It is a jig-saw of 15 national scientific and technological policies, plus the European Union's RTD Framework Programme. The latter certainly encourages cross-border cooperation, but it operates too much as a 16th element simply tacked onto the other 15.

In the United States and Japan, scientific and technological policy is rooted in a much more interdependent research fabric and exerts more effective leverage. The European research area must be more firmly based on common approaches and objectives, on drawing more benefit from the diversity of its potential. There is a need to go beyond the present static structure of '15 + 1' elements and develop a more dynamic configuration which is based on a more coherent implementation of the actions of Member States at the national level, of the Union within the Framework Programme and other policy instruments, and of inter-governmental research organisations.

Does this mean you want research policies to be more coordinated?

I know this word frightens some people. Coordinate does not mean 'impose' or 'replace'. The idea is not for some kind of central control dictating what research must be undertaken, in Sweden or Portugal for example. I would prefer to speak of consultation with the aim of highlighting a shared desire to achieve major objectives, but without wanting to paper over the diversity of approaches. The diversity of European research is an asset, but if it means everybody working away on their own in their corner, then it becomes a liability.

I believe we must return to the principle of subsidiarity as laid down in the Treaties - that is, for Europe to do what the individual member states are unable to do at the national level. Organising coordination is one of the European Commission's fundamental missions and one that has long been accepted in the field of the economics and competitiveness.

Philippe Busquin, Member of the European Commission responsible for research, and Michel Claessens, coordinator of RTD Info in the Communication Unit, during this interview: 'The European research area must be more firmly based on common approaches and objectives, on drawing more benefit from the diversity of its potential.'

A policy to strengthen the European reasearch area is therefore perfectly in line with the spirit and thinking behind the Treaties. I also think that the Union's research programmes have become rather the victims of their own success, and of the interest they have aroused. Science and technology have become determining factors for economic growth and competitiveness, but I also have the impression that the Union, that is all the member states as a whole, is being slow to adjust to this fact.

After four months' debate on this new approach to the European research area, how has this idea been received?

Remarkably well, because the European Council of heads of state and government, held on 23 and 24 March in Lisbon, largely ratified the principle. But I should also like to mention the important step taken two weeks earlier with the meeting in Lisbon organised by the [Portuguese research] minister José Mariano Gago.

This was a genuine forum, the first of its kind, during which ministers were able to talk with officials from the major European intergovernmental institutions - CERN, the ESA, EMBO, etc. - with representatives of leading national research institutions, industry and the universities, as well as with a panel of leading figures from the world of science. This dialogue, very much of the kind I would like to set up on a permanent basis, revealed a real consensus among all those involved in scientific and technological policy on the need to strengthen the European dimension of research policy.

Of course agreement must still be reached on what directions to take to give substance to the concept. The Portuguese presidency and the Commission are working to ensure that the next Research Council, to be held in June, can lay the foundations for this.

Is not one of the directions discussed the importance of basic research, which has perhaps remained the poor relation in European scientific and technological programmes?

It is true that many prominent members of Europe's scientific community believe that basic research should be made a higher priority, and I share their concern. But at the same time we must not lose sight of Europe's weakness in translating research results into innovations. A number of major initiatives, such as the creation of a genuine European patent, should help correct this. I believe we need to rebalance the various activities to some extent.

We live in an age in which the dividing lines between advanced science and applications have broken down. New worlds of knowledge are constantly developing and radically changing the way we live. Look at the impact the biosciences or space research are having. Scientists are always saying that the most important research projects are those which nobody has even thought of, but which are gestating somewhere without anyone being aware of how significant they could ultimately be.

Do you mean by this that we are seeing European policy adopt a new approach in this field?

No, because the introduction of the Fifth Framework Programme already marked a turning point in introducing a new vision and widening the role of European research, refocusing it on providing very open and concrete responses to the major challenges facing European society. In many fields where the citizen rightly makes high demands - health, food safety, the environment - the solutions which science and technology can bring require new knowledge to be developed. A lot of European support has been committed to projects researching genetics, the traceability of GMOs, climatic change, biodiversity, nanotechnologies, etc.

People have very high expectations of science and technology, but aren't they also rather suspicious of it?

The impact of scientific and technological progress on social structures and lifestyles is going to increase and accelerate. This means that society is going to be faced with a number of choices and ethical problems. Increasing pressures on the environment, the recent serious food-safety crises (BSE and dioxin), and the marketing of GMOs are quite rightly giving rise to public concern, and could threaten confidence

in science. If we do not want this disenchantment to result in obscurantism and regression, the scientific debate must be thrown open.

There is very strong demand for such a debate in Europe, but it is rooted in the context of Europe's cultural diversity. This diversity is a valuable and fertile resource, but it must be accompanied by a common dynamic for knowledge which is the only way to provide the answers on which society's choices must be based. One of the tasks of the European research area is to provide a framework for this debate, because the debate on these technical developments and their ethical and social implications increasingly needs to be held in a European context.

I would add that it is particularly important for young people to be made aware of the implications of science for society. It can be the best possible incentive for developing a taste for knowledge and a passion for research.

You will soon have to start work on preparing the Sixth Framework Programme for RTD 2002-2006, one of the major tasks of your period in office. How will this be influenced by your vision of the European research area?

I believe the fundamental approach must remain the refocusing of European research programmes on problem-solving. But when deciding the priorities, the new actions resulting from the present debate on strengthening the European research area must also be taken into account. Thus, the Sixth Framework Programme will also, for example, take into account the importance of subjects such as the mobility of researchers or the networking of centres of excellence and infrastructures. Central to its approach will certainly be a coordinated vision of the European research effort as a whole. ■

The ways forward

Among the recommendations for 'flexible, decentralised and non-bureaucratic' actions to promote a new European research area, the Lisbon European Council of March 2000 highlighted the following ways forward:

- concerted action, on a voluntary basis, by national and European programmes to optimise the resources allocated to European research in the member states;
- the 'mapping' of European centres of excellence;
- fiscal measures, access to venture capital and support from the European Investment Bank to create a more dynamic environment stimulating private investment in research, partnerships and the creation of start-ups in high technologies;
- the development of a transparent methodology for assessing the performance of national research systems, development policies and innovation capacities;
- the creation of a rapid trans-European data communication network linking all its research institutes, universities and ultimately the educational system as a whole;
- strengthened policy for the mobility of researchers, making it possible for Europe to attract and retain the best scientific minds;
- the creation of a simple and inexpensive European patent system to guarantee as effective an intellectual protection as the systems operating in Europe's principal competitors.

Scientists give their verdict

Nearly 30 scientists, winners of the most prestigious international awards, have given their verdict on the strengths and weaknesses of European research. At an informal meeting in Lisbon in March, they told European research ministers what they expect from Community policy. Here is what they had to say.

'Insistence on the pursuit of useful and profitable goals ignores the essential fact that the applications of fundamental research are usually unknown and cannot therefore be planned in advance,' points out Christian de Duve (winner of the Nobel Prize in Medicine, 1974). 'This does not mean that applied research must be neglected. But researchers should be alerted to the possible applications of their work and encouraged to participate in their development.'

No innovation without upstream commitment

Although unanimity is rare, this is one point on which the scientists interviewed most certainly agreed - and sent out an SOS. Fundamental research requires a long-term vision and needs support - the investment made is rarely lost. Just take a look across the Atlantic. The importance attached to 'generic research' and the scope available to scientists to move from ideas to innovation means that the Americans 'perform better and react more rapidly,' as Heinrich Rohrer (Nobel Prize in Physics, 1986) puts it.

Upstream commitment brings results. Many scientists call for the development of the kind of entrepreneurial scientific culture that is found in the United States with its many start-up and spin-off firms. 'Most inventions and progress come from small start-up firms,' believes Ivar Giaever (Nobel Prize in Physics, 1973).

'We are only now beginning to understand the importance of synergies between the research carried out at universities and industrial applications,' adds Lord George Porter (Nobel Prize in Chemistry, 1967). These links will prove all the more effective 'if industrial scientists are ad personam professors at university and if advanced students can carry out their research under qualified guidance at industrial laboratories,' concludes Werner Arber (Nobel Prize for Medicine, 1978).

What can Europe do?

One of the reasons for these repeated references to the contrasting picture in the United States compared to Europe, is that the brain drain, although reduced, has far from dried up. 'The only way to stop the brain-drain is to organise the return of PhD students attracted by good and well-paid posts at research centres working at the cutting edge of their discipline,' is how Jean Dausset, winner of the 1980 Nobel Prize in Medicine, pragmatically sums up the situation. The way to keep talented research students in Europe is to give them the training opportunities they need, which is precisely what the European Union has been trying to do for several years now through its support for the mobility of researchers. Rudolf Mössbauer, (Nobel Prize in Physics, 1961) believes 'European programmes for young scientists are very helpful and should be continued,' while John Cornforth (Nobel Prize in Chemistry, 1975) calls for 'a central European library' operating over the Internet, giving cheap and easy access to all the available scientific publications. These virtual possibilities should serve to create virtual centres of excellence, potential contact points for different disciplines.

What has the EU done for European research? A great deal in fact - and it could do even more if it were more flexible and less bureaucratic. 'EU programmes are fine, but they should mainly coordinate activities and not manipulate activities,' says Richard Ernst (Nobel Prize for Chemistry, 1991). It is scarcely surprising to find that most scientists want to be much more closely involved in research policy and suffer from incomprehension on the part of governments and politicians. Which does not stop Ilya Prigogine (Nobel Prize in Chemistry, 1977) from making the point that 'research is a policy in itself. Too tightly coupling its implementation with other policies could defocus the work.' ■

Werner Arber, Nobel Prize in Medicine, 1978

John Cornforth, Nobel Prize in Chemistry, 1975

Jean Dausset, Nobel Prize in Medicine, 1980

Christian de Duve, Nobel Prize in Medicine, 1974

Richard Ernst, Nobel Prize in Chemistry, 1991

Ivar Giaever, Nobel Prize in Physics, 1973

Rudolf Mössbauer, Nobel Prize in Physics, 1961

George Porter, Nobel Prize in Chemistry, 1967

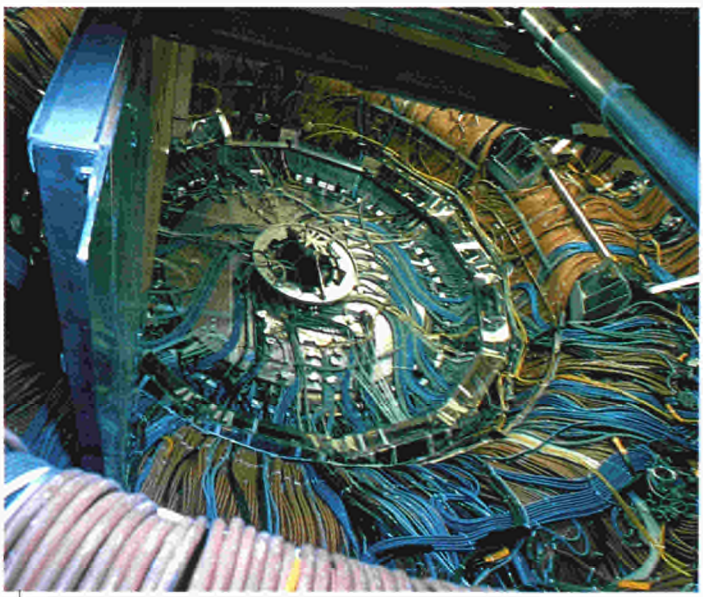
Ilya Prigogine, Nobel Prize in Chemistry, 1977

Heinrich Rohrer, Nobel Prize in Physics, 1986

The European scientific landscape

What new directions are national research support policies taking? What are their aims? What do the member states expect from the institutions they fund? How do the researchers view the situation? And what is the role of international support? A study funded by the European Union is now shedding light on all these questions, by combining a structural analysis with a field survey.

Six multidisciplinary teams of sociologists, political analysts and economists have taken a long hard look at public research systems in 12 European countries varying in size, growth rate, culture and level of scientific progress - the UK, France, Germany, Hungary, Denmark, Sweden, Ireland, Italy, Portugal, Spain, Norway and Iceland. At the same time, a field survey was conducted among 392 human genetics laboratories (see box p.9). This ambitious project, European Comparison of Public Research Systems, was carried out over a two-year period with support from the European Union.[1]



An example of a centre of excellence of worldwide renown: CERN (the European Laboratory for Particle Physics near Geneva.) View of one of the 6-metre diameter DELPHI detectors in the LEP electron-positron collider.

Research policies differ from one country to another, being rooted in a particular tradition and history which affect their development. However, over the past 30 years these differences have tended to erode due to a number of major - and common - trends, such as the restructuring of research institutions, a marked priority for new technologies, the emphasis on transfer to industry, and the institutionalisation of evaluation for programmes and institutions.

Research institutes are taking a new direction

In the past, public research seemed to have a more precisely defined mission. The key task of universities was to push back the frontiers of knowledge, transfer know-how, and train new generations of scientists. The specialist public institutes, on the other hand, concentrated on meeting the needs of government policy and supporting the industrial priorities set by governments. 'These institutes were expected to be able to anticipate and resolve questions that could arise in the fields of health, food safety, energy, etc.,' explains Philippe Larédo, director of research at the Ecole des Mines in Paris, who managed the project's laboratory survey. 'They were subject to various - and sometimes contradictory - reforms. In the United Kingdom they had to become more "service-oriented", in France they were pushed in the direction of academic research. In every case, these institutes failed to fulfil the role they should have in preventing and controlling the growing number of crises - contaminated blood and BSE for example.' In some cases the decision-makers transferred tasks which had traditionally fallen to research institutes to universities, which, due to a lack of equipment or human resources, were not necessarily in a position to take them on.

'There is a need for new approaches which are better rooted in public concerns and suited to each situation,' continues Mr Larédo. 'France, for example, in addition to maintaining these institutes, has set up a specific mechanism - complete with supporting legislation - for the processing of nuclear waste, an AIDS research agency, a committee for research into BSE, and - more recently - a food safety agency. To me, the concept of a generic approach seems completely outdated.'

Universities and innovation

Throughout Europe there is the same tendency to encourage closer links between public-sector research and private-sector expectations. 'This is not new. Do not forget that Louis Pasteur made major breakthroughs in biology at a time when he was seeking to solve problems posed by industry. It is useful for companies to help researchers to identify priorities and to support their projects. The situation is less healthy when public research is dependent on industrial contracts for access to research grants,' remarks Jacqueline Senker of Sussex University, the project's coordinator.

Innovation and *technology transfer* are the two key terms - the watchwords -

which have reshaped Europe's research policy over the past 20 years. Ministerial portfolios reflect this objective, often combining science, technology and education. Implemented under weak economic conditions, without real command of all the information and under time pressure, this reorientation has often been based on ready-made solutions. 'There has often been a tendency to imitate what has succeeded elsewhere in a comparable situation. Government enthusiasm for technology transfer does not necessarily mean that these initiatives are going to be a success,' continues Dr Senker, who believes there is an 'urgent need to correct this excessive emphasis on promoting industrial innovation.'

Too close a relationship between universities and industry raises a number of fundamental issues. Apart from the adverse effects of short-term, applied research on quality, Dr Senker believes that 'This cooperation can prejudice the status of "impartial expert", which is what researchers in the field of scientific policy are expected to be. It is also sometimes very difficult for an SME or company in the traditional sector to find the necessary expertise. Some universities are no longer interested in meeting such unsophisticated needs.'

And where does this emphasis on economic return leave fundamental research? Unfortunately, it is all too often the poor relation in the member states. Neglecting long-term research in this way is not without its effects in terms of failing to advance knowledge, tending to discourage talented researchers from adopting a career with an uncertain outcome, and penalising applied research, which is impossible without its upstream counterpart.

The hunt for funds

The public funds allocated to universities and research centres are traditionally channelled through one of two paths: *the research council* finances specific research projects on a competitive basis following an evaluation by scientists; *block grants* allocate institutes a global amount which they are then free to manage as they see fit. This latter method - with a guarantee of independence - is becoming more common. Jacqueline Senker believes that 'the two systems must continue to operate in parallel, although there should perhaps be stricter control over the way in which the money is spent in the case of the block grants. However, we must also remember that they do allow scientists to explore radically new fields which research-council evaluators might be inclined to refuse.'

Whatever form it takes, national research funding is inadequate in most countries. Additional sources available in certain countries include European funds (Ireland, Portugal, Spain), contracts with industry (Germany, Spain, Portugal, Ireland), and foundations set up by industry or non-profit-making associations (20% of the research resources of British universities). Some countries are also taking new initiatives, such as France which has just introduced an 'ecotax' with the revenue collected going to research on the environment and health.

Countering the 'single policy'

'Political perception of problems, orientations and objectives has become increasingly similar in every country,' notes the report. 'Institutions such as the OECD and the European Union have reinforced this trend. Their analyses of the various situations and the solutions needed have had the same influence on the national debate, in all countries,' explains Dr Senker. She believes officials everywhere have jumped on the bandwagon of evaluation, even if the effectiveness and impartiality of its use varies from one country to another.

This trend towards increasing uniformity is nevertheless meeting resistance from national cultures - cultures sometimes seen as obstacles to the 'new scientific policy' sought by policy-makers. For Dr Senker this 'multi-faceted' approach to research is

Innovation and technology transfer. The European watchwords of the past 20 years.

essential: 'The diversity of national systems must continue. It stops us repeating our mistakes and permits new initiatives. It also benefits scientific research. The interaction between scientists from different countries in EU-backed projects, each making their specific contribution, has generated an extremely creative process which is accelerating the dissemination of knowledge throughout Europe. European funding should promote multidisciplinary research, which is often neglected by national programmes, although it is frequently the source of innovative scientific and technological developments.' ■

(1) Supported by the Fourth Framework Programme's Targeted Socio-Economic Research programme (TSER).

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In the labs

In addition to the structural analysis of national public research policies, a field survey was conducted among 392 human genetics laboratories in seven countries: France, Germany, Iceland, Italy, Spain, Sweden, United Kingdom. 'These laboratories are to research what companies are to the economy: basic production units. Just as there are SMEs and multinationals, innovators and imitators, pioneers and developers, so too there are different kinds of laboratory,' explains Philippe Larédo, who managed the survey.

Human genetics was chosen because it is representative of a new method of knowledge production, is particularly active in the field of life sciences, adopts a transdisciplinary approach, and places the emphasis on applications while at the same time having direct links with fundamental research. 'This new method of knowledge production reflects the way in which the use of skills and knowledge is being spread increasingly widely throughout society and the economy. It also reflects a re-balancing of the roles, with research increasingly concentrating on problem-solving.'

The idea was for the laboratories to provide a 'compass card' of research, taking all their various activities into account: production of certified knowledge, involvement in training, contribution to gaining competitive advantages, anticipation and realisation of public objectives, participation in the public debate. Different activity profiles were defined on the basis of the way they combined these roles. Despite the very 'fundamental' nature of their research, more than half the laboratories have important links with hospitals and industry, which does not prevent two-thirds of them also playing a major academic role. 'Our hypothesis is that the more laboratories open up to other institutions the more strongly autonomous their strategies become, thanks to their involvement in several different programmes, and their relations with the socio-economic world - companies and hospitals - etc.' These strategic choices are made in situ, by each laboratory, and quite independently of criteria of nationality or parent institution. It is this which 'must raise many questions for the parent institutions and for incentive policy, whether regional, national or European.'

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Accelerating into the future

The Joint Research Centre's IPTS (Institute for Prospective Technological Studies) has just spent two years analysing the technological and social changes Europe is set to experience by the year 2010. It sets out a future in which the opportunities to be grasped will be matched by the challenges that must be met.

If there is one thing the often chaotic twists and turns of history have taught us, it is that there is no predicting the future. Nevertheless, prospective studies seek to pave the way to the future by anticipating major trends. In this age of accelerating change, it is a task that is more vital than ever.

This is certainly true for technology, and first and foremost the revolution in the information society and life sciences. But it is also important for the structures and organisation of society, marked as it is by the inevitable ageing of the population, the growing need for sustainable development, the advent of the knowledge-based economy, and economic and cultural globalisation.

What is more, Europe will face additional changes triggered by the inherent dynamics of launching the single currency and market, plus the arrival of an impressive batch of new member states.

Simultaneous challenges

Each of these developments is a challenge in itself. But the need to reflect on Europe's future becomes all the more urgent when one considers that all these changes will occur simultaneously and within the next decade. It is impossible to spread these changes over time. This simultaneity in itself represents a further challenge, and on a scale unlike anything seen before. It is this cross-analysis of the interactions between these imminent changes which is the distinctive feature of the approach adopted by the Futures project (see box).

This wide-ranging multidisciplinary study was launched by the IPTS at the beginning of 1998. Almost 200 experts and policy-makers were involved, drawn from industry, academia and the public authorities. These consultations and the analyses of a large number of prospective studies in the field of science and technology, economics, sociology and politics - at national and supranational level - made it possible to comprehensively chart this interdependent and on-going technological change, as well as Europe's competitive position in the face of globalisation, employment, education, demography, and social changes (and their cost).

'What was a significant achievement, we believe, was the careful sifting and synthesis of the source material in a way which allowed the IPTS to throw key policy issues into clear relief,' point out Gustavo Fahrenkrog and Ken Ducatel, who have coordinated the Futures project for two years. 'We have found that policy-makers are particularly interested in the reports precisely because they cross the boundaries of conventional lines of analysis and policy concerns.'

The 'technological dynamo'

The Futures report stresses the determining role of Information and Communication Technologies (ICTs) and life sciences, viewing them as the two driving forces in the 'technological dynamo' which is driving all the other changes. Europe presents a contrasting picture in this field. In many sophisticated applications involving complex new technologies - mobile communications, or biotechnological and biomedical research for example - Europe has achieved a strong position. The same is true for sectors which are increasingly incorporating a bundle of new technologies, such as transport and clean technologies.

However, over the past two decades Europe has clearly been lagging behind in the race to design and develop the basic components on which the expansion of the information society is founded, a race dominated by the United States and Asia. The question facing European decision-makers, whether in the public or the private sector, is quite clear: can Europe harness its energies and finally become a force to be reckoned with on the strategic front of the emerging technologies - such as new microchip generations, image technologies and artificial intelligence software?

Science and industry alone cannot provide the answer. Europe's ICT sector is already estimated to be short of around 500 000 information technology experts. By 2003 there could be as many as 1.7 million posts without the skilled personnel to fill them.

As to the booming life sciences, the present debate on GMOs makes it perfectly clear that the serious ethical and political questions they raise can no longer be ignored. Europe must find, for itself and on an international level, a transparent consensus position which satisfies public concern by clarifying what can be scientifically defended as acceptable risks.

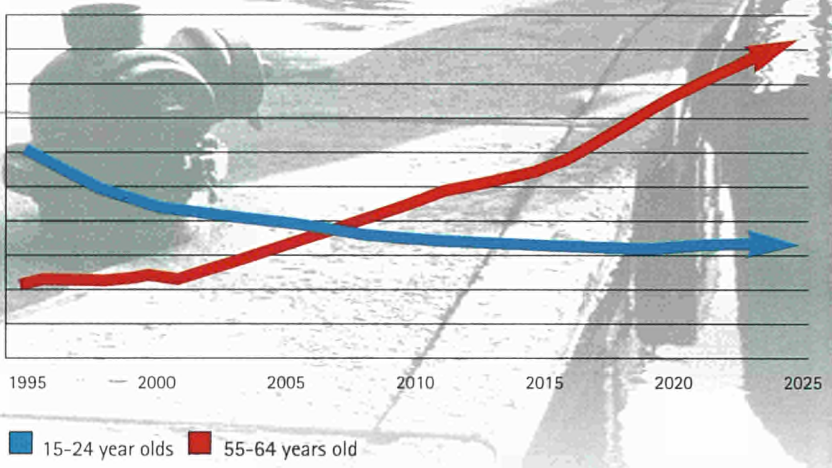
Society dictates its needs

The technologies which succeed are those which are adopted by society. This means that changes in lifestyle, human capital, and social problems hold the keys to the future. In this respect Europe presents a complex mosaic and the Futures report presents a scenario with increasingly diverse situations and patterns of social behaviour.

The demographic challenge and its implications for employment could not be clearer. From 2007, the growth of the working population, which until then will have continued to rise gently, will begin a long descent, eventually becoming negative. There will even be an inversion of the pyra-

The upside-down workforce

The changing proportions of 15-24-year-olds and 55-64-year-olds in the total population - European Union - 1995-2025



mid, with workers aged between 55 and 65 for the first time outnumbering those aged between 15 and 24. What is more, it is a trend with no end in sight. In 2025, the over-65s will account for the equivalent of 38% of the working population, compared with 25% in 1995. This 'grandpa boom' is going to affect not only the labour market, but also society's needs and the problem it will have paying to meet these.

Such a trend might at first seem like good news for unemployment. But only - and this is far from certain - if Europe succeeds in making the transition to a knowledge-based society without further delay. Education and training are already facing the immense task of providing lifelong learning. In addition to the employment aspects, this is going to be increasingly necessary in terms of the day-to-day lives of citizens in all their social and cultural relationships. 'Otherwise there will be a serious mismatch between what is technologically possible and what is socially accepted,' points out Jean-Marie Cadiou, IPTS director, in the introduction to the Futures report summary. 'This issue also raises the spectre of a multipolarised society in Europe, in which we will not only have traditional divisions between rich and poor, between core and periphery, but also new social dividing lines such as the 'haves' and 'have nots' of knowledge, the work rich and the work poor, and the wealthy retired as opposed to those on minimum incomes.'

At European level

One of the key lessons to be drawn from the Futures analyses is that none of the challenges we are facing can be met without adopting a common Europe-wide strategy. This is for the simple reason that politically - and in terms of regional or global governance in the context of a globalised world - the necessary changes are only possible if the European Union as a whole is totally committed to achieving them. 'A crucial advantage lies in the formidable potential available to Europeans due to the effects of scale stemming from the size of their community,' explain Gustavo Fahrenkrog and Ken Ducatel. 'There are many areas in which efforts are still uselessly fragmented and this holds us back. Examples include standards for electronic payment systems, and, more generally, the need for a combined voice in international arenas on issues such as genetically modified organisms and the reduction in greenhouse gases. Enlargement will further add to these scale effects, while at the same time presenting the Union with delicate problems of internal cohesion. We must establish solid pillars for joint policies while at the same time respecting the increased diversity of situations.' ■

Last February the Futures project culminated in a major conference in Brussels to present its results. The 15 reports providing a comprehensive summary of its work can all be downloaded from the website at: http://futures.jrc.es

Diabetes reveals its genes

Diabetes and its complications are a growing public health concern in Europe. To understand the role of genetic determinism in this complex disease, a consortium of European laboratories has gathered medical data on several thousand diabetes families and defined a common approach based on post-genomic analysis. The aim is to develop new medicines and an experimental methodology which can be applied to other complex diseases.

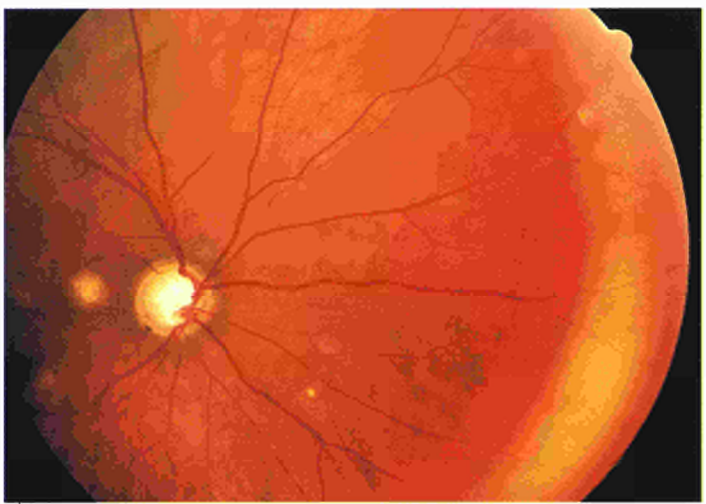
For the physiologist, diabetes is an illness whose main symptom is the presence of sugars in the urine. For the doctor, there is diabetes... and diabetes. This is because the presence of sugars in the urine can be a symptom of two very different diseases. Type 1 diabetes, which accounts for about 10% of all diabetes patients, affects young people and causes a progressive destruction of the pancreas. Type 2 is an illness of later life and involves a loss of sensitivity to insulin, the hormone secreted by the pancreas. Also known as non-insulin-dependent diabetes, type 2 diabetes affects more than 100 million people worldwide and becomes increasingly common with age. In Europe, diabetes and its serious complications - such as blindness, kidney complaints and cardiovascular problems - account for 8% of all medical costs.

Genetic determinism

In the early 1990s, a team headed by the French geneticist Philippe Froguel of the Institut Pasteur in Lille showed that a sub-form of type 2 diabetes could be caused by mutations of the coding genes for the enzyme glucokinase and for the nuclear transcription factor for hepatocytes. This was the first experimental proof of the role of genetic determinism in diabetes. However, in the vast majority of type 2 diabetes cases the genes do not actually cause the illness but rather predispose a particular individual to developing it in interaction with what are known as environmental risk factors, such as age, nutrition, weight or lack of physical activity. To use the jargon of the experts, type 2 diabetes is a multigenic and polyfactoral disease.

The question therefore is how to identify the role of genetics as distinct from lifestyle, and how to determine what genes are involved. This is the task of GIFT (Genome Integrated Force on Type 2 diabetes), a European research network coordinated by Philippe Froguel and financed by the EU.[1]

As in any study of medical genetics, the first step is to gather data on patient families. Several teams had already collected anonymous medical records on patients suffering from type 2 diabetes, complete with DNA samples and information on lifestyles and diet. GIFT entered these British, Danish, French and Swedish data into a single database - one of the biggest in the world, and one which is soon to have its own Internet site.



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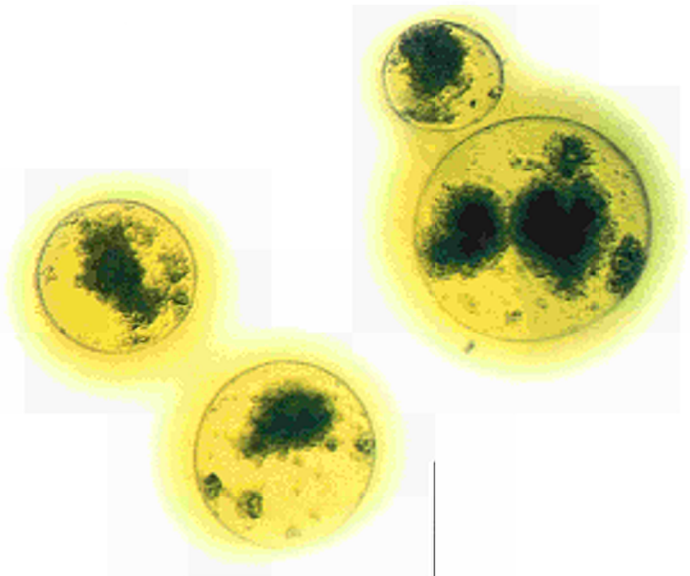
The fondus oculis of the diabetes subject. The head of the optical nerve is visible (clear spot) as well as indications of bleeding (irregular spots).

The post-genomic approach

But how can such a vast amount of information be used? 'The only way to understand the genetic determinism of such a complex disease is to combine a traditional genetic study with a post-genomic approach. The term itself is a contraction of 'genetic' and 'informatic', and indicates the new horizons opening up to biomedical research, which is seeking to understand and interpret the vast amount of information now available on the human genome sequence,' explains Philippe Froguel.

GIFT's Danish partner is responsible for the genetic epidemiological study to identify which genes predispose an individual to developing diabetes, their position on the chromosomes and their sequences. A British team is providing the necessary expertise in the field of bioinformatics and statistical analysis. This first research stage has already made considerable progress, identifying on chromosome 20 a DNA sequence (a locus) which is significant for the predisposition to develop type 2 diabetes. But it is one thing to identify the genes involved in the predisposition and quite another to determine their level of expression under normal or pathological conditions, i.e. their level of transcription into RNA which will in turn be translated into protein.

This is where the post-genomic approach comes in. One of GIFT's objectives is to apply the advanced techniques of DNA biochip or microarray technology to the study of diabetes. This makes it possible, simultaneously and automatically, to analyse the level of expression of several thousand genes (see box). These diabetes biochips will be developed in cooperation with the ValiGene biotechnology company in Paris, as part of the EU's incentive policy



Micro-encapsulated islets of Langerhans. Complete pancreas transplants have been carried out for a number of years. Researchers are now studying the possibility of transplanting islets of Langerhans which can already be separated from the rest of the pancreas. Experiments have proved successful on rats and dogs, but are not yet conclusive for man. Research is currently concentrating on transplanting pig islets.

to create a genuine European DNA biochips industry able to rival US supremacy.

These chips will be used to study the level of expression of predisposition genes both in man and in animal diabetes models. This should make it possible to identify a number of potentially susceptible genes, the role of which can then be tested in man.

Molecular clues to developing new drugs

What results can be expected? It could be supposed that a programme based on predisposition genes would yield results in the field of prevention, for example identifying patients genetically likely to develop the disease before they actually become ill. But this is not the area the GIFT researchers are concentrating on, believing the lifestyle influence to be too great to envisage any genetic screening. On the other hand, the study of predisposition genes could produce significant results in the field of pharmaceutical research. A knowledge of the levels of expression of the genes involved in a predisposition to diabetes could provide molecular clues to developing new drugs. If a particular gene is found to be over-expressed in a diabetes patient, molecules could be developed to interact with the protein coded by this gene and thereby reduce its harmful effect. This is one of the most promising industrial applications of post-genomics.

The consortium is currently establishing links with several European pharmaceutical groups with a view to developing new forms of treatment based on the genes discovered. This is why patent applications have been made for these genes. There are also plans to launch a European start-up company specialising in diabetes genomics. Finally, the consortium's study will make it possible to adopt a joint approach for research on genetic predisposition in multifactoral diseases. 'Our work on diabetes could serve as an experimental paradigm for the study of other diseases which remain an enigma to biomedical research,' explains Philippe Froguel, citing 'cancer, hypertension, neurodegenerative diseases such as Alzheimer's disease, and obesity' as possible examples. ■

(1) GIFT received 1.94 million euros from the EU's Biomedicine programme (FP4) and is continuing to be funded under the new programme, Quality of life and living resources.

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Genes and biochips

In a 'diabetes biochip', short oligonucleotides specific to diabetes predisposition genes - taken from the RNA preparations of a diabetes patient, for example - are deposited and fixed on the biochip surface. When this comes into contact with a DNA sample to be analysed, the nucleic acids it contains that correspond to the expression of the targeted predisposition genes will hybridise (i.e. form a double strand molecule) with prilers attached to the biochip. This hybridisation triggers an optical signal which is then automatically analysed.

Building the new man

Biomaterials which can be used to repair human organs or tissues are no longer the stuff of science fiction. They are being used increasingly often in skin regeneration, and this will soon be the case for bones, the liver and the kidneys too. Small European businesses are competing in a global market - estimated at several tens of billions of euros - in this highly competitive field which has revolutionary implications for the health and well-being of millions of severely handicapped people.

The medical applications of biomaterials in plastic surgery are increasingly operational and are destined to become generalised. The results of several research projects supported by the Industrial Materials and Technologies programme[1] testify to the European presence in this area of innovative treatments.[2]

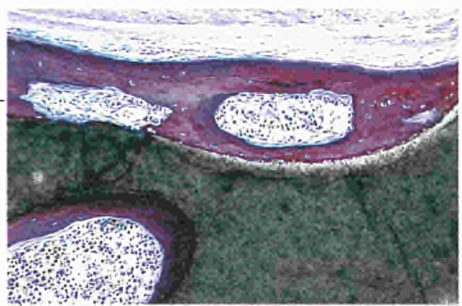
Although it is a very active field of research worldwide, Europe had not previously played a very significant role in skin research. Yet there is a huge demand, mainly from burn and ulcer patients. Diabetes sufferers, for example, frequently develop ulcers on their feet due to circulatory problems. 'If these lesions persist, sometimes the only solution is to amputate the leg,' point out Claudio de Luca and Alessandra Pavesio, who are coordinating a project called Development of a Biodegradable Scaffold for Dermo-Epidermal Grafts at an Italian company, Fidia Advanced Biopolymers (FAB).

One of this project's aims was to regenerate a perfectly natural skin in a single stage - a skin comprising both the dermis, principally made up of fibrous tissue, and the epidermis, mainly consisting of keratinocytes. Another important objective was to use autologous cells (i.e. those of the recipient) to avoid rejection by the patient's immune system. This made it necessary to construct a kind of three-dimensional scaffold of biocompatible materials which would stimulate the growth and production of both cell types within the damaged tissues themselves. This 3D architecture also had to be non-toxic, non-immunogenic and biodegradable, and to possess the necessary mechanical, physical and biological properties.

Prefabricated bones

Although life expectancy for the inhabitants of industrialised countries has almost doubled during the 20th century, there is another side to the coin. Cases of bone disease, and the incidence of fractures caused by excessively fragile bones, are constantly rising. Today a number of ways of reconstituting the damaged bone segments are possible. One of them - the most exciting one according to Joost de Bruijn of the Dutch company IsoTis - is the subject of the Isobone project. Apart from the project coordinator, IsoTis, there are two other companies - Novamont SpA (I) and Cinpres (UK) - and four universities[1] working on the project.

The aim is to rebuild the bone tissue using a biocompatible and biodegradable matrix on which autologous cells (such as the patient's bone marrow cells) are grown. This approach has a number of advantages. It rules out any possibility of rejection, unlike grafts using cells from a donor. It also avoids the need for two exhausting, or even dangerous, major operations - one to take a sample of healthy bone and the other for the graft onto the weakened bone. The feasibility of this technique has already been demonstrated in practice, which means that prospects for the future are excellent.



Histological section of porous calcium phosphate particles on which bone marrow cells have been cultured after which they have been subcutaneously implanted for 6 weeks. After implantation, the cultured cells have produced abundant amounts of bone tissue (purple stained tissue).

(1) University of Twente (NL), Instituto Nacional de Engenharia Biomedica and the University of Minho (P), Brunel University (UK).

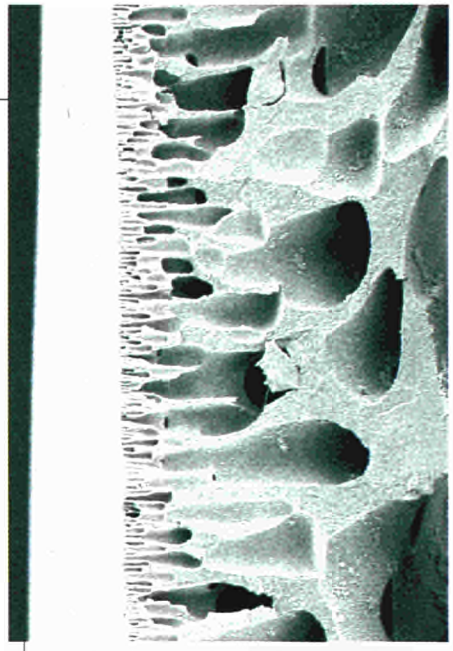
Contact | **Joost de Bruijn - IsoTis BV,** joost.de.bruijn@isotis.com

From design to clinical trials

The project owes its success largely to the way it managed to bring together complementary skills from universities and industry. As a company, FAB is well known for its excellence in the development of biocompatible materials, using, as the basic elements, derivatives of hyaluronic acid, a polysaccharide which plays a significant role in the skin as one of the major components of its extracellular matrix. HDB, a Belgian company with engineering know-how acquired in textile polymers, joined forces with FAB to scale production up to an industrial level. The *in vitro* and *in vivo* preclinical testing was carried out by four teams from the Deutsches Krebsforschungszentrum and the Rheinische-Westfälische Technische Hochschule - RWTH (D), the PASTIS-CNRSM institute (I), and the London Hospital Medical College - LHMC (UK).

Next came the clinical trials. Researchers from LHMC and RWTH drew up the protocols and made the evaluations for several kinds of wound such as burns, tattoos and sores. 'About 1000 patients have already received skin grafts,' estimates Mr de Luca. 'This multidisciplinary cooperation has enabled us to undertake the whole chain of activities, from materials design to clinical trials.' FAB now has an 800m^2 cell culture unit.

New membranes for biohybrid organs



Scanning electron micrograph cross-section (50 micron scale) of asymmetric polymer membrane for biohybrid organs based on polyacrylonitrile.

We are still a long way from creating complete new internal organs - whether kidneys or livers - but notable improvements can be made to existing methods of external dialysis. This is what members of the Development and Testing of Membranes for Biohybrid Systems project are trying to do. The project coordinator is Thomas Groth of the German research centre GKSS. 'Haemodialysis treatment, for example, involves a number of unwanted side-effects,' he explains. 'The filtration not only eliminates toxic elements but also those useful to the body.' Membranes in biohybrid systems must fulfil a triple function. They must permit the transport of nutrients, cellular products and oxygen, protect donor cells (whether animal or human) from the recipient's immune system, and ensure that specific cells from the natural organ remain present.

Two types of membrane have been developed by this project, which is being conducted by the GKSS in association with a small Dutch firm, Holland Biomaterials Group, a German company, Fresenius Medical Care Deutschland GmbH, and researchers from the Berlin University Hospital (D), Patras University (GR) and Strathclyde University in Glasgow (Scotland).

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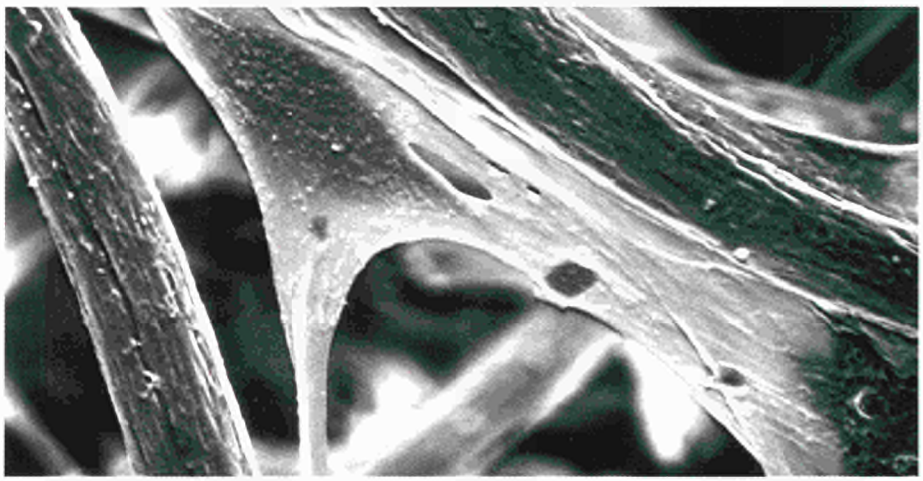
The challenge has been met. But it is not unique. As Uta Faure, scientific officer at the Research DG, reminds us: 'This project is part of a deliberate policy to boost Europe's industrial competitiveness.' This same objective is reflected in two more projects, and with equally impressive results (see boxes): one on bone repair and the other on membrane design for biohybrid systems. When it comes to surgery, Europe is well and truly in the third millennium. ■

(1) More commonly known as the Brite-EuRam programme (1994-98), under the Fourth Framework Programme.

(2) On 13 April a number of particularly interesting projects were presented to the media in Brussels, at an event organised by the European Commission. Three of them are described here.



This scanning electron microscope (SEM) picture shows fibroblasts of human skin growing and adhering to the three-dimensional scaffold of the biocompatible material Laserskin® developed by FAB.

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Open forum

This double-page forum aims to 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 – e-mail: michel.claessens@cec.eu.int]

The prize-winner's words

'Chance, or rather a combination of chances, played a determining role in the way our research developed. We could even easily stand accused of not always having had very precise objectives or extensively developed hypotheses ... And I believe our experience is very illustrative of the nature of fundamental research: often unpredictable, at times erratic, not always answering what was believed to be a simple question, but regularly opening up such broad horizons that a lifetime could be spent exploring each one ... The most important advances made by science are by nature unforeseeable and the presentation sometimes made after the event often reflects a reordering of reality, designed to attribute to its authors a foresight which they often did not have.'

Marc Parmentier, professor at the Université Libre de Bruxelles, on receiving the 1999 Prix Francqui.

Proposal

Problems ... and solutions

The spirit behind the Fifth Framework Programme, and more than likely behind the next one too, is 'problem-solving' - and society's problems in particular.

To make the process as effective as possible, it could be appropriate to make a global assessment of questions which must be solved as a priority. In which case a group of experts should be charged with identifying these priorities and analysing in detail all the necessary stages - and not only in terms of research - in genuinely solving the respective problems. This analysis could be carried out by a 'project' in its own right, instructed on how it should best organise and schedule its activities.

In regard to research and development, targeted calls for specific sub-categories could be issued by the European Commission to attract the best expertise.

But what is lacking at present is an active follow-up of known research results. Such follow-up would ensure that these results help to solve problems and also encourage the support measures (financial, administrative, legal, etc.) required for a global solution.

The monitoring could cover a sufficient number of years to take account of previous studies. These success stories could be presented to the general public. It would then be possible to subsequently increase the budget for research programmes.

André Pirlet, Project Manager, CEN - European Committee for Standardisation
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Figures

■ **Alcohol** - Monday morning blues? Mondays in Scotland bring a 20% increase in fatal heart attacks among men. Strange? One of the explanations is apparently excess alcohol consumption over the weekend. This is the view of Dr Christine Evans (University of Glasgow and Scottish National Health Service) writing in the British Medical Journal following a major epidemiological study.

■ **Birds** - of the 10 000 species of birds that started the last millennium, 2 000 did not make it to the end. Deforestation, oil slicks and other deadly poisons are continuing to do their work. This is the assessment of John Fitzpatrick of the ornithological laboratory at New York's Cornell University. Without these attacks on its habitat, a species should survive a million years.

■ **New technologies** - Between 25% and 50% of economic growth comes from technological progress - When a company adopts an innovation, it sees its workforce increase by 30% in just a few years and its salaries increase by 25% after three years - Europe devotes 1.8% of its GDP to research (compared to 2.8 % in the USA and 3% in Japan) and researchers account for 0.25% of the workforce, compared to 0.70% in the USA and 0.60% in Japan - More than 2 million new jobs have been created recently in high-tech sectors in the United States - The information and communication technologies sector is short of 500 000 professionals in Europe (15% of current jobs) - a figure that could reach 1.6 million in 2002. Between 1995 and 2005, Europe's workforce is set to increase by 6.9 million, but it will then fall by 2.2 million between 2005 and 2015 - The 25% of Europe's population represented by pensioners in 1995 will have increased to 38% by 2025. Source: *The IPTS Futures Project, Research, Technology and Employment - Perspectives towards 2010.*

■ **BSE** - Europe has about 41 million cattle over 2 years of age. 1% of these are consid-

Personal Opinion

Why not a bridge language?

As an interpreter providing simultaneous translation at a conference on European research, Guillaume Giraud decided to react to Commissioner Philippe Busquin's remarks on the cost of patents in Europe, which are much higher than in the United States owing, in particular, to the need to translate them into different languages, and the proposal for them to be limited to English. He springs to the defence of Esperanto:

'It is a solution which really does merit serious consideration, and I speak in full knowledge of the facts: I am a very rational thinker, which enabled me to obtain a diploma in civil engineering at Lille, I learned English, German, Spanish and Italian at school (each language presenting its own difficulties, particularities, etc.), and it was just two years ago that I heard about Esperanto and decided to learn it, ignoring the prejudices.

I was astounded! It is so easy to learn (150 hours of courses compared to 1,500 hours for English!). What neutrality of conception! What flexibility and unique precision compared to other European languages!

In short, an ideal solution as a bridge language between Europe's languages, without favouring any one country by choosing a national language, whichever one it is.

I am of course well aware that this could bring a lot of changes, especially in the translation/interpreting sector in which I earn my living. But I am convinced that the future of Europe and the unity of European nations must lie with a common auxiliary language (like the common currency now being introduced). I am therefore ready to make sacrifices to achieve this goal, even if it means changing my line of work.'

Guillaume Giraud
Translator-interpreter
gcgiraud@compuserve.com

Science and philosophy

Philosophy should be taught at French polytechnic, science and medical faculties. The proposal was submitted by Dominique Lecourt, who teaches at Paris-VII and believes that 'there is a considerable demand from the students; they want science to be presented to them other than from a purely technical viewpoint.' ■

Letters

Carmen Angulo is a physicist with a doctorate from the University of Seville, currently working at the Centre de Recherches du Cyclotron at the Université Catholique de Louvain-la-Neuve (Belgium). After spending 10 years at a number of European research centres - in Germany, France and Belgium - she decided to apply for a permanent research post at the Fonds National de la Recherche Scientifique (FNRS) in Belgium.

'I was told on the telephone that applicants to the FNRS need a diploma from a Belgian French-speaking university. In May 1999 I therefore started work on a thesis for a certificate providing access to teaching posts in higher education. But when I read the FNRS regulations closely I realised that applicants must have a doctoral thesis submitted to a Belgian French-speaking university. A thesis for a certificate to teach in higher education is not enough. In order to get round the FNRS regulations, it has been suggested that I should present a second doctoral thesis in physics. This seems inconceivable to me as I have been a doctor of physics since 1992!

'I am very surprised, and above all very disappointed.

'How is it possible for a Belgian federal organisation for scientific research to have regulations which do not provide equal opportunities for European workers? How is it possible for the FNRS to have regulations which render access for non-Belgians to permanent posts even more difficult?

'These regulations are in contradiction with the aims of the European Commission's research policy, and its scientific mobility and exchange programmes from which I benefited for several years. Mobility and exchange are very enriching for society and for the individual researcher, but when it comes to finding a research post all these legal obstacles are simply unacceptable.

'How is it going to be possible to create a European research area when the national research programmes of Member States are not open to non-nationals? What is the purpose of all my years of training financed by Europe?'

Carmen Angulo
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ered to be at risk. From 2001, compulsory post-mortem rapid detection tests will be carried out on a 1 in 10 random sample of this group, that is 40 000 animals. This decision was taken by the EU's Veterinary Committee, following a Commission proposal.

■ **Bug** - With more than 800 000 visitors expected compared to 650 000 in 1999, with 8 000 exhibitors setting up their stands in an area of 415 000 m², the 2000 CeBIT fair, Europe's largest international fair for information and communication technologies, held in Hannover, Germany from 23 February to 1 March, was bigger than ever. But technology nevertheless disrupted the CeBIT's opening ceremony when a short circuit in Hannover's public transport operating system shut down the metro line serving the exhibition for several hours. The result was thousands of visitors stuck for hours in monster traffic jams. The event was further disrupted by other computing failures over subsequent days (blocked turnstiles, etc.).

News in brief

Women and Science

'Scientific research, like other sectors of the labour market, reflects the tensions in society as a whole, with its inequalities and power struggles. It is therefore important not to consider the world of research and the organisation of scientific work as an area in which social positions are ideally and fairly distributed, but rather as a social segment produced by society, influenced by its values and regulated by its modes of organisation.' This is the conclusion of the report *Science policies in the European Union: Promoting excellence through mainstreaming gender equality*. Produced by a group of 12 senior women scientists from the Commission-sponsored ETAN (European Technology Assessment Network), this document sets out the debates held at the conference *Women and Science: making change happen*, which took place in Brussels on 3-4 April 1999. The aim of the conference was to hold a wide debate among scientists on the under-representation of women in European research, and to discuss appropriate ways of remedying it at the various levels of implementation of research policies.

More than 450 people took part, of whom 88% were women. 31% of participants worked in scientific research, 25% in the management of research, and 19% are responsible for policy making. The results of the two-day conference form part of a broader process which will develop further as part of the European research area.

The report of the ETAN group is the first publication to present statistics at a European level on the situation of women scientists. It tells us, for example, that while women make up at least half the students in the 'first cycle' (first two years of university studies), their numbers diminish at more advanced levels of study, and fall even more dramatically as careers progress. In the Netherlands just 5% of university lecturers are women, and in Finland just 18%. 'The facts and figures highlighted by this report are scandalous,' declares the group's rapporteur Teresa Rees, a lecturer at Cardiff University. 'They show that women scientists of real merit are systematically excluded to make room for mediocre men.' An angry outburst? Perhaps not. While not wanting to generalise, when Christine Wenneras and Agnes Wold looked at the evaluation procedure of the Swedish Medical Council they found it to be flagrantly discriminatory: the simple fact of being a man gives a candidate a 'bonus' equivalent to 20 high-level scientific publications.

So how to reverse the trend? By setting out the demands and the ways of achieving them. Four demands were formulated at the first Women and Science conference in 1998: the creation of a Women and Science sector within the Commission; an undertaking by the latter to promote women in science; more representation for women on decision-making bodies; and the production of a statistical report on the gender situation. While these four demands have been met (a Women and Science section has been set up under the Improving Human Potential programme), the need now is to use these measures to achieve real progress in gender mainstreaming - that is the will to make systematic advances in equal opportunities. Introduced by Eryl McNally, Member of the European Parliament and rapporteur on women and science, the conference ended with the presentation of a series of recommendations in the presence of Commissioner Busquin. These are addressed to the EU and its institutions, the member states, organisations involved in research and technological development, and scientists - both men and women. 'We do not want any more expressions of sympathy. We are looking for genuine commitment to change,' concluded Hilary Rose, professor of sociology at London's City University. *http://www.cordis.lu/improving/src/hp_women.htm*

Precaution: a European definition

'The decision whether or not to invoke the precautionary principle is made when scientific information is incomplete, inconclusive or uncertain, and when indications suggest that the possible effects on the environment or human, animal or vegetable health could be dangerous and incompatible with the level of protection chosen.' This definition, if it can be considered as such, is included in a Communication submitted by the European Commissioners to the Parliament and Council, published last February. The Commissioners reiterate that deciding what is an acceptable level of risk for society is a political decision. The question is, in complex fields where zero risk is rare if not non-existent, should one act, not act, legislate or make recommendations? Measures taken, the document states, 'must be proportionate to the level of protection sought ... be based on an examination of the potential benefits and costs of acting or not acting (including, if applicable and where possible, an analysis of economic profitability); be re-examined in the light of new scientific data and maintained as long as scientific information remains incomplete, imprecise or inconclusive and as long as the risk is deemed to be too serious for society to bear ... they must also be capable of awarding responsibility for producing the necessary scientific proof to permit a more complete risk assessment.'

Biotechnologies: research entrepreneurs

Biotechnology is a high-tech sector with many new and efficient companies which are a major source of new jobs. Some of these have been founded by researchers seeking to benefit from their discoveries and to launch themselves into the world of innovation. But many scientists are reluctant to take this step and to enter a world with unfamiliar rules. So that they do not give up or fail in their ambitions, the Commission is supporting a series of intensive three-day workshops allowing these potential entrepreneur-researchers to acquire the tools and know-how they need to achieve their aims - most notably by means of software designed for their specific needs.

'The aim is to provide scientists with the skills and knowledge they need to set up coherent projects which will interest venture capitalists,' explains Michel Lepers of Euro-Biobiz, who runs the Biobiz® training programme. Seventy-one researchers attended these workshops in a number of European cities in 1998 and 1999. The next workshops will be held between June and October in Stockholm, Dublin, London, Berlin, Tel-Aviv, Eindhoven, Lyon and Lisbon.

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http://europa.eu.int/comm/research/biotech/biocours.html

Young scientists at zero gravity

When an aircraft climbs at full throttle, then suddenly plunges earthwards at an angle of 45°, a state of zero gravity is experienced in the aircraft cabin for up to a minute. This zero gravity can be used to permit scientific experiments and observations comparable to those carried out in space. Since 1994 the European Commission and the European Space Agency have given young science students the chance to share in the experience - and the experiments. Thirty international teams - about 120 students in all - have been selected to go on the next series of these extraordinary flights, at Bordeaux-Mérignac airport in France between 16 and 27 October. With projects in fluid physics, materials behaviour, optics, biology, etc., this year's experiments cover all disciplines.

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http://www.esa.int

Physics out of favour

Why does physics leave Europeans cold? Why are fewer and fewer young people opting to study it? Europe's leading research institutes (ESA, CERN, ESO) have teamed up with a number of partners - among them the European Physical Society and the European Association for Astronomy Education - in an attempt to get to the root of a problem which forms part of a wide-ranging debate on science and society. Supported by the European Union, the 'Physics on Stage' initiative aims to reverse the current trend. It is essentially a vast brainstorming exercise carried out in 22 European countries throughout the year and involving scientists, teachers, institutions and the media in an attempt to develop new approaches and innovative teaching and communication aids. These will then be presented at the CERN Science Festival in Geneva during this year's European Week for Science and Technology, 6-11 November.

http://www.estec.esa.nl/outreach/pos

The challenges of telemedicine

Diagnosis, treatment, monitoring, distance learning: telemedicine has developed significantly over the past decade. An international symposium will assess the current state of progress on the treatment front (home care, elderly patients, isolated regions, etc.), the role of on-line developments in training, technological advances and their applications, and the ethical and legal issues raised by telemedicine. With support from the Improving Human Potential programme, young researchers from the EU and some 15 other countries will be attending the event which will include speeches and debates, workshops and presentations of projects and other activities. The symposium will be held in Gothenburg (Sweden) from 27 June to 1 July.

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Diary

■ *First world conference & exhibition on Biomass for Energy* - 5-9/6/2000 - Seville (E)
www.etaflorence.it/sevilla.htm
■ *European Business Summit* - 9-11/6/2000- Summit - Brussels (B) - Organised by UNICE
www.unice.org
■ *JRC Alumni Event* - Theme: "Science & Governance" - 29-30/6/2000 - Ispra (I)
Guelperi.vural@cec.eu.int
■ *Taking the opportunity! SMEs and EU Framework Programme V* - 29-30/6/2000-Oporto (P)
smedays@adi.pt
www.adi.pt/smedays
www.cordis.lu/sme/src/ev-oporto.htm
■ *XXIInd Congress of the Collegium Internationale Neuro-Psychopharmacologicum.*(CINP) - 9-13/7/2000 - Brussels (B)
laurence@iceo.be
www.cinp2000.com/
■ *European Workshop on Aviation, Aerosols, Contrails and Cirrus Clouds* - 10-12/7/2000 - Seeheim (D)
ulrich.schumann@dlr.de
www.op.dlr.de/ipa/meetin_e.html
■ *EurOCEAN 2000 - The European Conference on Marine Science and Ocean Technology* - Hamburg (D), 29/8-2/9/ 2000
ana.marques@cec.eu.int
www.cordis.lu/eesd/src/ev290800.htm
europa.eu.int/comm/research/envsc/eurocean.html
■ *NEODIET - European Conference on the Nutritional enhancement of plant-based foods* - 6-9/9/ 2000 - Norwich (UK) - First European research meeting focused on the consumer benefits of biotechnology applied to food production.
ifr.communications@bbsrc.ac.uk
www.ifrn.bbsrc.ac.uk/NEODIET/
■ *High Mountain Lakes and Streams: Indicators of a Changing World* - 4-8/9/2000 - Innsbruck (A)
hmls2000@uibk.ac.at
http://zoology.uibk.ac.at/congress/
■ *7th European Assembly on Telework and New Ways of Working* - 13-15/09/2000, London, U.K.
www.telework2000.com/
■ *A Changing Atmosphere - 8th Europ. Symposium on the physico-chemical behaviour of air pollution* - 18-22/9/2001 -Turin (I)
frank.raes@jrc.it
■ *Conference on Research Infrastructures* -18-20/9/2000 - Strasbourg (F)
http://www.cordis.lu/improving/src/ari_conf.htm
■ *12th European Union Contest for Young Scientists* - 18-24/9/2000 - Amsterdam (NL).

Finding your way through the maze of patents

Patents are key to technological development, not only because it is vital to protect the innovations that result from a research project, but also because they are themselves a fertile source of new innovations. European and national patent offices are a veritable goldmine of technological literature from which research bodies and companies - and especially SMEs - can draw useful ideas for developing their activities. Thanks to the esp@cenet system, created by the European Patent Office, this wealth of information can now be consulted via the Web. The problem is that for non-specialists it is far from easy to find their way around this vast library. The IPR Helpdesk (Intellectual Property Rights Helpdesk) at the European Commission (Innovation and SMEs programme) has therefore just launched a multimedia 'tutorial' which provides on-line instruction on how to make targeted searches in this huge reservoir of ideas. This particularly user-friendly tool is certainly worth checking out.

www.ipr-helpdesk.org/mm/esptut/index.htm

Sounding the alarm

If Europe is not quick enough to invest in developing a broadband communication network accessible to its researchers, its scientific and technological potential will be considerably handicapped compared to the formidable dynamic these new information highways are giving US research. This is the alarm cry sounded in February by the European Science Foundation and Academia Europaea (an association of 1 850 individual European scientists). These two organisations are making a joint and urgent appeal to the national authorities and the European Union to fund the investment to provide access to such a network, not only for university research institutes but ultimately for the educational system as a whole. They stress the need to extend the funding of the TEN-155 (Trans-European Network at 155 Mbit/sec) network, scheduled to end at the end of May 2000, till the decision is made at the end of the year on its successor, known as the GEANT Network - with a capacity of several gigabits/sec. This objective was included in the Communication, Towards a European research area.

www.esf.org/ftp/pdf/SciencePolicy/ESPB7.pdf

Green prize for European composites

Almost a million tonnes of fibre-reinforced plastic products are produced every year in Europe by around 10 000 companies - most of them SMEs - especially in fields such as shipbuilding. Traditional methods use components such as polyester resins, which pose real problems in terms of safety, storage and handling, as well as solvents whose fumes pose a serious threat to the health of workers. As part of its materials research, the Envirocomp project (Brite-EuRam programme) has developed a new generation of thermoplastic composites which present none of the damaging environmental and health aspects of traditional techniques while offering clearly improved physical and economic performances. Envirocomp was awarded a prestigious prize at the European Composites Days, held in Paris from 18 to 21 April 2000.

www3.integra.fr/jec/html/frame2.html

e-Europe on line

What are the aims of e-Europe? Who do they concern? What will this initiative lead to for companies, citizens, young people, researchers? Is electronic commerce reliable? What are on-line health and intelligent transport? Answers to all these questions and a great deal more information on digital technologies are available at a new site launched by the European Commission. The e-Europe initiative aims to give society as a whole the means of access to the new information technologies, and received clear backing and encouragement from the Lisbon European Council on employment, economic reform and social cohesion, held in March.

http://www.europa.eu.int/comm/information_society/eeurope/index_en.htm

Publications

General

■ Towards a European research area, Communication of the European Commission, ISBN 92-828-8719-7, research@cec.eu.int

■ The planet under pressure, leaflet, CG-62-98-EN-C, research@cec.eu.int

Agriculture, Food, Bioechnology

■ Inventory of public Biotechnology R&D programmes in Europe, Vol. 1, EUR 18886/1, Vol. 2, EUR 18886/2, isabelle.wolff@cec.eu.int

■ Pathogenic micro-organisms in poultry and eggs. 8. New technology for safe and shelf-stable products, (PR), EUR19214, ISBN 92-828-7442-7, EurOp

■ Interactions of food matrix with small ligands influencing flavour and texture, (PR), EUR19228, ISBN 92-828-7902-X, EurOp

■ Activity report (1997-98) of COST actions in the domain of food sciences and technology, (PR), EUR19219, ISBN 92-828-7722-1, EurOp

■ Issues in the dialogue between unconventional and orthodox medicines, (PR), EUR19110, ISBN 92-828-7434-6, EurOp

■ Diagnosis, monitoring and prevention of micro-organisms associated with contamination of poultry meat, eggs and egg products, (PR), EUR19215, ISBN 92-828-7441-9, EurOp

■ Alternative crops for sustainable agriculture, (Cf.P), EUR19227, ISBN 92-828-7831-7, EurOp

Medecine and Health

■ Guide européen relatif aux critères de qualité des clichés de radiodiagnostic, EUR16260, ISBN 92-828-7338-2, eesd@cec.eu.int

■ Guide européen relatif aux critères de qualité des clichés de radiodiagnostic en pédiatrie, EUR16261, ISBN 92-828-7339-0, eesd@cec.eu.int

■ Summaries of research projects supported by Biomed 2 (1994-98), vol. 1, ISBN 92-828-7426-5, vol. 2, ISBN 92-828-7315-3, renate.riede@cec.eu.int

Industrial Processes

■ Entrecruzamiento durante la hidrogenación del carbón a través de medidas de hinchamiento. Estudio de su relación con la conversión del carbón, (PR), EUR18433, ISBN 92-828-8313-2, growth@cec.eu.int

■ Optimierung under Verfahrens- und Maschinentechnik sowie des Reagenzieneinsatzes im Waschwasser-kreislauf, (PR), EUR17493, ISBN 92-828-8314-0, growth@cec.eu.int

■ Sistema de simulacion de minas subterraneas de carbon de tamano mediano o pequeno. Fase 2, (PR), EUR18927, ISBN 92-828-8315-9, growth@cec.eu.int

Environment

■ SHIVA: Studies of the hydrology, influence and variability of the Asian summer monsoon, study, EUR19084, ISBN 92-828-7758-2, eesd@cec.eu.int

■ Research and development in urban forestry in Europe, (PR), EUR19108, ISBN 92-828-7578-4, EurOp

■ Concerted action on dam-break modelling, (Cf.P), ISBN 92-828-7108-8, eesd@cec.eu.int

■ First sea trial of Geostar: the geophysical and oceanographic European station for abyssal research, (PR), EUR18885, ISBN 92-8287391-9, eesd@cec.eu.int

■ Ecosystem response to CO_2: the MAPLE project results, (PR), EUR19100, ISBN 92-828-7757-4, eesd@cec.eu.int

■ Forest research capacities in 18 European countries, (PR), EUR19217, ISBN 92-828-7576-8, EurOp

■ Ecosystems research report n°32: The Adriatic Sea, (Cf.P), EUR18834, ISBN 92-828-5744-1, eesd@cec.eu.int

Energy - Nuclear fission

■ Gas migration and two-phase flow through engineered and geological barriers for a deep repository for radioactive waste, (PR), EUR19122, ISBN 92-828-8132-6, eesd@cec.eu.int

■ European network of testing facilities for the quality checking of radioactive waste packages, (PR), EUR19123, ISBN 92-828-7817-1, eesd@cec.eu.int

■ Backfilling and sealing of underground repositories for radioactive waste in salt, (PR), EUR19124, ISBN 92-828-7923-2

International Cooperation

■ Health research with developing countries (Inco-DC 1994-1998), (Cat.P), ISBN 92-828-7390-0, inco@cec.eu.int

■ Copernicus 1998: Funded joint research projects, concerted actions and accompanying measures, (Cat.P), ISBN 92-828-6305-0, inco@cec.eu.int

Socio-economic Research

■ Defence restructuring and conversion: sociocultural aspects, (Cf.P), EUR19235, ISBN 92-828-8505-4, EurOp

PR : Project Report
Cf.P : Conference proceedings
Cat.P : Catalogue of projects
EurOp : http://eur-op.eu.int/general/en/s-ad.htm

Calls for proposals: overview

Deadlines	2000						2001			
QUALITY OF LIFE AND MANAGEMENT OF LIVING RESOURCES (www.cordis.lu/life)										
KEY ACTIONS	**JUNE**	**JULY**	**SEPT**	**OCT[2]**	**NOV**	**DEC**	**JAN**	**FEB[3]**	**MAR**	**APR**
Food, nutrition and health				11				9		
Control of infectious diseases				11						
The "cell factory"				11				9		
Environment and health								9		
Sustainable agriculture, fisheries and forestry				11				9		
The ageing population and disabilities								9		
Generic research				11						
OPEN CALLS [1]	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB[3]**	**MAR**	**APR**
Training: Marie Curie individual fellowships				11						11
Research training networks								1		
SME Measures (exploratory awards / cooperative research)			13				17			18
Accompanying measures	12			11				9		
Support for research infrastructure				11				9		

(1) Call published on 6/3/99 (2) Call published on 15/12/99 (3) Call scheduled for 15/11/2000

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

KEY ACTIONS	**JUNE**	**JULY**	**SEPT**	**OCT[1]**	**NOV**	**DEC[2]**	**JAN**	**FEB**	**MAR**	**APR**
Systems and services for the citizen				X		X				
New methods of work and electronic commerce				X		X				
Multimedia content and tools				X		X				
Essential technologies and infrastructures				X		X				
Cross-programme themes				X		X				
Future and emerging technologies [3]				X		X				
OPEN CALLS	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**
Future and emerging technologies [3] [4] [5]	15		15			X				
Support measures [6]	15		15			X				
SME Measures (exploratory awards / cooperative research) [7]			13				17			18
Intelligent manufacturing systems [7]			15							

(1) Closing date end of October for a call scheduled for June 2000 (subject to confirmation) (2) Closing date in December for a call scheduled for September (subject to confirmation) (3) Proactive initiatives (4) Open sector (5) Evaluation at least every 3 months (6) Call published on 10/2/2000 (7) Calls published on 16/3/99

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

KEY ACTIONS	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**
Innovative products, processes and organisation			15[2]						15[4]	
Sustainable mobility and intermodality			15[2]						15[4]	
Land transport and marine technologies			15[2]						15[4]	
New perspectives for aeronautics			15[2]						15[4]	
Generic research			15[2]						15[4]	
Measurements and testing research			15[2][3]						15[4][5]	
Support for research infrastructure			15[2][3]						15[4][5]	
OPEN CALLS [1]	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**
Training: Marie Curie individual fellowships			18						23	
SME Measures (exploratory awards / cooperative research)			13				17			18
Accompanying measures			15						15	
Intelligent manufacturing systems [6]			15							
Expressions of interest on research needs	15									30

(1) Reception deadlines for call published on 16/3/99 (2) Periodical call scheduled for 2/6/2000 (3) Targeted call published on 15/4/2000 (4) Periodical call scheduled for 15/12/2000 (5) Targeted call scheduled for 13/10/2000 (6) Call published on 16/3/99

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

KEY ACTIONS	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB[2]**	**MAR**	**APR**
Sustainable management and quality of water								15		
Global change, climate and biodiversity								15		
Sustainable marine ecosystems								15		
The city of tomorrow and cultural heritage								15		
Cleaner energy systems, including renewables								1		
Economic and efficient energy for a competitive Europe								1		
Support for research infrastructure			28[1]					15[3]		

(1) Environment and sustainable development call published on 18/11/99 (2) Indicative date, to be confirmed when launching the call scheduled for November 2000 (3) Environment and sustainable development only

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 2001

OPEN CALLS [1]	JUNE	JULY	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
Generic research								1[2]		16[3]
Training: Marie Curie individual fellowships			1[2]					1[2]	21[3]	
SME Measures (exploratory awards / cooperative research)			13				17			18
Accompanying measures			1[2]					1[2]-15[3]	15[4]	

(1) Call published on 18/11/99 (2) Energy only (3) Environment and sustainable development only (4) E&DD: advanced courses of study

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

OPEN CALLS [1]	JUNE	JULY	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
Generic research							22			
Support for research infrastructures							22			
Training: Marie Curie individual fellowships	14						10			
Other training actions[2]		25							26	
Accompanying measures		25							26	

(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]	JUNE	JULY	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
States in pre-accession phase		15[2]								
Copernicus 2			15[2]							
Mediterranean partners (INCO-MED)										
Developing countries (INCO-DEV)			15[3]							
OPEN CALLS [4]	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**
Accompanying measures [5]		X			X				X	
Fellowships for Japan									1	

(1) Call published on 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 the Emerging economies and industrialised countries group, for which call was published on 6/8/99 (5) Evaluation every 4 months

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

OPEN CALLS [1]	JUNE	JULY	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
SME Measures (exploratory awards / cooperative research) [2]			13				17			18
Economic and technological intelligence projects [3]		3			3				2	
Innovation projects			15[4]							
Awareness and assistance actions in the field of IPR and in the field of Innovation finance [5]							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 - Regional Innovation Strategy projects in NAC			15[4]							

(1) See also 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) Indicative closing date for a call scheduled for 15/06/2000 (5) Indicative closing date for a call scheduled for 15/09/2000

HUMAN POTENTIAL (www.cordis.lu/improving)

OPEN CALLS	JUNE	JULY	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
Research training network [1]										
Marie Curie individual fellowships [2][3]			13						14	
Marie Curie industry host fellowships [4]	15									
Marie Curie development host fellowships and training sites [5]			Next deadline: 16/05/2001							
Research infrastructure cooperative networks and exploratory workshops [6]								15		
High-level scientific conferences [2]								1		
Awards for first-class research [7]	29[8]									
Raising public awareness of science and technology [9]										16
S&T policy strategy: thematics networks and Accompanying measures (Strata) [10]	5[11]	Accompanying measures: Open till 15/06/2002								
S&T policy strategy: Accompanying measures (Strata)[2]	2									
Accompanying measures for the programme [2]		Open till 28/6/2002								
KEY ACTIONS	**JUNE**	**JULY**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**
Socio-economic knowledge base	28[12]									

(1) Call to be launched, date not decided (2) Call published on 16/3/99 (3) Individual fellowships, return fellowships, experienced researcher fellowships (4) Call published on 15/02/2000 (5) Call published on 11/6/99 (6) Call published on 15/11/2000 (7) Call published on 1/12/99 (8) Archimedes Prize (9) Call scheduled for 15/1/2001 (10) Open call on 01/03/00 (11) Closing date for thematic networks (12) Call published on 15/01/2000. The closing date has been postponed from 28/4/2000 to 28/6/2000

Impetus for innovation

The construction sector is the European Union's number one employer, representing 11% of its GDP and making it a leader on world export markets. But when it comes to innovation, it is a sector which has traditionally lagged behind. Now, thanks to the impetus of European research, a fair wind is blowing the industry towards new horizons.

Our housing, our workplaces, our leisure and entertainment facilities, the cityscape, the transport infrastructure... Everything that shelters and surrounds us plays an essential role in determining our standard of living and our quality of life. So how are the products of the construction industry currently evolving?

Over recent decades innovations in construction technologies have changed the design of buildings and stet. structures, the materials used and site practices. Yet, with the exception of a limited number of technical feats for high-profile structures such as major bridges or tunnels, the construction sector remains reluctant to innovate - especially when compared to the technological changes witnessed in other fields of industry.

After several years of growth, productivity in this sector has remained stagnant since 1991. Yet, paradoxically, much remains to be done in meeting social needs - housing, urban renovation, infrastructure - and maintenance costs remain high. Construction also lags behind in other key areas, namely quality, respect for the environment and sustainability. There has been little innovation in the products used in construction works and the energy used in buildings accounts for half of Europe's total energy consumption. Renewing Europe's urban environment also creates 400 million tons of debris per year - much of which finds its way onto public dumps (see p. 27).

The judgement of Scott Steedman, president of Eccredi (European Construction Council for Research, Development and Innovation) is uncompromisingly severe: 'The truth is that a culture of innovation has been totally lacking in construction in Europe for many decades. We know from the statistics that the level of investment in R&D in Europe is derisory. Interest in R&D and translating results into innovation is limited to a very few companies and institutions.'

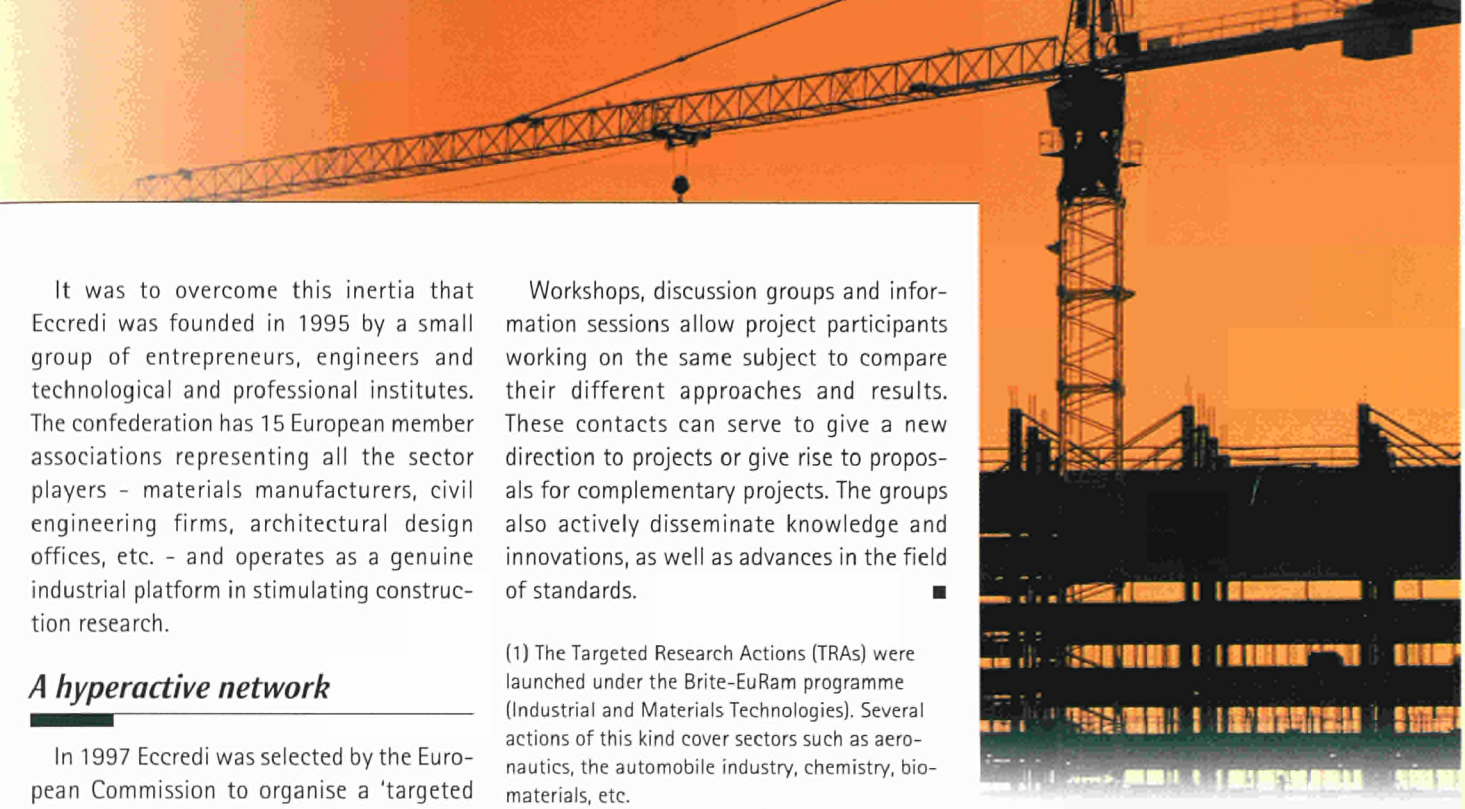
Conservatism and fragmentation

Two factors can in part explain this overcautiousness. 'The annual building replacement rate is 2%,' explains Georgios Katalagarianakis, scientific officer responsible for construction research in the European Commission, 'so the average life of a building is 50 years. Given such time-frames, clients tend to favour the most conservative options. They play safe.' Another characteristic of the construction industry which works against innovation is its fragmentation. In Europe the sector is made up of 2 million companies, 92% of which employ fewer than 10 persons. This is not very fertile soil for the development of R&D departments. It also makes it difficult for information on new materials, techniques or concepts to permeate through to all the different players, such as architects, contractors, bricklayers, etc.

The challengers from the Asia-Pacific region

European construction companies are winning more than 50% of major international contracts and their volume of activity beats Japan by 10% and the United States by 30%. But is this leadership position as unassailable as it may appear? The challenge could come from the Asia Pacific region, where the growth of major urban centres has created a 'golden age' for the construction and public works sector based on a daring innovation culture.

'The extraordinary demands of new construction have created a political and commercial climate in which innovation is encouraged, and there is a genuine pride in new engineering achievements,' explains Scott Steedman of Eccredi. In his opinion, in the Tokyo metropolitan area - one of the largest urban areas in the world - Japanese contractors are 'developing new concepts on a scale unprecedented in Europe. That this has not yet translated itself into world domination is more a factor of domestic demand in Japan, in view of the aftermath of the Kobe earthquake, than our ability in Europe to resist such competition.'



It was to overcome this inertia that Eccredi was founded in 1995 by a small group of entrepreneurs, engineers and technological and professional institutes. The confederation has 15 European member associations representing all the sector players - materials manufacturers, civil engineering firms, architectural design offices, etc. - and operates as a genuine industrial platform in stimulating construction research.

A hyperactive network

In 1997 Eccredi was selected by the European Commission to organise a 'targeted research action' on Construction technologies to preserve the environment.(1) Today Eccredi coordinates a network of more than 600 specialists from innovative companies, research centres, university laboratories, etc., who are involved in projects under the various European research programmes.(2) With 75 projects running in the first year and over 120 today, a vast number of research topics are covered. They can be subdivided into 13 thematic groups, ranging from recycling to seismic isolation, and including research on steel, wood, geotechnical engineering for underground construction, roadworks, the performance of concrete structures, fire protection, etc.(3)

Workshops, discussion groups and information sessions allow project participants working on the same subject to compare their different approaches and results. These contacts can serve to give a new direction to projects or give rise to proposals for complementary projects. The groups also actively disseminate knowledge and innovations, as well as advances in the field of standards. ■

(1) The Targeted Research Actions (TRAs) were launched under the Brite-EuRam programme (Industrial and Materials Technologies). Several actions of this kind cover sectors such as aeronautics, the automobile industry, chemistry, biomaterials, etc.
(2) Brite-EuRam, Craft (SMEs), SMT (Standards, Measurements and Testing), Environment and Climate, etc.
(3) Visitors to the site www.tra-efct.com can consult a detailed database on all the projects covered by the network.

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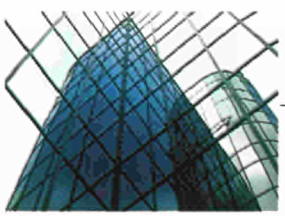

Steel houses

Although steel is used widely, often as the principal element, in industrial, commercial and prestige buildings, it is much rarer to find it used for houses or flats. The metal construction industry, backed by the steel industry, is currently engaged in a research and promotional drive with the aim of introducing new concepts, products and components to this huge market.

The building industry already uses many finished steel products in designing original or composite structures. Mixed steel-concrete floors are already used in some countries, but steel is not yet part of the frame.

A European project with seven partners, organised by the ECSC (European Coal and Steel Community), has highlighted the diversity of solutions in terms of the frames and finish of individual houses or apartment blocks. In its demonstrations it uses steel in combination with other materials to respect the variety of architectural concepts and local traditions.

The advantages of this approach are a very rapid and modular construction as well as the high energy efficiency of the buildings, even in very cold countries (Finland for example). For Pierre Mériguet (Research DG) steel offers the benefits of 'a material which permits an earthquake-proof design and good fire resistance, plus a light and recyclable construction.'

When the earth moves

Shock-resistant constructions. Buildings which return to their original shape after an earthquake. 'Shock-absorbers' which damp the energy impacting at sensitive points in buildings. These and other anti-earthquake technologies are at the heart of many research projects.

Europe is far from safe from seismic risks, and not only in the traditionally vulnerable areas (Italy, Greece, Balkans, Turkey), but also in countries with a 'dormant seismicity', such as Portugal. As to the rest of the world, the list of regions at risk would be too long to enumerate. Hence the importance of the work currently being undertaken by the Seismic and Vibration Isolation research group in developing innovative protection systems based on dissipation phenomena.

Flexibility

There are three distinct categories of quake-proofing methods. The first covers techniques designed to make constructions more flexible. 'The main aim is to protect people by raising the collapse threshold,' explains Claude Dumoulin, an engineer with Bouygues, one of the project partners. 'But a building which is deformed by an earthquake does not return to its original shape. These methods, which are among the oldest and least expensive, are not ideal.' In Europe's high-risk areas, constructors are legally bound to respect certain technical standards for this category of anti-seismic design.

Elasticity

The second approach is based on elasticity, designing buildings which are able to return to their original shape after deformation. Some nuclear plants, for example, are built on rubber mattresses which filter the shocks coming from the ground. 'Attempts are currently under way to perfect this technique which is used for particularly sensitive buildings, such as oil refineries, chemical plants, hospitals, civil security and police buildings, and bridges,' explains Mr Dumoulin. 'A number of key buildings in Italy are already equipped with "shock absorbers" of this kind.' But the mattress technique is not without its drawbacks. In the event of a seismic shock, the 'floating' building can move a great deal, leading to the violent rupture of the solid structures to which it is linked, such as pipes.

The ELSA laboratory at the Joint Research Centre in Ispra has a unique installation for simulating structural resistance to earthquakes. It uses hydraulic rams to subject prototype buildings to forces of the order of 100 tonnes. These tests are of value in validating the resistance standards adopted by the European building industry (Eurocodes).

Shock absorbers

Researchers are also studying the concept of shock-absorbing or damping mechanisms which are able to absorb and disseminate the energy impacting at a building's sensitive points. The devices being studied are either of the metal-based, elasto-plastic variety or rubber- or oil-based viscous shock absorbers. Used in combination with the mattress technique, these help reduce the building's movement.

These developments in seismic isolation are mainly designed to protect particularly strategic constructions. 'These technologies could be extended to other large buildings and to apartment blocks, as in Japan or California,' points out Georgios Katalagarianakis. 'We must look at ways of reducing their cost to achieve a more favourable risk-investment ratio.' 'The regulations must also take full account of these new devices in order to make it easier for the construction industry to use them,' adds Mr Dumoulin. ■

Recycled buildings

The construction industry has a poor record when it comes to waste management. Which is why researchers are trying to develop a 'sustainable' architecture, with buildings using recycled materials and designed so that most of the demolition debris can be recovered.

More than 25% of the waste produced in Europe comes from the demolition or renovation of buildings and half this waste ends up on public tips. Just 30% of the materials used in construction are estimated to be recycled, when practices in some European countries show that as much as 90% is potentially re-usable.

What is more, the construction industry not only poses a problem when its products reach the end of their life-cycles, but also at their beginning. The industry is a huge consumer of raw materials, using six to eight tonnes of materials per inhabitant every year .

A dual approach

'Recycling requires a dual approach: the increased use of construction materials containing recycled materials and a more systematic recovery of the debris from demolished buildings,' believes Carlo De Pauw, general coordinator of the European research network on construction technologies.

The second of these is by far the biggest challenge, because of the long life of buildings. Many structures being demolished today were built in the first half of the 20th century, without a thought for such matters. Recycling, however, is an activity which requires upstream preparations, in the choice of materials and the way they are assembled. The attention we are now giving to the design of sustainable buildings - that is their recycling potential - will therefore benefit future generations.

On the other hand, the role of the construction industry as a purchaser of recycled or recyclable materials is much more relevant to the present day. To demonstrate the fact, one of the members of the European research action Recycling in Construction, the Centre Scientifique et Technique de la Construction (CSTC - Belgium), recently constructed an experimental building using these materials.

Recovered but reliable

It uses various techniques. The walls, for example, are built with blocks of concrete in which the gravel has been replaced by waste from steel-making. The finish on the facing bricks is obtained using aggregates from crushed computer screens and televisions. The window-frames are in recycled PVC. The parquet floors are made out of the waste from waxed cartons used in the food industry. 'It is a demonstration house,' explains Edmond Rousseau of the CSTC. 'We have identified a range of 210 recycled materials which are already available on the market. These come from all over Europe. But in all cases these materials must clearly satisfy a series of technical requirements to ensure they bear comparison with traditional materials.'

Such an approach also presents a psychological challenge. The architects and building contractors are liable for 10 years for any defects which may affect their buildings - which explains a certain reluctance to use these new materials. To encourage the wider use of recycled materials which meet the strictest specifications, the CSTC is a partner in the ETN-RECY thematic network and is at present working on setting up an electronic fair. 'It is also necessary to organise the control networks required to ensure the origin of the recycled materials,' adds Mr De Pauw. 'It is better not to use concrete from a nuclear plant to build a house, for example.' ■

Waste from steel-making, aggregates from crushed computer screens and TV sets, recycled PVC and waxed cartons are all recycled materials used in the construction of this experimental house built by the Centre Scientifique et Technique de la Construction (Belgium).

An urgent need: the more systematic recovery of debris from building demolition.

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In the lead in the wireless world

Europe's mobile telecommunications research over the past decade has put it in pole position in time for the changeover to Internet access from mobile terminals. This gives it a considerable advantage in the next leap forward in the 'new economy'.

'The benefits of the new economy will only become apparent when we attain the critical mass of Internet penetration on the European market,' Commissioner Liikanen stated recently when presenting the e-Europe project[1]. At present, due to the spectacular growth of the US home-computer market and the resulting dramatic growth in on-line services, the critical strength of the United States in this new economy is two or three times that of Europe. But that trend could be reversed when mobile communications become a means of access not just to the Internet, but to a wide range of services such as directories, financial information, weather forecasts, e-commerce and medical monitoring

Sights set on m-commerce

With 200 million subscribers expected by the end of the year, Europe has a considerable lead in mobile telephony. The European GSM standard has effectively become the world standard while the penetration of mobile phones is being held back in the US as a result of competing incompatible systems. Europe has also acquired a digital telephone network with the potential to provide Internet access. Last but not least, it has the means to launch - within the next two years - broadband networks suitable for multimedia services using the UMTS standard (see box).

The stakes are certainly high. It is a question of launching m-commerce (mobile electronic commerce), a technology which will enable everyone, wherever they are, to consult information and place their orders. By 2003 many of the services currently available on a PC will have migrated to the GSM, creating a market estimated at 24 billion euros. By then 65% of Europeans will have a mobile phone, 85% of them suitable for Internet use.

An array of projects

This spectacular progress can undoubtedly be put down to the major research effort made in Europe since 1989 by equipment manufacturers, telecommunications companies and research centres, especially under the RACE, ACTS and - most recently - IST programmes[2]. The Frames project for example, in which market leaders Siemens, Ericsson and Nokia were all involved, served to spark off what has now become Europe's third generation standard, UMTS,' explains João Schwarz da Silva, head of the Mobile Communications Unit at the European Commission. 'Many of the services now available on your GSM have benefited from EU-backed research over the past decade. The On The Move and Move projects have laid the foundations for what is now known as WAP - Wireless Application Protocol - which provides Internet and electronic access from a mobile terminal - starting with mobile phones. WAP is a micro-navigator which trims the web pages to adapt them to a mobile-phone screen, with its limited display capacity.'

In addition, the Moments project has made it possible to test the viability of Internet-based, commercial multimedia services providing information, mail, maps, positioning, and various transactions via third-generation mobile terminals. For the longer term, the Samba project has shown that it is possible to transmit video images for television or medical imaging through a cellular network.

The tools of the future: digital screen, independent keyboard, smartpen - all wireless.

On-line mobiles: 'Many of the services now available on your GSM have benefited from EU-backed research over the past decade.'

2002 - the third generation

These research projects have made it possible to define the standards and frequency spectrums which will render these systems operational within two years and to test the viability of all kinds of applications. They have been backed up by a number of political and regulatory initiatives, leading most significantly to the Council decision by which each member state undertook to introduce, by 1 January 2000, a regulatory framework for licensing third-generation mobile telephony systems from 2002 onwards, and to encourage interconnections between operators. Europe must also obtain a sufficiently wide radio frequency spectrum at the next World Radiocommunications Conference, to be held in Istanbul in May of this year, to allow the development of these mobile telecommunication services as well as those for satellite positioning.

'Europe has a three-year technological lead,' believes Mr da Silva. 'We are currently experimenting with applications, most particularly in the tourism, insurance, health and electronic commerce sectors. But that has not stopped us from working on the fourth generation since 1997.'

However, this growth in wireless communications is also raising a number of new questions, especially in terms of the security of information and transactions, and the protection of users. Radio communications make it possible to pinpoint quite precisely where users of these wireless systems are located. The combination of mobility and positioning technologies (both terrestrial and satellite: GPS now, Galileo in the future) will provide users with services related to their immediate environment - the traffic situation for motorists, the nearest restaurant for pedestrians, for example. But anyone who requests information will at the same time be providing information about themselves.

(1) E-Europe, An information society for all. Communication on a Commission initiative for the Special European Summit in Lisbon on 23 and 24 March 2000.
(2) 60 million euros have already been granted to about 20 projects following an initial IST call for proposals.

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Mobile multimedia in three stages

We are entering the era of broadband mobile telephony, known as 'third generation' or UMTS (Universal Mobile Telecommunications System). Most European operators have planned to launch GPRS (General Packet Radio Service) services this year already, signalling the arrival of packet data-transfer technology in mobile telephony. This allows asymmetric transmissions in packet mode, like the Internet, while boosting transmission speed to 170 kbit/s.
By 2001, EDGE (Enhanced Data rates for GSM Evolution) technology will permit even faster speeds (384 kbit/s under certain conditions), opening the door to integrated multimedia combining voice, data, fixed images and video.
The third generation of mobile telephony (UMTS) is expected to be marketed in 2002 or 2003, permitting mobile multimedia services such as videoconferences and other as-yet-undreamed-of applications. The ITU (International Telecommunications Union) should complete the standardisation work this year, under the generic term IMT-2000 (International Mobile Telecommunications-2000).

The Galway meeting

The IST programme will be holding Mobile Communications Summit 2000 in Galway, Ireland from 1 to 4 October. Researchers, manufacturers and operators will all be present to discuss and present research projects on Evolving to the Fourth Generation. The major challenge in this respect is set to be the interoperability of broadband wireless networks and services.
Register at: http://www.mobilesummit.ie/

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The ozone shield under close surveillance

Several hundred top European and US experts in atmospheric chemistry and physics participated in Theseo 2000/Solve, last winter's largest ever campaign of measurements on the state of the ozone layer in the northern hemisphere. One of the key themes of current research is to investigate the collateral damage the famous polar ozone hole could be causing to the shield which protects the world's most populated regions lying in the northern hemisphere's middle latitudes.

Kiruna, Sweden, January 2000. 150 km north of the Arctic Circle, the world is in the icy grip of winter. The temperatures are plummeting, as they have on several occasions over recent years. The ground temperature is minus 35°C. At 20 kilometres altitude, at the heart of the polar vortex, the thermometer is close to minus 80°.

The sun is beginning to edge above the horizon for a few hours a day. In fine weather, it is just possible to make out, high in the sky, long streaks of motionless clouds. 'These are the typical clouds of polar winters - known as PSCs (polar stratospheric clouds) - which hold all the keys to how the ozone layer is being destroyed,' remarks Neil Harris, head of the European Ozone Research Coordinating Unit, Theseo 2000.[1] 'The colder it is up there, the more of them there are.'

Inflating the helium or hydrogen balloons at Esrange prior to launching them on a journey through the stratosphere of several hundred kilometres at altitudes of over 30 000 metres.

Identifying the culprits

Since scientists first discovered the hole in the ozone layer over the Antarctic 15 years ago, considerable progress has been made in determining the nature and causes of this phenomenon peculiar to polar regions.[2] First of all by precisely identifying the principal destructive agents, namely chlorine and bromine compounds, some of natural origin (such as the emissions produced by the major eruption of Mount Pinatubo in the Philippines in 1991), but many more of human origin.

In 1987, the Montreal Protocol was the first international initiative to regulate the large-scale use of CFCs (chloro-fluoro-carbons). Used on a massive scale in industrial applications such as aerosol sprays, refrigerants and solvents, these very long-lived gases were soon identified as the real destroyers of the ozone layer owing to the way they build up in the stratosphere 20 km above the Earth.

The next discovery was the major role played by the extremes of temperature found at very high altitude within the polar vortex. Every winter the circulation of air masses between 15 000 and 25 000 metres above the poles creates a massive eddy akin to the whirlpool produced in water draining from a bath.

While on the vortex's periphery the circular winds reach extremes of speed of around 200 km/hour, at its centre the stratospheric masses are remarkably stable and calm. At the still heart of the vortex, the air is exposed to lower and lower temperatures the higher you go. These are the conditions which give rise to the creation, at very high altitude, of the PSCs in question.

Trapped by the clouds

'These polar clouds are formed of masses of tiny frozen particles held in suspension, in which high concentrations of chlorine and bromine compounds are trapped,' explains Dr Harris. 'In this state, these gases cease to be the inert and non-reactive gases which they are at lower levels. Within these clouds, in which they accumulate in the form of aerosols frozen at minus 80°C, the gases release their chlorine and bromine atoms under the effect of the sun's rays. These then react with the ozone, breaking down the links between the three oxygen atoms of which it is composed.'

In reality, behind the basic mechanism described here, scientists have gradually discovered a polar stratospheric chemistry of extraordinary complexity. For several months of the year, the compounds present are subject to a whole series of actions and reactions, combinations and recombinations, conditioned by temperature, pressure, humidity, the circulation of the air masses and the sun's rays. Which gives some idea of the difficulty of measuring and understanding the molecular phenomena at work in an open environment within huge air masses at an altitude of 20 km above the Earth's polar regions in the depths of winter.

Ozone and the biosphere

In the Earth's ecosystem, ozone is formed as a result of the photochemical action of the sun's rays on the air's oxygen molecules in the stratosphere over the tropics. The movement of air masses then disperses the ozone thus generated into a thin layer which covers the whole globe at a very high altitude.

This envelope plays a key role in protecting the biosphere as it acts as a shield, blocking the penetration of a section of the sun's ultraviolet radiation, the UV-B rays, which can be very dangerous to living organisms. 'It is established beyond any doubt that UV-B rays can cause skin cancers, serious eye disorders and damage to immune systems in man and other mammals,' states Paul Simon, a specialist in solar rays at the Institut d'Aéronomie Spatiale de Belgique and an active participant in Theseo 2000. 'But these rays could also have an impact on plant life in general, as well as on the micro-organic plankton which hold the key to marine life. Many research projects are currently under way to try and measure the changes in the amount of UV-B radiation reaching the Earth's surface.'

Kiruna's unique location

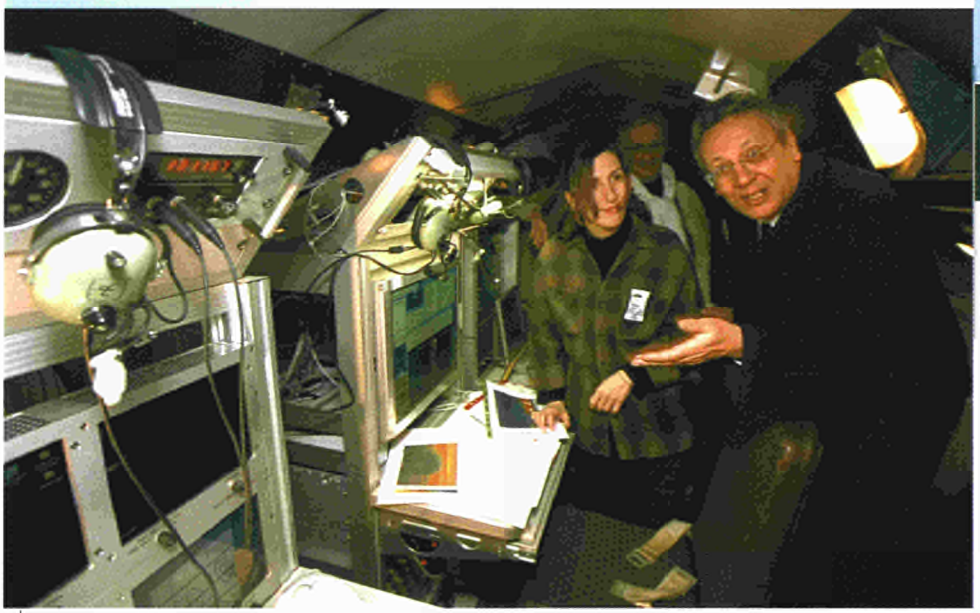
The Swedish Space Corporation's scientific base in Esrange-Kiruna is uniquely situated on the limits of this vortex. Over the past decade it has been the scene of all the measurement campaigns carried out by European programmes investigating the hole in the Arctic ozone layer. But this winter the joint research carried out by the Theseo 2000/Solve[3] Europe-US cooperation project has been on an altogether different scale.

The hangars in these snowy northern forests are packed with sophisticated spectrometric measuring instruments from all over Europe, waiting to be attached to the huge helium or hydrogen balloons (with a capacity of as much as 350 000 m^3 to take particularly heavy instruments) on the vast Esrange launching strip. They will then set off on a journey of several hundred kilometres through the stratosphere at altitudes that can exceed 30 000 metres. When their journey is complete, the instruments are recovered by helicopter - often from inside Russia.

A scientific squadron

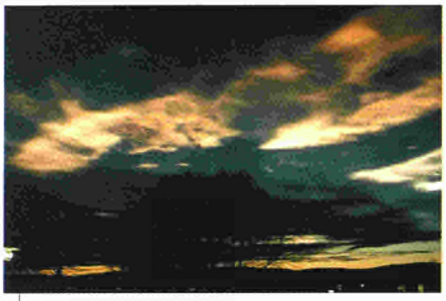
'Balloon measurements are particularly precise and accurate because the instruments cross the very heart of the stratospheric masses. They are one of the strengths of European research,' points out Dr Harris. 'Theseo 2000 has launched 600 sounding balloons and 30 heavy payload balloons, some of them travelling for almost 30 days. Aircraft are also used, converted into airborne scientific laboratories for remote analyses covering much larger air masses.' Four aircraft, from Germany, France and Switzerland, were deployed on the Theseo 2000[4] campaign, while the US Solve partners gave a particularly strong boost to the number of airborne measurements taken.

In the vast Arena Arctica hangar at Kiruna airport, NASA's Douglas DC 8, a converted passenger aircraft, makes an impres-



Philippe Busquin, European Commissioner responsible for research, on board the French Fokker ARAT which carried out a number of missions from Kiruna to study the stratospheric chemistry using a lidar device.

(1) Theseo 2000 is a one-year extension of the Theseo (Third European Stratospheric Experiment on Ozone) campaign which ran in 1998 and1999. This had been preceded, in 1991-92, by EASOE, the first European campaign of its kind, followed by the 1994-95 Sesame campaign.
Solve (SAGE III Ozone Loss and Validation Experiment) is a NASA research initiative.
(2) With different intensities: the much colder climate of the immense continent of Antarctica is causing much more serious ozone depletion than above the less extensive ice floe of the northern hemisphere.
(3) Theseo 2000/Solve also coordinated a number of experiments carried out under the national scientific programmes of individual EU Member States, and the United States also worked with researchers from Iceland, Norway, Switzerland, Russia and Canada.
(4) The German DLR Falcon, the French Fokker ARAT and Mystère 20, and the Swiss Air Force Lear Jet.



Forming at altitudes of 20 km and at temperatures of minus 80°C, it is these typical clouds of polar winters - known as PSCs or polar stratospheric clouds - which hold the keys to the chemistry of ozone destruction.

sive sight, packed with instruments and computers around which teams of scientists and technicians are huddled. Next to it stands the ER2, an even rarer bird. This is a former cold-war spy plane, its cameras now replaced by chemical sensors. It is a unique piece of equipment, able to carry out direct measurements during flights lasting several hours at an altitude of between 18 000 and 20 000 metres, at the very heart of the stratosphere. No wonder its pilot is decked out like an astronaut!

The other aircraft, which fly at more conventional altitudes - about 10 000 metres - mainly use the lidar (light detection and ranging) measurement technique. Based on the same principle as radar, this instrument studies the chemical composition of the PSCs located above the aircraft by means of the non-dispersed light reflected back by laser beams when they encounter the tiny airborne particles present in the clouds. Their exact nature and distribution can be identified by means of the signal received.

'The air observations are supplemented by the continuous measurements carried out throughout the winter by more than 20 ground stations as well as the data collected by the GOME (Global Ozone Monitoring Experiment) instrument on board the ER2 and ESA satellites. These measurements provide a wider framework for the experiments carried out at altitude,' explains Dr Harris. 'They are clearly less precise than the *in situ* analyses, but they permit estimates of the variations in the ozone layer density on much wider geographical scales, and most importantly over middle latitudes.'

Theseo 2000/Solve: the first results

The Theseo 2000/Solve campaign ended last March and in April the researchers published an initial report. The winter of 1999-2000 brought the latest in the series of record low polar temperatures recorded over the past decade. On 28 January 2000, 20 000 metres up, the stratospheric mass had cooled to around minus 80°C over an area of almost 15 million km² in the Arctic - or one and a half times the size of Europe. This is larger than anything previously measured in more than 40 years of observations in the Arctic stratosphere. It suggests an increase in the insulation and cooling of the air masses in the polar vortex in relation to the more variable and less cold troposphere climatic system found in air masses closer to the Earth's surface.

These conditions were therefore particularly favourable to the formation of polar stratospheric clouds (PSCs), which were present in great abundance from the beginning of December to the beginning of March. As a result, the chemical reactions so damaging to the ozone layer were very marked: on a number of occasions the ozone concentration was depleted by nearly 60% at an altitude of 18 km.(1) During the first two weeks of March, the average ozone quantity measured in the total air column over the Arctic was 16% lower than during the 1980s.

Theseo 2000/Solve also studied the impact of ozone-poor air masses leaving the polar vortex to mix with stratospheric layers in middle latitudes. In late February and early March the average ozone concentration in the air column fell to a level 15% below the average reference value observed before 1976.

(1) This was, however, partly offset by the fact that ozone depletion at altitudes of above 20 km was less.

Middle latitudes at risk

Theseo 2000/Solve was the high point of the three major European measurement campaigns carried out during the 1990s. By developing advanced instrumentation, it was possible to use the data gathered by thousands of balloons, hundreds of flying missions, and several dozen ground stations and satellite observations as vital input in developing increasingly sophisticated forecasting models. They proved that during a succession of cold winters, the ozone shield in the Arctic polar vortex could be depleted by as much as 50% for quite long periods and over increasingly large areas. These results show that it is going to be a long time before the results of the Montreal Protocol are felt.

'On the basis of present models, it can be estimated that, all things remaining equal, the decreased action of the chlorine and bromine compounds currently present could be spread over several decades,'

points out Jean-Pierre Pommereau, coordinator of the very important contribution by the French CNRS to Theseo 2000. 'But the conditions are anything but stable because, far from decreasing, the concentration of active bromine agents is actually increasing. We believe these are coming mainly from agricultural pesticides, an area not covered by the Montreal Protocol.'

Another question which is receiving a great deal of attention at present is the impact of polar phenomena on the densely populated middle latitudes. In these regions, the local ozone layer is estimated to have been depleted overall by an average of between 4% and 6% since the 1980s. In parallel with the polar campaigns, measurements carried out by sensors, observation satellites and ground stations have shown that in spring significantly worse depletions of the ozone concentration in the stratosphere above Western Europe may occur. To understand this phenomenon, scientists are closely studying the possibility of an exchange of ozone-poor Arctic air masses with those of middle latitudes at the end of winter when the polar vortex starts to weaken and disperse.

Ozone and climate change: interconnected problems

'We have reached a point where all the questions about global changes to the Earth's ecosystem are converging,' explains Anver Ghazi, who is responsible for the key action Global change, climate and biodiversity under the Fifth Framework Programme. To date, European research on the hole in the ozone layer has been a distinct field of study, focusing on stratospheric chemistry. But results have shown that the key element in the process is in fact the polar climate.

'To forecast the development of the ozone problem,' says Dr Ghazi, 'it is also necessary to forecast the effects of climatic warming over the polar regions as, paradoxically, it is not impossible that global warming in fact results in lower temperatures in the polar vortex. For the future, this would mean an increased density of polar stratospheric clouds and thus increased ozone destruction.'

The series of air measurements was considerably boosted by the ER2 former spy plane and NSA's huge DC8 converted into an airborne lab, made available under the Solve programme.

Climatologists accept such a hypothesis as being perfectly plausible. First of all, because - apart from its role in providing protection against UV rays - ozone is one of the greenhouse gases present in the stratosphere. This means that it plays a part in heating up the air masses within the vortex. When there is less of it, the vortex cools correspondingly, further exacerbating the conditions for its own destruction.

Secondly, at lower altitudes, climatic warming can lead to a build-up of energy, trapped by the accumulation of greenhouse gases such as CO_2 beneath the stratosphere. Within the vortex, the effect could be a cooling of the air masses lying at a higher level, which are insulated as a result.

'If such a process is confirmed, the need for policies to reduce our impact on climate change will become all the more urgent,' notes Dr Ghazi. Under the Fifth Framework Programme, this global approach certainly underlies projects within the key action Global change, climate and biodiversity. ■

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Europe's fragile forests

The environmental and economic disaster wreaked by last December's storms has raised questions about forest management practices. For some years now, researchers with the Storms project have been studying the damage to Europe's forests caused by wind, snow and fire. The team has developed assessment tools to be used by the experts in appraising silvicultural techniques and minimising risks.

'Since the great storms of the 1980s, a lot of studies had been carried out into the processes involved in forestry disasters,' explains Dr Alexandros Arabatzis, scientific manager at the Research DG. 'But no attempt had been made to construct a model of the research results. The Storms[1] project is different because it sought to develop a tool which could be used on a large scale to forecast and prevent the natural risks threatening our forests.'

Over a three-year period (1994-1997), eight European teams (Finland, United Kingdom, Ireland, Sweden, Portugal) pursued the same objective of developing tools allowing foresters to adopt the silvicultural techniques most appropriate to the types of trees and climatic and geographical characteristics of their region.

After storms, researchers collect field data which allow them to assess the vulnerability factors which exacerbated the wind damage.

This involved developing models to assess the risk of broken or uprooted trees in relation to wind speed and snow burden, and the risk of fire in relation to type of vegetation and wind direction (see box). This information then had to be fed into existing databases on climate and vegetation as part of a wider system designed to aid standardised decision-making.[2]

Three risk assessment models

How to assess the significance of factors exacerbating wind damage? The researchers started by gathering very extensive field data obtained at the time of past disasters as a basis for assessing what factors make trees vulnerable. This ranged from quantifying and describing the trees affected - to create a statistical risk model - to in-depth studies of the physical variables at work in the damaged forests, ultimately permitting an 'empirical-mechanistic' approach.

More specifically, the scientists collected data on wood properties (density, compression zones, etc.) by analysing samples of broken or uprooted trees and comparing them to those from trees which remained intact. They also included analyses of soil characteristics (type, degree of humidity, etc.) and oscillation frequency measurements for various species. Finally, they field tested the resistance of Scots pine, Norwegian spruce and birch, by subjecting them to various forms of bending and pulling, and simulated storms on forest models.

This mass of data, providing a pointer to the factors behind the destruction of trees, was used to create two separate assessment models for level of vulnerability. Known as Hwind and Gales, these were constructed on the basis of calculations of the stress the trees must withstand and their resistance to uprooting.

The importance of the crown

'The advantage of a project such as Storms is that it allows you to use several different approaches to the problem and then compare and validate them. Such a method would be impossible at a national level,' explains Barry Gardiner, a researcher with the Forestry Commission (Scotland). 'In this respect it has been a success. The three models we have developed - the statistical approach, then Hwind and Gales - give very similar predictions, despite the different methodologies.'

Hwind and Gales certainly agree on one major point: trees with smaller crowns are the most vulnerable. They are quickly uprooted or broken, unlike trees that stand alone and are free to develop a luxuriant crown, solid trunk and powerful root system. This explains why the edges of freshly cut stands on the top of a hill - even a relatively unexposed one - are at great risk. Also line clearings, current practice in planted forests in England and Ireland,

increase wind penetration to the plots. Repeated fertilisation should also be avoided as this promotes crown development at the expense of the root system.

The decision-making tools developed on the basis of these models are allowing forestry experts to analyse the effects of various silvicultural techniques. By modifying the climate parameters and introducing the specific characteristics of the local species and soil types, they will be able to choose the techniques most suitable for the eco-geographical conditions in question. Gales is already available in Great Britain and will soon also be available in France.

Don't expect miracles

Does all this mean that we can now avoid the kind of damage we saw in France, Germany and Switzerland last December? Not exactly, as Seppo Kellomaki, project coordinator and researcher at the Faculty of Forestry at Joensuu University (Finland) points out. 'Whatever the species and growing methods, a storm of such violence inevitably causes damage. But it is becoming increasingly important to take as many precautions as possible to limit the impact of high winds because the climate is tending to become warmer and damper. This brings an increased risk of uprooting, especially in Northern Europe where the period of freezing, which helps anchor the roots during the winter months, is becoming shorter. It is therefore preferable to plant trees with a strong root system, especially if there are regular forest clearings.'

Although the Storms project is now complete, the researchers are nevertheless continuing to work on improving their models. 'Data are the key to a model's quality,' stresses Barry Gardiner. This is why Scottish researchers have started carrying out aerial measurements by Lidar (radar laser) to provide a more detailed description of stands - in particular the height and diameter of the trees - and thereby supplement the present insufficient field data. Meanwhile, the Finnish researchers are continuing their work on the resistance of different species by concentrating on the risk of snow damage. ■

(1) Silvicultural Techniques Offering Risk Minimising Strategies.
(2) A version of this system is now available on the Internet.

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Fire, the scourge of southern forests

While wind and snow are the two major scourges of Europe's northern forests, Mediterranean regions are ravaged by fire. Preventive management to protect forests against fire - principally studied by Portuguese researchers - has been fully integrated in the Storms project. Portuguese teams have developed models for assessing the risk of fire based on measurements of the quantity of materials that allow a fire to start and then develop. Another key factor, as in the case of storms, is the determining effect of winds.
The Storms project has also developed original methods for assessing vegetation, based on a calculation of the Spectral Vegetation Index from images obtained by Lansat TM and on the Leaf Area Index (LAI) which describes the vegetation structure. A specific computer program, Firemap, has also been developed to assess the risk of fire spread at regional level. This has been tested by the Portuguese forestry services.

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Communicating uncertainty

Although there is substantial evidence for the greenhouse gases of the industrial revolution producing global warming, some scientists point out that this may not be significant on a geological time-scale. What is the public to think - and how can science communicators help?

When the issue of global warming comes up, one thing is certain: uncertainty. Not everyone is sure that global warming is really taking place or, if it is, that this is significant. After all, on a geological time scale, the human effect is swamped by 'natural' swings in temperature, and a recent report in Nature suggests that even over the last 500 years such variations may be greater than previously believed - although the results also 'confirm the unusual warming of the twentieth century'.(1) At the same time, a paper in Geophysical Research Letters argues that recent record temperatures could indicate that the rate of global warming is speeding up,(2) and some experts are now estimating that there could be as many as 100 million ecological refugees by the middle of this century. To confuse matters more, the news is not all bad: global warming could yield improved crops in some parts of the world. According to new research at Oxford University's Environmental Change Institute, the south of England could become an important wine-growing region and even southern coastal Scotland could be producing wine within 50 years.

We must (not) act now

Scientists typically want to be very sure of their results, but in the case of climate change this does not seem to be possible. Conclusions vary according to the length of time studied or the assumptions made about the future. Uncertainty is the rule. Sceptics say, 'If you are so uncertain, let's wait for more evidence.' Energy companies may ask how they can possibly make the dramatic cuts in the use of fossil fuels now being suggested,(3) when there are no viable large-scale alternatives and in the face of such uncertainty. Environmentalists retort, 'The evidence is clear, and the uncertainty means we must act now - we are experimenting with the only planet we have!'

The diverse perspectives of these different sectors mean that each is likely to interpret the data from their own viewpoint and provide their own estimates of the costs of both outcomes and mitigation. Can science communicators help cut this Gordian knot?

Typical of the cautious scientific approach is the current position statement of the American Geophysical Union: 'AGU believes that the present level of scientific uncertainty does not justify inaction in the mitigation of human induced climate change ...' A triple negative which is technically accurate and suitably cautious but leaves the reader unsure as to whether action is needed. Scientists are also fond of imprecise terms, such as 'doubtful' and 'probable', but what will the public understand on reading that scientists think this outcome 'likely' or that observation 'unusual'? Perhaps the writer is thinking in terms of '95% probability' or a trend that is 'statistically significant', but unless the terms are defined the reader may understand something quite different. The IPCC(4) has found that such terms can even vary in usage between the chapters of its reports. To address this problem, it is developing internal guidelines for writing teams to facilitate clear and consistent use of terms, even where these cannot be quantified.

Where the risks can be quantified, some have adopted an 'expected value' approach, assigning probabilities and costs to various possible outcomes and multiplying these together. Probabilities certainly help to explain terms such as 'likely' and 'unlikely', but they are necessarily subjective and using expected value is only appropriate for events where the worst outcome is acceptable. But this is not the case with global change. There may be a high level of uncertainty, but if the worst forecasts become reality, the result is unthinkable.

Perhaps the best contribution science communicators can make is simply to ensure that the uncertainty of climate change is not made more uncertain by the language used to communicate it. Niels Bohr once said, 'Never express yourself more clearly than you are able to think.' But never less clearly either. ■

(1) Nature, 17 February 2000
(2) Geophysical Research Letters, 1 March 2000
(3) According to many scientists, climate stabilisation requires greenhouse gas emissions some 60% below 1990 levels.
(4) UN Intergovernmental Panel on Climate Change