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Human resources

CAPITALISING ON A VALUABLE EUROPEAN ASSET

Research: a vocation •

Pull-out mobility guide •

Universities and enterprises •

Editorial

A European awakening?

Increasing investment in research from 1.9% to 3% of GDP by 2010, as decided by the Member States in Barcelona last year, will mean the creation of around 500 000 research posts a year.

But, apart from the financial aspects, does Europe have sufficient human resources to meet this challenge? In other words, does the Union have the means to realise its ambitions? It is time to take a closer look at the facts.

First of all, let us take a look at higher education. The Union 'produces' proportionally more science and engineering PhDs than the United States – in 2000, 5.6 per 10 000 people aged between 25 and 34, compared with 4.1 in the United States. However, because of a lack of jobs and attractive career prospects, many of them choose to emigrate, either to other countries or other professions. In terms of researchers, the proportions are reversed: 5.4 per 1 000 active members of the population in the Union and 8.7 in the United States. If Europe were able to manage its science and technology graduates as efficiently as the United States, it could double its present total of 920 000 researchers.

Then there is the matter of young people. It is often said that they are giving scientific studies and careers the cold shoulder. Statistically, this is undeniable. However, recent Eurobarometer surveys carried out by the Commission also show that this is not because young people are not interested in science and technology. Their level of interest in these subjects remains above the European average. The sticking point is the teaching – science lessons are seen as unattractive and difficult.

The final positive sign is the presence of women. Taking the EU as a whole, during the period 1990-2000, the number of women students studying science and engineering subjects in higher education increased from 25% to 30%. In 2001, 34% of university researchers were women. However, their absolute numbers have increased by 8% since 1998, compared with a 3% increase in male researchers.

In addition, a number of foreign scientists – especially Asians – opt for Europe when deciding to train outside their country of origin, attracted by the quality of its science as well as its cultural and social environment.

If Europe really wants to give substance to its research policy ambitions, it certainly has the brainpower to meet present challenges. It also has some valuable assets – quantitative and qualitative – to meet those of the future.

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'Let's be proud of our researchers'

Human resources are central to the dynamic of the European Research Area. This is why the Sixth Framework Programme is allocating nearly 10% of its funding to actions which relate directly to them. Commissioner Philippe Busquin sets out his views on the subject.

You stated that, to retain its position, Europe needs an extra 500 000 researchers a year in the medium term. Is this a realistic target?

It is not only realistic, it is vital. Knowledge is our only genuine source of wealth. If we want to retain our position in the world, we need an ambitious research and innovation policy in the face of serious rivals – namely, the United States and Asian countries. This is why Europe must increase the level of investment in research to 3% of GDP and it cannot achieve that without additional 'brains'. Why 3%? Because we know that a quantified target can promote concrete action – the Maastricht criteria demonstrated that. Also, public opinion is beginning to realise that there is a correlation between investment in research and innovation and levels of employment.

The Sixth Framework Programme will allocate €1.58 billion to mobility actions and measures to promote research careers, which is a 50% increase on the previous period. What is the main objective of these actions?

This increase is not without reason. It is inherent in the research activity for researchers to feel the need to be exposed to fresh ideas, and to perfect their knowledge at foreign laboratories or research centres. European research also stands to benefit a great deal from multiculturalism. The Marie Curie actions will enable some 9 000 researchers to work abroad every year and thus to create a new generation who will 'Europeanise research'.

Our aim is for these actions to be seen as a reference point for implementation of the European Research Area and for them to be followed up by similar actions, in particular at Member State level. These initiatives also enable us to identify the obstacles to mobility. For example, recently I met a French researcher who worked in Portugal for a few months and who discovered on his return that he was no longer entitled to unemployment benefit.

So does job insecurity remain a problem of particular concern for researchers?

Most certainly – to combat this we are currently working on a Communication on research careers which should be adopted by the Commission. Rather than defining a European status, it seems to me that it would be better for each Member State to ensure that its researchers benefit from an 'acceptable' status. It is incredible for scientists aged between 30 and 35 to continue to be shunted from one insecure post to another. Europe must create a genuine employment market for its researchers, male and female, irrespective of the field of activity, employer (public or private) or country. Europe must be proud of its researchers – our best researchers must become better known and recognised European figures.

Europe produces more science PhDs than the United States and Japan, but has fewer researchers. This lack of available jobs seems particularly marked in the private sector.

We are counting on companies to meet two-thirds of the investment needed to increase investment in research to 3% of GDP. We therefore need an economic and social environment which is going to motivate firms. But now European companies are focusing more and more on other regions of the world. Although still employing European researchers, they are locating them in other continents. Europe is therefore investing massively in the training and education of its researchers without drawing full benefit from it. This is why a series of objectives designed to make it easier for companies to invest in research, in particular by changing the regulatory framework, are set out in the Communication *Investing in research: an action plan for Europe* which was adopted in April this year.

For more information on this Commission Communication: http://www.europa.eu.int/comm/research/era/3pct/index_en.html

Research:

The life of a researcher resembles that of his research – a constant questioning. A decision to embark on a research career is usually preceded by considerable soul searching. It could be described as a vocation; it is certainly a passion. The path can be tortuous: doctorates, post-doctorates, grants and temporary contracts, promises of permanent posts, uncertainty about which direction to take, stiff competition, the constant search for funds, and projects which ultimately lead nowhere. Add a little luck, a large dose of intuition and imagination, and the picture is complete!

'My parents were teachers. As far back as I can remember, when I was about 10, the idea of being a researcher appealed to me. At career guidance sessions, I remember specifically having mentioned it as something I wanted to do. So, it is a vocation, but one that probably didn't come about accidentally as I come from a background which was culturally but not economically rich,' explains Pablo Achard, a French physicist and post-doctoral researcher at the EU's particle physics laboratory, CERN (Geneva). Research can be described as a vocation – a calling perhaps, something strangely inevitable, with its roots firmly embedded in childhood and confirmed in later life.

Erwan Brugalle, a mathematician and member of Real Algebraic and Analytical Geometry (RAAG), a European research network, prefers to speak of an 'subconscious vocation'. 'I have always been interested in maths for the pleasure and attraction I found in it. Several years of study gave me a pure maths with few employment prospects outside teaching and research. As it was maths for its own sake which fascinated me, I opted for research. It was a way of getting paid for indulging in my passion.'

Just another day at the office

Doctoral researchers are paid – but often very badly. Nevertheless, some countries can seem like genuine 'research havens' in this respect. In Norway, all doctoral candidates receive a subsidy or a grant from their university. In Ireland, anyone working towards a PhD is considered to be a student and receives money from the government or is sponsored by companies. Money is rarely an obstacle. 'A PhD takes three or four years. I see it as a job, that's all,' believes Frances Coughlan, who is in the last year of her PhD in engineering at the University of Limerick (IE). 'A job where I work from eight to five, Mondays to Fridays, and for which I receive a cheque at the end of the month. The danger in seeing research too much as a vocation is that you will allow yourself to become so overwhelmed by the work on your thesis that you never manage to finish it on time.'

But not all those working towards a doctorate enjoy this kind of comfort. In France, those who opt for medical research, for example, have to complete at least eight years of study. Only about one quarter of them receive any financial support (at the legal minimum subsistence level), the others being left to their own devices.

a vocation

What is more, the doctorate is just the first stage. Norbert Babscan, a Hungarian doctor of physics and general secretary of the Postgraduate International Network (PINet), thinks that 'a doctorate should prove, in principle, that someone is able to undertake scientific work alone. But this theoretical ideal is far from being verified in practice. Doing a thesis often amounts to being trained under the supervision of a professor who includes you in a project he is running himself. Under the old Central European system, there was a diploma known as the "candidate researcher", which was not obtained until the age of 40, whereas a traditional and internationally accepted concept of a doctorate is something you obtain in your early thirties.'

Taking the post-doctoral gamble

A doctorate is often just the first step. 'But a doctorate is perfectly sufficient for industry, where younger people are preferred,' points out Florian Berberich, a German physicist and post-doctoral researcher in Grenoble (FR). But those whose calling is research know that a post-doctoral qualification is essential. They also know that it is a highly competitive field with an uncertain future. Universities have few resources and offer few prospects of stable employment, high earnings or a solid career. Rami Olavi Vaino, who lives in Finland – a particularly dynamic country on the research front – sees this in his chosen field of space. 'In physics, astrophysics, and above all astronomy, there are no more than a handful of permanent posts in the entire country. These are held by senior researchers and professors. Meanwhile, the hundreds of young doctorate holders and post-doctoral researchers have to get by on grants and temporary contracts. It is at this stage that the competition is the keenest. Although it acts as a stimulus for excellence, competition also eliminates some very capable young people from the scientific circuit, who finally opt for much more comfortable employment in the private sector.'

So the lot of the young would-be researcher is often a seemingly endless sequence of post-doctoral work. Although national grants make it possible to remain at the same

institution, European grants are generally only for two years. This condemns many researchers to a nomadic existence. 'Research is a passion. It can lead to as much distress as satisfaction,' says Claire Foullon, a specialist in solar physics and astronomy. 'You never stop working, or at least thinking about your work. You are constantly plagued by questions. I sometimes have an idea when out rollerblading or swimming,' says Florian Berberich.

Too much of a good thing

Sports and research have one thing in common: competition. Researchers are familiar with this, accept its rules and do not frown upon it. 'We have to live with competition. It is a way of selecting the best,' says PINet's Babscan. 'A little competition is healthy. It stimulates people to work better,' says Marco Albani, a post-doctoral researcher at Harvard University (USA).

But it is not as simple as that. Although competition between laboratories and universities provides a positive stimulus, rivalry between peers can be damaging. 'Team spirit needs to be more important than the quest for glory and recognition,' believes Véronique Boisvert, a Canadian physicist and post-doctoral researcher at CERN (CH), who completed her doctorate at Cornell University (USA). Team spirit doubtlessly depends on the team leaders and house style. Janette Friedrich, a German philosopher who is head of teaching and research at Geneva University (CH), has seen how competitiveness has evolved over the years. 'I was not aware of much competition when trying to get a grant, or funding for study visits, as at that stage researchers function as individuals who are independent of any institution. But since joining the university, I have observed competition in the form of distrust, the failure to recognise the theoretical opinion of others, and a lack of openness and respect. I have the feeling that this competition is increasing as members of my generation are now beginning to battle for the few university professorships available.'

Yet Claire Foullon, who has worked at universities in Scotland (Glasgow and St. Andrews) and Belgium (KU Leuven), experienced no pressure in academia. 'I left the academic world to join the Belgian Royal Observatory. If I have ever felt the pressure of competition and a "master-pupil" relationship, it is at this public research institute and not before. The project leaders orchestrate the competition within the group and control external co-operation. Profit also exerts as much pressure as in the private sector. This falls short of creating an atmosphere conducive to research.'

The search for funds

Research funds are sometimes in short supply. 'The target of 3% of the Union's GDP allocated to research by 2010 is very ambitious. Unfortunately, some countries, like France, are taking steps in the opposite direction. This is a serious matter as many studies show the correlation between a country's research activity and growth,' stresses Frenchman Alexandre Urani, head of a research project at the Central Institute of Mental Health in Mannheim (DE) and member of Eurodoc, a council for post-graduate students and junior researchers in Europe. 'I am all the more aware of the financing problems faced by public research as I come from the private sector,' explains Michèle Gué, a lecturer and researcher at the Université de Montpellier II (FR). 'When you want to obtain funds to start work on a new research theme, for example, you have to present publications which refer to results. But as you are just starting out, nothing has yet been published. That is the dilemma.'

This sometimes makes it feel like a case of "published or be damned". The quest for funds intensifies the race to get into print. Publishing is clearly important to the progress of knowledge but, under pressure, it can distract the researcher and make him or her focus on the superficial. 'We must be able to resist this pressure. This is crucial if we do not want to sacrifice quality,' urges Friedrich.

The price of liberty

Can money and freedom go together? 'I believe that the real pressure researchers feel in my field comes mainly from the subsidy committees rather than the university or laboratory,' says Véronique Boisvert of CERN. 'Research projects will go ahead if these committees think they warrant funding. Fortunately, there seems to be sufficient leeway within this support framework for a project to take the direction desired by the research team.'

When asked about the pressure an institute exerts on its researchers, Pablo Achard, who also works at CERN, responds with a cryptic physics analogy: 'Is it an electron which creates an electromagnetic field by moving or is it the field of influence of the electron's trajectory? It is both at the same time. One joins a team whose research priorities and means are determined by its evaluators. But we can also participate in these choices and influence them.'

So is freedom of research real, relative or Utopian? Friedrich has a philosophical reply. 'That depends on what you understand by freedom,' she says. 'If it is the freedom to choose the subject and method of research, I think it is real. But if it includes the recognition of differences in research and having in place the conditions to allow all types of research to be carried out, then this is not really the case.'

Doctorates on the increase

There are fewer and fewer science students in Europe. But, paradoxically, those who do take science at university are increasingly likely to go on to study for a PhD.

The countries ahead of the pack in this field are Sweden (1.17 per 1000 inhabitants aged between 25 and 34), Finland (0.97), the United Kingdom (0.78), Germany (0.75), and France (0.71). They are all clearly ahead of the United States (0.47) and Japan (0.24), even if the latter two count more researchers in their workforce as a whole.

These global figures do not, however, take into account specialisations. In Belgium, Denmark, France and the United Kingdom some 20% to 30% of doctoral students are foreign, who do not necessarily remain in Europe. Many Europeans go to the United States to work on their post-doctoral degrees (see article *Drawn to the USA*). Finally, a significant number of doctors leave the scientific world to take up other occupations.

An undying passion

Richard Jacobsson, a Swedish physicist, has been dreaming of research since he was a child. And CERN has fascinated him since he was a teenager. Today he works there, plans to stay and believes passionately in his work.

For me, being a researcher is certainly a vocation. I have always been curious about science and I must have been six years old when I first thought of a research career. The idea was behind everything I did. I was first attracted by astronomy and chemistry before turning to physics – I first contacted CERN when I was 14. Today, I work there, which really is a dream come true. I see this institution as a 'fortress' in combating the ignorance which exists in society and which is such a threat to our future. Fundamental research is at the heart of humanity's boundless curiosity and its results are crucial in the long term.

It is difficult for me to speak of research as a job. It is a continuous learning process and it is that which is so important in enabling an individual to evolve. You are not a researcher because you are an expert in a particular subject but because you know how to ask the right questions which lead to new discoveries.

Being a researcher at CERN is, in fact, a way of benefiting from the advantages of mobility without leaving the premises. It is a global laboratory which offers enormous scope for working in various fields with different people. Words like "national" or "foreign" have no place in particle physics. It is only by combining the efforts of many different countries within multinational infrastructures – like CERN, FermiLab in the United States or KEK in Japan – that we can undertake this research. At the same time, these huge facilities are made up of a multitude of technological components that were designed and built to enable physics institutes all over the world to carry out scientific experiments. The same is true of studying the information produced by this research. A high level of mobility between all the centres of excellence is essential. In addition, I do not believe it is correct to speak of a brain drain to the United States in this field. That is perhaps more true of industrial research.

Curiosity breeds curiosity

Editor of the astrophysics column for the French monthly "La Recherche", Jacques-Olivier Baruch decided to change course after completing his thesis.

Is it strange to leave the world of research for journalism? Not really. Curiosity is a characteristic required for both activities. The big difference is in the subject of inquiry. Scientific journalists probe and try to penetrate the world of research and how it operates, while researchers probe and try to penetrate the world and how it operates.

When I decided to round off my studies with a thesis at the Paris Observatory, I was expecting to perceive all the secrets of the Universe and of the astrophysicists with whom I would be working. I watched with pleasure all my little planets revolving around me and the laboratory of which I was a part, but it remained an essentially cloistered existence.

The offer to help organise the shows at the future planetarium at the Cité des Sciences (Paris) allowed me to pass on to the general public all the information about space which I, myself, found so fascinating. It was a good way of making a living which mixed business with pleasure to the extent that for me they became one and the same thing. But the more I became familiar with the scientific world in all its diversity, the more I realised that there is more to science than knowledge. There must be more to scientific reporting than simply popularising content. The scientific approach, the observation of this closed world and its controversies, of its hierarchies with its excluded and those favoured by political and industrial interests, are all ingredients which enable you to better realise what is really at stake. So it was perfectly natural for my career route to lead me to become a scientific journalist. And in this field a journalist has to be a scientist because you can only get to the bottom of a subject when you have come to understand its many dimensions.

The range of subjects I covered became considerable. I also felt I was contributing to the democratic process by informing the reader about scientific facts. I satisfied my need to tell a small part of the story. Each time a different bit, as each subject must be approached from a different angle, adopting a particular slant on the subject so as to capture the reader's interest and enable him or her to follow the reasoning through to the end. This has to be geared towards a particular media, as well as the appropriate category of readers, listeners or viewers. It is rather like an astrophysicist who looks at all the many sources of light with his different instruments and then tells us about this world he sees through the end of his telescope. Strange, isn't it?

Choosing a mentor

What do doctoral and post-doctoral students think of their mentors? What role do these experienced scientists play in the destiny of budding researchers? 'The choice of supervisor can be important and help determine your chances of success. But it is not the only factor,' says Augusto Palombini, an active member of the ADI (Italian association of doctoral students and researchers). It is an opinion that is sometimes questioned, and often shared. Here is how some others view the situation.

'A good supervisor-student relationship helps you to enjoy your work and is one of the most important factors in making a success of your PhD. This master-pupil relationship gradually evolves into a dialogue between scientists who discuss the results of a project in which they share an interest. This is an essential part of the process towards the intellectual maturity which is essential to the development of genuine and independent scientists.'

Shu-Wang Qiao, immunologist,
doctoral student at the Oslo University Hospital (NO)

'I always had very active relationships with my mentors, in the sense that I tried to contribute to the choice of problems to investigate. In this respect, it was not a master-pupil relationship. This is probably quite typical of young researchers, even if some of them find it more comfortable, at least at the start, for a senior researcher to take important decisions for them.'

Rami Olavi Vainio,
assistant in physical sciences at the University of Turku (FI)

'There are good and bad doctoral supervisors everywhere, some

who use the results of their doctoral students for their own benefit and others who are honest. I would add that they are rarely very skilled when it comes to management. Management skills are not innate and it is perfectly understandable that somebody who is competent in his or her chosen field is not going to excel in everything, such as in HR management. This is why an association of researchers such as Eurodoc proposes that all doctoral supervisors should have certain basic notions in this field.'

Alexandre Urani, manager of a research project at
the Central Institute of Mental Health in Mannheim (DE)

'I believe a bad relationship with the research supervisor can have a lot to do with a student deciding to abandon his or

her doctorate or deciding to leave the academic or research world on completing it. I believe the master-pupil relationship is still very strong at universities. It is less evident in the research world.'

Véronique Boitsvert, physicist,
post-doctorate at CERN (Geneva – CH)

'While working on a doctorate you learn to organise a research subject and to identify other questions. You are not yet independent and you are influenced by your tutors. During a post-doctorate degree, you still have a research supervisor who you discuss things with and who helps you to contact people at the start, but you are completely free in your research. You are no longer a pupil. You take initiatives.'

Florian Berberich, physicist,
post-doctorate at the ESRF (Grenoble - FR)

'I am very indebted to my supervisors in terms of learning and understanding, but I have always been very active and sometimes made very independent choices. I prefer to speak of a mentor rather than supervisor.'

Marco Albani, doctor of forestry sciences,
post-doctorate at Harvard University (USA)

'My doctoral supervisor does not play a decisive role in my work. He is the head of department and, therefore, very busy. I have heard complaints from some of my colleagues that the supervision is not as close as it used to be, that the master-pupil relationship is weakening. Nevertheless, it depends on the situation, the time available to supervisors and how interested they are in the particular research project.'

Frances Coughlan,
doctoral student in engineering at the University of Limerick (IE)

Momentum to

Mobility strengthens the links between laboratories, helps centres of excellence to form and enables researchers to carry out research they may not be able to do at home, exposing them to other cultures and approaches. But mobility has its downside too – when researchers are forced to chase after funding from institution to institution. Nevertheless, who can deny the benefits of human resource mobility? This is why it is at the heart of the Union's new research policy.

Young people are travelling more and doing so earlier in their lives. But they are not taking to the road for pleasure alone. According to the *Strata-Etan*(1) report, there were 1.4 million expatriate students worldwide in 1992, equally split between the human sciences and the exact sciences. Studying abroad is set to rise as a trend, attracting an estimated 3 million students in 2010 and 5 million in 2025. More than three-quarters of expatriate students study in five countries: the United States (34%), the United Kingdom (15%), Germany (13%), France (11%) and Australia (8%). Exchanges between North America and Europe are quite substantian, although the traffic is busier in one direction than the other: 49 000 Europeans cross the Atlantic to study every year compared with 28 000 North Americans making the trip to Europe (for intra-European figures, see the box *Quantifying European mobility*).

One thing leads to another

This initial relocation for university studies often leads to other things. Claire Foullon, who studied earth sciences at the Université de Paris XI, did her master's at Edinburgh University through the EU's Socrates programme. 'As I wanted to continue to study and work in English, which is vital for international research, I took part in a summer project at Glasgow University before beginning my doctorate at St Andrews University.' But Foullon is French and the UK only funds registration fees for foreign students. This prompted her to contact the British Council, the Rotary Club and the Association of Women University Graduates – all to no avail. 'I even tried to start a thesis elsewhere, but in vain because my profile did not match their criteria.' But her perseverance paid off in the end. As the first post-graduate student to be assisted by the EU's Plato exchange network, she is now completing her doctorate at the KULeuven in Belgium – and in English. 'It is thanks to European mobility networks that I was able to complete my thesis.'

Practical matters

Although financing is no doubt the primary problem, every expatriate researcher will also be familiar with the many other practical problems and administrative hassles of settling abroad. An employment contract requires a residence permit which is itself often linked to having an employment contract. Getting visas for family members is quite a struggle too. Information received in the home country is one thing and what you are told in the host country is often something else again. There are endless requests for documents and the cogs of the administrative machine turn frustratingly slowly. There are also the financial considerations of where to pay taxes, how to benefit from social security and how to guarantee pension rights. Social security contributions are often paid in the host country for future benefits one never sees.

On the personal front, it is clearly much simpler if an expatriate researcher is single. Many spouses of doctoral or post-doctoral researchers have difficulties finding a job or even a crèche to free up enough time to look for one. These practical difficulties can lead to partners being forced to live apart, if the researcher's spouse decides to stay behind.

Then there is the language question. One can get by everywhere with English of course, and one of the reasons the United Kingdom attracts so many foreign researchers is because it offers them total language immersion. It takes time, nevertheless, to acquire a perfect command of another language, and that can pose problems. 'In a foreign language, it is difficult to possess all the subtleties of vocabulary enabling me to express my precise thoughts, and thus to be totally understood as I would like,' explains Tony Remans, a Dutch-speaking Belgian biologist working for a doctorate at the INRA (FR).

(1) Strata-Etan expert working group, Human resources in RTD, Final report, 21.08.02 – downloadable document*:*
ftp://ftp.cordis.lu/pub/rtd2002/docs/bench_0802.pdf

move

Opening up new horizons

For students who decide to embark on studies abroad, these difficulties are often of secondary importance. Joining a new research team, the immersion in another culture and the exposure to alternative scientific approaches opens up new and invigorating horizons for those who travel abroad. 'Mobility has its good and bad points, but the advantages certainly outweigh the disadvantages,' believes Pál Venetianer, a professor at the Biological Research Centre in Szeged (HU). 'It is beneficial for the institutions and above all for a country's research performance. For the individuals, that depends. Mobility strengthens the personal development of many of them – probably the best of them.'

If there is general agreement that mobility is on balance beneficial, that leaves the question of where to go. Some do not consider it necessary to cross the border. 'I believe that post-doctoral

(2) Erwan Seznec, Dominique Martin-Rovet and Stéphane Roy, Du brain drain au back drain, Le long chemin des biologistes français présents aux Etats-Unis, CNRS, *May 2002.*

Quantifying European mobility

Nearly 7% of higher education students in the Member States come from foreign countries. Most of the traffic (2.4%) is in the form of inter-Union mobility. Of the remaining 4.6%, 1.7% come from Asia and Oceania, 1% from Africa, 1% from non-EU European countries and fewer than 1% from the United States. The United Kingdom has the highest intake of foreign students (15%), followed by its small neighbour, Belgium (11%), which has a particularly large proportion of African students, mainly from Morocco.

More Greeks (52 825) than nationals from any other Member State travel within the EU to study. They are followed by the French (35 363) and the Germans (34 621). There are also some favoured destinations: the Chinese have a predilection for Finland, the Greeks for England, the citizens of Bosnia and Herzegovina for Denmark, the Turks for Germany, and the Americans for Ireland.

Logically enough, former colonial powers welcome students from their former colonies: Algerians and Moroccans in France, Surinamese in the Netherlands, Congolese in Belgium, and so on.

The 'hard' sciences and technologies attract a large number of foreigners. In 1999, they represented 32% of the total in these branches in the United Kingdom, or more than twice as many as for all the other specialities combined. In France, they account for 5% of master's students and 29% of doctoral students, including a large proportion of North Africans.

training is very beneficial, but I believe it is important to change laboratory and subject, but not necessarily country,' is the view of one French biologist who participated in the CNRS[2] survey.

Humane mobility

Does moving to a new country trigger a fear of the unknown? Not necessarily, but too many changes can be a real problem. 'The uncertainties about the future which mobility can bring and the difficulty of integrating into different environments can be a psychological handicap which causes some to abandon scientific research,' continues Venetianer. Other – particularly senior – scientists also have their reservations. Patrick Echegut, a researcher at the Centre de Recherche sur les Matériaux à Haute Température in Orléans (FR), advocates a 'humane mobility which does not treat individuals as merchandise, and which is beneficial to the researcher and the host laboratory.' He also distinguishes between a form of forced mobility – 'a body of nomadic researchers without status and forced to do their master's bidding' – and a 'desired mobility, which subsequently permits integration into more stable situations, and which should not last too long but be seen as the search for new experience.'

'Mobility for mobility's sake' certainly has its drawbacks. An endless series of post-doctorates, dictated by circumstances (grant, country, laboratory), is not always the answer and there are many who dream of one day being able to settle down. 'Mobility grants are generally rewarding but they can be an obstacle to permanent research posts,' believes Michèle Gué, a lecturer and researcher at the Université de Montpellier II (FR). 'Young people apply for grant after grant as they move from post to post and extend their CV. The danger is also that these researchers, who are at the start of their career, may become intellectually as well as geographically mobile. This could lead to them jumping from grant to grant and not having the time to devote themselves to their chosen research subject. What is more, these young people are often asked to do the work of super technicians and make too little use of their project management and development skills.'

A return ticket please

Finally, the lack of research posts in the country of origin often makes it extremely difficult for researchers to return home. This results in a brain drain which Europe desperately wants to plug in the interest of its scientific competitiveness. 'Mobility is fundamental at the outset of a research

Here are a number of national associations of students, PhDs and researchers

France *Confédérations des Etudiants Chercheurs (CEC)*

Made up of some 30 local associations, located in 13 French university regions, the CEC represents PhDs and young researchers at national level. (Presentation in English).
http://garp.univ-bpclermont.fr/cec

Germany *Thesis*

An interdisciplinary network of young scientists and PhDs, Thesis is not limited to Germans but is open to foreign and expatriate researchers. (Possibility to chat on the site in English, Spanish, Dutch and Swedish).
http://www.thesis.de

Ireland *Graduate Student's Union*

Site hosted by Trinity College, Dublin. The GSU site is a useful gateway to Ireland for students and researchers.
http://www.gsu.tcd.ie/

Italy *Associazione Dottorandi e Dottori di Ricerca Italiani (ADI)*

Newsletter, databank containing CVs of Italian researchers, publication details of books based on personal testimonies (*Cervella in fuga* is one of the latest), links, and more.
http://www.dottorato.it/

Sweden *Sveriges Doktorander (Sdok)*

An association of PhDs promoting exchanges of experience between Swedish students as well as researchers. (English version available)
http://www.sdok.net/english/index.html

Netherlands *Landelijk AiO-en OiO-Overleg (LAIOO)*

The LAIOO is a national organisation of students and PhDs at Dutch universities which hosts a very practical site with information on social security legislation and tips on doing a thesis, etc. (English version available)
http://pubwww.tudelft.nl/laioo/

United Kingdom *National Postgraduate Committe (NPC)*

The National Postgraduate Committee is run by and for postgraduate students, with the aim of promoting interest in research and postgraduate studies.
http://www.npc.org.uk/

Europe *Marie Curie Fellowship Association*

This is an association of researchers who have been awarded a Marie Curie grant by the European Community. The MCFA produces a newspaper, organises regular meetings between its members, and hosts a very practical site with, among other things, details of how to access European opportunities (portal, grants, etc.), a career guide, a discussion forum and many useful links.
http://www.mariecurie.org

career. I regret not having moved a little more, but I decided to stay in Italy. In my country, you find it much more difficult to find an opening when you return from abroad,' explains Fabio Monforti-Ferrario, a researcher at the Italian agency for new technologies, energy and the environment, ENEA in Bologna. Gué thinks that 'Mobility must be a choice and not a one-way ticket'.

Faced with the shortage of posts at universities and public research centres, many opt for the private sector. Enrico Piazza, a doctor of physics, chose this route and is very pleased he did. He also maintains that a doctorate is an excellent professional qualification with which to obtain a rewarding position in a company. He believes that 'post-doctorates simply enable universities to recruit highly skilled staff cheaply without incurring the costs associated with full-time jobs.'

'There are more permanent posts in the private sector,' explains Remans, 'but many researchers prefer to continue to switch from one post-doctorate to another, which often amounts to just ploughing on blindly with no goal in sight. They see the private sector as being much harder and more commercial, and few of them acquire the ability to enter it. I am not speaking about scientific abilities but the ability to go out and land a job.'

However one looks at it, compared with the United States and Japan, the lack of crossover between the public and private sectors is the Achilles' heel of the European Research Area (see box *The Commission's point of view*).

The Commission's point of view

The European Commission has just published a Communication entitled *Researchers in the European Union: one profession, multiple careers which is based on an analysis of career*(1) prospects in the European Union. This document identifies the factors which shape a scientific career, namely training, recruitment methods, employment conditions, assessment mechanisms, and career advancement.

The Communication proposes concrete actions to encourage and structure a better dialogue and exchange of information with researchers, and aims to create a genuine competitive labour market in the research field in Europe.

The recommended actions include:

- a 'European Researcher's Charter';
- a 'Code of conduct for the recruitment of researchers';
- common mechanisms to evaluate and recognise competencies, qualifications and research results;
- the development of advanced training instruments;
- access to sufficient funding and minimum social security benefits for doctoral candidates.

On presenting the Communication, Research Commissioner Philippe Busquin stated: 'It is essential for us to give more encouragement to young people to pursue scientific careers and to ensure that Europe retains its talent. Failure to do so would reduce our chances of creating a genuine European knowledge market and of achieving our aim of making the EU the most competitive knowledge economy in the world.'

(1) Downloadable document: europa.eu.int/comm/research/fp6/mariecurie-actions/pdf/careercommunication_en.pdf

European citizen

Why not make life easier for those whose profession takes them to other countries? INRA's Tony Remans proposes Union 'citizenship'.

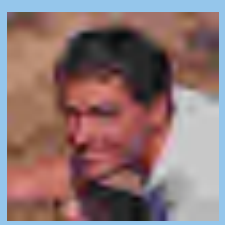
Tony Remans, 27, a Belgian biotechnology researcher and father of a young son, has been engaged in post-doctoral research at INRA (FR) since February thanks to a European grant. He has also been awarded a doctorate in Australia and attended workshops in Spain and England. 'I have met many researchers of different nationalities. Most of them have the same fears and problems,' he stresses. These relate to the complicated matter of finding a stable job and the often Kafkaesque administrative difficulties (social security, residence permit, pension, etc.) facing all those who decide to move in a Europe.

Remans believes the solution lies in creating a European citizenship, granted according to precise criteria, for those who work in other EU countries. 'If we really want a united Europe, that should be feasible. These citizens would have a European passport and would be able to live in any Union country with their family and without having to obtain residence permits for themselves and accompanying persons. They would pay tax to the Union and not to the country of residence (the latter subsequently receiving compensation from the EU). Social security institutions set up by the Union would deduct contributions from their wages. This system would enable them to benefit from European health cover and family allowances valid in all the Member States.'

'This solution would contribute significantly to advancing the European ideal. There is more to a Union than a single currency and the removal of customs barriers. International co-operation and interaction also means citizens being able to live and work without difficulty in any one of the Member States.'

'That said, the Union's actions enabling young scientists to make the most of their initial experiences of life and study abroad are important and I am very pleased to benefit from them, to be able to live in France and work at the INRA. Mobility helps to structure the European Research Area. I believe that it achieves important interactions between researchers and institutions.'

The willing nomad



With a German mother and an Italian father, Guido Germano, doctor of chemistry, studied and worked in Germany, the USA and the United Kingdom before returning to Italy.

'You are welcomed abroad if you are on a student exchange scheme or for a post-doctorate, but when it comes to joining the permanent staff of an institution the preference always goes to nationals,' explains Germano. He started a doctorate in Germany with a six-month grant, followed by a small Italian grant for three years. Today, Germano is the president of the ADI (Associazione Dottorandi e Dottori di Ricerca Italiani), an organisation he co-founded. 'One of our first battles was to obtain a 50% increase in the level of doctorate grants. We also wanted to convert these grants into employment contracts but unfortunately we failed to achieve this goal.'

At the age of 35, after a post-doctorate at Bristol University (UK) and another at Bielefeld University (DE), Germano (19 grants, four prizes) feels he has sacrificed a great deal for research and sometimes feels he cannot stand it any more. 'On several occasions I have wanted to quit this profession, and I am not sure that one day I will not do so.' Moreover, the support mechanisms make freedom of research difficult. 'You have to request funding for subjects that are in fashion at the time. You then have to wait and, by the time the funds are available, you find you have found a better idea for your research.'

Competition? It all depends. As a junior professor at the Phillips-Universität Marburg (DE), Germano has not felt it at this level. 'This type of post was perhaps not in very great demand, especially as there is no prospect of a permanent appointment as a full professor, and also perhaps because fewer students are choosing to study chemistry and the other hard sciences. The best often move away from research, just after their thesis, and find stable and economically attractive employment in other areas. On the other hand, the competition is very stiff for a post as full professor.'

Researchers without frontiers

A guide to mobility opportunities and tools

Penetrating the mobility barrier

You cannot have science without scientists. As Europe's research efforts gather pace, it will need not only to produce more S&T personnel, but it will also have to allocate its existing pool of researchers as effectively as possible in order to capitalise on its wealth of know-how and expertise. And this requires a high degree of researcher mobility.

Although in principle researchers enjoy unfettered movement within the internal market, in practice, there are still too many administrative, cultural and linguistic obstacles. Recognising these constraints, the European Union's Sixth Framework Programme (FP6) has set aside more than €1.5 billion for a series of specific actions aimed at galvanising researcher mobility.

The Marie Curie Actions have been designed to facilitate the free movement of researchers across a borderless Europe and dismantle the invisible frontiers that tend to tie researchers down.

This special supplement provides a rundown of these mobility initiatives which help researchers with everything they need to get moving. This ranges from a special web portal for locating training and job opportunities, to special centres that help them find their bearings in their host country, as well as special reintegration initiatives for when they return home. It also outlines EU-funded mobility grant and award schemes for organisations and researchers.

MARIE CURIE **ACTIONS**

A host of oppor

The Marie Curie host-driven actions aim to boost the availability of transnational training and mobility schemes in Europe, particularly for researchers in the early stages of their careers.

The 'host-driven actions' are open to universities, research centres and enterprises, particularly SMEs, active in R&D and based in the Member States, associated states (Iceland, Israel, Liechtenstein, Norway and Switzerland), and, in certain cases, third countries. These schemes allow institutes to 'host' temporarily both less experienced and experienced researchers from other countries, who take part in joint research or benefit from training activities geared specifically to their needs.

• Marie Curie Research Training Networks

A network must include at least three research partners established in at least three EU member or associated states. Two of these must be based in either a Member State or candidate country. EU funding ranges from €800 000 to several million euros, at least 65% of which must go to hiring researchers for fellowship training programmes.

Research Training Networks (RTN) offer researchers the chance to spend up to three years working in an international research team. The scheme is open to researchers with up to ten years' research experience. They have to apply directly to the host institutions following an international publication of vacancies.

For every €100 million spent on this action, the Commission estimates that up to 60 RTNs will be set up, involving 600 research teams, and leading to the mobility of up to 1 200 researchers.

A first call for proposals, with two deadlines, was published in December 2002. The first deadline (for €115 million) closed on 3 April 2003. Contracts between the networks and the European Commission should be signed between October 2003 and January 2004. Vacancies will be advertised in the scientific press and on the CORDIS website. The next deadline (for €115 million) is on 19 November 2003. It is expected that an additional call will be published with deadlines in 2005 and 2006.

• Marie Curie Host Fellowships for Early Stage Research Training

This scheme supports institutes or consortia willing to provide researchers in the first four years of their career with specialised training for up to three years outside their home country.

The training focuses on acquiring S&T competencies in research, but it can also include other practical skills such as research management or languages. The idea is to help researchers enhance their job prospects, encouraging them to take up long-term research careers.

Projects may be submitted either by a single host or by several inter-related groups in one country working together on a common research or training theme; or by multi-partner hosts, such as those involved in formal collaboration in the organisation of international doctoral studies (e.g. Euro-PhDs). The size of the projects will range between €300 000 and €2 million.

The Commission estimates that every €100 million invested in this action will result in approximately 1 500 person-years of research training.

A first call for proposals was published in December 2002, with two deadlines. The first deadline (for €60 million) closed on 2 April 2003. Contracts between the host institutions and the European Commission should be signed in the beginning of 2004. Vacancies will be advertised in the scientific press and on the CORDIS website. The next deadline (for €70 million) is on 11 February 2004. It is expected that an additional call will be published with deadlines in 2005 and 2006.

tunities

• Marie Curie Host Fellowships for the Transfer of Knowledge

Two knowledge transfer schemes are available. The Marie Curie Development Scheme aims to enhance the potential of R&D bodies, particularly in less-favoured EU regions and candidate countries. It allows research institutes to hire experienced foreign researchers for up to two years and to send their own researchers abroad for up to one year.

The Marie Curie Industry-Academia Strategic Partnership Scheme promotes co-operation between universities and businesses by allowing them to exchange experienced researchers for up to two years. A research organisation must apply for funding together with its industrial partner.

Overall assistance is expected to range from €100 000 to €1 million. The Commission estimates that every €100 million invested in this action will result in approximately 1 400 person-years of research transfer.

A call for proposals was published in December 2002. The first €40-million deadline closed on 22 May 2003. Contracts between the host institutions and the European Commission should be signed at the beginning of 2004. Vacancies within the development scheme will be advertised in the scientific press and on the CORDIS website. The next deadline, with a budget of €45 million, is 19 May 2004. An additional call is expected to be published with deadlines for 2005 and 2006.

• Marie Curie Conferences and Training Courses

This action provides researchers in the first ten years of their career with funding to attend conferences and training courses – held by universities, research organisations, scientific centres or industrial facilities – in order to network and keep abreast of the latest scientific developments.

The Commission provides funding to the organiser for either a 'series of events' –conferences or training courses – or a 'large conference'. A 'series of events' project must contain at least 4 events, whereas a 'large conference' project will comprise of only one large international gathering.

In both cases, Commission funding covers the costs related to the participation of researchers and the project's management expenses, as well as part of the organisational expenses for 'series of events'.

The funding provided will depend on the nature and scope of the activities to be undertaken and on the number of eligible researchers involved. The project size for 'series of events' will range between €250 000 and €1 million. For large conferences, a typical project size will be €50 000.

The first call for proposals was published in December 2002 with two deadlines – on 1 April 2003 and 20 April 2004 – each with a budget of €10-million. A second call is expected with deadlines in 2005 and 2006. The selected conferences and training courses will be listed on a regular basis in the conference database on the CORDIS website.

Individually crafted

The individual-driven Marie Curie Actions allow researchers to apply directly for training fellowships tailored to suit their personal professional development needs.

'Individual-driven actions' provide funding to help researchers take up fellowships in Europe and beyond. They also offer career development and mobility opportunities to researchers from third countries to come to Europe for training.

• Marie Curie Intra-European Fellowships

These fellowships are open to researchers from EU member or associated states with at least four years of research experience or a PhD. Fellows take part in tailor-made research programmes in European R&D institutions for up to two years. The idea is to give promising researchers the necessary boost to become scientifically independent.

Before applying, a researcher must first find an organisation willing to hire him or her for up to two years. They then apply together for funding. If the application is successful, the Commission signs a contract with the host institute, who in turn signs an agreement with the researcher. The size of the projects vary between €60 000 and €180 000.

The next deadline, for a budget of €55 million, is on 18 February 2004.

• Marie Curie Outgoing International Fellowship

This action aims to enhance the careers of European researchers with at least four years of research experience or a doctorate degree by giving them the chance to broaden their international research experience. Successful applicants will be eligible for advanced research funding for up to two years, followed by a compulsory reintegration phase of up to one year in their home institution. Before applying, researchers must first identify the type of advanced training required and explain how it will improve their career prospects. Researchers must also find a research institution in a third country to host them for their fellowship period and another in their home country willing to hire them on their return. Commission funding will vary from €120 000 to €240 000.

The latest call for proposals closes on 12 February 2004 and has a budget of €18 million.

• Marie Curie Incoming International Fellowships

These fellowships aim to attract top-class researchers from outside the EU and the associated states to undertake research training in Europe for up to two years. Their purpose is to enhance European scientific know-how and improve research co-operation with the rest of the world.

The fellowship is open to third-country researchers with at least four years' experience or a doctorate degree. The bulk of the funding will be used to cover the researcher's expenses and the actual research project. In the case of fellows from emerging economies and developing countries, the scheme also includes financial support to help them return to their home country once the fellowship ends.

The Commission estimates that funding will range from €72 000 to €185 000. To apply for this financial support, potential fellows must find a European research institution willing to host them.

The latest call for proposals closes on 12 February 2004 and has a budget of €11 million.

Rewarding excellence

Marie Curie Actions are not just about fellowships. They also aim to put the spotlight on the best that European R&D has to offer and promote research as a career path.

Three Community schemes promote European research excellence and highlight its results to the wider scientific community. These actions are of particular interest not only to European-based researchers but also to European researchers based outside the continent who are looking to return to Europe to continue their careers.

• Marie Curie Excellence Grants

Marie Curie Excellence Grants fund the development of transnational research teams, particularly in emerging fields of R&D. Each 'excellence team' is based at a research institute in a Member State or an associated state and is managed by a leading scientist who has already shown the potential for excellence and the capability to lead a research team. The scheme also hopes to lure such world-class talent back to Europe.

Prospective team leaders and their host organisations apply to the Commission for funding. If the application is successful, the Commission signs a contract with the host organisation which, in turn, signs an agreement with the team leader and each of the members of the team.

It is up to the team leader to assemble the team of researchers, who can be of any nationality and level of experience. There is no upper limit to the number of researchers involved, but the transnational nature of the group is important.

The size of the grant, which can run for up to four years, depends on the nature and scope of the research project and the number of researchers in the team – but the Commission estimates projects will range from €0.8 to €1.6 million.

The first call for proposals was published in December 2002 with two deadlines – on 20 May 2003 and 18 May 2004 – with a budget of €25 million and €30 million respectively. A second call is expected with deadlines in 2005 and 2006.

• Marie Curie Chairs

A Marie Curie Chair is a newly created, high-level position at a research organisation in an EU or associated state which combines teaching, PhD supervision and research work. The scheme aims to encourage world-class researchers of any nationality to move to Europe to continue their careers.

The appointment usually lasts for three years, but shorter periods (with a minimum of one year) are possible. Potential chair-holders apply to the European Commission together with the host organisation. If the application is successful, the Commission signs a contract with the host organisation which then has to sign an agreement with the chair holder.

The amount of funding available depends on the type of activities chair-holders will undertake during their tenure and are expected to vary from €450 000 to €750 000.

The first call for proposals was published in December 2002 with two deadlines – on 20 May 2003 and 21 January 2004 – each with a budget of €5 million. A second call is expected with deadlines in 2005 and 2006.

• Marie Curie Excellence Awards

The Marie Curie Excellence Awards aim to give public recognition to outstanding scientists with a record of past mobility who have achieved a standard of excellence in their given field, and whose results have contributed significantly to the progress of knowledge in that field.

Researchers of any nationality are eligible, provided they have taken part in an EU training and mobility programme for a minimum of 12 months. By rewarding the past achievements of researchers who have taken part in mobility schemes, it is hoped others will be encouraged to take part in similar initiatives. Researchers can nominate themselves or can be put forward by others. Five prizes of €50 000 are on offer each year. These are announced at a high profile Awards Ceremony in the presence of a grand jury and the European research commissioner. Marie Curie Award winners will be expected subsequently to take part in publicity events to promote research as a career option in the context of the European Research Area.

The first call for proposals was published in December 2002 with two deadlines – on 20 May 2003 and 18 May 2004 – each with a budget of €0.25 million. A second call is expected with deadlines in 2005 and 2006.

A bright research future in Europe

Encouraging researchers to spend time working and training abroad is one thing – ensuring they really benefit from the experience when they return home is something else. The European Union has launched two schemes to help researchers reintegrate after a training period abroad.

Researchers are often hesitant to give up secure employment at home to take up positions in a research organisation abroad for fear that it will prove very difficult for them to reintegrate into their national R&D structure upon their return. Many believe that travelling abroad can affect their prospects for promotion or that their new qualifications may not be recognised back home. 'Return and Reintegration Mechanisms' aim to deal head-on with these perceived obstacles by making it as easy as possible for researchers to return to their home country after a training period abroad. One such scheme targets European researchers who have taken part in an EU-funded mobility scheme, and another focuses on experienced researchers who have been working outside Europe for many years and would like to return.

• Marie Curie European Reintegration Grants

These grants are on offer to researchers from the EU and associated states who have taken part in a EU-funded training and mobility scheme for at least two years. They aim to help these researchers to capitalise fully on their experience abroad and to support their reintegration into professional scientific life in their home country.

The grant is a contribution towards the cost of undertaking a well-defined research project in a member or associated state and will not cover the salary of the researcher. Researchers can apply for these grants, together with their reintegration host organisation, a year to six months before their fellowship programme ends. The host organisation will receive the grant as a lump sum.

Researchers can apply for these grants at any time between now and 31 October 2004. The Commission will evaluate these proposals in batches. A total of €20 million is available for 2003 and another €19 million for 2004.

• Marie Curie International Reintegration Grants

The second type of reintegration grant is aimed at experienced researchers who have been working outside Europe for the past five years and who wish to return to resume their European research careers.

The Commission hopes the scheme will help researchers towards the successful transfer of the knowledge they have acquired during their time abroad, and will go some way towards stemming the brain drain in Europe.

The financial support will fund a well-defined research project in an EU or associated state. The returning researcher applies to the Commission together with a reintegration host organisation. The grant lasts for up to two years, although, the host institution must commit to the effective and lasting reintegration of the researcher for at least three years. Unlike the European reintegration grant, the researcher does not have to be a former Marie Curie fellow.

The Commission will accept applications for this action on a continuous basis between now and 31 October 2004. A budget of €7 million is available for 2003 and another €10 million for 2004. The Commission will evaluate these proposals in batches.

A vital career link for researchers

The European Researcher's Mobility Portal, which was launched on 10 July 2003, is a unique on-line resource. It provides over 1 500 links to research organisations offering fellowships, grants and job openings across Europe and internationally.

A general lack of information on European grants, fellowships and training opportunities for researchers is often cited as one of the major obstacles to cross-border mobility. Researchers realise that interesting career development opportunities are out there – it is just a matter of finding out where and figuring out how to go about applying for the funds.

Making it easier for researchers to become more 'mobile' is essential to the creation of a genuine European scientific community and the success of the European Research Area. However, up until now, there has been no central information resource for researchers interested in finding out more about European research grants, fellowships and job vacancies.

To fill this information gap, the European Union has set up a unique "Researcher's Mobility Portal". The portal (http://europa.eu.int/eracareers) – launched on 10 July 2003 – was constructed in close co-operation with research ministries from across Europe. Major European and international scientific organisations – such as the European Science Foundation, the European Space Agency, UNESCO, and NATO – have also been involved.

It is the first web portal of its kind to link to the full range of organisations offering training, mobility and career development opportunities for researchers across the entire European Research Area. The portal lists R&D vacancies in academia, industry, R&D organisations and foundations.

http://europa.eu.int/eracareers/

Why waste time? The portal allows researchers to look for suitable grants and fellowships at EU, national and international level.

Streamlining the hiring process. Organisations can publish job vacancies and search the CV database in order to find suitable candidates from all over the world.

Let the portal work for you. Register with the Researchers' Mobility Portal and post your CV. Potential employers can then contact you directly with exciting job offers.

Face-to-face advice. Portal users will have free access to the services of the European Network of Mobility Centres which provides personalised assistance to researchers (and their families) posted or about to be posted abroad.

Locate your ideal job in minutes. If you are looking for a research job, start by searching the portal for vacancies by country and research discipline.

Find out what to expect. For those contemplating moving abroad to take up a research position, the portal will guide you to the best sites to find out about life in your host country.

Making mobility manageable

The forthcoming network of mobility centres (ERA-MORE) will provide one-to-one assistance to national and foreign researchers before, during and after a training period abroad.

The Europe-wide network of mobility centres is one of several concrete measures undertaken by the European Union to make it easier for researchers to take up training positions abroad. The network is a direct response to the difficulties facing researchers undertaking a mobility experience and their families.

The lack of comprehensive information and assistance services for researchers at European level has had a damaging impact on the image of Europe as a research destination so far.

The network has been set up in close co-operation with the Member States, the candidate countries, and the non-candidate countries associated to FP6 (Iceland, Israel, Liechtenstein, Norway and Switzerland). It aims to provide researchers and their families with comprehensive and up-to-date information, as well as personalised assistance, on all matters relating to their professional and daily lives in their host country.

For the most part, the centres are based in existing establishments in the 33 participating countries.

Some 40 so-called 'bridgehead organisations' have been selected by the research ministries in order to help setting up the national networks. Mobility centres provide personalised assistance on all practical matters relating to a move abroad. Experts are on hand to advise on issues such as:

- Visas
- Work permits
- Job opportunities for accompanying partners
- Salaries and taxation
- Pension rights
- Health care
- Social security
- Accommodation
- Day care and schooling
- Language courses
- Social and cultural issues
- Intellectual property rights

The formal launch of the network is scheduled for the end of 2003 or the beginning of 2004.

Drawn to the USA

More than one in seven doctorates received by foreigners in the United States are awarded to Europeans. Of these Europeans, about 75% stay behind. With generous research grants, state-of-the-art facilities, an international environment, and streamlined bureaucracy, America has a lot going for it.

'The strength of the USA is us,' claims one young French doctoral student in a survey carried out by France's Centre National de Recherche Scientifique (CNRS)[1]. Edelgard Bulmahn, German education and research minister, would not argue with that. A survey commissioned by his ministry[2] indicates that of the 11 000 or so Germans who were awarded a PhD in 1998-1999, 1 000 set off to do a post-doctoral degree in the United States thanks to financing from their home country. After China and Japan, Germany is one of the principal suppliers of scientific brainpower to the United States. Between 1990 and 1998, the number of German scholars (post-PhDs, assistant professors and research fellows) in the United States increased from 5.2% to 7.2%.

After having completed a doctorate at their home university, young Europeans are often advised by their doctoral supervisor or laboratory on what direction to take for a post-doctorate. That often means North America. Why does the United States have such a power of attraction? The reasons are well known. 'A better salary, more stimulating research environment, personal development, the chance to perfect your English,' is how Marco Albani sums it up. This Italian who is doing a post-doctorate at Harvard also makes the point that 'there is less bureaucracy in the US and it is possible to work independently.'

Road to Rome

For many young researchers, the United States is a kind of initial immersion in the world of research, perhaps comparable to the trip to Rome that was de rigueur for the painters of the past. 'I often thought of the United States, especially since the most interesting researchers and teams in my discipline settled there. But I decided against it due to my family situation – I am happily married with a young child and my wife has her own career,' explains Rami Olavi Vaino, an assistant in the physical sciences at the University of Turku in Finland.

'The United States is founded on a tradition of immigration and has long facilitated the mobility of researchers. The USA is also one of the best regions in the world for scientific research, in all disciplines. I am seriously thinking of going there,' enthuses Shuo-Wang Qiao, a Norwegian doctoral student of immunology. 'I would like to spend two or three years there… but I would not like to spend my [entire] life there. Not because of the research environment, but because of the American way of life,' comments Fabio Monforti Ferrario, a researcher at the Italian Energy and Environmental Agency (l'ENEA) in Bologna).

Alison Lester will soon be setting off for Chicago, on a temporary mission as part of CERN's international co-operation scheme. 'I am going for one year. Until Geneva gets its new particle accelerator, the only comparable machine in the world on which I can experiment and process my specific research data is near Chicago. So, for me, this is the only way to pursue an analysis that could certainly prove useful for our work, which will subsequently continue here in Switzerland, with new detectors.'

Money matters

Whatever the intentions and exchange systems, the figures are revealing (see box). At present nearly 75% of Europeans who complete a doctorate in the United States try to remain there (compared with 49% in 1990). Two-thirds of them soon find employment in the country. Salaries are high and there are very real career opportunities in the academic world as well as the private sector. Unlike Europe, industry is the country's biggest employer of scientists: it finances 66% of R&D and carries out an even higher proportion (74%) thanks to public contracts.

'Europe and its researchers have ideas, but they are cruelly lacking in the financial and human resources to put them into practice,' points out Michèle Gué, a teacher and researcher at the Université de Montpellier II (FR). She draws attention to the 20th anniversary of the identification of the Aids virus by professor Luc Montaigner – who now works in the United States – and his team of six researchers at the Institut Pasteur. 'The Americans had to get out their heavy artillery – the necessary funds and more than 50 researchers – for Dr Robert Gallo.' It is certainly true that the United States does not baulk at financing research. To take just one example: the budget of the National Institutes of Health (federal institute responsible for biomedical research) doubled between 1998 and 2003.

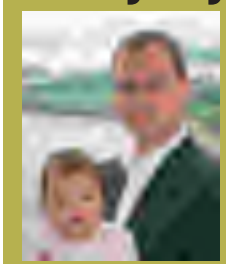
Each to his own

Does that mean we should imitate the United States? 'I am not in favour of a copy/paste approach to US practices. European research has its own characteristics and these should be preserved,' continues Michèle Gué, who did her doctorate in the US and spent several years there.

'One example is the ability to explore several avenues. In the case of US public research, the system of grants obliges researchers to work and publish on the very precise topic for which the grant is awarded. This is a strict rule and there is no getting away from it. In Europe, on the other hand, it is possible to pursue new lines of inquiry which may not have been envisaged at the outset. In a context where the trend is for increased uniformity, this diversity of approaches is necessary for the advancement of science.'

(1) Erwan Seznec and Dominique Martin-Rovet, Etat des lieux 2000 sur la présence des Français en science et ingénierie aux Etats-Unis – Les cerveaux, fous d'Amérique? Pas vraiment…, *published by the CNRS.*
(2) La relève allemande aux USA, *carried out by the Centre de recherche sur l'innovation et la société (CRIS).*
http://www.jeunesdocteurs.com/fplr/70/05.html
3) Erwan Seznec, Dominique Martin-Rovet and Stéphane Roy, Du brain drain au back drain, Le long chemin des biologistes français présents aux Etats-Unis, *CNRS, May 2002.*

Everyday life in Japan



The research field stretches far beyond the USA. Japan, which ranks number three worldwide in the R&D league, is particularly dynamic, with many opportunities for young researchers to pursue fascinating programmes. The German Jens Nieke is one of those who took the research route to Tokyo.

Jens Nieke, 36, an engineer in aeronautics and astronautics with a doctorate from Berlin's Technical University, is now a researcher at the National Space Development Administration of Japan (NASDA). 'It was hell at first. Living in a tiny room in the centre of Tokyo, problems with the language and culture. Unlike in other Asian countries, English is not widely spoken in Japan. That means you have to learn Japanese which takes a lot of time and effort. When people ask me what Japan is like, I reply: 'difficult'. The solution is to find your own niche. We are fortunate to live on Daiba, a small island lying just outside the city and I cycle to work.' Nieke has married in Japan and has a five-month-old daughter, Lena.

Tokyo, a metropolitan area of some 30 million inhabitants measuring 100 km across, has a mind boggling population density, with 2 million commuters a day passing through the world's busiest station (Sinjuku).

'But Tokyo is a fascinating city. The people are friendly, positive and always busy. It is a reassuring city. The old and the new are found side by side, up to three generations can live under the same roof, and you can see temples dating back thousands of years standing alongside post-modern architecture. Japan is a laboratory for humankind's future – from space exploration programmes to robotics – including a case study on how to survive deflation, which is also beginning to rear its head in Europe.'

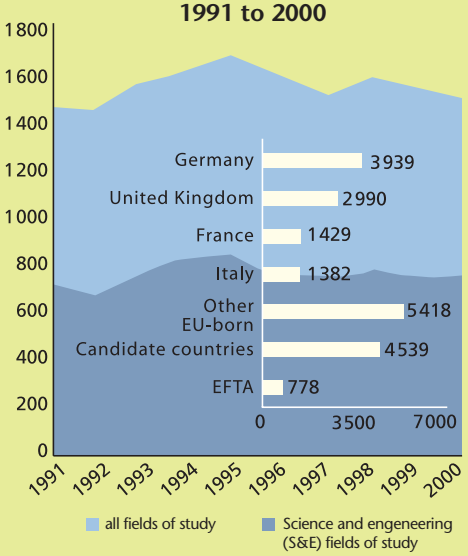
In 2000, when he was a doctoral student in Berlin, Nieke also worked at the Deutschen Zentrum für Luft- und Raumfahrt (DLR). 'It was when I was at this aerospace centre that I met a senior scientist from one of the NASDA Earth observation laboratories. It was he who invited me to come to Japan.

Crossing the Atlantic

- *A question of degree…* Figures on the attractiveness of the USA are difficult to compile on a consistent basis. One simple way is to estimate the number of people living in the United States with a university degree in a scientific(1) and technological field, although this does not make it possible to distinguish between different categories or between those who are there temporarily and permanently. A classification drawn up by the NSF, relating to a population of approximately 1.3 million highly educated residents, shows that, in 1999, Germans (70 000 residents) ranked third (after Indians and Chinese) and the British fifth (65 000). The latter constitute something of an elite with 20% of PhDs.
- *Jobs linked directly to S&T…* Again, according to the NSF, in 1999 almost 865 000 people of foreign origin were employed directly in sectors linked to science(1) and technology in the USA. Of these, 87 500 were of EU origin. The British led the field (28 000), followed by the Germans (25 000), the Italians (almost 8 000) and the French (less than 3 000).
- *Doctorates and post-doctorates*. Between 1991 and 2000, almost 15 160 EU nationals obtained a doctorate in the United States, some 50% of them in a science or technology subject, or about 700 to 850 S&T PhDs every year (see graph per nationality). Between 1995 and 2000, more than 70% of graduates with a PhD continued to reside in the USA. Three-quarters of them went on to take post-doctorates, or to embark on research or teaching careers.

(1) In the USA, the 'science' category includes the social sciences.

EU-born PhD recipients in the US: 1991 to 2000



Third European Report on S&T Indicators, 2003

The trip was made possible thanks to a grant from the European INCO programme for two years. I then continued my research with a post as visiting scientist.'

NASDA is the realisation of one of Japan's ambitions. It is now the second country, after the United States, in terms of its space research budget, which stood at €2.5 billion in 2001. NASDA has been developing the Kibo module for the international space station and satellite systems. Nieke is working most notably on the Adeos-2 Earth observation satellite programme, whose precursor was launched in November 2002.

'I am studying the calibration and validation of the GLI (Global Imager) which is a key sensor for research on climate and studying the geophysical parameters of the oceans, the atmosphere, the continents and the cryosphere.' He also heads a European Space Agency project to compare the data supplied by the new European Envisat satellite and by Adeos-1 with those from other international probes.

'Generally speaking, communication between the visiting scientists and their Japanese colleagues, who work very intensively, is not that easy. The visiting scientists are usually only in contact with their supervisor a few times a month. The atmosphere is different at NASDA, which recruits the best engineers and scientists from all over the country. They have often spent a year in the United States or Europe and are more open than their colleagues in other laboratories. The environment is, therefore, very pleasant. On the other hand, there is a very heavy workload because NASDA is embarking on an ambitious space programme with very few people. At the end of the day, this situation is very positive in terms of your career. We are able to work alone on a specific problem, when in the United States you would find about 30 researchers and in Europe about a dozen working on the same kind of question.'

Balancing the gender equation

Are women the future of research? As the Union finds itself facing a growing shortage of researchers, the failure to exploit the potential of half its population – who in fact obtain more university degrees than men – is a terrible waste. But to correct the imbalance, the scientific world must do something to overcome its prejudices and taboos.

To find out more

- *National Policies on Women and Science in Europe* (report of the Helsinki Group) www.cordis.lu/improving/women/helsinki.htm
- Statistics and indicators europa.eu.int/comm/research/science-society/women/wssi/index_en.html
- Information on 'Gender and Research' at European level www.cordis.lu/improving/women/home.htm
- National policies on 'women and science' www.cordis.lu/improving/women/policies.htm www.cordis.lu/improving/women/reports.htm

'There are a lot of women in the lower echelons of research. But their numbers subsequently dwindle. No doubt because science is very competitive and you must remain highly productive at all times,' says Shuo-Wang Qiao, a doctoral candidate in immunology in Norway. 'When women take a career break, usually to have a baby, that is considered rather long and it is very difficult for them to return to the scientific world.'

Figures tracing the progress of academic research careers clearly show when women start to fall behind. In Europe, most women researchers work at universities (see diagram). Slightly more women than men complete first degrees, but then only 37.8% of them go on to do a doctorate (compared with 62.2% of men). Although female doctors hold their own in terms of assistantships, they fall behind when it comes to assistant professors and, finally, hold just 11.6% of full professorships. It is in Finnish universities that women are most numerous – 18% of professors are women.

The weight of tradition

Just under a third of public researchers in the EU are women. But in four Member States – Portugal, Ireland, Greece and Finland – the score is 40% or more. 'It seems that women are better represented in countries where scientific professions are less developed and where the institutions are relatively new,' point out the authors of the latest report on S&T indicators.(1) In other words, countries where traditions run less deep. This is an interesting point. It is borne out by industrial research, where women represent an average of between 18% and 24% of researchers, falling to under 10% in a country with an advanced technical tradition such as Germany.

There can only be one conclusion: habits need to change. There are signs that this is now happening. The number of university degrees in science and engineering subjects awarded to female students grew from 25% to 30% in the EU in the late 1990s. In 2000, 30% of female students chose to study these subjects. That same year, about 40% of new

Separating fact from myth

The chapter on women scientists in Europe in the "S&T 2003 Report"(1) takes an in-depth look at three notions concerning the situation of women in the world of research and science.

The situation will evolve naturally as an increasing number of women pursue scientific studies. But how long will that take? Applying the Gender Segregation Index (GSI) defined by United Nation's cultural organisationUnesco – with present posts shared equally between men and women as and when they fall vacant – is a very long term remedy. In Belgium, for example, equality between the sexes would take between 40 and 211 years depending on the levels in the academic hierarchy.

The home and children place women at a disadvantage. In Sweden, 14% of category A university teachers are single (compared with 7% of the men); in Germany, 71% of women physicists have no children and have no plans to have any; in Ireland, 49% of female academic staff are without children (compared with 25% of men). On the other hand, it would appear that fertility boosts a man's career! A study carried out among French engineers shows that the majority of management posts are held by fathers of four or more children.

Women researchers publish less. In the United States, male professors publish almost three times as many works as their female counterparts. The over-representation of men in certain particularly dynamic research groups no doubt explains this phenomenon. For Europe as whole, no figures are available. But women publish more in the southern countries (Italy, Spain, France) and in certain disciplines (biology, earth sciences and biomedicine.

doctors were women: 50% in the life sciences, 30% in maths, 27% in physics, 20% in engineering and 19% in computer science.

Women seem to be increasingly turning to science. But is science welcoming them? What must be done for things to change? Many believe it is simply a question of changing mentalities. The world of science mirrors society as a whole. 'The drive to obtain parity between men and women in politics can serve as an example. Any progress in this direction in our society can help reduce misogynist thinking,' says Claire Fouillon, an astrophysicist.

Misogyny and mixed research

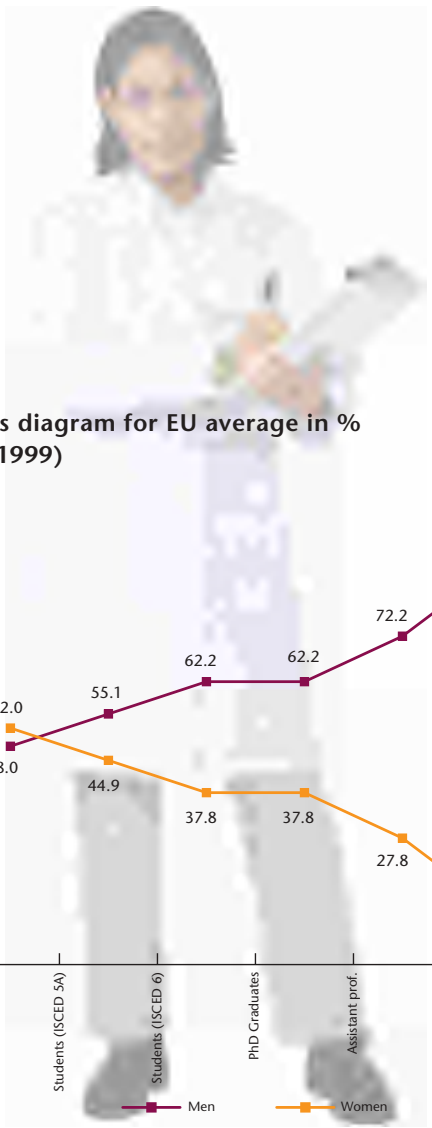
Many women researchers are all too familiar with these traditional misogynist mentalities. Flaminia Saccà, professor of sociology at the University of Cassino and head of research at Rome's La Sapienza University, says that 'the bosses tend to see male researchers as being more professional. It is when they need help with non-scientific and more administrative-style activities that they turn to women researchers.'

Atmosphere plays a part too. There are the attitudes of others and one's own feelings. 'One of the greatest difficulties is perhaps retaining confidence in yourself and your work, as the atmosphere in the institutions is rarely conducive to that. But I have seen, on many occasions, that the power struggle is not just one of men against women, but also between men and between women,' notes Janette Friedrich, a lecturer and researcher at the University of Geneva.

Where this power struggle is absent, achieving equality becomes easier. At the end of the day, it is a question of corporate culture. Fabio Monforti-Ferrario works at an Italian public research centre (ENEA in Bologna). He says he is unaware of any 'aggressive competition'. 'My women colleagues can consider their family – and so can I – without risking their careers,' he explains. 'In such a context, it is easier to achieve equality between men and women.'

Some young scientists would like to see more 'mixed' research. 'There are unfortunately too few women in the research world, at least in maths,' laments Erwan Brugalle. 'I say, unfortunately, because in a group where one sex is dominant, the atmosphere quickly becomes quite charged. I do not know if it is easier to be a male or female researcher, but the latter certainly need an extra dose of courage: the courage to join a group where the opposite sex dominates.'

(1) Third European Report on Science & Technology Indicators 2003, European Commission, Research DG.



Scissors diagram for EU average in % (1998-1999)

Women and Science

Over the past few years, members of the Research DG's Women and Science Unit (originally a 'small group') have initiated a number of studies on the situation of women scientists. Among other things, these reports have made it possible to compile consistent statistics on the 'gender' dimension.

To find out more:

- *Women in Industrial Research (the situation of women researchers in the private sector)* europa.eu.int/comm/research/science-society/women/wir/indew_en.html
- *Work in progress: a study on women scientists in Central and Eastern Europe and the Baltic States* europa.eu.int/comm/research/science-society/women/enwise/index_en.html

A boost

Young people are becoming increasingly disenchanted with science. They no longer view scientific studies and careers as attractive. Yet science can be fascinating and is crucially important in an increasingly technical world. So what can be done about it? Scientists, teachers and science museum curators have decided to act. Informal education, interactive Internet sites, continuous training and a more active approach to science teaching are just some of the methods they are using to spark renewed interest.

'I was far from being a good pupil, but I had a maths and physics teacher who inspired me to work. I did experiments at home, I watched science programmes on television, and sometimes I knew the subject matter even before the lesson began. After that, it was plain sailing.' All the way to Munich's Ludiw-Maximilians University in fact, where Florian Berberich did a degree in physics. This was followed by a doctorate at the Rossendorf Research Centre (DE), which finally led to a research post at the European Synchrotron Radiation Facility (ESRF) in Grenoble.

A lack of imagination

In science, as in many other subjects, school is crucial in arousing an initial interest. But teaching approaches too often seem to lack imagination and there is growing concern at the way young people are becoming disenchanted with science and technology (S&T). Two recent surveys on the attitudes of Europeans towards S&T[1] proved revealing. In candidate countries, the majority of respondents – 52%, compared with 40% for the EU – cited earnings and job prospects as the main reason why students are not studying science. In the EU, 67.3% of the young people interviewed attributed their lack of interest to the boring nature of science lessons and 58.7% said they were too difficult.

'The reasons for this lack of enthusiasm for science are complex,' explains physicist and teacher Antonella del Rosso, head of education at the EU's particle physics laboratory CERN (see box *Retraining at CERN*). 'Science classes are generally seen as being very hard. If they are optional, they are avoided. If compulsory, many students do not really follow and try to just scrape through as best they can.'

As a result, the numbers choosing science subjects at university are declining dramatically. In France, for example, the numbers are down from 133 000 in 1996 to just 98 000 in 2001-2002. The European report *Strata-Etan*[2] states that the number of students choosing the basic sciences (chemistry, physics, maths) have declined by a third in recent years in Germany, the Netherlands and the United Kingdom. Some consolation can be found, however, in the fact that figures are remaining steady – or even increasing – for the more recent disciplines, such as biology, information technology, as well as earth and environmental sciences.

Informal education

New initiatives are being launched all over Europe to encourage more active and inventive teaching methods as a means of giving a much-needed boost to science education. These range from science games for the youngest children to continuous training for teachers. Museums are giving free rein to their imagination, travelling exhibitions are taking to the road, competitions are being launched, and new ideas are flowing freely. The organisers are convinced of the benefits of this 'informal education' as a vital alternative ways of boosting interest in science and, hopefully, in scientific careers.

Many universities and research centres support teachers. In the United Kingdom, the National Centre for Biotechnology Education visits schools, on request, to demonstrate practical experiments. www.ncbe.reading.ac.uk/NCBE/NCBE/menu.html

for science

Of course, museums can only play a part if pupils can actually reach them – which is not always the case for rural schools – and if teachers are able to find a slot in the school timetable for such extra curricular visits. There is always the Internet, of course, which enables teachers and pupils to download documents, join clubs, enter virtual competitions, and generally find excellent ideas for making science more appealing.

The stakes could scarcely be higher. 'Science is part of a civilisation's general culture,' stresses del Rosso. 'Especially [as] technology is so much a part of our everyday lives, and there can be no technology without research. There is a real danger of people disconnecting from the world of science, if we do not train future generations in the scientific developments which are all around us.'

(1) Europeans, science and technology – *Eurobarometer 55. 2 December 2001 (survey carried out in the Member States) and Eurobarometer – Candidate countries 2003.*
(2) Benchmarking National R&D Policies, Human Resources in RTD, *Strata-Etan expert working group, Final report, 21.08.02.*

Retraining at CERN

CERN runs two kinds of teaching programmes. Since 1998, the HST (High School Teachers at CERN) programme has been held during the first three weeks of July and is attended by teachers from all over the world. More recently, the new, shorter PhT (physicsteachers@cern) is a three-day course which ends with the launch of a competition to find the best teaching project supported by particle physics laboratory. This aims to encourage direct contact between teachers and 'science in action', and to provide teachers with information they can use in their lessons. The programme dates are published on the CERN website.

CERN funds the HST programme in full and teachers pay nothing. For the PhT courses, teachers only have to pay their travelling expenses. There is growing demand for both courses and teachers are selected on the basis of their CV and motivations.

'The HST programme offers teachers a very intense human and personal experience. An important element – also included in the PhT programme – is the direct interaction, without intermediaries, with the scientists. The two programmes enable teachers to recharge their batteries,' explains Antonella del Rosso of the education and communication group.

This positive effect continues as teachers who have completed the programme are encouraged to maintain links with CERN. 'Teachers [contact] us for teaching material and they participate in other initiatives, in particular other European programmes, such as "Physics on Stage". They also help us to develop teaching material and in popularising science.'

To find out more: http://public.web.cern.ch/Public/education/edu.html

Teachers: passing the baton

There are approximately 4.5 million teachers in the EU, which is about 3% of the active population. In Germany, the figure is 2% and, in Belgium, 5%. On average, 60% of teachers are aged over 40. In primary education, this proportion soars to 78% in Germany and 74% in Sweden.

At secondary level, it is in Italy that ageing is most apparent (91% of teachers are aged over 40 at lower secondary level, and 82% at upper secondary level). In France, 16 000 teachers will be retiring between 2002 and 2006. Ireland is having problems recruiting science and maths teachers. The Norwegian Teachers' Union estimates that an extra 20 000 teachers will be needed between now and the year 2005.

The *Strata-Etan* report cites a number of examples of good practices. The Netherlands, for example, is offering retraining for engineers and researchers in the private sector to fill vacant teaching posts. Sweden and the United Kingdom are looking at ways of improving teacher status. The German Foundation for Science has launched a six-year programme to support a number of initiatives to improve the quality of science and maths education, in particular through multidisciplinary projects, which also include courses in pedagogy and sociology.

University challenge

With increasing globalisation and competition, the erosion of public budgets, and a changing socio-economic environment, universities are facing the complex challenge of successfully changing without sacrificing their academic freedom or compromising their fundamental research and teaching missions. Given their central role in the knowledge economy and society, the Commission has launched a wide-ranging debate(1) on the future role of universities and the changes they are confronting.

Standing at the crossroads of research, education and innovation, universities are strategically placed to influence the scientific and technological future of society. Yet they face many challenges in the course of their mission. Global competition, the marketing of knowledge, shrinking notions of space and time, along with changes in the nature of intellectual work generated by advances in the information and communication technologies, as well as the accelerated pace of knowledge acquisition, are rapidly transforming research and education.

What responses will European universities bring to these challenges? To what extent can they take inspiration from what is happening elsewhere? How can they achieve and maintain excellence? In what way should they and can they contribute to local and regional growth? Where will the financing be found for the Alma Maters of tomorrow?

'Europe needs to analyse its own strengths and weaknesses and to develop a European scientific approach, with its own programme and models for its universities,' states the European University Association (EUA) in its reply to the consultation launched by the Commission.(2)

Excellence in diversity

The Commission's consultation exercise must produce responses to the demands currently being made of universities, which no one institution can meet. These include the need to pursue a pioneering role in fundamental research, to open up to new sections of the population and democratise teaching, to train researchers, to capitalise on their research results, to fulfil missions of expertise, and to be more firmly rooted in the local socio-economic and cultural fabric.

For this reason the League of European Research Universities (LERU) would like to see a university system characterised by 'excellence in diversity'. This would empower universities to make the most of their specific assets and to formulate their missions accordingly. Some universities would concentrate on fields of applied research and on forging close links with industry and regional bodies. Others, specialising in first-cycle education, would concentrate on teaching a wide range of subjects. A third type would be universities with a large ratio of doctoral students that would contribute to fundamental research.

For its part, Euroscience (European Association for the Promotion of Science and Technology) proposes a dual network model split into centres of excellence training teachers and researchers, and publicly funded universities open to the growing demand for knowledge and providing free access to results.

Spotlight on supremacy

Whatever their speciality, excellence needs to be a common characteristic of universities. On that, everyone is agreed. There is a need to 'identify the areas in which different universities have attained, or can reasonably be expected to attain, the excellence judged to be essential at European or international level – and to concentrate on them the funds to support academic research,' notes the Commission.

Among other things, this must involve increased interdisciplinarity. 'It is crucially important to maintain and strengthen the excellence of teaching and research, without compromising on quality, while still ensuring broad, fair and democratic access.'

But who will judge this excellence, if not the universities themselves? How long will they give themselves to acquire this status? Does pursuit of this objective not risk concentrating subsidies and attention on certain institutions to the detriment of others? And should this drive for excellence be publicly or privately financed?

A question of funds

Money… That is the Achilles' heel of university education in the Union. Over the past decade, the European student population has increased from 9 million to over 12.5 million. More students should logically mean more teachers, more researchers and more resources. But no. There is not a single Member State in which expenditure on higher education has increased in line with this growth in student numbers.

The difference compared with the United States is glaring. The Americans allocate 2.3% of their national income to university education compared with 1.1% in Europe. US academic institutions not only have more students than European ones, but also have on average between two and five times more funding per student. In addition, financing through private donations is a well-structured and highly dynamic philanthropic tradition in the United States, with active alumni networks and foundations.[3] In Europe, this kind of financial mobilisation often encounters constraints linked to the legal status of universities and the lack of tax incentives. The 'sale of services', another important source of funds, is generally limited and sometimes blocked by legal restrictions imposed on universities, while some are distrustful of what they see as a slippery slope towards the commercialisation of academia.

Contact

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To find out more

- European University Association (EUA)
  www.unige.ch/eua/
- European Association of Institutions in Higher Education (EURASHE)
  http://www.eurashe.be/default.htm
- The National Unions of Students in Europe (ESIB)
  www.esib.org/

European education area

Following the launch of the European Research Area, what could be more logical than a European education area? The process was launched at the Bologna Conference in 1999. What has come to be known as the **Bologna Declaration** is a statement of intent for wide-ranging reform of university education aimed at achieving greater harmonisation of the education policies of some 30 European countries. Meeting in Prague in May 2001, European education ministers confirmed their desire to concentrate their efforts on these objectives. They lent their support to the idea that higher education should be viewed as a 'public asset' which is the responsibility of society as a whole, and that students are full players in the university community.

The Prague meeting confirmed six principal points concerning higher education:

- the adoption of a system of more transparent and comparable university degrees permitting easy and effective recognition;
- the introduction of a training structure based on two main cycles with a degree awarded after the first cycle of three years;
- the introduction of a system of credits similar to the ECTS system (European training credits);
- the promotion of mobility for students, researchers and administrative personnel;
- the development of common instruments with which to evaluate the quality of teaching; and
- an increased European dimension in university course content.

The next meeting will be held in Berlin on 18 and 19 September 2003.

Note: in March 2002, the European Council in Barcelona expressed the desire for European education and training systems to become a 'global quality reference' by 2010.

Higher education

Europe has some 4 000 institutes of higher education in 45 countries, 1 000 of which are genuine 'universities' on the basis of the criterion of being authorised to award doctorates.

Researchers

Universities employ some 34% of European researchers, with large variations from one Member State to another – 26% in Germany, 55% in Spain, more than 70% in Greece. Universities carry out 80% of European fundamental research.

Mobility

Intra-European mobility remains low – only 2.3% of students spent a period of study in another Union country in 2000. EU programmes have proved a considerable aid to mobility over recent years. In 1999-2000, for example, some 100 000 students and just over 12 000 teachers benefited from the Erasmus programme. Some 40 000 people took part in the Leonardo programme, which supported university-enterprise mobility projects between 1995 and 1999.

The EUA believes that 'universities recognise the need to attract more private funds and have more diverse sources of funding, although the situation varies a great deal from one country to another.' It also fears that only certain highly attractive institutions would be able to manage and achieve a balance between various partnerships. 'A clear mission and objectives are essential in balancing the risks of being too ready to comply with external requests, which usually result from short-term needs, [and] could erode significantly the values of critical thinking, autonomy and academic freedom, and also disadvantage specific disciplines.'

Transparent management

There is also the complex question of the many different and sometimes opaque systems of university management. Universities are rooted in the national or regional environment and differ considerably in terms of methods of governance, legal and administrative frameworks, internal organisation, and so on. The European R&D Advisory Board (EURAB) proposes the development of a transparent system for calculating the real cost of research as a basis for comparison. The EUA, for its part, says it is ready to conclude clear contracts for granting additional public subsidies on the basis of the strategic management, day-to-day management and quality assurance capacities of the beneficiary institutions.

The EUA believes that the emphasis should be placed on boosting university research capacities by pumping resources into promoting new doctorate opportunities, interactions between different generations of scientists, interdisciplinary studies, and networks and partnerships. This would make it possible to attain critical mass. The association also stresses the need for financial and other support to develop inter-university networks for teaching and research. These networks would help to establish joint programmes at various levels, including teaching and doctorates. The process of adapting structures and methods has already begun at most universities due to recent developments in knowledge and the growing number of interdisciplinary fields.

(1) The role of the universities in the Europe of knowledge, Communication from the Commission, *COM (2003) 58 final. europa.eu.int/eur-lex/en/com/cnc/2003/com2003_0058en01.pdf*
(2) This reply was presented at the Convention of European Universities in Graz (AT) between 29 and 31 May, attended by European Commissioners Philippe Busquin (Research) and Viviane Reding (Education).
(3) This system of private donations, which are in part tax deductible, leads indirectly to a degree of public financing.

The knowledge society

What does this much-discussed concept really mean? Has economic and social progress always been based on knowledge? 'Never before to this degree, and never before in history has knowledge played such an intense role in the economy and the functioning of society as it plays today,' pointed out Philippe Busquin at a conference organised by the Catholic University of Milan.

Today, more than 50% of economic growth is directly or indirectly attributable to technological progress. The knowledge society revolves around four pillars:

- the production of knowledge through research;
- its transmission through education and training;
- its dissemination through information and communication technologies;
- its exploitation in the process of technological innovation.

Migrating to the private sphere

Companies too have their researchers and Nobel prizewinners. From multinationals to small enterprises that spring up near university campuses, fascinating careers beckon in the private sector. There is just one problem: the scarcity of posts and the generally low level of private investment in top-level human resources.

'Not for a moment did I want to return to academic research, because the private sector is just as motivating and there are also some teaching opportunities. There is a need to structure research in the framework of partnerships, joint projects and consortiums (especially European). This usually means there are targets and timetables to be respected, but I don't see this as a constraint but as a stimulus,' explains Françoise Soussaline, a doctor of physics and biophysics. During her productive career, she has worked as an assistant at the Faculty of Medicine in Paris, a researcher at France's national institute for health and medical research Inserm, as well as the Department of Biology at the Commissariat à l'Energie Atomique (CEA).

In 1985, Soussaline decided to take a big step. She founded Imstar, a company specialising in software and image analysis systems in the medical field. 'In my case, it was something quite different to landing a better post. It was more a question of embarking on a formidable experience in terms of personal development. The positive elements are clearly a sense of being able to choose your objectives – at least to a degree – and then working towards them, setting up teams, communicating your know-how and enthusiasm, and innovating at many different levels – technical, relational, entrepreneurial.'

From the conceptual to the concrete

The enthusiasm of industrial researchers is not confined to those who start up their own companies. Scientists working in the private sector often find real job satisfaction from getting to grips with concrete applications. Enrico Piazza, who has a PhD in environmental sciences from the University of Florence, is an engineer with Park Air Systems (NO), which specialises in air transport communication, navigation and surveillance systems. There is no stress here finding funds or getting work published – 'We have a marketing department for that,' notes Piazza. 'I occasionally miss the prestige that goes with an academic post, or the freedom to pursue research without having to do it in my free time, but the private sector is more suited to my nature.'

The right profile

Companies look for certain profiles, which are not always easy to find. A glance at the report of a meeting – hosted by oil giant Total group – of the Association Bernard Gregory (www.abg.asso.en/adherents/club/ce-4.html) makes that immediately clear. Although the private sector wants qualified researchers it also wants

Applied research on the powering of a mode of transport in Wildernath (Germany). © Siemens

individuals able to communicate, convince, discuss and co-operate. 'A company does not recruit a manager without estimating his or her potential in terms of personal and career development. But it is precisely on this fundamental point that companies have certain qualms about PhDs,' states the report. This is why industry sometimes prefers to employ their researchers at an earlier stage and then train them in the specific skills they are looking for. Total currently finances 70 PhD students in France, 30 to 40% of whom they will later hire.

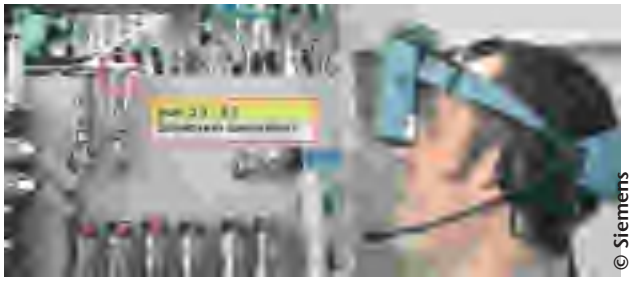
Leena Lehtinen, a researcher in metallurgy at Outokumpu Kokkola Zinc (FI), has exactly this kind of 'private profile'. 'We are not only able to carry out experiments in the laboratory but also on a pilot scale, in which tests are part of our everyday work,' she explains. 'In particular, I appreciate being able to see the results of my research being put into practice. In addition, the close co-operation with customers is another fascinating aspect of working in a company.'

Bridging the divide

So does this mean that European industry is well stocked with researchers? Not really. Fewer than half of all science and technology specialists are engaged in private sector research, compared with 80% in the United States and 70% in Japan. Ireland is above this average level (see graph). It is followed by Germany and the United Kingdom. In the UK, university-enterprise partnerships have assumed particular importance, with many co-operation initiatives in the realms of higher education. These include consultancy services for companies, specialist training, measures to facilitate the use of research results, and the creation of expert networks. British universities are seeking to instil a genuine business culture and are making every effort to bridge the private-public sector divide. The result has been a continuous increase in the number of PhD holders being hired by UK companies: 30% of science PhDs graduates in 1997 chose a private sector career, compared with 22% in 1994(1).

Private sector exodus

However, the latest figures from the UK Scientific Research Council show that quite a large part of the work of these private-sector PhD holders is not related to science and technology at all. In 1998, more than half of all highly qualified scientists recruited by companies were hired in the fields of management, production or finance. 'This means that the exodus from the public sector represents a real – and increasing – loss of human resources in the field of scientific innovation,' point out the authors of the report entitled *Human Resources in RTD*.(1) Another study by the Research Council (2000/2001) shows that just 52% of science PhD holders in the UK continue to engage in *bona fide* research following their doctorate.(2)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Switching science

Leading private sector players do not, however, take a negative view of what could be seen as another kind of 'brain drain'. 'These opportunities to change career course that industry is able to offer its researchers are very interesting for those who, at a given moment, envisage ending their research work,' asserts Léopold Demiddeleer, director of corporate and new business development R&D at Solvay Research & Technology (BE). 'They then move into the field of production or marketing (product development) or join the patent department. In a company whose activities range from design to application, an engineer or researcher can specialise in technical areas and why not join the management team at a production plant?'

Researchers themselves sometimes take unexpected directions from the outset. Marco Albani, a doctor of physics, works in the financial department of Caboto, a subsidiary of Banca Intesa, Italy's leading investment bank. 'It is only recently that physicists and economists have engaged in dialogue. The field of econophysics applies methods of statistical physics to finance. Risk analysis and certain computing techniques are derived from physics. In my job, I use 100% of the knowledge I acquired during my studies by applying it to the field of banking.'

(1) Benchmarking National R&D Policies: Human Resources in RTD, Strata-Etan expert working group, Final report, 21.08.02.
(2) In Denmark, on the other hand, 49% of science and 37% of engineering PhD holders employed in the private sector are mainly engaged in research tasks. Between 15% and 20% of them move to other activities in the course of their careers.

Michèle Gué: private-public

A researcher in the pharmaceutical industry for the past 12 years, Michèle Gué was sent by her company to work on a post-doctorate in the United States. All in all, Gué's career has traced an unusual path.

'This experience was not only of use to me personally, but also for the company and the host university which drew up the research contracts,' she explains. In the USA, Gué joined the team at an international laboratory. 'Working with colleagues who do not speak the same language or adopt the same approach to research was sometimes unsettling, but always enriching. When I returned I felt more European than French.'

Shortly afterwards, the company was taken over and her post disappeared. That led to 20 months out of work. 'The economic situation caused me to point my career in a new direction.' After passing the necessary examinations, Gué became a teacher and researcher at the Université de Montpellier II (FR) in 1999.

Her particular route has equipped her to understand both the public and private spheres, to build bridges and generally improve communication between the two – especially through students. 'Universities are too closed to the private sector and industry is too coy in its contacts with universities. A number of prejudices remain on both sides and – even if the situation is improving – it is difficult to break down the barriers. Personally, I want to show young people the opportunities which lie outside universities and the possible bridges between public and private research.'

One means of doing so is by organising *doctoriales®*. These are annual seminars attended by PhD holders in all disciplines and company representatives. The aim is to increase awareness of multidisciplinarity and the various forms of research partnerships with industry. At these seminars, young people work together in teams to set up an innovation project and present it to a jury of professionals. 'A questionnaire is handed out to the participants to assess their impressions and professional ambitions. After a week of getting acquainted with the world of industry, they acquire a different vision of their post-doctoral future. The percentage intent on an academic post falls significantly,' she notes.

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The incorruptible Marie

Marie Curie was the only famous person 'whom fame has not corrupted' – at least that was the glowing verdict of esteemed physicist Albert Einstein. RTD Info looks at the life of an exceptional woman scientist whose name has become a standard-bearer for the excellence of European research.

When Maria Sklodowska was born in Warsaw in 1867, Poland was under Russian rule. In this poor and humiliated country, where even speaking the national language was a crime, the acquisition of knowledge was a means of avenging a cruel fate. A brilliant student and polyglot, Maria attended the underground university where intellectuals gave courses in secret. Her first job, however, was as a governess, which she took in order to support her older sister who was studying medicine in Paris. Poland's universities did not admit women at the time.

In 1892, Maria became Marie and also moved to France. She soon made up for lost time, gaining a degree in physics and then in mathematics before meeting Pierre Curie. The physicist did not invite her out to dinner or a dance, but asked her to assist him in his work on a doctorate. They married in 1895 and had a daughter, Irene, in 1897.

Marie was now 30 years old. She and Pierre were both interested in the recent discovery by Henri Becquerel of a mysterious invisible radiation emitted by uranium. In a basic workshop, they built a complex apparatus able to detect these emissions for which they invented the term 'radioactivity'. They faced a daunting task, involving the analysis of a vast number of metal compounds and minerals. On 12 April 1898, in an presentation to the Academy of Sciences, Marie Curie announced that 'two uranium minerals, uraninite (uranium oxide) and chalcolite (uranyl copper phosphate) are much more active than uranium itself. This is a remarkable fact and suggests that these minerals may contain a much more active element than uranium.'

Glowing discoveries

Four months later, the Curies isolated an unknown metal – which they named polonium – whose activity is 400 times greater than that of uranium. Shortly afterwards, they made the key discovery of radium whose rays are a truly spectacular 1.4 million times more radioactive than uranium and are visible in the form of a luminous glow. This metal soon proved to be an invaluable tool in exploring the microscopic structure of matter. It was not long before doctors at the St Louis Hospital in Paris began to use it in the treatment of cancer.

Marie had a good year in 1903. She obtained her doctorate in June. In December, the Nobel Prize in Physics was awarded jointly to the Curies and Henri Becquerel for discovering natural radioactivity. But disaster struck in 1906 when Pierre was tragically killed in a street accident involving a horse-drawn carriage. 'Between his conception of things and mine, there was, despite the difference in our country of origin, a surprising kinship,' she wrote. But science continued. Known as the 'illustrious widow', Marie Curie became the first woman to teach at the Sorbonne. In 1911, she was awarded a second Nobel Prize, in chemistry this time, for determining the atomic weight of radium and studying its properties.

The war effort

The Institute of Radium at Paris University, built according to Marie Curie's instructions, had scarcely been inaugurated when the First World War broke out in 1914. Research now focused on a new front. To speed up the process of diagnosis, small vehicles equipped with X-ray equipment – known as petites Curies or 'small Curies' – were dispatched to the trenches so as to be able to treat and operate on patients more quickly.

When peace returned, the Institute started up again. It taught the science of radioactivity and trained researchers from far and wide. Irene became a research assistant to her mother. The latter, who had never sought personal gain from her discoveries, found herself having to devote considerable energy to finding the necessary funds to purchase the few grams of radium needed for the Institute's research.

She later witnessed the discovery of artificial radiation by Frédéric and Irène Joliot-Curie. She died in 1934 from leukaemia, brought on by her years of exposure to radiation – just the year before her daughter and son-in-law were awarded the Nobel Prize. It was 59 years later that Pierre and Marie Curie were reburied in the Pantheon, the final resting place which France reserves for its greatest citizens.