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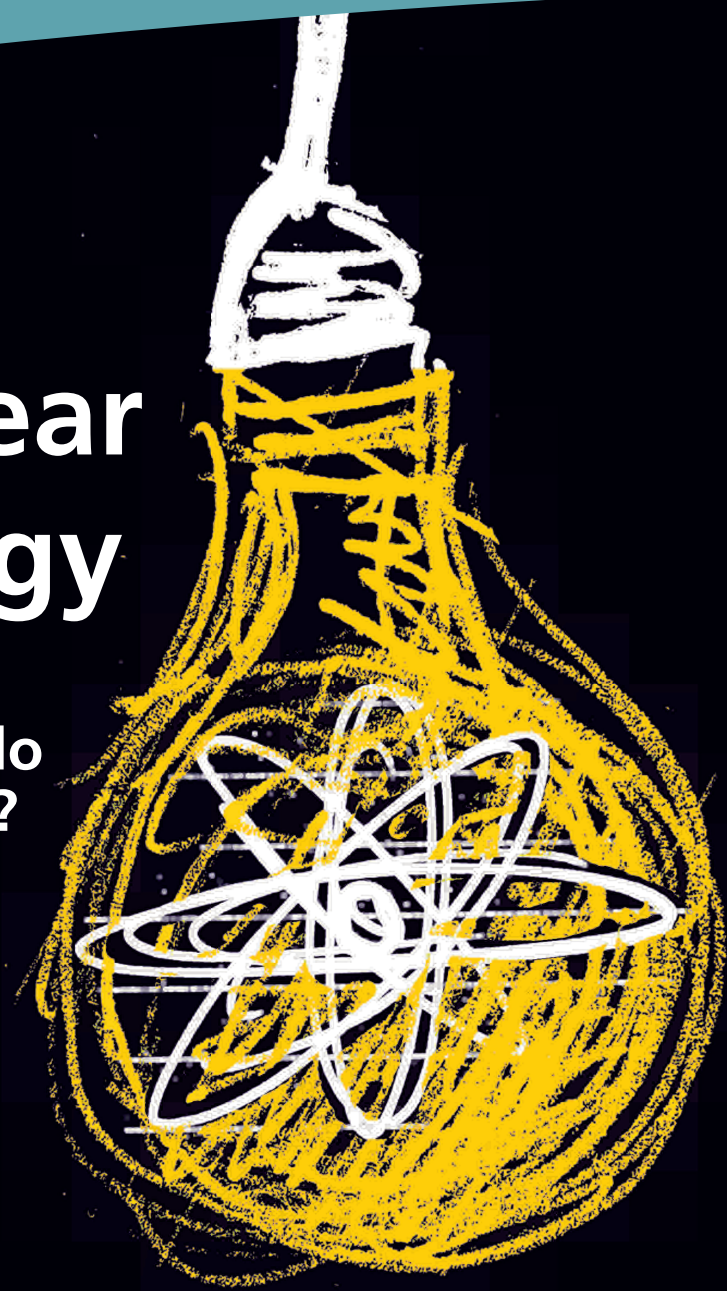
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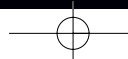
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Nuclear Energy

Can we do without it?



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Editorial

Science under pressure

Sacked or suspended... while others are being prevented from publishing – it is not unusual for scientists who publicly express doubts or fears about the consequences of their research to find their civic conscience causing them professional problems. At a time when science is perhaps too often seen as the universal magic wand, there is the temptation to have scientists say what the politicians or captains of industry would like to hear. Consequently, by virtue of being placed in the service of non-scientific objectives, research can sometimes be put under pressure.

The article on page 35 broaches this delicate subject. Often condemned to isolation by the power of their institution or hierarchy, those lone

individuals acting as the 'conscience' of science do not always have the legal or legislative tools to ensure their voices are heard and their rights are respected. In this respect, science is a very human and mundane activity, with its fair share of conflicts, slip-ups and moral issues.

Researchers must therefore be able to speak out freely on the ethical aspects of their research, subject of course to the exclusion of 'denouncements' inspired by the settling of scores, unhealthy rivalry or other base motives. In this respect, if researchers want to combat any form of censure then they must also show more transparency. This is especially true today as their current role is often multifunctional, operating as researchers, experts and fund-raisers at

one and the same time. This causes confusion, conflicts and sometimes irregularities. It blurs their image and that of science along with it. Aware of the problem, the publishers of certain journals now require their contributors to cite the source of their funding as proof that an article deemed to be scientifically correct is not, at the same time, potentially biased.

Until researchers speak openly and transparently about the nature and power of science – as well as of their personal position – instances of such bias will continue to occur. This is both regrettable and has potentially devastating consequences.

DOSSIER

Nuclear energy

3 Nuclear energy The benefits of an unpopular sector



Once the 'darling' of the 'glorious thirties', nuclear energy is now out of favour. So much so that several European countries have decided to dispense with it. No doubt the reservations have more to do with the issue of waste management than the safety of installations. But the nuclear sector has one major benefit: producing no greenhouse gases, it is – alongside renewable energies – a particularly sustainable means of producing electricity. It is also of strategic importance in reducing Europe's energy dependence.

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Medicines and the environment

15 Taking the pollution out of health care

Many pharmaceutical molecules which are designed specifically to be persistent and lipophilic are evacuated into the environment through waste water. In-depth research is seeking to quantify and remedy this insidious pollution which has been ignored for too long.



Portrait

18 Ice seasons

A meeting with Ursula Schauer, a German oceanographer who spends a large part of her life in Arctic or Antarctic regions. The research she helps carry out on board the *Polarstern* floating laboratory is crucial to our understanding of the climate.



Sixth Framework Programme

20 The class of 2003

The selection of projects submitted following the first round of calls for proposals during the first half of last year was eagerly awaited. In particular, it was an initial test for the 'new instruments' designed to strengthen the European Research Area around specific research priorities. We present the results and analysis.

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Environment

32 Researchers on the high seas

Tireless hunters, constantly migrating from one ocean to another, tuna have a notable habit of coming together in schools. Nine research teams in the Fadio project made the most of this gregarious peculiarity – already familiar



to fishermen hoping for a bigger catch – to study, count and protect this species of vital economic and ecological importance.

Science and ethics

35 Protecting the 'whistle-blowers'

Scientists, researchers and technicians may want to sound the alarm when they believe that certain developments they are working on have the potential to harm. The idea of a conscience clause designed to protect such whistle-blowers is gaining ground.



Scientific co-operation

38 The Prigogine legacy

A pioneer of 'post-classical' physics, this 1977 winner of the Nobel Prize for chemistry (who died in 2003) saw himself as a citizen of a 'greater Europe' – an open Europe, able to extend a hand to the scientific community in his native Russia.



International co-operation

40 The sounds of Ethiopia

Ethnomusicology is to sound like archaeology is to objects and linguistics is to words. Here we tune into a multidisciplinary and multinational project attempting to document, classify, study and preserve Ethiopian cultural heritage.



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this interdependence is evident in regularities on a larger scale – and often even on several scales. In many cases, the laws are auto-similar, meaning that they show the same profile for different scales, like fractal curves.'

Mathematical patterns

These notions are at the basis of an approach that makes it possible to study systems of every kind by means of the same mathematical methods. It is this aspect that the EU-Russian project has developed in various fields of study, producing impressive results.

At the end of the five years, there was clearly a need to pursue the research further. But the rules of the game had changed and urgent measures were no longer justified. Scientific co-operation between the European Union and Russia was beginning to evolve in the new framework of international and competitive participation in the Union's calls for proposals. For Russian researchers, the transition was not always easy. 'Some scientists were not able to submit projects that were competitive by European standards,' explains Antoniou. 'The Commission's new programme also required scope for commercial applications, and not all the teams were able to demonstrate this. It is one thing to switch from a theoretical modelling to an algorithm which uses its principles, but something else again to use these algorithms in prototype systems and then in realistic and competitive commercial applications.'

Nonetheless, several teams met the challenge and 15 projects, originating in research fields initiated thanks to Prigogine, passed the test, most of them based at Moscow University, St Petersburg University and the Nuclear Research Institute in Dubna. 'The previous programme had given us a boost,' notes Melnikov. At Moscow University, an autonomous dynamic had clearly been generated with the creation, in 1995, of the Institute for the Mathematical Study of Complex Systems (with Prigogine as honorary president), which proved fertile terrain for the development of basic theoretical tools.

The scope for applications

The Commission tends to finance projects at the point where theories give rise to applications, which it has done in fields as diverse as immunoinformatics, stock exchange models, quantum computing, or the study of cardiac or cerebral rhythms. At Dubna, Professor Victor Ivanov, director of the Laboratory of Information Technologies, is a specialist in the complexity of the Internet. 'The approach adopted by Ilya Prigogine is the basis we adopt to model the traffic of information packets. A judicious choice in data aggregation reveals stable statistical laws. Knowledge of these laws enables us to detect anomalies and to develop protection systems, as well as tools to optimise the traffic. We are also developing the same kind of approach for stock market forecasting.'



Ilya Prigogine liked to communicate his interest in science to young people. He is shown here after giving a physics lesson to 12-year-olds at La Cordeille d'Ollioules, near Toulon (FR).

But whether it is in Brussels, Moscow, Dubna or St Petersburg, one element remains constant: the unconditional admiration for Prigogine, at both the scientific and personal level. Iuri describes him as 'a universal spirit, in the great tradition of the Enlightenment'. Vladimir Belokurov, vice-rector of Moscow University, describes the Nobel laureate as 'always open and ready to listen to others, interested in the ideas of the young and ready to give them a push in the right direction.' Others maintain that Prigogine was ahead of his time. 'We are convinced that his thinking will influence the 21st century,' observes Antoniou. 'But he was already thinking further ahead. He said that after irreversibility and auto-organisation the next big challenge for science would be to shed light on the relationship between the body and the soul.'

Prigogine, who published a number of notable works with the philosopher of science Isabelle Stengers,⁽³⁾ never paid attention to disciplinary barriers. First drawn to law, he studied psychology before turning to chemistry and then physics and mathematics. Each area of interest led him to another, even more fundamental one. Alexey Sissakian, vice-president of the Dubna Institute, describes him as an old-fashioned philosopher: 'He was deeply convinced that the distinctions between physics, chemistry and other disciplines introduced artificial barriers, whereas nature forms a continuously interacting whole.'

(3) Recommended reading: I. Prigogine et I. Stengers, *La Nouvelle Alliance*, Paris, Gallimard, 1979 – I. Prigogine, *Physique, temps et devenir*, Paris, Masson, 1982 – I. Prigogine et I. Stengers, *Entre le temps et l'éternité*, Paris, Fayard, 1988 – I. Prigogine, *Les lois du chaos*, Paris, Flammarion, 1994 – I. Prigogine, *La fin des certitudes*, Paris, Odile Jacob, 1996.

To find out more

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The sounds of Ethiopia

Ethnomusicology could be described as the archaeology or etymology of sound. Intrigued by the music of other cultures, Jean-Jacques Rousseau was already wondering in the 18th century whether 'European' musical notation was of universal application. Later, jazz and its African roots would open the door to 'world music'. We tune into a Franco-Ethiopian research project with international resonance.

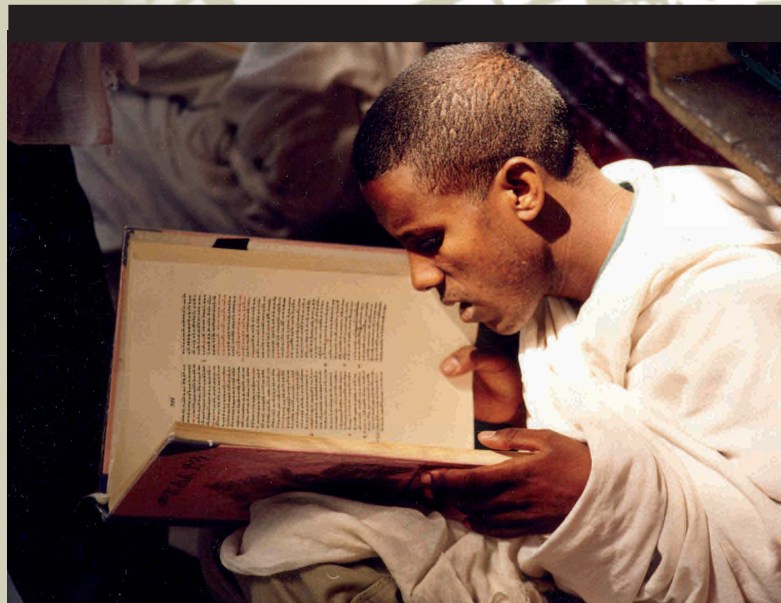
'Ethnomusicology is a rapidly developing subject. This is not surprising when you consider the interest young people show in music, travel, humanitarianism, humanism, and contact with others,' explains Olivier Tourny.⁽¹⁾ A researcher at France's Centre National de la Recherche Scientifique (CNRS), Tourny is scientific director of the Franco-Ethiopian programme "Ethiopian Traditional Music, Dances and Instruments". More than 20 students and researchers are currently working on the project, most of whom are French and Ethiopian, but also Italians, Belgians, Germans, Americans and Japanese. 'There is strength in numbers. Everybody is working in a different field, making recordings and carrying out investigations. In this way you can soon collect valuable information on the musical heritage of an entire country. We can now compare and corroborate our findings. If I had been working alone – as is traditionally the case in anthropology – moving from one ethnic group to the next, it would have taken me a lifetime to get such results. By which time, a lot of music would have disappeared.'

The aim is to document, collect, preserve, study and disseminate the traditional music, dances and instruments of one of the richest and most complex African countries in this field. Ethiopia has an exceptional musical heritage, marrying ancient Jewish, Christian and Muslim influences. Strange as it may seem, until this programme was launched in 2000, there had been no systematic research into Ethiopian music.

The "q'essoc" heritage

The story of Tourny's research begins in Israel. Back in 1986, the ethnomusicologist Simha Arom – who was working at the time at France's Laboratoire de Langues et Civilisation à Tradition Orale (Lacito), met religious leaders of the Ethiopian Jewish community (known as q'essoc), in Jerusalem. They were keeping alive some very ancient liturgical traditions – traditions threatened by contemporary Jewish practices. Fascinated by this unique heritage and determined that it should be preserved, Arom studied and collected the songs and accounts still circulating among members of this emigrant community.

When working on his thesis, some 10 years ago, Tourny immersed himself in this rare ethnomusicological heritage as he penetrated the secrets of some 80 Judeo-Ethiopian liturgical songs. His initial ambition was to transcribe them rather than simply record them, ensuring that this heritage was not only conserved but also better understood.



'In this work, the transcriber really is faced with the proverbial anguish of staring at an empty page, not prompted, in this case, by the need to invent and create, but to reproduce with your hand and pencil what you hear with your ears and brain.' As in the case of a translation, is the transcription true to the original? That is the test. 'One day I showed my transcriptions to a friend, who started to sing them. What he produced was not anything like a Judeo-Ethiopian liturgical song. But it marked the beginning of my work, and the art of transcription is something that must be learned.'

A multidisciplinary pool

This meticulous musical study also opened up a passionate area of research in the Ethiopian field and progressively aroused interest in a multidisciplinary approach. History, sociology, linguistics and anthropology all have a bearing on ethnomusicology. 'Many musical practices remain little known, even in the country itself. Many of them are also threatened by the spread of hybrid cultures, what are known in our jargon as *ethno-urban* cultures.'

The project team have already worked on Ethiopian lyres, Ari and Male polyphonies from the south of the country, liturgical dances of the Christian Orthodox Church, Harari wedding songs, Gurague dances, and various religious traditions. The project is now set to lead to the founding of the Ethiopian National Sound Library which will house the recordings (audio and video) made by the researchers, the archives of historical sound recordings, and local documents. The next step looks set to be a new sound anthology of Ethiopian music. ●

To find out more

<http://www.vjf.cnrs.fr>

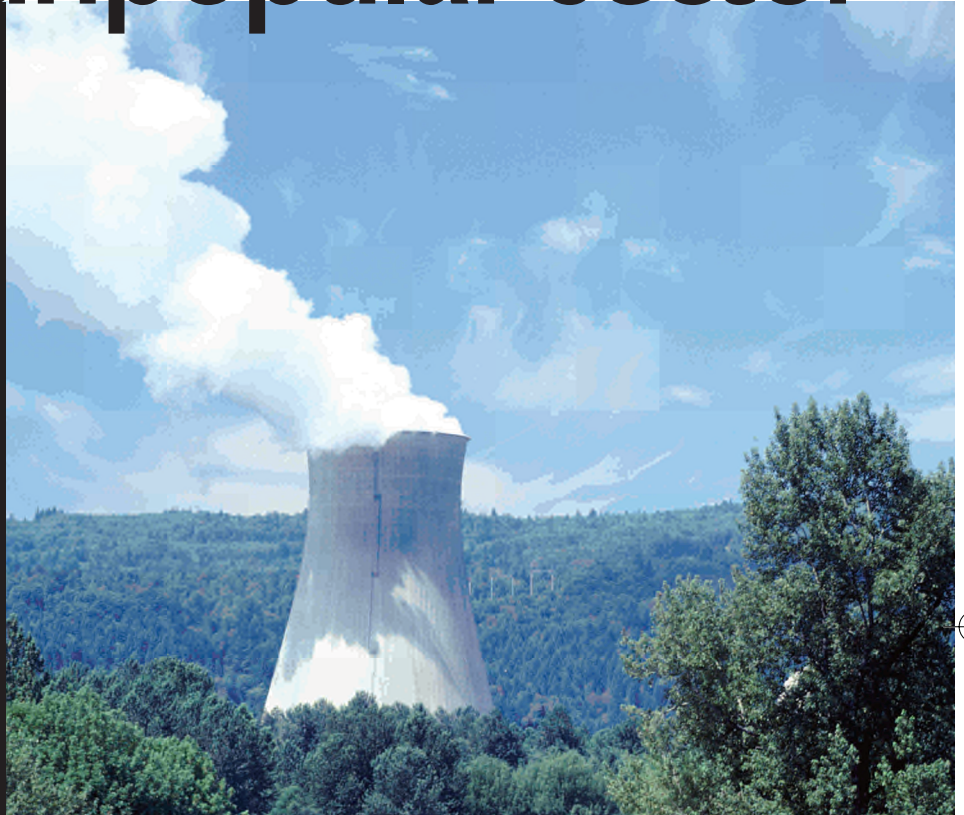
Contact

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(1) All quotations by Olivier Tourny.

The benefits of an unpopular sector

If there is one subject over which European society is split, it must be nuclear energy. The 'darling' of energy policy for the majority of EU Member States during the 'glorious thirties', for the past two decades it has been at the centre of much controversy – so much so that several European countries have stated their desire to abandon nuclear energy altogether. But surely such a stance is now seriously at odds with the need to respond to the new problem of climate change? Over recent years, this question has become central to the challenge facing the future of our energy – not just in Europe, but globally.



So what are the drawbacks of nuclear energy? They are certainly very real. In terms of nuclear waste alone, they are no doubt as difficult to accept as they are to resolve. In the present context, however, this sector has the major benefit of being equally difficult to ignore. Alongside renewable energies – currently of limited potential – nuclear fission is a means of producing electricity not only on a very large scale but also in a sustainable way – not a single greenhouse gas molecule is emitted from the nuclear reactions involved. Also, in terms of strategy, nuclear energy can enable Europe to reduce its growing energy dependency which is compromising its future.

Such is the dilemma facing the Union's energy policy. With electricity flowing increasingly between the Member States to meet peak demand, the nuclear sector now provides more than a third of Community needs. Meanwhile, the implications of the stated desire of several Member States to abandon nuclear energy remain somewhat vague. We know little about how such a policy would be implemented or what alternative production solutions would be able to meet environmental constraints. What is more, this is happening at a time of Union enlargement to include new states with their own sizeable contingent of nuclear plants!

Dismantling the Brennilis (FR) plant – 'Either we shut down the nuclear sector and give up on Kyoto, or we do not shut down the nuclear sector and we respect Kyoto.' (Loyola de Palacio, Commissioner responsible for energy and transport). © CEA

Indignation from a climatologist

'Abandoning nuclear energy as we enter the 21st century is not only an anachronism, but is and will remain, for a long time to come, the biggest mistake ever made by a Belgian government. Further developing nuclear energy is – on the contrary – one of the most effective ways of serving sustainable development (...). Any policy that seeks to abandon it is utopian, if not dishonest...'

It was in such forthright terms that Professor André Berger, the internationally renowned climatologist, expressed his views in an open letter addressed to Belgian Prime Minister Guy Verhofstadt, in January 2003. It followed his government's decision ultimately to cease using nuclear energy.

The situation is paradoxical to say the least. Under the Kyoto Protocol, signed in 1997, Europe undertook, by 2012, to reduce its CO₂ emissions by 8% compared with 1990 levels. When the growth in energy consumption is



taken into account, this means reducing CO₂ emissions by 550 million tonnes by the target date, which is double the commitment made at the time of signing the protocol.

Putting it crudely

The Union has resolved to make a considerable effort to double the use of renewable energy, targeted to meet at least 12% of its primary supplies by 2012. Yet even if it succeeds, this would only reduce its emissions by 200 million tonnes – leaving 350 million outstanding.

The nuclear sector currently represents a 'non-emission' of almost 180 million tonnes of CO₂. Shutting it down would bring even more constraints on having any hope of meeting Europe's commitments towards combating climate warming. The problem is further complicated by the inevitable increase in world energy demand: electricity consumption is expected to rise by 3% by 2030.

Loyola de Palacio, the Commissioner responsible for energy and transport, summed up the dilemma very succinctly: 'Either we shut down the nuclear sector and give up on Kyoto, or we do not shut down the nuclear sector and we respect Kyoto. It is as simple as that: sometimes you have to put it crudely so that people understand.'

Economic aspect

The problem can also be approached from another angle: that of energy costs. Compared with other forms of production, the electro-nuclear sector can bear high capital depreciation. Despite being spread over a very long period, depreciation costs represent at least 60% of the cost per kWh compared to around 20% for gas turbines. And as a result of the stringent safety requirements, operating costs⁽¹⁾ are also nearly double. On the other hand, nuclear energy offers a considerable economic plus: the supply of uranium is subject to few of the costs or uncertainties of fossil fuels and its share of the cost per kWh is five times less.

The net result of these factors is that, provided production and market share remain at present levels, the current average production cost for electricity generated by the nuclear sector as a whole remains very competitive. But will that remain the case in the totally open electricity market now in the making?

Another logic

The picture would be very different, however, if we made a study of the global environmental impact of electricity production which is not strictly quantifiable. The Externe-E European research project has provided the first very significant figures in this respect. These show that the *externalities* associated with fossil fuels (cost and effects in terms of health, deterioration of the urban environment, agricultural productivity, etc.) weigh very heavily indeed.⁽²⁾ In Germany, for example, the external cost per kWh generated by the wind power sector is 0.05 cents, compared with between 5 and 8 cents per kWh for electricity generated at

(1) By including the costs of processing and storing radioactive waste, as practised at present, and taking into account the possibilities for geological disposal.

(2) See RTD info no.35, p. 18 or europa.eu.int/comm/research/news-centre/fr/env/02-10-env02.html#note02

Excellence at risk

The present confusion about the future of nuclear energy in Europe is undermining, if not threatening the very existence of, activities linked to nuclear physics. The first-rate scientific and technological know-how acquired in this field is the fruit of more than 50 years of continuous research.

The future may well be uncertain, but given the global environmental context it is more than likely that the nuclear sector will continue in some form or another in Europe.⁽¹⁾ So can we allow this excellence to be depleted? It is capital which needs a dynamic research framework if it is to survive, while the present lack of prospects is forcing young people to look elsewhere for a research specialisation. What is more, the choices of the past alone make it imperative to safeguard this scientific capability. As a result of prevarication, Europe has failed to mobilise sufficient resources to bring credible and common solutions to the problem of radioactive waste. Vital know-how is also needed to manage existing plants. Finally, progress in nuclear physics is not limited to the nuclear energy sector alone but has a vital role to play in medicine, industry and other fields.

It is to maintain know-how in this field within the European Research Area that the Union supports, through the Euratom project under the Sixth Framework Programme, actions to promote and develop human resources and mobility, in the form of grants and special training programmes (in particular co-operation with third countries).

(1) No doubt in certain developed countries such as France and Finland, which show little inclination to shut down their nuclear sectors and, on a global level, most certainly China and other emerging countries.



Remote handling of very active materials: can we allow excellence built up over half a century to be depleted?

an oil-fuelled thermal plant, and between 1 and 2 cents for natural gas. The external costs per kWh for nuclear energy (0.2 to 0.7 cents) are, by comparison, remarkably low throughout Europe.

The WETO⁽³⁾ study – which is very pessimistic about climate warming if present energy production and consumption trends are projected through to 2030 – is based on another approach. One of the alternative models adopted by this research project shows that a strict application of the Kyoto Protocol, with a tax levied on CO₂ emissions, would bring a significant reduction in global energy consumption. In terms of an economic logic dictated by prices, this scenario would result in a redistribution of the energy cards: the increased competitiveness of nuclear and renewable energies would win these two sectors a 35% increase in market share compared with a scenario exempt from CO₂ tax.

Before the benefits of nuclear energy are universally accepted, there remains the obstacle of the 'dark side' of the atom and the fears it

(3) World energy, technology and climate policy outlook. See RTD info no.39, p. 34 europa.eu.int/comm/research/rtinfo/39/article_291_fr.html



arouses. Are we going, after interminable delays, to finally get to grips with rendering harmless the poisonous waste that the sector is continuing to accumulate? Can we further improve the reliability of nuclear technologies and provide more transparency, without which the public can never make a democratic choice in their favour? Finally, are we prepared to place our trust in the ability of researchers – in the public and private sectors – to design future generations of power stations that will overcome the disadvantages of those alongside which we live today?

European inventory

Seven Member States – Austria, Denmark, Greece, Ireland, Italy, Luxembourg and Portugal – do not use nuclear energy for their electricity production. Austria built a nuclear plant in the 1970s but never started it up. Italy, which had two, decreed a moratorium following the Chernobyl disaster and shut them both down permanently in 1990.⁽¹⁾ And the Netherlands, whose nuclear production meets just 5% of national electricity production, can almost be included among these ‘non-nuclear’ countries.

Seven other Member States have 140 reactors between them, supplying 864 TWh, or one-third of the Union’s electricity production. Half of Europe’s nuclear energy is produced by France which, subsequently, meets more than three-quarters of its own needs while also exporting.

However, among the latter group, five countries which are major nuclear producers are now pulling back. Sweden started the trend. In 1980, following a referendum, it set the goal of decommissioning all of its 12 working reactors by 2010, a date that has become the subject of debate, however.⁽²⁾

Spain (where electronuclear production meets 28% of demand) imposed a moratorium in 1984 that is still in force. Its task made easier by North Sea oil, the United Kingdom, while remaining the Union’s third largest nuclear energy producer, also stopped building any new plants 20 years ago and a White Paper published at the end of 2003 offers little prospect of any change.⁽³⁾ In 1998, Germany, with Europe’s second largest production capacity, also decided to abandon nuclear energy over the coming decade. Belgium, whose seven reactors produce more than half its electricity needs, plans to do the same between 2015 and 2025.

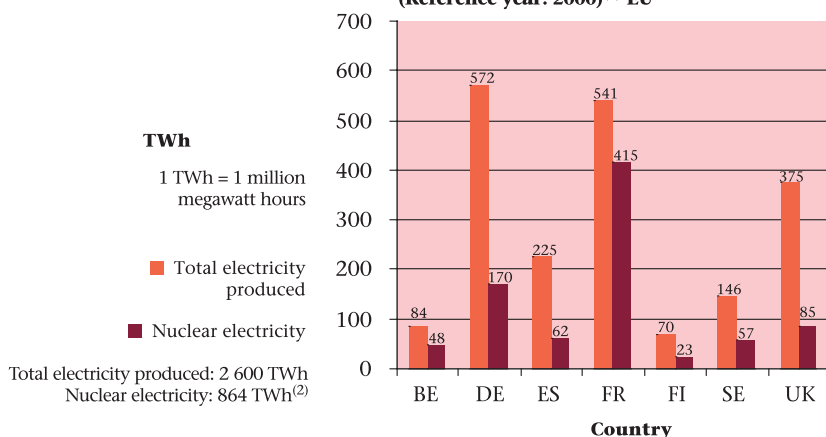
Only France and Finland – the only countries at present committed to building a new plant – have come out in favour of pursuing the nuclear energy option.

(1) Paradoxically, this ‘denuclearised’ country imports massive quantities of nuclear electricity, from France in particular.

(2) However, just one plant has been decommissioned since and nuclear energy continues to meet four-fifths of Sweden’s electricity needs.

(3) www.dti.gov.uk/energy/whitepaper/index.shtml

Nuclear electricity production: the figures (Reference year: 2000)⁽¹⁾ EU

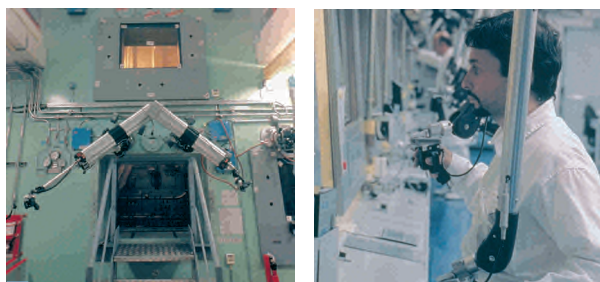


(1) Source: EC – Transport-Energy DG. Statistics published in January 2003.

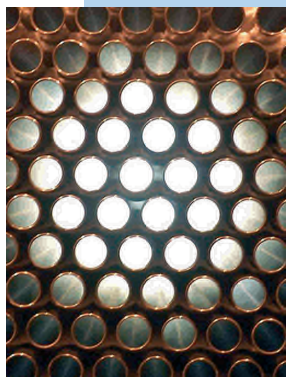
(2) Including 5 TWh produced by the two nuclear plants in the Netherlands, not included in this graph.



Site of the uranium mine at Ecarpière (FR), active between 1959 and 1991 (closed and converted today) – nuclear energy is also a strategic option for partly reducing Europe’s growing energy dependency which is compromising its future.
© Cogema – J.M.Taillat



A new shielded chain, Atalante 2, is a pole of excellence in the chemistry of the separation of actinides from irradiated fuel (Marcoule power station (FR)).
© CEA-FOULON



Device for charging fuel rods with zirconium.
© AREVA

There are risks and risks

The debate on nuclear energy is based on the principle of precaution. The facts, the fantasy and the risks inherent in other options must all be taken into account when gauging the pros and cons.



The positron emission tomography technique as used for 3D imaging in neurological, cardiac and oncological applications – nuclear physics and radioactivity find applications in many sectors of the technological society.
© CEA – L.MEDARD

Reactors generate a vast quantity of artificial radioactivity for which extremely sophisticated means of confinement are needed. The Chernobyl 'exception' remains fresh in our memories. In addition to this issue of safety, there is the matter of security. It is no myth that a civil nuclear programme can serve as the launching pad for military activities and illegal trafficking in fissile materials.

Unmitigated evil?

In response to this indictment by the anti-nuclear camp, champions of nuclear energy reject any blanket condemnation of radioactivity. It is a phenomenon which occurs naturally throughout the earth's biosphere, at both harmless and harmful (radon, for example) levels. Artificially produced radiation is also finding increasing applications in medical, industrial and scientific fields. Draconian measures are applied to the dangers these ionising rays pose to populations and to those personnel who are exposed to them on a daily basis, as well as to the radioactivity within the confines of nuclear plants. Meanwhile, research is continuing on radioprotection and the safety of nuclear installations, notably in EU programmes.

But if these nuclear plants are so safe, why Chernobyl? It is now generally acknowledged that this was not due to a failure in the state-of-the-art technology. This one-off disaster occurred within a badly designed plant (no double shell) and following a staggering series of human errors that defied all logic of safety. By contrast, the only other serious and significant nuclear accident recorded – the loss of control followed by meltdown of the reactor core at the Three Miles Island plant in the USA in 1982 – caused no major external damage, the confining wall doing its job effectively.

Chernobyl – the sarcophagus can be seen resting on the reactor which exploded. This was just one disaster at a badly designed plant that followed a staggering series of human errors defying all logic of safety.

© Vadim Mouchkine/IAEA/SGN

Euratom: Europe's research arm

Signed back in 1957 in the wake of the Treaty of Rome, the Euratom Treaty initially set the ambitious task of 'contributing to the rapid growth of the nuclear industries'. Given the uneven manner in which the industry has developed in a limited number of Member States, this plan for a 'common nuclear market' was never realised.⁽¹⁾

On the other hand, the role of Euratom as a lever for continuing European research in this field has never been in doubt and has been incorporated in successive Union programmes. It has been granted funding of € 1.2 billion for the 2002-06 period, 61% of which is earmarked for 'fission' research (see page 14). The rest will go to waste management, radioprotection and reactor safety. Various institutes of the Joint Research Centre (JRC), in Ispra (IT), Karlsruhe (DE), Petten (NL), and Geel (BE) will be undertaking 60% of these missions. The JRC is also providing active European support for the IAEA's efforts in controlling fissile materials and combating illegal trafficking.

(1) The last 'indicative joint nuclear programme' in 1996 sealed the project's fate by specifying that 'it is for each Member State to decide whether or not to develop the peaceful use of nuclear energy.'

To find out more

- Euratom activities under the Fifth and Sixth Framework Programmes www.cordis.lu/fp5-euratom/src/projects.htm
- www.cordis.lu/fp6-euratom/
- Joint Research Centre www.jrc.cec.eu.int/

Striking the right balance

Compared with disasters in the chemical or transport sectors, for example, the nuclear industry can be proud of having achieved a remarkable level of industrial safety within the Union over many decades.⁽¹⁾ The rare incidents remained under control and were all without major consequence. The nuclear sector is part of a technological society in which risk management must always be a factor. Despite the draconian precautions, the threat of nuclear terrorism remains present of course. But is the risk not much greater with biochemical (sarin gas) or bacteriological (anthrax) weapons which are much easier to make? Also, when making a balanced risk assessment, surely the incalculable risks linked to climate warming (in which the nuclear sector is a 'zero player') must also be included in the equation?

(1) In January 2003, the Commission nevertheless suggested that the Member States should adopt a much more coordinated European approach to nuclear safety

Waste management: a crucial matter

The issue is urgent. Although they have operated their nuclear power plants for decades, none of the Union countries which opted for nuclear energy have implemented acceptable and lasting solutions for the highly radioactive and long-life irradiated materials that are building up in safe but 'provisional' depots at the production sites. This failure to act is seriously compromising the prospects of benefiting from a sector with zero greenhouse gas emissions as part of a European energy strategy for the 21st century. Reprocessing, separation, transmutation and geological disposal are all possible solutions.



Research at the Asse salt mine (alongside the Gorleben salt dome – DE) with a view to the long-term storage of nuclear waste. In addition to granite, which provides an excellent geological shield, other underground formations are being studied as possible environments for deep permanent disposal.

Although it does not represent an environmental 'threat' likely to suddenly run out of control – as could be true in the case of a serious fault in reactor safety systems – radioactive waste is the Achilles heel of a future electronuclear industry. It has been seized upon by the fiercest opponents of nuclear energy as a reason in itself to shut down the sector – a view that is not without public support.

The fact is that this waste is building up all the time. Although very harsh measures already apply to storage security, the problem of disposing of these materials – which sometimes have a very long radioactive life – remains unresolved. Geological burying remains the single possible and acceptable solution (subject to the confirmation of current studies), yet there is no country in the world which has effectively put it into action.

To understand the issues involved in this complex problem, it is first necessary to define exactly what is meant by the rather general term 'nuclear waste'. Nuclear waste consists of a wide range of radioactive elements which are defined in terms of their activity levels – **low- and medium-level waste (LMLW) and high-level waste (HLW)** – and the duration of this activity. For the latter, the dividing line stands at 30 years – under 30 years, it is referred to as short-life waste and, beyond this period, long-life waste.

LMLW: danger management

LMLW makes up about 90% of nuclear waste. It comprises the consumable materials and protection equipment used at nuclear power plants, but also, to a large extent, the radioactive waste from non-energy sectors such as radiography technologies, imaging and tracing. Despite its low intensity – representing just 1% of the total radioactivity that must be managed – it undoubtedly has the potential to seriously damage human health, so rigorous precautions must be respected when handling and storing such material.

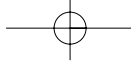
Given its diverse origin, all European countries, whether or not they have an electronuclear programme, are faced with the same problem of waste management. The Commission's latest estimates put the volume at around 150 000 m³ for the Union as a whole, plus several tens of thousands of m³ stored in the candidate countries.

Nevertheless, considerable progress has been made as regards the rate at which nuclear plants produce this kind of waste. In the early 1990s, when the power generated by the electronuclear sector was comparable to today's levels, annual production was around 80 000 m³. Experts believe that the dismantling of plants will reverse this trend. It is estimated that in the near future the total volume of short-life waste in the Europe of 25 will increase at the rate of around 40 000 m³ a year.

In most cases, however, this category of waste is not cause for major concern. Following various treatment processes to reduce its volume and activity it is solidified in concrete, bitumen or polymers ready for permanent surface storage at specialised centres.

For the small fraction of this LMLW with a radioactive life which exceeds 30 years, the problem is more complex. Representing about 17 000 m³ in the Union as a whole, this originates mainly in the fuel cycle plants of the nuclear industry. The present practice of surface storage for periods of a century or more is far from satisfactory. Consequently, this must be considered for geological disposal.

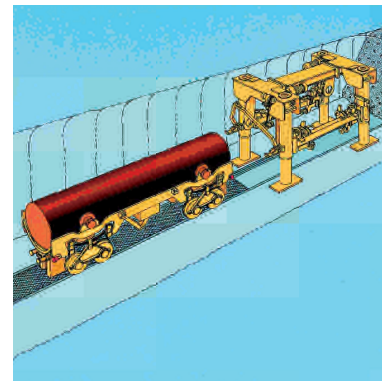
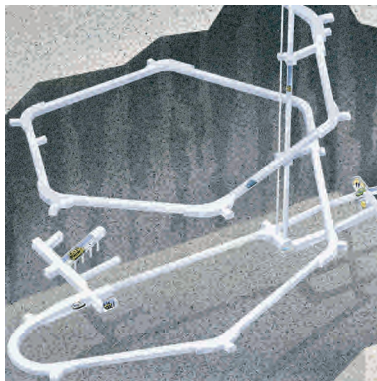




High-level waste problems

The second category, known as **high-level waste (HLW)**, comes from the used fuel of nuclear plants. This highly radioactive and heat-emitting waste can remain active for thousands if not hundreds of thousands of years. It contains a variety of elements:

- The spent fuel is made up of about 96% uranium and 1% plutonium, both of which are *major actinides*. Some



Plan of the geological disposal project at Äspö (SE), at present Europe's most advanced in terms of feasibility. Image of an underground handling device.

A brief glossary

Actinide: the family of radio-elements with an atomic number between 89 and 103. Uranium and plutonium are classified as major actinides as they are present in large quantities in fuel waste. Minor actinides are formed in small quantities in the reactors as a result of neutron capture by the fuel cores.

Nuclear fuel: fissile material – uranium or a uranium/plutonium mix – used in a reactor to trigger a nuclear chain reaction. To achieve this, uranium previously enriched with uranium 235, a fissile isotope, must be used, rather than uranium 238, which constitutes 99.7% of natural ore and is not enriched.

Isotopes: elements with atoms possessing the same number of electrons and protons, and therefore the same chemical properties, but a different number of neutrons.

Period, or half-life: time during which a radio-element loses half of its radioactivity.

Fission products: fragments of heavy core resulting from the fission of uranium and plutonium atoms. Most of these are radioactive and auto-convert into other elements.

Radio-element: any radioactive substance. Radioactivity, which poses a danger to man and the environment, is measured in becquerel.

countries have chosen not to reprocess this fuel, in which case it is known as Spent Fuel destined for Direct Disposal (SFuDD). The Union has already accumulated about 12 000 tonnes of SFuDD, with another 5 500 tonnes being held by those countries set to join the Union later this year. Annual production is estimated at 1 730 tonnes in the Europe of 25.

- Other countries have, however, chosen to recycle this waste at two sites, one at La Haya in France and the other at Sellafield in the U.K. These plants extract a new fuel from it which can be used at power plants, thereby reducing the radiotoxicity and volume of residual waste after processing.

- Finally, there is the 3% of *fission products* (caesium, selenium, strontium, iodine, technetium, etc.) and *minor actinides* (neptunium, americium and curium) which come from the irradiation of fuel inside the reactor. Irradiation also leads to the formation of very diverse radionuclides in the shells and sleeves which come into contact with the fuel.

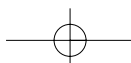
The total volume of waste from the reprocessing of used fuel, fission products and minor actinides currently stored in the Union is about 6 000 m³ and is increasing at the rate of 240 m³ a year. If the SFuDD is then added to this figure, the result is the equivalent of a building with a surface area of 850 m² rising to a height of almost 30 metres, with an extra floor three metres high being added on every year. That is the scale of the problem facing Europe's electronuclear industry. The real challenge, scientific as well as political, is how to manage this volume, the burden of which will be handed down to numerous generations to come.

HLW is at present stored around the nuclear plants themselves or at provisional disposal sites where it is cooled in ponds or ventilated wells. This cooling phase must continue for about 50 years. But then what? Given the present state of our knowledge and technology, only one solution can be envisaged, at least in the medium term: the storage of high-level waste in deep geological deposits.

Awaiting burial

This concept, which all the experts seem to favour, originated in 1997 in Africa, during a study of the uranium deposits at Oklo (Gabon). Two billion years ago, an exceptional concentration of ores triggered a chain reaction in these genuine 'natural reactors'. This continued for 500 years before being extinguished, leaving radioactive fission products trapped in the sediments. So, why not follow this example? The depositing of waste in deep geological formations could be 'the' viable response to the unmanageable life of various radionuclides. That left the matter of testing the technological feasibility.

The Hard Rock Laboratory (HRL) in Äspö (Sweden), built between 1990 and 1995, played a central role in subsequent studies. This is a vast underground complex lying at a depth of 460 metres beneath the huge mass of granite in the 'Scandinavian shield', two metres of which is



enough to keep out radiation. This particularly suitable rock formation has resulted from a very ancient mountain range.

Scientists at the HRL, which receives European funding, are trying to reproduce the conditions of a future subterranean nuclear waste deposit. The heat emitted by radioactivity is mimicked, for example, by electrical resistance. This technique makes it possible to study the many questions raised by the prospect of storing waste for hundreds of thousands of years. How will the rock react to such exposure to heat and radiation? Can underground water circulation be affected? How can the waste be treated to prevent its corrosion? What materials must be used to fill the wells containing the waste?

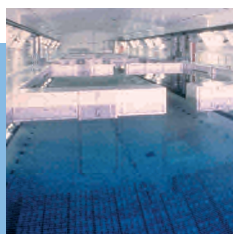
All these questions are being studied by the consortium of European laboratories participating in the Prototype Repository project, headed by the Swedish firm Svensk Kärnbränslehantering AB in Äspö. The aim is to assess, over a number of years, the performance of a disposal site tested on a life-size scale and to develop models to predict long-term behaviour. In the medium term, Sweden could decide to build

United Kingdom and Spain, a final choice has yet to be made. The great unknown remains the difficulty of winning public acceptance for such solutions – and, in particular, the degree of opposition from the ‘not in my back yard’ brigade.

Union pressure

In this fragmented European landscape, what role can the Union play? Two Commission Directorates-General are currently involved: Research, and Transport and Energy. In early 2003, at the initiative of Energy Commissioner Loyola de Palacio, two new Directives on safety in the nuclear sector and the management of radioactive waste were submitted for the approval of the Member States and the European Parliament.

From left to the right, reprocessing oven, control room and barrel filling and storage operations, and reprocessed uranium control room at the Tricastin-Pierrelatte (FR) site.
© Cogema – P.Lesage



Unloading, plus a view of spent fuel in a cooling pond at the d'Oskarshamn/SKB plant (SE).
© Bengt/O.Nodin

a permanent disposal site for its radioactive waste in its granite subsoil.

Neighbouring Finland has already taken the political decision. Following a long and remarkable democratic debate, the Olkiluoto site, adjacent to one of the country's two nuclear plants, was chosen. Work on building the underground disposal site, which is also located in granite rock, is due to begin in 2010 for completion around 2020. The Finnish Parliament has passed a law stating that a further assessment will be made in 2050 to decide whether or not the site should become permanent, taking into account the technologies available at the time.

These two Scandinavian countries are by far the most advanced in defining their waste management policies. Other countries are still at the stage of seeking the best storage concept in other geological formations. In the underground laboratories at Mol (Belgium) and Bure (France), for example, researchers are looking at the possibility of storing nuclear waste in deep clay deposits. In Germany, studies are being carried out in the former salt mines at Asse and Morsleben and in the underground exploration of the Gorleben salt dome. But in these countries, as in the

The ‘waste’ proposal called on the Union countries to stop dithering and to get a grip on the problem. The text did not say what solutions should be adopted; nor did it advocate the EU assuming responsibility for the problem, leaving that firmly in the hands of those Member States which chose the

nuclear option. What it did do was set a precise timetable for the Member States to take a final decision on the choice of disposal sites – to be subsequently vetted by the Commission – by 2008 and to have them operational by 2018. Deemed ‘coercive’, to date this proposal (together with the ‘safety’ Directive) has failed to be adopted in the face of strong opposition.

Urgent need for research

The Union is, on the other hand, in a position to provide the Member States with the scientific elements essential for a rational decision. That is where the research DG comes in. Under the Sixth Framework Programme (FP6), nuclear waste management is a major research priority for Euratom and the focus of many of the activities at the Joint Research Centre (JRC), especially at the Institute for Energy in Petten (NL) and the Institute for Transuranium Elements (ITU) in Karlsruhe (DE).

The ITU's expertise is seen as particularly strategic and the possible key to a promising development, i.e. one day, mastering the operational



technologies with which to isolate the most harmful radio-elements and transmute them into other elements which are less active and have a shorter life. Major research was carried out on this subject in 13 Euratom projects during the Fifth Framework Programme (1998-2002) and others are currently being launched under FP6.

Advanced chemical techniques made it possible, for example, for the Partnew project to perfect the synthesis of organic solvents which permit the extraction of two minor actinides: americium and curium. The aim now is to transmute these radionuclides into isotopes with a shorter life – or which are not radioactive at all – by bombarding them with rapid neutrons. This approach has already brought results in the case of technetium 99 which, with a radioactive life of 211 000 years, has been converted into a stable element, ruthenium 100.

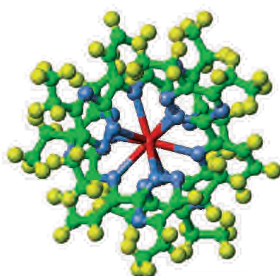
Transmutation on an industrial scale remains a matter for the future, however, although there are a number of avenues to be explored. 'One promising technological way forward is the development of dedicated reactor burners using a waste-enriched fuel, i.e. one rich in minor actinides,' explains Alex C. Mueller of the Institut de Physique Nucléaire d'Orsay (France), a partner in the European PDS-XADS project. Fundamental physicists and nuclear industrialists are working together on this project to make an initial feasibility study for such a reactor burner in which the necessary neutron source for transmutation would be a proton accelerator.

No time to dither

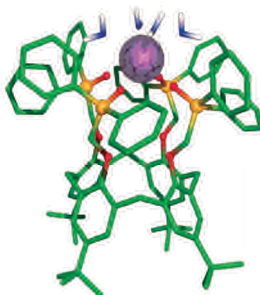
Researchers engaged in waste management research therefore bear a heavy responsibility. If they do not find a lasting solution within the next decade, nuclear programmes will inevitably be abandoned. By then, the accumulation of waste – made worse by the progressive dismantling of the power plants that are still operating today – will have become unmanageable. The exorbitant costs, in terms of safety and security, of continuing the 'provisional' storage would exceed the burden future generations could bear. Any dithering in the face of this demand would, literally, be a 'time bomb'.

In June 2001, the Russian Duma surprised the whole world by passing a law authorising the importing of foreign nuclear waste. This represents a clear infringement of the international principle, applied within the Union, which makes each country responsible for managing its own

nuclear waste. Is this a sign that events are getting out of control? Could we imagine a nightmare scenario in which some countries become genuine nuclear dustbins?



Cyclical phenolic compounds are able to form a genuine cation trap. Calixarenes (from the Greek calix meaning vase) are already used in reprocessing uranium in nuclear waste. See: europa.eu.int/comm/research/success/en/ene/0062e.html © CEA



Examples of projects

● Geological disposal

- PROTOTYPE REPOSITORY: Full-scale testing of the KSB3 concept for high level radioactive wastes
www.skb.se/templates/Page.asp?id=3352
www.vaisala.com/DynaGen_Attachments/Att5045/5045.pdf
 Contact: Christer Svemar, christer.svemar@skb.se

● Sorting and transmutation

- PDS-XADS: Preliminary design studies of an experimental accelerator driven system
 Contact: Bernard Carlucc, bernard.carlucc@framatome-anp.com
 - PARTNEW: Partitioning: new solvent extraction processes for minor actinides
www.nc.chalmers.se/partnew.htm
 Contact: Charles Madic, charles.madic@cea.fr

Achieving critical mass

There are two other crucial dimensions of European research policy in the field of nuclear waste management:

- First, all the Member States must be able to share in the results of research carried out by European underground laboratories in various geological environments – granite in Sweden or Finland, saline rocks in Germany, and clay in Belgium and France. That is the aim of the NET.EXCEL network, launched in November 2002 and welcomed by Research Commissioner Philippe Busquin as 'an example of the way in which research programmes can be pooled to achieve critical mass at European level'.



- Subsequently, the sustained promotion of training for those young physicists and engineers who must guarantee European know-how in this sector, which is among the best in Europe.

Visual control of fuel rods and handling of radioactive materials in the Melox factory laboratory for the production of MOX fuels at Bagnols-sur-Cèze (FR).

© Cogema – S.Jezequel

Contact

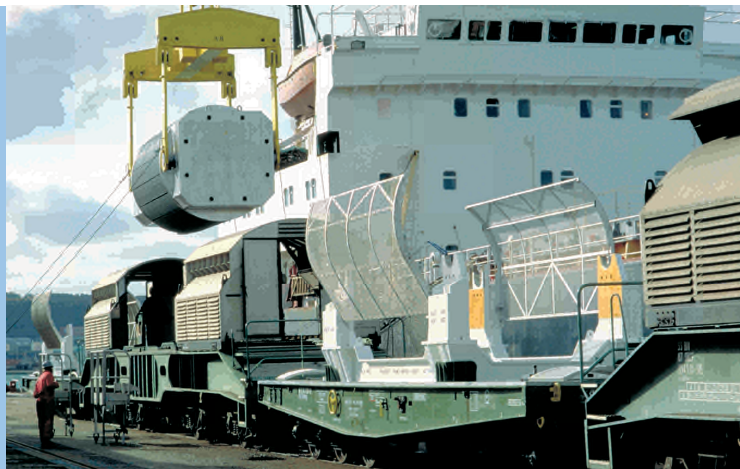
●NET-EXCEL: Network of excellence in radioactive waste management and disposal
 Christer Svemar,
christer.svemar@skb.se

Irradiated fuel: contrasting choices

Irradiated fuel contains approximately 96% uranium and 1% high energy plutonium. Both these radionuclides can be recycled: uranium can be used in reactors after enrichment, and plutonium in combined reactors with uranium in the form of MOX (Mixed Oxide) fuel. The main advantage of reprocessing is that it reduces the quantity and toxicity of the radioactive waste, in particular due to the recycling of plutonium, one of the most toxic of the radionuclides.⁽¹⁾

But there is a downside too. Organising this reprocessing requires complex logistics and a lot of transporting of radioactive waste⁽²⁾ between the reactors, reprocessing centres and MOX production plants. Europe has just two MOX plants: the Cogema factory in La Hague (France) and the BNFL factory in Sellafield (United Kingdom). Furthermore, major transformations must be made to a nuclear power station before it can use MOX.

The decision on whether or not to recycle spent nuclear fuel ultimately remains a complex political choice. While the United States has abandoned reprocessing, Russia, Japan and China are pursuing this option and the European countries have mixed feelings. France, Germany and Belgium authorise some of their nuclear plants to use MOX whereas the United Kingdom and the Netherlands do not use MOX at their plants, but nevertheless reprocess their spent fuel. The other Member States, including the 10 new members, have elected not to practice reprocessing.



Unloading spent fuel in Cherbourg, bound for La Hague (FR). Despite the safety and security measures, the transport of fissile material remains highly controversial.

©COGEMA – J. M.Taillat

(1) See also the box Fast neutrons versus slow ones, p.13.

(2) Such high-security transportation often gives rise to demonstrations by anti-nuclear campaigners.

To find out more

- European waste policy – Transport and Energy DG - Radioactive Waste Management in the Enlarged European Union – Fifth Situation Report, EUR 20653, February 2003
europa.eu.int/comm/energy/nuclear/publications/synopses/eur20653_en.pdf
- Full list of EU publications on nuclear waste
europa.eu.int/comm/energy/nuclear/waste/index_en.htm
- 'Waste' Directive proposed by the EC in January 2003 (not adopted)
europa.eu.int/eur-lex/en/com/pdf/2003/com2003_0032en01.pdf
- Inventory of radioactive waste in the EU
europa.eu.int/comm/environment/docum/98799sm.htm
- Institute of Transuranium Elements, Joint Research Centre
itu.jrc.cec.eu.int
- International Atomic Energy Agency
www.iaea.org/index.html

Transparency: a key requirement

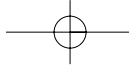
There is more to the research role than finding a solution to the technical problems posed by waste management. One of the reasons Europe is lagging behind is the mistrust amongst the public. The Eurobarometer 2002 survey found that more than three-quarters of Europeans believe they are badly informed, while less than a fifth believe that the nuclear industry is transparent on these issues.

As Paul Govaerts, Director-General of the Centre d'Etude Nucléaire (SCK-CEN) in Mol (Belgium) explains, the solutions found to the technical obstacles will not be the sole determinants of the nuclear industry's future. This is why the SCK-CEN is employing 'many researchers from non-technical disciplines to carry out research on ethics, and the perceived risk to health and communication'.

Greater transparency and improved information to overcome public mistrust was actually one of the priority areas for Euratom research under the Fifth Framework Programme. The RISC0M2 project, for example, assembled a team of British, Swedish, French and Czech researchers to define 'a European approach to public participation and decision-making in nuclear waste management'.

To find out more/Contacts

- Eurobarometer 2002: the Europeans and radioactive waste
europa.eu.int/comm/energy/nuclear/publications/doc/eb56_radwaste_en.pdf
- Project RISC0M2: Enhancing transparency and public participation in nuclear waste management
Ulf Gustafson, ulf.gustafson@ski.se



Voyage into a (semi) virtual future

What are the technological prospects which provide a basis for the pursuit and relaunch of a European strategy for the nuclear energy sector? Nuclear physicists and engineers are currently exploring ideas, some still in their infancy but others nearer fruition.

They had been given approximately 25-30 years. But most of the 150 or so nuclear plants still operating in the Union are ageing less quickly than expected. The timetable for decommissioning is therefore set to be extended, stretching from 2010 to 2020. But what could be available to replace them by then? The development of any technological renewal must respect the constraints of maximum risk control and therefore takes time.

The EPR option

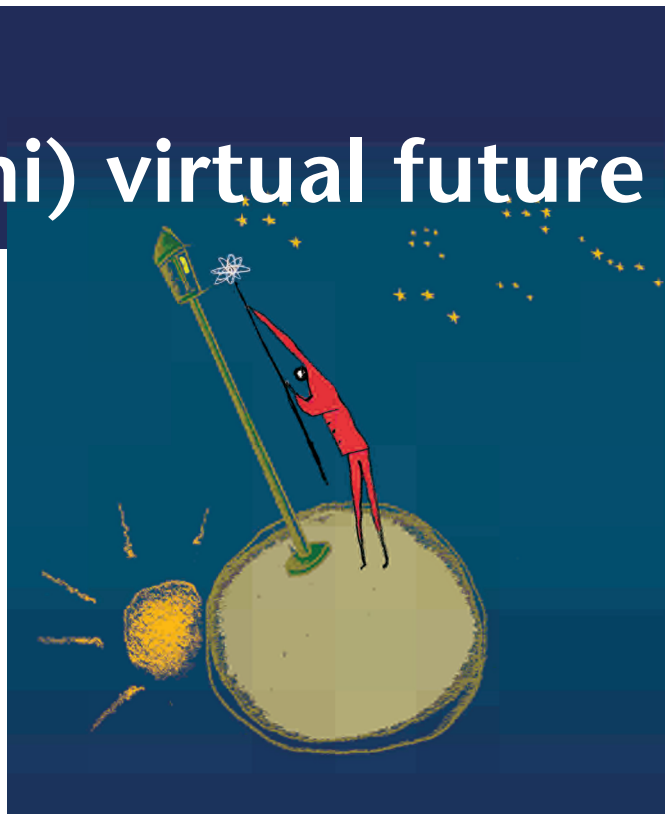
Two 'realistic' developments can be envisaged. Given their different time-scales for implementation, one does not rule out the other. In terms of investment, however, they could prove to be rivals. The 'quickest' solution is the third-generation reactor which would represent a transitional stage. This involves improving the safety and productivity parameters of the pressurised water reactors which make up the greater part of Europe's present nuclear energy capability.

This project is known by the acronym EPR – European Pressurised Water Reactor. It was proposed back in 1992 by the two major European players in the nuclear sector at the time: Framatome of France and Siemens of Germany (today merged under Framatome ANP). Apart from a rethought and reinforced conception of safety – based in particular on standards rendering impossible the kind of failures recorded at the time of the 'reference accidents' of the past – the EPR seeks to boost the performance of this 'traditional' design substantially. Its nominal power would be increased to almost 1.5 GWe, giving it an electricity generating capacity which is unequalled today.

This increased efficiency would mean a reduction of almost 10% in the kilowatt-hour produced. The reactor's life expectancy would be 50 years or more. Finally, the EPR project is designed to consume a very large proportion of MOX fuels, re-using much of the plutonium which results from the fission by combining it with uranium.

Controversial debate

In October 2003, French Industry Minister Nicole Fontaine announced that her government was tending towards a positive decision for the EPR solution. Supporters of the project took the view that this switch to the third-generation reactor would meet an anticipated demand for the renewal and extension of the nuclear market in the short term, in



emerging countries (such as China) as well as Europe. At the end of 2003, the Finnish operator TPO – mandated by its government which is currently the only one in the Union to have decided to increase its present capacity of four reactors – came out clearly in favour of the EPR and placed a first firm order worth € 3 billion with the Arena⁽¹⁾-Siemens consortium.

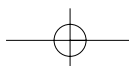
However, France itself has not yet made the final decision on implementing the EPR, which remains a subject of controversy. Apart from the expected opposition from the anti-nuclear campaigners, there is also some criticism from industrialists and supporters of nuclear energy who would like to see more innovative reactors. Its detractors see the thinking behind the EPR (conceived a decade ago) as simply a continuation of existing technologies. Although improved, they would be insufficiently revised, in their view, in particular in terms of reduced waste production.

The fourth generation looms

Other innovative alternatives are, in fact, already beginning to take shape. This brings us to the world of the *fourth generation* and a vast field of research aimed at developing, within the next 15 to 20 years, radically new concepts which would correct the weak points of present reactors – notably in terms of a better use of fuel and a reduction in waste – while offering increased safety and lower production costs.

Research undertaken so far in this field has focused on improving the **fusion** process itself, in particular its use of 'rapid neutrons' which had been

(1) Framatome subsidiary.



abandoned (see box). Work is also continuing on **fuel** composition, by including a maximum proportion of fuel recycled at the production site. Another focus of research is the transport of the energy produced by new **coolants** – gases, liquid metal and molten salts rather than water. A gas coolant makes it possible to use the direct cycle (electricity generation without passing through a secondary circuit) which increases output.

Fourth-generation systems also promise a substantial increase in operating **temperatures**, from the present 300°C in pressurised water reactors to 850°C. In thermodynamic terms, this temperature increase would make it possible to achieve a 50% yield in the conversion of heat into electricity.

At these levels, nuclear power plants can become sources of co-generation. The associated heat production would then be used in industrial processes. It is also believed that the heat produced by coastal power plants could be used for the large-scale development of sea-water desalination. If temperatures could climb to 900°C, for example, the heat recovered would be able to produce large quantities of hydrogen by means of the thermochemical cracking of the water. Hydrogen is particularly interesting for generating energy using fuel cells with zero greenhouse gas emissions.

Europe between fission...

Where does Europe lie in this nuclear future? Time and competing technologies are both determining factors.

With a solid base after almost 50 years of activity, the electronuclear sector must compete with other energies. It is therefore up to the industry itself to manage its continued activity autonomously in the short term of around 30 years. European support for research is limited to a shared interest, first in the issue of waste management and, to a lesser extent, in the monitoring of satisfactory and coordinated safety measures.

On the other hand, Europe is involved in certain projects with a view to the 'fourth-generation' technology. Euratom, under the Fifth Framework Programme 1998-2002, lent its support to the Michelangelo⁽²⁾ thematic network. Launched in 2001, this brings together a major group of industrialists and scientists and has set itself the mission of defining a strategy for keeping open the option of fission nuclear energy in 21st century Europe.

(2) Michelangelo Network - Competitiveness and sustainability of nuclear energy in the EU.

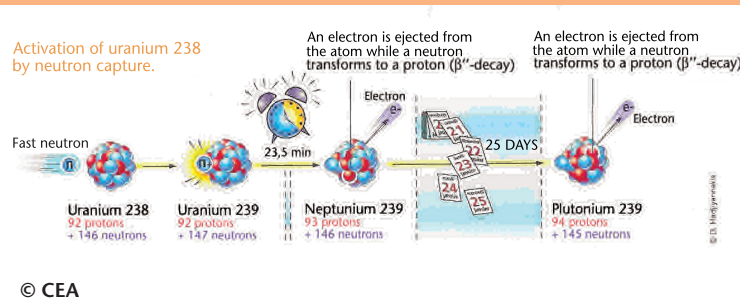


Fast neutrons versus slow ones

Nuclear technologies generally use uranium 238 (described as fertile) as fuel. This is collected in the natural state and then pre-enriched with isotope 235. It is this isotope, representing about 3% of the content, which produces the fission reactions when bombarded with thermal neutrons, so-called slow neutrons. Approximately 1% of uranium 238 captures neutrons to produce plutonium 239, which is also a fissile material (see diagram). When it leaves the power plants, the spent fuel therefore contains a large part of uranium and about 1% plutonium.

During reprocessing, the uranium and the plutonium can be industrially separated from the spent fuel and reused to form a fissile mixture known as MOX. However, in thermal neutron plants, the MOX can only be recycled two or three times. Consequently, in this type of reactor it is only possible to use a small part of the nuclear fuels involved.

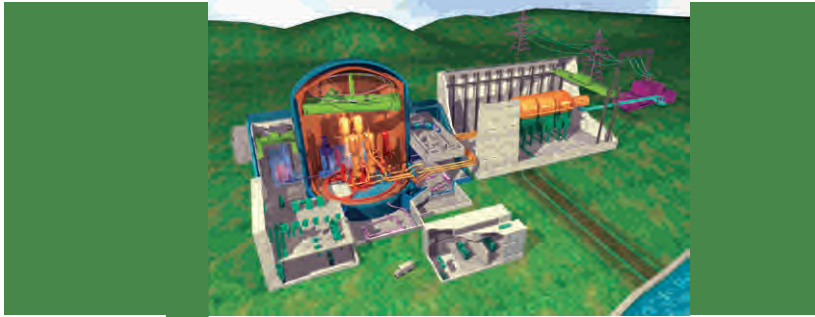
Bombarding fissile materials with higher energy neutrons, known as fast neutrons, is an alternative. This permits better fission of the plutonium and increases the capture of neutrons by the fertile uranium 238 present in the fuel to convert it into plutonium 239.



The 1970s brought a major development in fast neutron technology, with the concept of breeder reactor. These were presented as machines which produced more fuel than they used. Nevertheless, the development of this technology has encountered fierce opposition as plutonium 239 is also one of the raw materials used for nuclear weapons.

The breeder reactor built at Kalkar (Germany) has never been used. Apart from the experimental Phénix reactor at Marcoule, that is still suitable for service, France tried to make large-scale use of its Superphénix reactor at Creys-Malville. The experience did not produce convincing results and the reactor was shut down after two decades in 1997.

Following a radical reappraisal, fast neutron technology, which is very interesting in terms of minimising waste, could again find favour in the context of fourth-generation reactors.



Plan for a prototype third-generation EPR plant: increased safety levels; substantial improvements in performance permitting an almost 10% reduction in the kilowatt-hour; nominal power increased to almost 1.5Gwe (a generating capacity unmatched to date); increased recycling and thus reduced waste; and a life expectancy of at least 50 years.

Research activities are also supported in the framework of four of the concepts adopted by the Generation IV Forum (see box): the HTR (High-Temperature Reactor), the fast gas-cooled reactor, the super-critical water reactor and the molten salt reactor). Another project is looking at seawater desalination. Calls for proposals for research on fourth generation reactors are continuing under the Sixth Framework Programme (FP6) 2002-2006.

...and fusion

The much longer-term prospect – at least 50 years ahead – offered by **thermonuclear fusion**, is very different. Control of this means of energy production, which involves harnessing the high-energy reactions at work within the sun and other active stars, would bring an unprecedented revolution in the history of mankind and remove any doubts about future energy supplies.

In the last few decades, the Commission has already invested several billion euro of EU funds – € 750 million under FP6 – with a view to the long-term realisation of this ambitious and strategic project. It is also the subject of active international co-operation by the United States, Japan, Russia, China and Korea.

Thanks to these efforts, Europe is today a leading partner in this joint research that is now entering a crucial stage: the construction, now firmly approved, of the first demonstration reactor, known as ITER. After a lengthy selection process, in November 2003 the Union chose to submit as sole European candidate the research centre at Cadarache, in France, as home for the ITER. The participants met in Washington a month later but did not manage to make a final choice between the Union site and the only other remaining candidate, the RokkashoMure site in Japan. The decision is expected in February 2004.

To find out more

- On Europa
europa.eu.int/comm/energy/nuclear/index_en.html
europa.eu.int/comm/energy/nuclear/doc/brusselsfdemay2002.pdf
- Generation IV
www.world-nuclear.org/info/printable_information_papers/inf77print.htm
www-cad.cea.fr/fr/dossiers/electronucleaire/index.htm
- EPR
www.edf.fr/html/en/decouvertes/voyage/nucleaire/d13p/nucleaire-epr.html
- HTR cluster
ie.jrc.cec.eu.int/htr-tn/ECS2002/Hugon_563.pdf
- Fusion on Europa
europa.eu.int/comm/research/energy/fu/fu_en.html
- ITER site
www.iter.org

To find out more

- gen-iv.ne.doe.gov

The International Generation IV Forum

Founded on the initiative of the US Department of Energy (DoE), this forum for research and reflection includes ten member countries – Argentina, Brazil, Canada, France, Japan, South Korea, South Africa, Switzerland, the United Kingdom, the United States – plus the European Commission. Its aim is to explore the possible future of the electronuclear sector through to 2030. Initial research has identified six systems⁽¹⁾ which meet the stated requirements in terms of sustainability (especially the drastic reduction of waste), economy, safety and security (non-proliferation and protection against terrorism).

Research and development in these new fields is consequently at the start-up stage. A co-operative effort is now required to coordinate the work of the partners and to specify the conditions for the sharing of information and intellectual property. For its part, the Commission is supporting a number of research projects and a European exploratory network.

(1) SFR: sodium-cooled fast reactor; LFR: lead-cooled fast reactor; VHTR: very high temperature gas-cooled thermal reactor; GFR: gas-cooled fast reactor; SCWR: supercritical water-cooled reactor; MSR: molten salt reactor.

Taking the pollution out of health care

'The attention paid to date by governments and scientists to the impact of pharmaceutical products on the environment can be described as weak or negligible.' That is the verdict of Professor Roberto Andreozzi (University of Naples 'Federico II'), chemist, expert on oxidation, and coordinator of one of the three European research projects in the Pharma Cluster. The aim of this research is to make a detailed study of the toxicity of the principal persistent molecules found in waste of medicinal⁽¹⁾ – or para-medicinal – origin, and to propose effective treatment solutions.

More than 3 000 pharmaceutical substances are used in the Union. A recent survey estimated that more than 100 tonnes of prescription drugs are issued every year in Germany alone. European consumption of antibiotics (used widely in veterinary medicine) is on the same scale as the production of certain pesticides – several thousand tonnes a year. Yet, unlike many other molecules which are commercially available, pharmaceuticals are designed specifically to have biological effects. They are often persistent and lipophilic, properties which aggravate their polluting potential.

Antibiotics: cautious optimism

Launched in 2000,⁽²⁾ the three research projects included in the Pharma Cluster are looking at the three main facets of the problem of waste of medicinal origin. The Eravmis project is concentrating on the impact of veterinary antibiotics. 'With production running at over 5 000 tonnes a year in Europe, these are by far the most widely used molecules,' explains project coordinator Alistair Boxall of the Cranfield Centre for Eco Chemistry (UK). The research has focused on three major antibiotics, members of the tetracycline, macrolide and sulphonamide families. 'Along with our Dutch, Danish and Spanish partners, we had already acquired expertise in studying and detecting these substances, but this European co-operation has made it possible to draw on a pool of skills not possible at national level,' stresses the project coordinator.

Eravmis tested the migration of these three classes of antibiotics into soils and groundwater, as well as their life expectancy in these environments. Researchers studied what happens to their metabolites and their impact on various families of living organisms – bacteria, of course, but also algae, aquatic plants, worms, freshwater invertebrates and fish cell

(1) The results of these studies will form the basis for regulations under the Reach legislative initiative. Proposed by the Commission, this aims to regulate the impact of chemical products on the environment (see In brief, page 27).

(2) The key action Sustainable management and quality of water under the Fifth Framework Programme.

lines. So, what did they find? Apart from aquatic plants, which proved sensitive to sulphonamides (whose structure is similar to certain pesticides), it is only bacteria that react to the concentrations generally found in the environment. As these products are, in fact, designed mainly to combat bacteria, this is hardly surprising. For other living organisms, the first effects are only found at concentrations above 1 mg/kg. Even the most contaminated sites studied scarcely reached half this concentration.

Although a reassuring result, a word of caution must be sounded. 'Much remains to be done,' reports Boxall. 'Our studies were over short periods – three weeks at the most – and we know that some of these molecules remain in the environment for months. And as farm animals are treated regularly with antibiotics, some environments are subject to continuous exposure, the effects of which require further investigation.'



A number of parameters affect the effectiveness of water treatment plants, such as the nature of the products, time spent at the plant, slurry activation, etc. A European study carried out in four countries revealed the presence of various pharmaceutical agents at the plant outlet points.



'Post-treatment' analysis

The Rempharmawater project looked at the impact of a wide range of human medicines at a key stage, i.e. the point of exit from sewage treatment plants. With the exception of accidental pollution or special cases, pharmaceutical products enter the environment after passing through the human body. They are present in the urine and faeces which enter the purification networks before ending up in the aquatic environment or being spread as slurry on the land. An initial study of the pharmaceutical molecules present at these sewage plant outlets was carried out in the four project partner countries (Italy, France, Greece and Sweden). The effectiveness of the treatment was shown to be highly variable with very different results, depending on the nature of the products, time spent at the plant, slurry activation, etc.

'In the effluent analysed we recorded the presence of 26 pharmaceutical agents belonging to six therapeutic classes: antibiotics, beta blockers, antiseptics, anti-inflammatories and lipid regulators,' explains project coordinator Roberto Andreozzi of the University of Naples 'Federico II'. The researchers then scrutinised the behaviour of six of the most common such products: carbamazepine, clofibrac acid, diclofenac, sulfamethoxazole, ofloxacin, and propranolol.⁽³⁾ Having established their half-life (the time required for half their molecules to break down



Around 140 000 tonnes of shampoo enter the water cycle every year in Germany alone. Soap, bubble baths and other PPCPs – pharmaceuticals and personal care products – also have an environmental impact which researchers are beginning to study very seriously.

From identification to risk analysis

To find out more

- Site with reports on the Envirpharma conference
www.envirpharma.org/

Contact

- Jeanne Garric, Cemagref (FR)
jeanne.garric@cemagref.fr

The Envirpharma conference – organised in Lyons (FR) in April 2003 by Cemagref, a partner in the Rempharmawater project – took initial stock of the Pharma Cluster results. 'To date we have identified many substances which we know enter the environment,' explained Jeanne Garric (Cemagref). 'But we

know little about their impact. We must develop the biological tools to carry out a genuine risk analysis, especially at very low doses.'

Scientists must also look at the problem of mixes, as none of the molecules identified is present in isolation. Antibiotics, for example, are often administered directly in the form of a 'cocktail' by a veterinary surgeon. In the natural environment, pharmaceutical products are also present alongside pesticides and other compounds likely to reinforce or alter their action, create synergies, etc. Although these are not easy processes to study, this is a vital area of research which has been earmarked for funding under the Sixth Framework Programme.

naturally) in the laboratory they found themselves facing some very worrying results: for the first two compounds, this half-life was 1 712 and 600 days respectively – or almost five years in the case of carbamazepine. 'Although tests carried out on algae, fish and invertebrates showed that these products generally only produce an effect at concentrations higher than those found in the environment, it must be stressed that such tests, especially those using algae, are not able to reproduce the real conditions of their potential activity. Additional research and evaluations are therefore needed to define the risks posed by these molecules, as well as by other similar products.'

There is one note of optimism, however. The researchers also made an evaluation of how this pharmaceutical residue behaved when exposed to the latest treatment, in particular exposure to powerful oxidants such as ozone or hydrogen peroxide. To do so, they concocted a concentrated cocktail of their six molecules, subjected it to oxidation, then administered it to the alga *S. Leopolensis*, known to be particularly sensitive to pollutants. The alga showed no adverse affects, indicating that such treatment effectively combats toxicity.

Kind to body and environment

Poseidon,⁽⁴⁾ the third project in the cluster, concentrated on studying the different water treatment technologies currently available. This involved scrutinising the results achieved in the case of pollution by both medicines and by pharmaceutical and personal care products – PPCPs

(3) The principal prescriptions for these products are as follows: carbamazepine: epilepsy; clofibrac acid: anticholesterol; diclofenac: anti-inflammatory; sulfamethoxazole: antibiotic; ofloxacin: urogenital infections; and propranolol: Parkinson's disease.

(4) Poseidon brought together eight partners in Germany (2), Switzerland, Austria, Finland, France, Spain and Poland.

for short. The latter – with over 8 000 preparations currently available over the counter at shops across Europe – represent a huge volume, with 140 000 tonnes of shampoo products alone entering the water cycle every year in Germany.

Thomas Ternes of the Bundesanstalt für Gewässerkunde (BfG – Koblenz, DE), the project coordinator, explains that 'we have identified many possible avenues for improvement. In some cases, we can collect and treat urine separately, considerably reducing contamination at the treatment plant outlet. Also, simply increasing the retention time, by using modern waste-water

treatments, makes it possible to effectively eliminate all the hormones. Finally, if ozonation is added to these methods, all pharmaceutical products are rendered biologically inactive, at least as far as we can detect at present.'

As regards drinking water, Poseidon has served to establish that we have the technology (active carbon filtration, nanofiltration, oxidation) to eliminate all the products studied – although at a price, of course. Researchers recommend creating an ecological label as an incentive to industrialists to make available products which are kindest to the ecosystem.

To find out more/Contacts

- Eravmis project (Environmental risk assessment of veterinary medicines in slurry)
www.silsoe.cranfield.ac.uk/ecochemistry/research/project/evkt1-ct.htm
Alistair Boxall, Cranfield Centre for Eco Chemistry (UK)
a.boxall@cranfield.ac.uk
- Rempharmawater project (Ecological assessments and removal technologies for pharmaceuticals in wastewaters)
cds.unina.it/%7Ermarotta/
Roberto Andreozzi, University of Naples "Federico II" (IT)
randreoz@unina.it
- POSEIDON project (Assessment of Technologies for the Removal of Pharmaceuticals and Personal Care Products in Sewage and Drinking Water Facilities to Improve the Indirect Potable Water Reuse)
www.eu-poseidon.com/
Thomas Ternes, ESWE (DE)
ternes@bafg.de
- European Commission
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kirsi.haavisto@cec.eu.int

Veterinary products: the need to investigate

Although antibiotics are the most commonly used molecules in veterinary care, they are not necessarily the most active. A number of European studies have stressed the worrying impact of certain anthelmintics (vermifuges) which contaminate the environment through animal excrement. 'Laboratory tests show that these substances are toxic at low concentrations,' stresses Alistair Boxall. 'Research is necessary to assess their real impact in the environment.'

An article that appeared in the journal *Environmental Science and Technology*, published in connection with the Eravmis project, in co-operation with a US researcher, reviews the current state of knowledge on this question. The authors give a long list of other suspect veterinary products, especially antifungals, hormones, growth promoters, anaesthetics, and anti-coccidiosis drugs.

To find out more

- The article can be downloaded free of charge at:
pubs.acs.org/



Spreading the knowledge

An important function of the coming together of the Eravmis, Rempharmawater and Poseidon projects under the umbrella of the Pharma Cluster is to permit the exchange of data collected and the dissemination of the research results. The Commission is supporting this ambition through a new project called Triton. This aims to communicate new knowledge about product toxicity and technologies to clean up pollution to young PhDs and doctors active in this area. In this way it will also contribute to the harmonisation of practices at European level.

Triton offers seminars and intensive distance training modules on analytical chemistry, the evaluation and management of environmental risks, and advanced technology for water treatment, organised by five university centres (FI, DE, ES, PL, AU).

To find out more/Contact

- www.tut.fi/units/ymp/bio/en/board/triton.htm
- Tuula Tuhkanen, Tampere University of Technology (FI)
tuula.tuhkanen@tut.fi

Ice seasons

A number of multidisciplinary teams are currently engaged in the study of polar regions, knowledge of which is vital to understanding climate change. One of these explorers of this icy world is the German oceanographer Ursula Schauer. A slightly built woman with unquestionable scientific and moral authority, she confronts the unknown with remarkable calmness. Whether as mission leader or researcher on a specific project, she spends months at a time on-board her old friend, the *Polarstern* icebreaker.

'At first, I was simply fascinated by the sciences. Growing up in Berlin, the marine environment was not familiar to me. Perhaps it was a taste for the contradictory that caused me to be attracted to oceanography. It really was a very exotic subject.'

After studying the Baltic Sea bight off Kiel, Ursula Schauer became one of Germany's first women physical oceanographers. She remembers raising a few eyebrows during the first 10 years of her career, but never had the feeling her gender worked against her. 'Provided there is an understanding environment, the researcher's life can become a collective adventure. My family follows all my trips, checking where I am every day. When she was small, my daughter thought the *Polarstern* was my boat,' she confesses.

In fact the *Polarstern* belongs to the Alfred Wegener Institute for Marine and Polar Research located in Bremerhaven, northern Germany. Rarely at the quayside, this icebreaker spends most of the year sailing the polar seas, usually the Arctic waters in summer and the Antarctic waters in northern winter. Ursula Schauer, a researcher with 13 years' polar experience, generally leaves with the ship every other year, on missions lasting from several weeks to several months.

Attraction of the Poles

Her attraction to the Poles was not immediate. As a student at Kiel, Ursula was content with day trips on the Baltic Sea and the chance to observe the exchanges between the Baltic and North Sea waters. Later, during her first contract with the German Hydrographic Institute in Hamburg, she analysed the conditions for conserving radioactive waste dumped at sea. This is when she learned how to measure deep-sea micro-currents – as well as the importance of international contacts. 'I remember a violent storm that forced us to seek shelter in the Faeroe Isles. A number of other vessels had done the same thing. It was a very special opportunity to meet researchers from all over the world,' she recalls.

After this applied science phase she signed a contract with the Institute for Marine Research at Hamburg University. It is there that she was to discover the Far North, while studying convection currents in the Greenland Sea. It proved a revelation. What is more, her boss appointed her as mission leader. 'I was astounded. I did not know the boat, the peo-

ple or the problem. But I told myself that if he thinks I can do it, it means I must be capable. I started to read all the literature on polar seas while I was on board. I wanted to make it a success.' Mission accomplished! At the end of 1989 she was offered a permanent post at Bremerhaven. Since then the Poles have determined the rhythm of her life.

Polarstern village

Ursula Schauer knows the *Polarstern* as if she had built it herself. She can explain the reason for every cable, every nut and bolt, every measuring instrument. Everything in fact that goes to make up a unique vessel, from its technical characteristics as a particularly powerful and manoeuvrable icebreaker to its nine scientific laboratories equipped with many devices, some of them submersible. 'Each immersed instrument has an electrical connection six thousand metres long. You can imagine the mechanical stress on the cables, the importance of the rolling out and rolling in operations. Of course, each system also has a back-up to avoid breakdown. The boat also has its own workshop on the lower deck able to make just about anything that may be needed,' Ursula explains. There are no fewer than seven decks on this icebreaker able to carry, with complete autonomy, up to 50 scientists and 40 crew on missions lasting several months – plus the two helicopters!

This floating village is also a science village. Each expedition is multidisciplinary and multilingual. 'Polar research is essentially international. We need the best experts from many disciplines – biology, geology, geophysics, glaciology, chemistry, oceanography, meteorology, etc. It is often the nature of the overall programme that indicates who should be appointed as scientific manager.' Of her seven scientific missions on the *Polarstern*, Ursula Schauer has headed three.

On these trips, she cannot be involved in a specific research project. 'Leading a mission requires constant attention. You have to reconcile the objectives of all the teams, plan the stations so that everyone can gather data, keep in mind the technical constraints and also deal with the most commonplace practical problems,' she says. 'I will never forget my surprise, during my first trip as mission leader, when I realised that everyone was counting on me to decide who would be sharing a cabin with who. I didn't know most of them, but it was up to me to decide.'



Depending on whether she sets sail as a researcher or chief scientist, the trip is very different. Ursula Schauer likes them both. While often working on very advanced research projects, she also has the global vision enabling her to include different approaches within a common perspective.

Water, ice and climate

'For a long time oceanography, as well as the study of polar regions, were quite *static* branches. By that, I mean that the temperature and salinity of deep waters were believed to be constant, to the point where they were used as references for calibrating instruments. Today, we know that these are changing parameters, as are ocean currents and ice thickness. They are a part of the varying climate,' she notes.

Conditions in the polar oceans are closely linked to the atmosphere. The key question is to determine to what extent changes are natural and to what extent they could be the result of increased greenhouse gases. For this, we must compile and test models, Ursula explains. 'The reality is complex and we can only grasp parts of it. In meteorology – the very short-term study of climate – we have quite good models based on the initial state of the atmosphere that provide forecasts on how it will develop. If we want to progress to climatic modelling, we must also include the state of polar ice and of the oceans because these interact with the atmosphere. But our knowledge of these is still poor.'

The first task of research is therefore to gather data on the state and flows in the vast reservoirs made up of water and ice. Observation is the starting point for modelling. Science is now beginning to realise how

surface phenomena, such as wind and temperature, interact with the ocean depths to a much greater degree than previously thought.

Cruise in the dark

Ursula Schauer's last mission was in the winter of 2003, not in the waters of the Antarctic, as would be expected for the season, but in the Arctic. 'I was appointed scientific director of this mission because I initiated it. At first, it was not easy convincing the scientific committee that selects the projects, but other teams backed us and we finally won approval. We knew the trip would take place under relatively difficult conditions because the ice would be thicker and therefore progress slower at that time of year. In fact this caused us to cancel part of the programme. The data collected are nevertheless exciting and many researchers would like to go for further winter expeditions.'

Important processes of water-air-ice exchange, such as the formation of the Arctic ice pack, take place in winter rather than in summer and we have nearly no observations of them. The formation of ice also affects water salinity. Salt increases significantly the density of the surface water that descends to the ocean depths, thereby giving rise to major convective currents which do not exist in summer. It is therefore essential to also record observations of polar regions in this season too, Ursula stresses. One thing is certain, the *Polarstern* was not designed for a quiet life. ●

To find out more

- Alfred-Wegener Institute
www.awi-bremerhaven.de/index-e.html
- Ursula Schauer
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The class of 2003

This first wave of calls for proposals (published between December 2002 and May 2003) received a budget of some € 5 billion or nearly 30% of the total budget of € 17.5 billion available for the period 2002-2006. The European research players certainly responded in strength to this initial invitation under the Sixth Framework Programme (FP6): the Commission received more than 11 600 replies involving more than 100 000 cross-border research teams. These partnerships not only included teams from the enlarged European Union – the accession/candidate countries were represented in 40% of the projects submitted – but also from some 25 other countries whose teams were active in almost one-fifth of the proposals.

New instruments put to the test

The calls covered all the fields envisaged by FP6. Excluding the 4 720 applications for support granted by the Union in the field of the Marie Curie Actions, as well as the replies to various categories of specific aid⁽¹⁾, the proposals related to 4 630 research projects involving 70 000 participants within the FP6 thematic priorities.

Many of them – between a third and a half depending on the sectors – were for ‘traditional’ projects (Specific Targeted Research Projects (STREP) and Coordination Actions), as well as Specific Support Actions (SSA).

However – and it is here that the results of this first call for proposals under FP6 were so eagerly awaited – the interest shown in the new instruments, namely the Integrated Projects (IP)⁽²⁾ and Networks of Excellence (NoE), was undeniable.

Integrated Projects: € 1.3 billion

For six of the priority themes,⁽³⁾ 104 IPs were selected, representing a total financial participation by the Union of almost € 1 240 million. *Genomics and health* (38 projects receiving a total of € 359 million for 853 participants), and *Nanosciences, materials and production processes* (14 projects, € 192 million, 448 participants) led the field in terms of size.

A closer look at the critical mass achieved by the IPs, as regards Community participation and financing, shows that the highest levels were achieved by *Aeronautics and space* (eight projects with 43 participants on average and an average funding request of € 21 million), *Food quality and safety* (six projects – average size 48, average funding € 13 M) and *Transport* (eight projects – average size 30, average funding € 20 M).

The concept of IPs therefore seems to have been well received by European research circles who managed to mobilise bigger teams around better coordinated goals than during previous Framework Programmes.

The process of evaluating and selecting the replies to the first round of calls for proposals issued by the Commission during the first half of 2003 is now complete. As the financing contracts are finalised, we take an initial look at the results, especially for the new instruments – Integrated Projects and Networks of Excellence – deployed for the seven major research priorities

Launching the networks

With a total of 57 Networks of Excellence (NoE) selected for total EU funding of € 540 million, the second of the new instruments got off to a less impressive start. Designed to coordinate and optimise an increased European dynamic in the development of the knowledge society and economy, by their very nature they are more difficult to launch.

Once again, the highest level of participation is found in the fields of *Genomics and health* (15 NoE for a total funding of € 124 M and 616 participants, producing a high average figure of 41 participants per network), and the *Nanosciences, materials and production processes* (17 NoE, € 111 M and 384 participants). A record 183 participants were mobilised by the four research networks selected in the field of *Transport*. In terms of finance, € 188 million was awarded to two NoE in the field of *Aeronautics and space*, bringing together 66 mainly industrial participants.

However, overall, and compared with the involvement in IPs, industrial participation in the networks was somewhat disappointing. The interest shown in this new instrument came predominantly from academic and public research circles.

To find out more

- Catalogue of the IP and NoE selected
europa.eu.int/comm/research/fp6/firstcallresult_en.html

(1) Support for Union policy in the field of prospective scientific and technological studies; international co-operation; co-operation with national research activities; research infrastructures; science and society.

(2) The exact data on IP and NoE in the Information Society Technologies priority are not included in this analysis. In all the categories combined, the call which closed in this field in the first half of 2003 attracted some 1 600 project proposals. The total request for Community funding was over € 6 billion (for an available budget of € 1 billion); 236 projects were finally selected.

(3) 1. *Genomics and health*; 2. *Nanosciences, materials and production processes*; 3. *Aeronautics and space*; 4. *Food quality and safety*; 5. *Sustainable development and global change* (analysed under three sub-priorities: *Energy, Transport, Climate and Ecosystems*); 6. *Citizens and governance*; 7. *Euratom* (nuclear research).

Too much success?

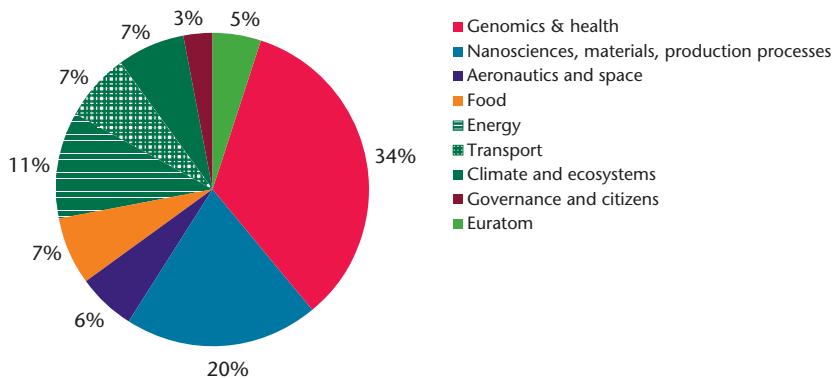
It is a common finding: calls for proposals issued by European research programmes often meet with a considerable over-response. In all the categories combined, the 4 000 research projects or so submitted represented a request for Community funding equal to almost the total available budget for the entire five-year period. Only 700 of these could be selected. Certain sectors are more prone than most to this excessive demand, such as information society technologies (almost 1 600 proposals representing more than 21 000 participants), the nanosciences and production technologies (1 000 proposals and 22 000 partners), the life sciences, sustainable development, and global change.

‘The number and variety of responses to the first calls for proposals are encouraging. They indicate the enthusiasm of researchers and companies and their desire to pool their resources at European level,’ stresses Philippe Busquin, European Commissioner responsible for research. ‘But our budget, however significant it may be, is just 5% of total research spending in Europe.’

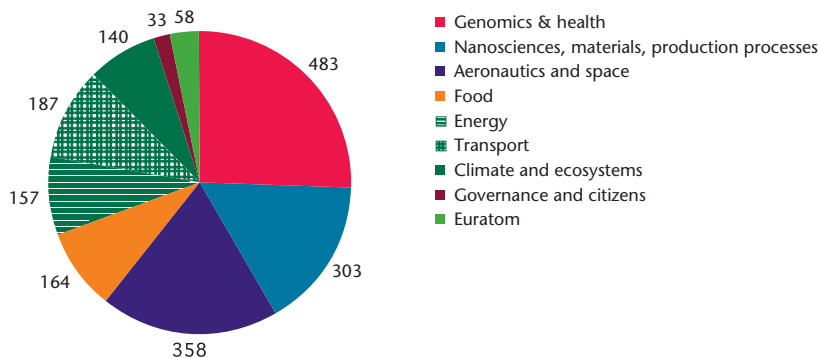
This over-response enables evaluators to select the best and thus provides a guarantee of high quality. On the other hand, it means excluding some good projects, into which a lot of time and money was invested during the preparation – especially in the case of the new instruments. Consequently, Philippe Busquin would like the quality of certain projects – which it was not possible to select – to be highlighted so that they can attract other sources of national or multinational funding.

But are there any other solutions to this over-response? Given the express desire to generate projects with a sufficient critical mass, there can certainly be no question of increasing the number of projects selected by inviting the researchers to make a downward revision of their costs and research ambitions. On the other hand, more ‘focused’ information in the work programmes – which are the basis for calls, as well as two-stage procedures for calls for expressions of interest – and project proposals are certainly ways of avoiding the submission of projects that are insufficiently suited to the programme objectives.

IP & NoE in 2003: breakdown of the 161 projects selected per priority⁽¹⁾
(1) Excluding the Information society technologies priority



IP & NoE in 2003: breakdown of financing of € 1883 million per priority⁽¹⁾
(1) Excluding the Information society technologies priority



IP: Integrated Project
NoE: Network of Excellence

SMEs

Small and medium-sized enterprises represented 17% of the participants and 13% of the financing for the selected projects in the priority research fields. Although many SMEs were partners in the IPs (but much more rarely in the NoE), they tended to be concentrated in the traditional projects (STREP) which have specific ambitions that are more usual. The now tried-and-tested formula of co-operative research (CRAFT) received some 850 proposals involving around 9 000 SMEs.

Overview of calls for proposals

The latest news on the nature, closing dates and indicative budgets of calls for proposals already launched or scheduled for the coming months. For additional specific information on each of these calls, go to the page indicated below on the Europa site which provides direct links to the on-line documents and procedures available on the CORDIS server.

europa.eu.int/comm/research/fp6/calls_en.cfm

Abbreviations used – IP: Integrated Projects – NoE: Networks of Excellence – STREP: Specific Targeted Research Projects – CA: Coordination Actions – SSA: Specific Support Actions – Nd: not determined

CALL IDENTIFIER	RESEARCH FIELDS OR ACTIONS TARGETED	CLOSING DATE	INDICATIVE BUDGET (MILLIONS €)
INTEGRATING AND STRENGTHENING THE EUROPEAN RESEARCH AREA			
Life sciences, genomics and biotechnology for health		rtd-genomics@cec.eu.int	
FP6-2003-LIFESCIHEALTH-3	Thematic call (STREP, SSA): innovative treatment and coordination of action to combat transmissible diseases (HIV, malaria, tuberculosis) and poverty-related diseases	24/03/2004	12
FP-2003-LIFESCIHEALTH-II	Periodic call for the SSA (participation of SMEs – international co-operation – candidate countries – exploitation of results – objectives of the ERA, EU strategy and support for life science policies)	15/04/2004	4
Information society technologies		ist@cec.eu.int	
FP6-2002-IST-C	Future and emerging technologies (FET) – Continuous submission of proposals ⁽¹⁾ : call open until 31 December 2004 <i>(1) see: www.cordis.lu/ist/fet/int-o.htm</i>	31/12/2004	60
Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices		rtd-nmp@cec.eu.int	
FP6-2003-NMP-TI-3-main	Thematic call (particularly: fundamental research; auto-organisation and assembly; molecular motors; characterisation and handling methods; bio-inspired and hybrid materials; nanobiotechnological interfaces; intelligent biomaterials for tissue repair; integration in industrial technologies; measurements and testing; life cycle; effect on health and the environment; ethical aspects and consumer awareness; etc.	12/05/2004	105 ⁽¹⁾
FP6-2003-NMP-STEEL-3	Specialised call in the field of very low CO ₂ emission steel production processes (IP only)	17/03/2004	25 ⁽²⁾
<i>(1) A specific FP6-2003-NMP-TI-3-ncp identifier is set for the CA targeted at an enlarged Europe</i> <i>(2) A budget of € 5 million from the Iron and Steel Research Fund should be added to this amount</i>			
Aeronautics and space		rtd-aerospace@cec.eu.int	
FP6-2003-Aero-1	'Aeronautics' thematic call (particularly: increased competitiveness, noise and emission reductions, safety and security, capacity and safety of air transport system)	31/03/2004 ⁽¹⁾	300
FP6-2003-SPACE-1	'Space' thematic call in the field of GMES (particularly: water resources risk management, atmosphere) and satellite communications (particularly: mobility applications; tele-medicine; distance learning; convergence and integration of space telecommunications with GMES and Galileo)	31/03/2004	60 ⁽²⁾
FP6-2002-Aero-2	'Aeronautics' periodic call for SSA (participation of SMEs – international co-operation – candidate countries – exploitation of results – objectives of the ERA, EU strategy and support for aerospace policy): final closure in March 2006.	31/03/2004 28/09/2004	7
<i>(1) Including € 200 million for the IP and NoE; 100 M€ for STREP and CA</i> <i>(2) Including € 54 million for the IP and NoE</i>			
Food quality and safety		rtd-food@cec.eu.int	
FP6-2003-Food-2-B	Periodic call for the SSA (participation of SMEs, international co-operation, participation of candidate countries, exploitation of results, scientific and organisational management of projects)	29/09/2004	5
Sustainable development, global change and ecosystems		rtd-sustainable@cec.eu.int	
FP6-2002-Transport-2	Periodic call for the SSA (participation of SMEs – international co-operation – candidate countries – exploitation of results – objectives of the ERA, EU strategy and support for policy) in the field of 'Sustainable surface transport': final closure in March 2006	06/04/2004 22/09/2004	5
FP6-2002-Transport-3	Thematic call (clean engines, hydrogen and fuel cell propulsion, noise reduction, light vehicles, vehicle guidance, maritime design, intelligent rail systems, etc.)	06/04/2004	150 ⁽¹⁾
<i>(1) € 105 million of which for IP and NoE</i>			
Horizontal actions for the participation of SMEs		research-sme@cec.eu.int	
FP6-2003-SME-1	Periodic call: co-operative research projects	21/10/2004	75
FP6-2003-SME-2	Periodic call: joint research projects	06/04/2004	41
FP6-2003-SME-3	Periodic call: SSA	06/04/2004	2

News in brief... News in brief...

Action now

In these challenging economic times, the Commission is forever invoking the sacrosanct red line imposed on the budgetary deficits of the Member States. This is to ensure respect for the stability pact that underpins the euro's credibility as a currency. But one percentage can conceal another: 3% is also the official EU target for R&D expenditure – both public and, above all, private – as a proportion of GDP, failing which Europe will ultimately miss out on a sustainable return to growth. This objective is central to the so-called Lisbon strategy, a bold plan launched in 2000 to enable the Union to become the most competitive knowledge-based economy in the world. So how close are we to achieving this ambitious target?



In November 2003, Research Commissioner Philippe Busquin made public the latest key figures for science, technology and innovation, regularly updated by the Commission. Together with the results of a recent survey on the 'brain drain', the data do not provide much cause for optimism.

They show that, in 2000 and 2001, the Union's overall research performance was clearly below that recorded in the latter half of the 1990s. The biggest gap between the United States and Europe was in terms of the resources available for private research. An aggravating factor was that European companies invest more – almost € 5 billion more – in research carried out in the United States than US companies invest in Europe. The Union, in fact, attracted 10% less US research investment than it did a decade earlier.

This shows that the transatlantic gap is widening rather than narrowing, as confirmed by a whole series of indicators – frequency of publications, number of patents registered, trade in high-tech products, etc. A vigorous response is needed, which is now forthcoming at the Union's highest political levels. In April 2003, the EU adopted its "Investing in research" action plan which outlined a path to achieving the 3% target. Not content with having this plan approved by the European Council of October 2003, Commission President Romano Prodi presented the Commission's "Growth initiative" at the same meeting. In addition to the emphasis placed on achieving progress in the pledges made for transport infrastructures, this new strategic leap requested of the Member States places great stress on the need to give priority to major research projects. Specifically, it stipulates that a "Rapid start-up programme" should be launched covering such priority fields as space, nanotechnologies, new generations of lasers, and fuel and hydrogen cells.

This need to revitalise research was also on the agenda at the European Council meeting, held the following month, on ways of improving the status of research careers in Europe (see below). As Busquin stressed: 'No more fine words: it is action we need, and now.'⁽¹⁾

(1) Speaking in similar terms, Education Commissioner Viviane Reding has also sounded a warning that 'the success of the Lisbon strategy hinges on urgent reforms', especially in higher education. See: [http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/03/1520\[0\]RAPID&lg=EN&display=](http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/03/1520[0]RAPID&lg=EN&display=)

To find out more

- Key figures for science, technology and innovation 2003-2004
www.cordis.lu/indicators
- The 3% action plan
<http://europa.eu.int/comm/research/era/3pct>
- Brain-drain
http://europa.eu.int/comm/research/fp6/mariecurie-actions/home_en.html
- Growth initiative
http://europa.eu.int/comm/dgs/policy_advisers/experts_groups/ps2/docs/agenda_en.pdf

One profession, multiple careers

Research is the business of researchers and the 3% target must be accompanied by a vital increase in human resources – an estimated 700 000 researchers over the next few years. In July 2003, the Commission published an important communication entitled "Researchers in the European Research Area: one profession, multiple careers". This document analyses the characteristic features of the profession and the factors which determine the course of a research career at European level (the role and nature of

research training, differences between recruitment methods, contractual and budgetary aspects, assessment methods and prospects for career development). This reveals structural weaknesses as well as significant differences depending on the field of research and the geographical, legal, administrative and cultural environment. These differences, coupled with the obstacles to a cross-border research career, are preventing the emergence of a genuine Community employment market. This situation also has a marked impact on the attractiveness of research careers for young people and the way the general public views researchers. The communication also draws attention to a number of examples of good practice and the initiatives launched in several Member States to reduce the effects of the above-mentioned differences. These various situations are to be investigated further and the Commission is to launch, on a voluntary basis, a series of specific actions aimed at providing better overall coordination of efforts to recognise the profession.

To facilitate mobility within the European Research Area, there are plans to create a 'European researcher card' – and, for non-Community scientists, the equivalent of a 'scientific visa' – that would make it possible to remove a number of obstacles in the areas of social security, taxation, family reunions, etc.

To find out more

- The document can be downloaded from the following site (by entering the references: COM/2003/0436 final)
europa.eu.int/prelex/rech_simple.cfm?CL=en

ef... News in brief... News in brief.

Rewarding team spirit



'The Descartes Prize illustrates how the dynamism and commitment of our researchers should be highlighted,' said Research Commissioner Philippe Busquin at the award ceremony for this prestigious prize in Rome in November. Descartes does not seek to be an EU Nobel Prize. Rather than thrusting individual figures into the spotlight for their remarkable work, it seeks to reward efforts which are central to the European concept of research, such as team work, networking, mutually rewarding co-operation and multidisciplinary.

The award ceremony is the culmination of a year-long process, starting with a call for candidacies launched by the Commission the previous year (for 2004, see www.cordis.lu/descartes). In 2003, 230 teams, representing the work of 900 scientists, responded. Of these, 34 were judged eligible (one in economic science, ten in the life sciences, nine in the fundamental sciences, two in the earth sciences, six in the information sciences, and six in engineering). Women coordinated 17% of the research teams (compared with 13% in 2002) and Central and Eastern European countries participated in more projects than the previous year. Eight teams were nominated for the final stage of the selection process. The Descartes jury – headed by the physicist and mathematician Ene Ergma, Vice-President of the Estonia Academy of Science – then

had the unenviable task of choosing just two prizewinners.

First prize (€ 700 000) went to the "Polymer light-emitting diodes for displays" (Pledd) project, coordinated by Richard Friend of Cambridge University. This multinational team of British, German, Dutch and Swedish researchers from universities and industry developed polymer-based light-emitting diodes which open the door to significant innovations in display technologies. The glass or silicon in screens of all kinds could, for example, be replaced with much cheaper plastic.

The second prize (€ 300 000) went to the Nutation project (with teams from Austria, Belgium, France, Germany, the Czech Republic, Poland, Russia, Spain, and the Ukraine). In tackling the problem posed by the very slight inclination of the Earth's axis as it orbits the Sun (known as nutation), the researchers developed a new model that dramatically improved the precision of satellite positioning and navigation systems, which can now be measured in terms of centimetres rather than metres. This progress could prove of great benefit to space missions and satellite applications, especially in the framework of such major European projects as Galileo and GMES.

To find out more

- <http://www.cordis.lu/science-society/descartes/home.html>
- Pledd: www-oe.phy.cam.ac.uk
- Nutation: www.astro.oma.be

Europe's realpolitik

To find out more

- www.europeansocialsurvey.org
- Contact: Research DG
Virginia Vitorino
virginia.vitorino@cec.eu.int

(Sweden excepted). Many citizens are concerned about immigration, asylum seekers and racial tension. As for the major social issues, most young people seem to have few illusions – or even little hope – that things will get better, although a fair proportion of them sign up for humanitarian and charitable work.

These general trends were revealed in a major survey carried out by the European Commission with the aim of measuring the attitudes and views of Europeans. More than 40 000 interviews were conducted in 22 European countries. The survey aims to provide a set of comparable data every two years. The longer term goal is to be able to analyse the interaction between developments in Europe's political and socio-economic institutions and the civic sensibilities of its citizens.

Europeans do not have great confidence in their politicians and political institutions. The Portuguese, Spanish, Poles, Czechs and Slovenes seem the most sceptical. In countries where voting is not compulsory, the turnout at elections is low, especially among the under-30s

... and Prix Marie Curie, Exercising research mobility

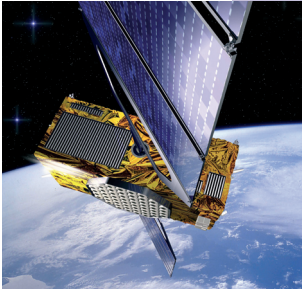
Marie Curie fellowships enable young European researchers (35 000 to date) to pursue their training abroad. Now we have the Marie Curie awards for those who made best use of this mobility opportunity. Some 84 entries (including 23 from women researchers) met the eligibility criteria for the first year of the competition in 2003. Five young researchers with impressive credentials received the accolade last November at a special ceremony in Brussels during European Science Week. Paola Barbara Arimondo from the UK, Daniel Bonn from the Netherlands, Leticia Fernanda Cugliandolo from Argentina, Marco Dorigo from Italy and Luis Serrano Pubull from Spain each won a € 50 000 prize. French physicist H el ene Langevin-Joliot, granddaughter of Marie Curie headed the jury.

To find out more

- Marie Curie Actions
europea.eu.int/comm/research/fp6/mariecurie-actions/home_en.html

News in brief... News in brief...

Europe takes historic step in space



Months of explorations, consultations and debates culminated in the adoption of the White Paper on Space and a multi-annual action plan to act on the good intentions. Then, on 25 November 2003, the EU and the European Space Agency (ESA) signed an historic agreement that lays the operational foundations for closer European co-operation. This accord gives decisive impetus to what is now a clearly defined European space policy, founded on a number of key objectives: guaranteed independent EU access to space and command of the technologies to achieve it; the development of scientific excellence and an assured EU presence in space exploration; more efficient and competitive companies and strengthened human resources in the space sector, especially among young people.

On the basis of this common vision, the new agreement seeks to develop active co-operation between the EU and the ESA – in terms of know-how and infrastructures – on the implementation of the action plan. In the short to medium term, this is of particular relevance to Galileo (satellite navigation) and GMES (environment and security) projects, the development of telecommunications (to close the ‘digital divide’) and European scientific and industrial participation in the international space station.

To find out more

- Text of the agreement
europa.eu.int/comm/space/doc_pdf/agreement_en.pdf
- White Paper on Space
europa.eu.int/comm/space/whitepaper/index_en.html

The science of gender, *She Figures 2003*



Two-fifths of PhDs in the EU are women. They hold 34% of posts in higher education, 31% at public research institutes, and just 15% of private sector research jobs. However, in approximately half of the Member States, just one woman for every ten men reaches the higher echelons of a university career. In eight of the 15 Member

States, and in nine out of the ten candidate countries, women hold less than a quarter of the seats on scientific councils. Although everybody agrees that women are under-represented and under-employed in the research field, this gap is thrown sharply into focus

by the statistics in the “She Figures 2003” report, initiated under the auspices of the Helsinki Group and published by the Commission.

This document provides a genuine reference tool for policy-makers seeking to study European and national trends for highly qualified women (and men). It contains a wealth of statistics, descriptive indicators and explanatory texts relating to the Member States and associated countries. ‘We cannot afford to lose out on this pool of intellectual potential, and we must not stifle diversity in research,’ said Research Commissioner Philippe Busquin.

To find out more

- Download the complete report
europa.eu.int/comm/research/science-society/pdf/she_figures_2003.pdf

Humour

The words which govern us

Politicians and media people, always the centre of attention in our societies, tend to “dumb down” their message. Rather than explaining, they generally prefer to over-simplify, so as to reach – they believe – the greatest number of people. In this context, economists, scientists, lawyers and philosophers find it hard to be heard. On the rare occasions when they do manage to communicate an important notion, then the mass communication experts run it through their mill to reduce the thought to its most simplistic expression. ‘Too complicated, sum it up in 20 seconds!’ Here, in no particular order, is a selection of the kind of principles which govern us. First of all, we have the very amusing ‘precautionary principle’ which, despite its air of scientific caution, could perhaps best be summed up as ‘the less is known, the more notice is taken of it’.

Another favourite of mine is the already hackneyed ‘subsidiarity principle’ that some wags would say consists of ‘letting everyone do badly what they think they can do better than anyone else’. My attention has also been drawn to the very recent dogma of ‘enlargement’ by which it would appear reasonable to ‘try and get 25 to do that which 15 is already too many to do successfully’.

And what about the ‘3% pact’? The term employed by our leaders to allow themselves to ‘exceed a maximum budget deficit of 3% of gross domestic product (GDP)’. Something which must certainly not be confused with the ‘3% commitment’ which causes the very same leaders to ‘make no visible effort to allocate a minimum 3% of GDP to research’.

I also have a soft spot for ‘sustainable development’, which is blithely used on all occasions when speaking of any remotely green subject, as well as its cousin ‘Agenda 21’, very few of whose admirers are aware that it refers to their own action programme for the new century.

In this total confusion of values, notions of minimum, maximum, logic or efficiency no longer mean anything to anybody. Scientific vocations grow rarer, young Europeans dream in their masses of becoming singers, our citizens are unable to count without a calculator... and yet Europe remains in the making. I feel a great sense of satisfaction in thinking that democracy in general, and in Europe in particular, must be exceptionally robust to have withstood, to date, such shoddy treatment.

Candide

ef... News in brief... News in brief...

Avoiding the wrong chemistry

Risk prevention can give rise to complex legislation. There are about 40 European directives and regulations dealing specifically with chemical products. Cumbersome and ill-suited to the potential dangers of already old products, these texts needed to be recast and clarified. In May 2003, the Commission proposed a new system, known as "Reach", for the registration, evaluation and authorisation of the marketing of chemical products. This new regulatory framework makes companies more accountable while streamlining costly and bureaucratic procedures. It aims to provide better protection of human health and the environment, while improving the competitiveness and innovation capacity of European industry.

Reach is an example of participative policy. Last May, the Commission posted a project for this new approach on the Internet so as to gather further comments on its feasibility. The principal contributions came from industrial associations, as well as environmental and animal rights NGOs. Several Member States and third countries expressed their views and many individuals, including those working in the sectors concerned, also gave their opinion.

This feedback resulted in important modifications. Guarantees for the protection of health and the environment have been strengthened and a new more operational system introduced for professionals. Reach is currently awaiting the approval of the European Parliament and Council.

To find out more

- Enterprise DG
europa.eu.int/comm/enterprise/chemicals/chempol/whitepaper/reach.htm
- Environment DG
europa.eu.int/comm/environment/chemicals/whitepaper.htm

AIDS 2003: a devastating year

To find out more

- www.unaids.org/

AIDS is far from beaten. Estimates published by UNAIDS and the World Health Organisation (WHO) in their "AIDS Epidemic Update 2003" report show that last year the disease hit particularly hard, with 3 million deaths and 5 million new cases of infection, bringing to some 40 million the number of people living with the HIV virus worldwide.

Africa – where one in five adults is HIV-positive in the southern part of the continent – is hardest hit. In several Sub-Saharan countries, the mortality rate shows a trend which mirrors that of new infections, highlighting the absence of prevention and treatment programmes. On the other hand, there are wide variations from one country to another: 39% of the population is infected in Botswana and Swaziland but just 1% in Mauritania, while 1% of pregnant women are HIV-positive in Senegal compared with an average of 20% for Africa as a whole.

Outside Africa, 1.5 million people are carrying the virus in Eastern Europe and Central Asia. By the end of 2002, India had 4 million HIV carriers. The report stresses that in China 'serious epidemics have been raging for several years in certain regions'.

Commenting on the figures, South Africa's elder statesman Nelson Mandela said that the AIDS disaster was not just a public health issue but also a human rights one. Today, just 300 000 people have access to AIDS drugs in developing countries. On 1 December 2003, the WHO and UNAIDS launched the "Treat 3 million by 2005 initiative". To support this strategy, the Union is currently developing a set of programmes devoted to AIDS and communicable diseases worth nearly €1 billion, €400 million of which will be through the Commission's Sixth Framework Programme.

Living in a hungrier world

The UN's Food and Agriculture Organisation (FAO) has just published 'The state of food insecurity in the world 2003'. Although hunger declined in the 1990s, the latest figures show that this positive trend is now slowing in some countries, such as China, which had previously recorded marked progress in combating famine.

The UN agency reports that 842 million people were under-nourished in 1999-2001: 10 million in the industrialised countries, 34 million in the transitional economies and 798 million in developing countries. Chronic hunger and AIDS form a lethal alliance. The food crisis in southern Africa, for example, cannot be combated effectively as long as HIV is decimating populations that could be employed in vital food production.

The World Food Summit set itself the aim of halving the number of hungry people by 2015. The programme is targeting action on two fronts: increased agricultural production in rural communities and immediate food aid for famished populations. A broad international consensus and national and regional political support are crucial to success.

To find out more

- www.fao.org/
- www.fao.org/french/newsroom/news/2003/24779-fr.html

Letters

Reflections on the researcher's lot

Reading your issue on the job of the researcher led me to reflect on a number of points. First, there is the effect, no doubt poorly anticipated by the powers that be, of the further internationalisation of research structures. These are now largely organised as networks, especially at European level. This leads to management difficulties, in particular because the traditional hierarchical structure loses its authority.

Another development in research that is not without consequences for its organisation is its tendency to become increasingly multidisciplinary. New forms of dialogue are needed between people from different backgrounds. This can be very fruitful, but it is also a 'centrifugal' force which is difficult to manage at a time of budgetary restrictions. The arrival of archaeology in a crystallography laboratory, for example, is a source of exciting new avenues of inquiry, but also of new conflict. The mandarin, the former 'ayatollah' in his field, loses his scientific authority. He or she must adapt to the interdisciplinarity which implies more collective decisions.

You also raise the question of the relationships between university and industry. For a number of years already, the Rhône-Alpes region where I work has developed financing programmes involving researchers and companies. Practices have developed which function perfectly well, at least in certain fields, such as supraconductivity. It is difficult, however, to launch initiatives in new fields

and to depart from this 'club' of contractual relations. It would be useful to introduce meetings between senior researchers and industrialists with the aim of establishing new links. Although there are such contacts among PhDs and at the level of the scientific supervisory bodies (such as the ministry and the Centre National de la Recherche Scientifique), it is harder to do this at the level of senior researchers working in the field. At this level, there are few opportunities for contacts outside of the major conferences, where one only meets colleagues working in the same area. As to the learned societies, which could play a key role in this connection, they are often too attached to outmoded notions of academia.

In the current context of the clear disengagement of the public sector, with reduced research funds as one of the consequences, it is vital to open up new avenues of financing, such as from the private sector, while ensuring that this support is not directed entirely at final research. This would have the advantage of promoting the practice of explorative research in French and European companies.

Philippe Odier,
director of research, CNRS Grenoble (FR)

Research DG publications



European research area

- RTD info – Special human resources edition **Capitalising on a valuable European asset** – August 2003 – Magazine (also available in French and German)⁽¹⁾ – 40 p. – research@cec.eu.int
- **Instruments of the Sixth Framework Programme** – Leaflet (at present also available in German and Italian) – 14 p. – research@cec.eu.int
- **European Research Advisory Board: Report of activities (2001-2003)** – 20 p. – research@cec.eu.int
- **Research on gender, the environment and sustainable development** – Survey – 205 p. – piia.tuomisto@cec.eu.int
- **Descartes Prize 2003** – Brochure (also available in Italian) – 36 p. – georges.vlandas@cec.eu.int

Life sciences - Health

- **Melanoidins in food and health, vol. 4** – COST 919 – Reports – 204 p. – john-b.williams@cec.eu.int
- **Antimicrobial resistance research** – 1999-2002 – Revised edition. – Project catalogue – 183 p. – anna.lonnroth@cec.eu.int
- **Telemedicine Glossary (Concepts, Technologies, Standards and Use)** – 5th edition – 2003 – Working document – 1276 p. – luciano.beolchi@cec.eu.int

Environment

- **The EU-US scientific initiative on harmful algal blooms** – Report – 57 p. – elizabeth.lipiatou@cec.eu.int
- **Measurements of environmental radioactivity and calculation of the population dose: Ispra site 2002** – Brochure 36 p. – jrc-publications-office@cec.eu.int

Energy

- **Energy: issues, options and technologies – European Opinion Research Group** – Report – 124p. – research@cec.eu.int
- **New ERA for electricity in Europe** – Brochure – 27 p. – rt-d-energy@cec.eu.int
- **Hydrogen energy and fuel cells - A vision of our future** – Report – 33 p. – rt-d-energy@cec.eu.int
- **Renewable energy technologies and Kyoto Protocol mechanisms** – Study – 60 p. – rt-d-energy@cec.eu.int
- **Key Action 5 - Cleaner energy systems, including renewables – External Advisory Group** – Report – 30 p. – ciaran.mangan@cec.eu.int
- **Annual monitoring report on the RTD activities conducted under the EC and Euratom research Framework Programmes** – Report – 111 p. – birgit.de-boissezon@cec.eu.int

- **A thematic network on gas issues in safety assessment of deep repositories for radioactive waste (Gasnet)** – Report – 48 p. – rt-d- Euratom@cec.eu.int

Industrial technologies

- **Historical atlas of Europe's mining areas** – COST G2 (2 vols) – Atlas – anna.danti@cec.eu.int
- **Improvement of buildings' structural quality by new technologies** – COST C12 – Report – 225 p. – ilias.samaras@cec.eu.int

International co-operation

- **INCO in the Sixth Framework Programme (2002-2006)** – Leaflet – 15 p. – inco@cec.eu.int
- **Impact assessment report on the specific programme - 4th FP (1994-1998)** – Report and summary – 249 p. and 15 p. – inco@cec.eu.int
- **A worldwide vision for European research - Perspectives in International Co-operation in Science and Technology** – Brochure – 54 p. – inco@cec.eu.int

European research in action

Themes recently published and available in the 11 EU languages as part of the series of leaflets intended for the 'general public' (format: 6 pages) edited by the Research DG. research@cec.eu.int

- Resistance to antibiotics
- Research
- Biodiversity
- Nanotechnologies
- Aeronautics
- Global monitoring for environmental security

These leaflets (particularly those published at an earlier date) may also be downloaded at the following site:

europa.eu.int/comm/research/leaflets/index_en.html

From Eurostat and Eur-Op

- **Science and technology - Statistical pocketbook** – Data 1991-2001 – 84 p. – €10 – Eurostat, reference KS-43-03-500-EN-C – online.eur-op.eu.int/
- **Communication in the candidate countries** – Data 1995-2001 – CD-ROM – EUR-OP reference: KS-53-03-871-3A-Z – publications.eu.int/general/en/publications_en.htm

⁽¹⁾ also in Spanish on the Web page: europa.eu.int/comm/research/rt-dinfo/index_es.html

Agenda

European notebook

- **European Business Summit (EBS) – Research and Innovation: A European strategy for more growth and jobs** – 11-12/03/2004 – Brussels (BE) – www.ebsummit.org/
- **2nd International Symposium of Electrical, Electronic and Computer Engineering** – 11-13/03/2004 – Nicosia (CY) – neu-cee2004.neu.edu.tr/
- **HEAT 2004 – Domestic technologies** – 16-17/03/2004 – York (UK) – www.smarthinking.ukideas.com/Heat.html
- **IADIS 2004– International Conference on Applied Computing** – 23-26/03/2004 – Lisbon (PT) – www.iadis.org/ac2004/
- **VEGETATION 2004: International Users' Conference** – 24-26/03/2004 – Antwerp (BE) – www.vgt.vito.be/vgtapen/pages/home.htm
- **EURADWASTE '04: Symposium on the management of nuclear waste – Organised by the Joint Research Centre** – 29-31/03/2004 – Luxembourg (LU) – ftp://ftp.cordis.lu/pub/fp6-euratom/docs/ev_euradwaste_2004_fr.pdf
- **11th European Tech Investment Forum** – 30-31/03/2004 – London (UK) – www.e-unlimited.com/
- **Ecology Without Frontiers: Environmental Challenges Across Europe** – 5-7/04/2004 – Exeter (UK) – www.britishecologicalsociety.org/
- **Geriatrics 2004 – Elderly Health Congress** – 7/04/2004 – Antalya (Turkey) – www.geriatri.org/en/purpose.php
- **World Congress on Public Health – Sustaining Public Health in a Changing World** – 19-22/04/04 – Brighton (UK) – www.phaworldcongress.com/

Knowledge Europe in 2020 –

A vision for university-based research and innovation



Held under the auspices of the EU's Science and Society programme, this conference will draw conclusions from the wide-ranging consultation with actors from universities throughout the European research area. 26-28/04/04 – Liège (BE)

europa.eu.int/comm/research/conferences/2004/univ/index_en.html

- **EuroOCEAN 2004: Conference on Marine Science and Ocean Technology** – Held under the Irish Presidency of the European Union – 10-13 May 2004 – Galway (IE) – www.euroocean2004.com

- **CRIS 2004 - International conference on current research information systems – Putting the Sparkle in the Information Society** – 13-15/05/2004 – Antwerp (BE) – www.eurocris.org/conferences/cris2004/index.html
- **IMS Forum 2004: Intelligent Engineering Systems** – 17-19/05/2004 – Cernobbio (IT) – www.imsforum2004.org
- **British Allergy Week** – 17-21/05/2004 – UK
- **Urban Transport 2004 – Tenth International Conference on Urban Transport and the Environment in the 21st Century** – 19-21/05/04 – Dresden (DE) – www.wessex.ac.uk/conferences/2004/urbantransport04/index.html
- **Annual Meeting on Nuclear Technology 2004** – 25-27/05/2004 – Dusseldorf (DE) – www.jahrestagung-kerntechnik.de/
- **8th Congress of the International Society for Musculoskeletal Shockwave Therapy** – 29/05/-1/06/2004 – Vienna (AU) – www.ismst.com/

- **World Bioenergy 2004 – 'Taking you from Know-How to Show-How'** – 2/06/2004 – Jonkoping (SE) – www.elmia.se/worldbioenergy/
- **About Internationalisation – Cultures, Actors, Organisations, Machines** – Organised by the Société Française des Sciences de l'Information et de la Communication – 3-5/06/04 – Istanbul (TU) – congres.sfsic.org/
- **Object - Excavation - Intervention: Dialogues between Sculpture and Archaeology** – Organised by The Henry Moore Foundation – 4-5/06/2004 – Leeds – UK – www.henry-moore-fdn.co.uk/site/thesite/institutep/index.html
- **ALLC/ACH 2004 – Computing and Multilingual, Multicultural Heritage** – Organised by the Association for Literary and Linguistic Computing and the Association for Computers and the Humanities – 16/06/2004 – Gothenburg (SE) – www.hum.gu.se/allcach2004/
- **Fourth European Conference 'Promoting Workplace Health'** – 14-15/06/2004 – Dublin (IE) – www.whpdublin2004.org/
- **International Conference on Groundwater Vulnerability Assessment and Mapping** – 16/06/2004 – Ustro_ (PL) – khgi.wnoz.us.edu.pl/vulnerability.htm
- **Fourth Ministerial Conference on Environment and Health – 'The future for our children'** – Organised by the WHO, Regional Bureau Europe – 24-28/06/2004 – Budapest (HU) – www.who.dk/eprise/main/WHO/Progs/BUD/Home
- **IST Mobile & Wireless Communication** – 27-30/06/2004 – Lyons (FR) – www.mobilesummit2004.org/
- **INPC2004 – International Nuclear Physics Conference** – 27/06/-2/07/ 2004 – Gothenburg (SE) – www.fy.chalmers.se/conferences/inpc2004/
- **EACR 18 – 18th Meeting of the European Association for Cancer Research** – 3-6/7/2004 – Innsbruck (AU) – www.fecs.be/conferences/eacr18/index.shtml

- **Thinking beyond tomorrow: a safe and nutritional food chain for the consumer** – Conference organised by the Irish Presidency of the Union – 17-18/06/2004 – University College Dublin (IE) – www.foodchain2004.com/home.html

- **ECMLG 2004 – Conference on IS Management, Leadership and Governance** – 1-2/07/2004 – Reading (UK) – www.academic-conferences.org/ecmlg2004/2-ecmlg2004-home.htm

International Notebook

- **Science and Humanities – Conference organised by the University of Kogakuin (JA) and the University of Limerick (IE)** – 9-11/03/2004 – Tokyo (Japan)
- **EuroIndia 2004 – Cooperation Forum on the Information Society** – 24-26/03/2004 – New Delhi (India) – www.euroindia2004.org/
- **18th World Conference on Health Promotion and Health Education** – 26-30/04/2004 – Melbourne (Australia) – www.health2004.com.au/
- **IFFS, 18th World Congress on Fertility and Sterility** – 23-28/05/2004 – Montreal (Canada) – www.iffs2004.com/
- **15th International AIDS Conference** – 11-16/07/2004 – Bangkok (TH) – www.aids2004.org/

Discovering... Competing... Investigating

Special focus



Discovering your ecological footprint...

Imagine you are Robinson Crusoe. How big must your island be for your sustainable survival – to meet all your needs in terms of food, energy, building materials, clean air, drinking water and waste disposal? The answer involves your ecological footprint. If your lifestyle places too much pressure on the area available (for example, by lighting large camp fires every night to help ease your loneliness), your longer-term survival could be threatened. The ecological footprint is a measure, expressed in hectares, that promotes awareness of man's exploitation of nature's resources, whether individually or collectively. By filling in a questionnaire on the Internet, an individual can determine his or her

own footprint on the basis of their consumption and the resources needed to meet it. The result is then displayed and set against the national average. This personal measurement helps you to appreciate how small, daily gestures can avoid placing what is ultimately an unsustainable burden on the environment. Switching off lights, turning down the heating a couple of degrees, opting for public transport or a bicycle, not producing excessive quantities of food that are then thrown away... it all helps!

The Americans – who top the consumption league – currently need ten hectares per person, the Italians four, and the Indians less than one. Today, nature is able to offer approximately 1.9 hectares of bioproductive space per inhabitant. By 2050, when the global population looks set to reach 9 billion, the figure will have fallen to 1.2.

According to the WWF (World Wide Fund for Nature) report *Living Planet 2002*, in 1999 the global footprint was already 20% above the earth's biological capacity, following an 80% increase between 1961 and 1999. Over approximately the

same period (1970-2000), biodiversity shrank considerably: populations fell by 15% for land species, 35% for marine species, and 54% for freshwater species. If the needs of industrial countries continue to grow at current rates, we will soon require at least two extra planets able to provide the same wealth of resources as the Earth.

The Ecological Footprint Network coordinates the efforts of teams and groups all over the world who are interested in the ecological footprint, but who do not always use the same methods of calculation. In particular, the network is endeavouring to achieve harmonised accounts of natural assets and to define standards for assessing ecological viability.

Calculate your footprint
www.myfootprint.org

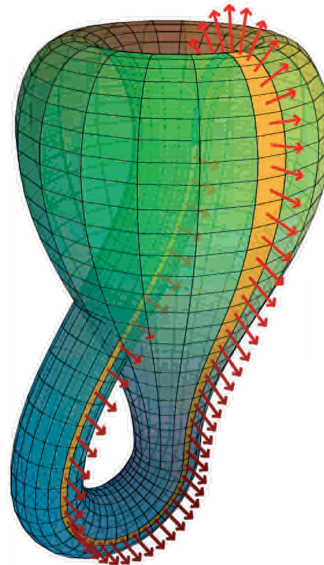
To find out more
www.ecofoot.net

+Plus: beauty and pleasure of the maths

Boring? Maths? How wrong you are... exclaim the experts who have just launched the virtual magazine *+Plus*. Their hope is to encourage those who found maths a 'turn-off' to turn back on again and to present this aesthetically appealing, fun and creative subject as a second chance. Published five times a year, their magazine fully exploits the many creative and educational possibilities offered by the Internet. Clear, well presented, easy to use, interesting and entertaining, *+Plus* seeks to demonstrate to a wide public (from beginners to devotees) that maths is not what you think it is'.

For example, the researcher Marcus du Sautoy analyses the number 23 displayed on the shirt of the Real Madrid player (British footballer David Beckham) in a discussion on chance and numbers, while Chris Budd, lecturer at Bath University, presents the chaos theory by talking about such mundane examples as the relationships between urban population growth and management of living space.

+Plus is a participant in the Millennium Mathematics Project, a British initiative launched by Cambridge University. However, the vocation is



international, and one of the contributors is Konrad Polthier from Berlin's Technical University. This expert on imaging explains mathematical phenomena, with the aid of computer images which lend the magazine an undeniably aesthetic appeal. In its latest issue, readers can discover how the strange Klein Bottle and Möbius Band are such intriguing shapes that they can be applied to themselves. All in all, *+Plus* offers a fascinating and painless way of exploring abstract notions, following the experts, and setting out to track down mathematical solutions.

To find out more

- www.plus.maths.org/
- Plus@maths.cam.ac.uk

Investigating.. Reflecting.. Learning.. Discovering..

Three exhibitions

What kind of climate are we creating?

Climax, Cité des sciences et de l'Industrie, Paris (FR) – 31.08.04

To find out more

- http://www.cite-sciences.fr/english/ala_cite/expo/tempo/planete/portail/glp.html
- www.cite-sciences.fr

At this 'exhibition-simulation' on climate change the visitor can 'experience' possible climates of the future on Earth by forecasting different scenarios. For example, possible limits on greenhouse gas emissions into the atmosphere are presented to visitors by using a series of images projected through 360°. This is followed by the

'Forum of opinions' where you can listen in to interviews with leading experts from Europe and the US. The final part of the exhibition is a simulated game where the visitor is invited to take the controls of a virtual earth management machine and can see the results displayed on giant screens. Everyone can choose their own scenario – a tripling of the number of cars on the road in China, reforestation of Northern Europe, development of sustainable energy in the USA, etc. When you enter the data, the game calculates in real time the CO₂ concentration and its consequences for the climate 50, 100 or 200 years into the future.

The exhibition is translated into English and Spanish and the Cité site is opening a special 'Managing the planet' portal presenting a wealth of information on the climate and sustainable development.



The age of aviation

Die Gebrüder Wright und der Beginn des Motorflugs, Deutsches Museum, Munich (DE) – 14.11.04

Photographs, early flying machines, and contemporary accounts are combined at this exhibition – of particular fascination for children – relating the era of the Wright brothers, Wilbur and Orville, designers of the first motor-propelled aircraft, *Flyer-I*, which took off from a beach in North Carolina on 17 December 1903. This biplane had two wooden propellers but no wheels, simply sliding over the ground. Chains provided the transmission system for the propellers and the pilot lay on his front beneath the wing, alongside the engine. After four years of determined effort, the *Flyer-I* finally made its maiden flight, but not before the Wright brothers had built the first wind tunnel in the United States where they tested more than 200 wing profiles. An era that began with an initial 12-second flight culminated in some impressive performances at the beginning of the century. In 1905, *Flyer-II* was able to remain airborne for over half an hour, flying at a speed of over 60 km/hr – a lesson in resourcefulness and tenacity.

To find out more

- www.deutsches-museum.de
- www.deutsches-museum.de/ausstell/sonder/motorflu.htm

What use are flies?

CreepyCrawly, Heureka, The Finnish Science Center, Vantaa (FI) – 12.09.04



This family exhibition that even the organisers describe as 'an experience' immerses the visitor

in the invisible and sometimes ghoulish world of the insects that live all around us. They are discovered in a fun way by means of the 'Reduction Machine'. Young visitors can, for example, see themselves reduced to the size

of an insect and print out a genuine postcard depicting them on this Lilliputian scale. There are also answers to those very logical questions children love so much, such as 'How much waste do mites have to absorb in one year?' and 'What use are flies?'

To find out more

- www.heureka.fi/portal/englanti/
- info@heureka.fi

The brain and its mysteries

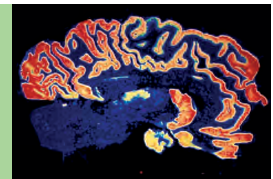
With a volume roughly equivalent to that of a milk carton, the brain contains 100 billion neurones, each of which can make up to 10 000 connections. This impressive construction holds the key to the very essence of our being – and destroys it when it goes wrong. Parkinson's disease, migraine, epilepsy, schizophrenia, anxiety, depression, Alzheimer's disease and multiple sclerosis are all the result of diseases of the nervous system. But research is making headway. Medical imaging is making it possible to pinpoint exactly where the brain is affected, molecular biology is helping us to understand how some of the nerve cells operate, genetics has identified the hereditary component of various neurological diseases, and new treatments are now being made available.

The European Dana Alliance for the Brain (EDAB), a group of researchers and specialists currently comprising 120 participants from 24 countries, has set up an Internet site to keep the general public informed on progress concerning our knowledge of the brain and research in neuroscience. Visitors can consult a range of documents, all easy to understand, on the 'major questions' posed by this (still) mysterious organ – What are the characteristics of nerve cells? How is information channelled through our body? How to 'find your way' around the topology of the brain, and how does the brain develop? The association's journal *Eurobrain* features articles on more 'common' problems such as depression, dependency, memory, and sleep disturbance.

This multilingual site (English, French, German, Italian) also includes a number of links – in particular to patient associations and the families of sufferers.

To find out more

- www.edab.net/



Researchers on th

Fishermen have long observed the behaviour of tuna fish, even benefiting from it to make bigger catches. Scientists working on the Fadio project have now drawn inspiration from their methods for other purposes. Sophisticated equipment, tailor-made for their needs, should make it possible to study the mysterious behaviour of these fish, estimate their population and movements, and find out more about their role within the marine ecosystem – and the potential dangers they face.

A thick branch is floating in the middle of the Indian Ocean – it may have been spewed out by a Madagascan river in flood or torn from a tree in cyclone-hit Tanzania. It has been adrift for weeks. Scientists on the Fadio project have just discovered it and are excitedly preparing to launch an armada of instruments and sensors as this apparently insignificant branch has attracted several thousand tuna fish.

Researchers are interested in the behaviour of this emblematic fish, an athletic hunter and tireless migrator, able to swim across entire oceans. The interest is partly due to its economic importance, but above all to its ecological role. At the head of the food chain, this large predator plays a key role in the pelagic ecosystem.⁽¹⁾ Given the extent to which it is fished, any indications that can help estimate population size are very valuable.

The behaviour of tuna fish is in itself a fascinating mystery, central to which is the notion of the school. Tuna – and most of their pelagic relatives, and even much smaller species such as anchovies and sardines – regularly come together in schools. Are these concentrations linked to food, reproduction, predatory behaviour or orientation? How long do they last, and how often do they occur? What environmental factors (temperature, available food, potential dangers) play a part in the creation, expansion or dispersal of these schools? Pertinent questions every one, but questions to which we have few answers.

Encouraging schooling

It is not easy trying to monitor the behaviour of the tuna fish which has a long life and is highly mobile, disappearing from view and then resurfacing at the other side of the ocean, where you least expect it. But one aspect of its behaviour does help the researcher: its tendency to collect around floating objects. This can be a piece of wood, rope, a tyre, or even a simple coconut. Whatever the particular nature of the object, for the scientist it is an FAD or Fish Aggregating Device, acting as a magnet by attracting fish in sometimes impressive numbers.

The phenomenon has not escaped the attention of fishermen who, after making use of natural FADs, decided to manufacture their own. There are many such buoys anchored around the islands of the Pacific, the Atlantic and the Indian Oceans, generally used by local populations for subsistence. But there are also hundreds of 'drifting' buoys deposited in the open sea by seiners, huge industrial fishing vessels using nets some 1 600 metres long and 200 metres deep in which they try to entrap the

schools of tuna fish. Today, more than half of tropical tuna fish caught worldwide (3.8 million tonnes a year) are caught with the aid of an FAD.

The primary aim of the Fadio researchers is to manage and conserve the natural environment – and that means understanding how it works. They are also looking at possible ways of using these FADs as windows through which to observe the pelagic ecosystem. Attracting concentrations of fish in the way they do, they provide ideal 'observatories' for studying this otherwise very elusive fauna. But to do so means having the equipment to be able to observe what is happening below the surface.

High-tech and customised FADs

Fadio therefore set about designing and making special FADs, packed full of instruments so as to collect the maximum information. Buoys with simple vertical sounders already exist. 'This type of device, which is quite easy to use, has one drawback,' explains Laurent Dagorn, project coordinator. 'It gives little information about the tuna fish themselves because

they have the unfortunate habit of not liking to swim beneath the FAD, preferring to remain alongside it.' The sounder is nevertheless essential for understanding the fauna composition, especially the smaller fish which are the tuna's natural prey.



The first mission by the Fadio project to the Seychelles – fitting an echo sounder to the exterior of the vessel.

© IRD/C. Girard

the buoy, and thus details of the number of tuna fish present, the depth at which they are swimming and perhaps even the specific species and size. 'With a horizontal beam, you collect more complex data requiring more sophisticated software to interpret them,' continues Dagorn. 'There are also setting-up problems to be solved. The engineers who prepare the equipment must know, for example, whether it is better to observe at 300, 500 or 800 metres to capture 80% of the biomass. Compromises must be made, as the further you look, the more energy is needed.'

on the high seas

Group dolphin fishes - Indian Ocean
©Bertrand Wendling

These buoys, which are genuine technological marvels, will also be equipped with hydrophones to record sounds (an important source of information) and a listening station with which to read the data supplied by the 'tags' that the researchers have fitted to some fish.

Benefits of tagging

Tags are small transmitters either attached to the tuna fish or surgically placed in its abdominal cavity. They give information on a particular fish and are the logical complement to the sonar which provides information on group behaviour. These tags not only indicate the presence of a fish of a particular origin, but also the depth and temperature of the water it is swimming in. Fadio is also trying to develop new sensors able to indicate if the tagged fish has an empty or full stomach, is alone or is a member of a group.

As one of the pioneers of this system, Kim Holland, of the University of Hawaii, has unrivalled know-how. Holland's university is closely involved in the Fadio project and, together with the Institut de Recherche pour le Développement (FR), was the only institution for many years to show an interest in tuna fish behaviour around FADs. It has its own large pool where it is possible to study these animals in captivity.

Together, all these instruments should make it possible to build up a valuable fund of information on tuna fish behaviour. The Fadio project is concentrating on instrumentation for drifting buoys, while the University of

Hawaii is working with anchored buoys. Collecting the data is not the only problem, however. The information must be stored for subsequent retrieval, while the various instruments also need a power supply. Whatever the solution finally adopted from among the many possibilities, it would no doubt

be preferable not to have all the instruments operating continuously but only at the time of the most significant events. It will be for the researchers to try and identify these periods. We know, for example, that many small pelagic fish form schools during the day and then disperse at night. If tuna fish do the same, nocturnal data collection would not yield a result.

Co-operating with the fishermen

Fadio's first sea mission was designed to travel to the study zone off the Seychelles, find the FADs, test and calibrate the equipment and establish contact with the fishermen. 'We did not exactly expect a hostile reception,' points out the coordinator, 'but we were surprised by the readiness with which the fishermen were prepared to help us. They told us where to find their buoys which, in their business, is obviously information



Example of a Fish Aggregating Device (FAD). Made from wood and bamboo, this 'floating object' is able to attract fish in impressive numbers sometimes.

©IMR/L.Nottestad



To find out more

- www.fadio.ird.fr/
- dagorn@ird.fr

that must be very jealously guarded. It augurs well for the future as we will no doubt soon be asking anyone who finds one of our buoys to collect it so we can retrieve the information.'

The contact was helped by the presence of French and Spanish fishermen in the team – the two principal nationalities of fishermen in this zone. Greek, Belgian and Norwegian scientists are also working on the project, each contributing specific skills. 'We are working, for example, with a team from the University of Las Palmas, in the Canary Islands, that is specialised in remote detection,' explains Dagorn. 'In fact, we need precise satellite information on the zones where our FADs will be located. We need as much data as possible on the environment around the buoys (temperature, quantity of plankton, etc.) because if any one of them indicates a change in behaviour we must try and find out if there is an environmental explanation.'

Understanding how and at what distance fish locate FADs (perhaps from 10 km), why and when they form schools, and how their diet influences their behaviour, are all of scientific interest. Beyond that, ultimately Fadio could help provide for the better management of fish stocks and thus pave the way towards a more sustainable fishing. At present, the only real source of information on fish populations is the fishermen themselves. This information is often incomplete and subject to bias. Acoustic data therefore provide an independent and complementary source of information when compiling fish statistics, to enable study of the populations of species fished.

In the longer term, researchers hope that – as the tuna fish reveal their secrets and more instrument buoys are launched – it will be possible to obtain details of population status, their spatial dynamic and other elements, all of which are vital to protecting a bountiful but fragile resource.

(1) Located in surface waters as opposed to the benthic ecosystem on the seabed

Partners in the Fadio project

- Institut de Recherche pour le Développement (FR) – coordinator
- Institut français de recherche pour l'exploitation de la mer (FR)
- Instituto Tecnológico Pesquero y Alimentario (ES)
- Universidad de Las Palmas de Gran Canaria (ES)
- Institute of Marine Research (NO)
- University of Aegean (GR)
- Université Libre de Bruxelles (BE)
- University of Hawaii (USA)
- SERPE-IESM - Société d'Etudes et de Réalisations de Protection Electronique (FR)

Top right, the Skipjack tuna (*Katsuwonus pelamis*, 2-5 kg, 40-50 cm), one of the most common species found around FADs.



Bottom right, the Yellowfin tuna (*Thunnus albacares*, 4-5 kg, 50 cm although sometimes measuring over a metre), which can also be found around floating objects.



© IRD/P.Opic

More selective fishing

Instrument buoys, even if less sophisticated than those developed by the Fadio project, could favour a more sustainable fishing industry. Professionals are faced with the problem of so-called by-catches – fish belonging to species or age groups that they do not want to catch. These are generally thrown back into the sea either dead or in a poor state, adding to the adverse ecological impact of fishing. FADs making it possible to know whether the fish sought are present at a given location before dropping the nets would therefore constitute progress. Such tools could be a by-product of the Fadio project whose partners include an industrialist and a buoy manufacturer.

An 'ecological trap'?

How long do fish remain at buoys? Researchers hope that instrument buoys will give them an answer to a seemingly mundane but in fact crucial question. The seiners deposit FADs which they leave to float for a couple of months before returning to the site. These buoys may function as ecological traps, immobilising the fish for several weeks, during which the fishermen come to reap a rich harvest. Alternatively, the fish may just stop off there for a few hours or perhaps days before continuing on their way. In the latter case, fishing under FADs would pose fewer problems in terms of sustainability.

Data currently available on anchored FADs seem to point towards the most optimistic of the two hypotheses. Scientists succeeded, for example, in tracking one tuna fish which visited three buoys in a single day. But it also seems that some tuna fish stay under the same buoy for a long time. In particular, it is still not known whether a drifting FAD induces the same behaviour as an anchored FAD.

Protecting the 'whistle-blowers'

What can a scientist or engineer, or even a technician, do when faced with a conflict between professional obligations and civic conscience? How can he or she sound the alarm when convinced that certain developments or research pose a potential threat to health, the environment or society? How can a person avoid being sidelined, excluded or even prosecuted for deciding to speak out? In the field of science and technology, the idea of including a conscience clause in international labour law – to protect the 'whistle-blowers' – is gaining ground.

Traditionally, science has had a built-in safeguard in the form of the necessary approval by the scientific community itself of the scientific and technical value of progress in knowledge. Exercised by a mechanism known as peer review, which controls the publication of research results in recognised scientific journals, this self-regulation certainly covers the quality of knowledge and respect for professional practices among researchers.⁽¹⁾ But can it take into account ethical issues related to the impact of research on society?

Under pressure from economic competition, scientific and technological priorities are increasingly being determined by industrial – and military – considerations. Public-funded research is going down the same road, as well as being subjected to budgetary limits. Acknowledging that science is involved in an increasingly complex process of knowledge production and innovation – one largely outside its control and requiring increased vigilance to ensure respect for even the most fundamental principles of precaution – 13 renowned publications (such as *The Lancet* or the *Journal of the American Medical Association*) published a common manifesto in September 2001 setting out their concerns.

The Geneva days

Ethical questions linked to progress in science and technology are today at the heart of many of society's most lively debates. There is a need, however, for these discussions to draw on the expertise of those actually involved in the production of knowledge, who are often best placed to assess the implications. In September 2003, in Geneva, a two-day international seminar was organised by the Association for the Promotion of

(1) The researcher community is increasingly acquiring its own professional policy in the field of self-regulation and the denunciation of 'scientific misconduct' (fraudulent results, plagiarism, etc.). See in particular the compilation drawn up by the European Science Foundation, *Good scientific practice in research and scholarship*. www.esf.org/sciencepolicy/170/ESPBI0.pdf

Scientific Accountable Behaviour (APSAB) and the Fondation Science et Conscience de l'homme (FSC). The theme was the need to provide a genuine legal safety net guaranteeing the right to expression and the absence of reprisals against those whose professional activity causes them to 'blow the whistle' on certain areas of research and development.

Lone voices

But who are these whistle-blowers? Some become whistle-blowers almost inadvertently by circulating validated results on sensitive subjects. For others, the choice is more deliberate: their conscience as both a scientist and a citizen causes them to denounce a potential risk or to pursue a line of research likely to make waves, despite intimidation 'from above'. At some point and to varying degrees they become victims of discrimination or coercion.

Two such researchers came to the meeting in Geneva, held – symbolically – within the walls of the International Labour Organisation, to relate their experiences. One was the British biophysicist of Hungarian origin, Arpad Putzai, suspended from his duties at the Rowett Research Institute (Scotland), in 1998, for having gone on television to express his doubts about the harmlessness of genetically modified apples. The other was André Cicoella, an expert on glycol ethers and the potential health risk posed by these solvents, who was sacked from the *Institut National de Recherche et de Sécurité* (INRS, France) in 1994.

In recent years, more and more members of the scientific community have chosen to speak out in this way. But after a brief period in the media spotlight they often disappear from view. Today, who remembers the militant Russian environmental journalists Alexandre Nikitin and Giorgii Pasko, the Israeli nuclear technician Mordechai Vanunu, the French doctors Jean-Jacques Melet and Jean-François Viel, or the Argentinean eco-toxicologist Guillermo Eguiazu? Often condemned to isolation by the governors or hierarchy of their institution, they lack the legal or legislative instruments to make themselves heard and defend their rights.

Democratic rights

Yet it was as long ago as 1974 that UNESCO adopted a recommendation on the status of scientists, stipulating that: 'The Member States must seek to favour conditions so that researchers, with the support of the



public authorities, shall have the responsibility and the right [...] to express themselves freely on the human, social and ecological value of certain projects, and in the final resort to withdraw from such projects on the grounds of conscience.'

'This text is unfortunately little known,' regrets Bruno de Padirac, head of scientific policy studies at UNESCO (Paris). 'One possibility,' he suggests, 'would be to adopt this recommendation as a basis for drawing up an international convention that would have legal force.' It must also be remembered that one of the missions of UNESCO's Commission on the Ethics of Scientific Knowledge and Technology (COMEST), set up in 1997, is to sound the alarm when necessary.

In Europe, the United Kingdom seems to be the most advanced in this field, with its *Public Interest Disclosure Act*. This legislation applies to all employees, salaried or otherwise, private and public sector, and covers a great many situations – from negligence to health, security or environmental risks. Across the Atlantic, the *Whistleblower Protection Act* applies to public research only. This allows scientists and others to exercise their freedom of expression, even in cases where it is in conflict with other rules, such as confidentiality clauses.

Support groups

A number of NGOs are supporting these whistle-blowers in the campaign for transparency. The International Network of Engineers and Scientists for Global Responsibility (INES), for example, is active in a number of areas but most notably the banning of nuclear weapons and ethical questions. 'On such matters, we try to lend our support to the whistle-blowers and intervened on behalf of the Argentinean Guillermo Eguiazu, for example, a scientist of national and international renown,' explains Armin Tenner, the organisation's president.

After carrying out research on the impact of pesticides and other chemical compounds on agriculture, Eguiazu campaigned for years to have his research results made public in the interests of consumer protection. 'He was subjected to serious intimidation at his university. His laboratory and equipment were destroyed by persons unknown, and his budgets were cut. We have given him financial support and are now looking for a sponsor to provide him with the material means to pursue his research,' continues Tenner.

To find out more

- INES
www.inesglobal.org
- APSAB
www.apsab.span.ch/clc

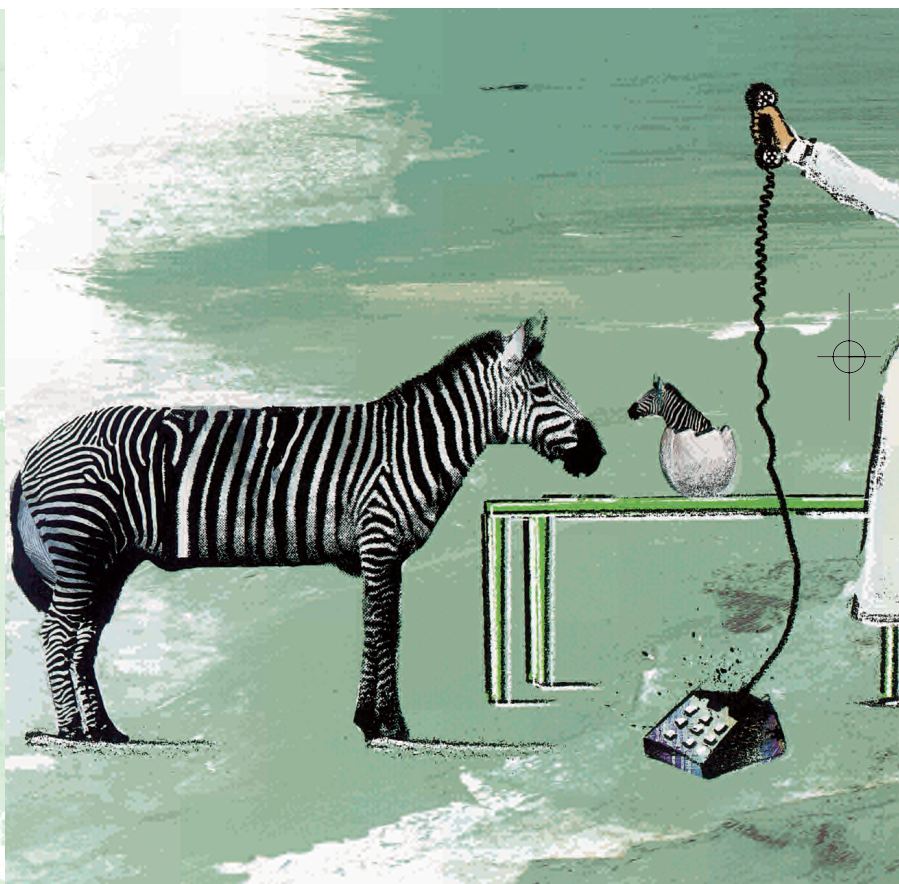
Contacts

- APSAB – Frédéric Piguet
apsab@bluewin.ch
- FSC – Henri-Philippe Sambuc
sambuc@iprolink.ch

A number of world famous scientists have also appealed publicly for their peers to act responsibly. Of particular note is Joseph Rotblat, the British nuclear physicist of Polish origin, co-founder of the Pugwash movement in 1957, and winner of the Nobel Peace Prize in 1995. He stresses the need both to protect the whistle-blowers and to draw up a code of ethics – a kind of Hippocratic oath – that would commit young researchers.

Project on the table

The Geneva seminar looked in particular at the APSAB and FSC proposal to draw up an international convention – under the auspices of the International Labour Organisation – on a so-called active conscience clause,⁽²⁾ applicable specifically to scientists and engineers working in any public or private organisation. The two associations want this project to be discussed in all quarters: with professional and trade union organisations, scientific societies, NGOs and foundations, national, European and international bodies, etc.



(2) That is, giving the right to take voluntary action to draw attention to potential dangers or to condemn certain practices. The passive conscience clause – the right to refuse to perform certain acts – is a legal reality already applicable in many situations, both professional (especially for doctors, psychotherapists, journalists) and individual (refusal to do military service, right to refuse medical treatment).

A conscience clause for science?

The APSAB/FSC project is seeking to be of international legal force. It proposes that the whistle-blower should be able to inform an independent body⁽¹⁾ of any continuous and deliberate activity that violates:

- the principle of precaution;
- public health;
- the environment;
- and • ethical and professional codes regarding scientific research and technological production.

An important point for discussion, called into question in particular by the trade union organisations invited to the debate, is that the conscience clause is limited to scientists and engineers. The APSAB and FSC believe this restriction is necessary because 'the objective is to help regulate key aspects of the system of production. The person who blows the whistle on serious problems should know the ins and outs of the risks involved. An executive without a scientific background who denounces facts because he or she reads in a "confidential" report that serious risks had been proven could find himself or herself in the middle of legal proceedings, face to face with legal experts whose knowledge is far greater than his or her own. This would be disastrous.' Under no circumstances must recourse to the clause be 'polluted' by cases which are essentially 'denouncements' resulting from a conflict – even justified, by abusive social practices, for example – between individuals and their employer.

In practice, the conscience clause project also includes proposals for the effective protection of the whistle-blower (respect for his or her anonymity if the denunciation is clearly not abusive, compensation for any harm suffered as a result of acting) as well as the extension of proceedings against entities responsible for the aforementioned violations if the information proves well founded.

(1) Namely, an independent body in the country in which the headquarters of the organisation or company for which he or she works or the headquarters of the parent company are located.



Ethics at the heart of European research

Although the European Union has not adopted any position on the specific problem posed by the conscience clause, the ethical dimension of progress in science and technology at European level is receiving

increasing attention in the Framework Programmes financed by the EU. Barbara Rhode, head of the unit responsible for 'ethical questions of research and science' at the Research Directorate-General, made the point in Geneva that – in addition to particular attention to sensitive questions raised by the life sciences, such as the use of human embryonic or foetal tissue or the use of animals – ethical evaluation now extends to other fields, in particular sustainable development and international co-operation.

In December 2001, the Commission launched the 'Science and Society action plan' which includes six actions of ethical import. The *Codes of conduct for ethics in research* is also due to be published shortly by the Union, setting out the various codes of conduct adopted by research bodies, in the EU-15, the future Member States and some other countries such as Israel and Turkey. This inventory will make it possible to analyse their similarities and differences with a view to developing a harmonised and coherent European code of conduct for ethics.

To find out more

● europa.eu.int/comm/research/science-society/ethics/ethics_en.html

The Prigogine legacy



Mikhail Gorbachev during a private discussion with Ilya Prigogine in 1991.

Ilya Prigogine, winner of the Nobel Prize for chemistry in 1977⁽¹⁾, died in Brussels last May. He was a lifelong promoter of European science and, to his mind, Europe always included his native Russia. In 1992, he was appointed head of a vast trans-national co-operation programme for scientists. Its work in analysing complex systems continues today and has given rise to 15 projects involving researchers from Moscow, St Petersburg and Dubna.

Ilya Prigogine left Moscow when he was just a young child. He was born there in 1917, the year of the revolution, and immigrated, with his family, to Western Europe in 1921, finally settling in Belgium eight years later. Yet he never forgot Russia – and Russia never forgot him. Elected to the Academy of Sciences and invited many times to give conferences in the USSR, Prigogine developed close contacts with many Soviet scientists. It was, therefore, only natural for the European Commission to turn to him when, in 1992, the Union decided to extend a hand to this far eastern wing of the “European House”. ‘The situation there was terrible,’ remembers Iouri Melnikov, a project manager on one such joint endeavour. ‘Scientists no longer had any support or prospects. Prigogine wanted to help research in Russia, rather than encourage Russians to leave the country. That is why he became actively involved in setting up solid networks to enable them to co-operate with the European Union.’

Order behind the chaos

On the European Commission side, the idea for co-operation with the scientists of the former USSR – with the aim of building on the work of this Nobel prize-winner for chemistry – came from Michel Carpentier, who was in charge of information technology research programmes. He was convinced that Prigogine’s theories on complex systems could lead to developments and applications in many fields⁽²⁾. The latter, for his part, knew that the mathematics and physics of complexity had been the subject of advanced research at a number of Russian schools (Kolmogorov, Gelfand, Fock, Bokoyobov) and that any programme should certainly draw on their knowledge and abilities. It took a one-year pilot phase to identify the partners before the main five-year project phase was launched in 1994.

But what exactly are these complex systems? They are characterised by a state of non-equilibrium and the autonomous creation of information. They are also sometimes called auto-innovative or auto-organised. Whether it is the Earth’s climate or the human brain, the flow of information on the Internet or in any living organism, the entire universe or the New York stock exchange, they are all systems with a common characteristic: they are in part unpredictable and cannot be explained by determinist mathematical principles alone.

‘It was Ilya Prigogine’s genius to be able to recognise the order behind the apparent chaos of all these systems,’ explains project coordinator Ioannis Antoniou, who studied for his PhD under Prigogine, later becoming his close associate and vice-president of the Solvay Institutes in Brussels. ‘Since that day, my own fate has been very closely linked with that of Russia. I have an office at Moscow University, as did Prigogine himself. The impressive results achieved over the past five years cover such a vast field that we can hope to achieve results in many directions.’

‘Behaviour often seems chaotic at the individual level, but if you hit upon the right aggregation of data, marvellous statistical laws are revealed to you, a melody concealed beneath all the noise,’ Antoniou continues. Why? ‘This is because the behaviour of individuals is interdependent and

(1) The prize was for his theory of dissipative structures by which a system far from a state of equilibrium can suddenly become ordered (the living cell for example). Prigogine sheds light on the dynamic of unstable systems and their importance, whereas physics had traditionally concentrated on stability.

(2) After the departure of Michel Carpentier, this idea received the enthusiastic backing of George Metakides.

Europe takes historic step in space

Months of explorations, consultations and debates culminated in the adoption of the White Paper on Space and a multi-annual action plan to act on the good intentions. Then, on 25 November 2003, the EU and the European Space Agency (ESA) signed an historic agreement that lays the operational foundations for closer European co-operation. This accord gives decisive impetus to what is now a clearly defined European space policy, founded on a number of key objectives: guaranteed independent EU access to space and command of the technologies to achieve it; the development of scientific excellence and an assured EU presence in space exploration; more efficient and competitive companies and strengthened human resources in the space sector, especially among young people.

On the basis of this common vision, the new agreement seeks to develop active co-operation between the EU and the ESA – in terms of know-how and infrastructures – on the implementation of the action plan. In the short to medium term, this is of particular relevance to Galileo (satellite navigation) and GMES (environment and security) projects, the development of telecommunications (to close the ‘digital divide’) and European scientific and industrial participation in the international space station.

To find out more

- Text of the agreement
europa.eu.int/comm/space/doc_pdf/agreement_en.pdf
- White Paper on Space
europa.eu.int/comm/space/whitepaper/index_en.html

The science of gender, *She Figures 2003*

