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eirma

PROFITING FROM RESEARCH AND DEVELOPMENT

ABB

Open up to opportunity

Innovation provides competitive advantage by enabling businesses to differentiate their products, protecting and enhancing profit margins and market share. As competition in manufacturing and services increases, there's little room for those that can only offer me-too products: more aggressive, lower-cost competitors soon out-run them.

What's been true in assembly for many years is now becoming true in activities that depend on innovation, as well educated workforces and developing industries in the former Eastern Bloc, China and India join the fray. Governments that believed a gentle transition to a knowledge-based economy would protect standards of living and jobs must recognise this isn't so.

Advanced economies can either try to fight globalisation or embrace it by seeking out the world's best talent and using it for mutual advantage. This issue of *Innovation Quarterly* discusses how best to use the opportunities that globalisation brings, drawing on the experience of four companies that are doing it well.

Globalisation provides one source of innovation. There's another that is often overlooked: universities and other public research organisations. The second feature in this issue looks at better ways for companies to engage with these organisations. At the heart of the discussion is the shift from open science to open innovation, in which the public and private sectors adjust their outlooks for the benefit of both. It turns out that, as with globalisation, the key to extracting benefits for both partners lies in co-operation, communication and mutual respect.

PROTON boost to university technology transfer

European industry should get easier access to university research, thanks to the creation of a network of technology transfer professionals.

PROTON Europe aims to promote and professionalise technology transfer at universities and other public research organisations (PROs). It was formed at the beginning of 2003 and now has members at around 120 universities in more than 25 countries.

"Everybody recognises pre-competitive research is very important. At least two-thirds of all such research is done within universities and PROs and it's the source of tomorrow's competitiveness," said Gilles Capart, chairman of the management board of PROTON Europe. "If we kill that we'll be completely at the mercy of the other economies in the world.

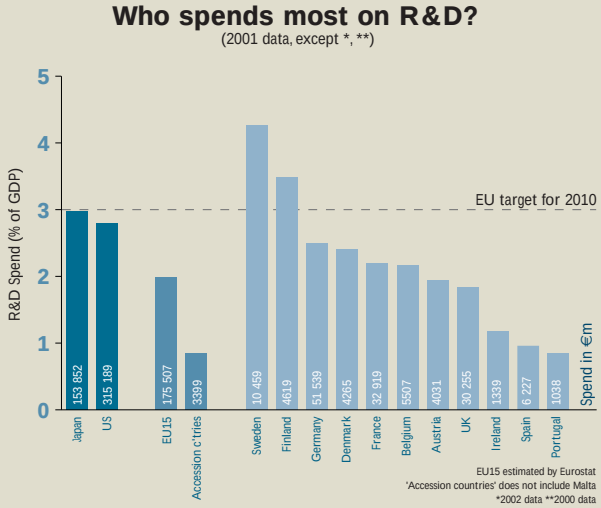
"The purpose of the network is to professionalise the technology transfer office mission and so to reinforce Europe's research potential," he added. Capart believes universities and PROs want to improve their technology transfer operations to help sustain their pre-competitive research base.

PROTON Europe has two missions: to increase the skills of technology transfer professionals through training and by sharing best practice; and to improve the recognition of the profession.

Capart also sees PROTON as aiding partnerships between industry and universities, and increasing the flow of start-ups.

"It's important but unlike in the US it is not a process that happens spontaneously. The process has to be assisted," he said. "You can increase the rate of spontaneous formation of companies two- or three-fold and this is usually in fairly new technologies. This is extremely helpful in rejuvenating the economy, so it is a long-term policy."

Capart: pre-competitive research is very important



The European Union must invest an extra €87 billion a year on research and development (R&D), at today's prices, to meet targets set in a bid to boost the region's position as a knowledge-based economy.

The European heads of state declared in 2000 that the EU should be spending 3% of GDP on R&D by 2010.

Figures for 2001 show EU R&D expenditure as a proportion of GDP was 1.98%, compared with 2.98% in Japan (in 2000) and 2.8% in the US.

Sweden and Finland show the highest R&D intensities, of 4.27% and 3.49%, respectively. Germany, France and the United Kingdom together account for almost two-thirds of the EU's R&D spend.

Europe will also need enough trained people to undertake and exploit the extra research the 3% target implies. This means involving more women, making it easier for the private sector to benefit from its research and increasing public funding to attract able people.

Help for small businesses

The European Commission has set aside at least €2.2 billion of research grants to help small- and medium-sized enterprises (SMEs) grow into large and sustainable businesses.

"Small and medium-sized enterprises are central to Europe's innovation and technological breakthroughs," said Philippe Busquin, European research commissioner. "It is vital for Europe's SMEs to have access to funding, knowledge and corporate partnerships."

The DETECT-it project will identify and encourage innovative SMEs to apply for funding under the sixth Framework Programme. €1.7 billion of the funding will go to sector-specific research carried out by SMEs. A network of business innovation centre incubators will cluster more than 1000 SMEs into these target sectors. Experts will be on hand to guide SMEs to the right funding programmes.

Venture capital company's latest investment recognises the value of university research

IP2IPO Group, a venture capital company that commercialises university technology, has invested in a speech-recognition software company that has been spun out from King's College London.

Phonologica was founded by Professor Roy Pike FRS, Clerk-Maxwell professor of theoretical physics, and Dr Barbara Forbes, a linguist. Their recognition system is based on an extensive mathematical analysis of how human beings speak.

The company expects its software will be undemanding of computing power, noise tolerant and applicable to all languages, dialects and accents. The market for speech recognition systems is expected to be worth $4 billion in 2005.

The Phonologica deal is part of a long-term relationship with King's College London, in which IP2IPO will help find and facilitate spin-outs. IP2IPO will invest £5m in spin-out companies over five years, in return for stakes in them. It also gets 20% of King's College London's equity in spin-out companies and technology licences.

A similar deal with the University of Southampton sees IP2IPO investing £5m in spin-outs over four years in return for a stake. It also gets 20% of Southampton Asset Management, the university's technology transfer company.

IP2IPO has also invested £20m in the University of Oxford's chemistry department in return for half of the university's stake in any spin-out companies and technology licences that are based on intellectual property the department creates.

At the University of York, IP2IPO has invested £1.15m for a one-third stake in a company set up to commercialise work from the Centre for Novel Agricultural Products (CNAP), which specialises in plant and microbial gene discovery. It will also invest in spin-outs based on CNAP's IP.

Apple's iPod success demonstrates the market value of open innovation

Apple sold more music players than computers in its most recent quarter, a tribute to a product developed using an open approach to innovation. The company shipped 807 000 iPods last quarter, up 909% on the same quarter last year. It shipped 749 000 Macs, just 5% more than a year ago.

Music player sales helped boost quarterly profits to $46m from $14m a year ago. Revenue for the quarter was $1.9 billion, up 29% on a year ago.

The iPod integrates expertise from a number of external partners. The player uses microprocessor designs done by ARM in the UK, data compression schemes from the German academic scene, American business management and Taiwanese assembly.

The miniature hard disc at the heart of the player comes from the merged hard-disc operations of IBM and Hitachi. It is assembled in Thailand from parts sourced from around the Pacific Rim.

The iPod's consumer-friendly design is helping Apple challenge the music industry's traditional business model. The iTunes music store has already sold 50 million tracks online in the US and will be rolled out in Europe later this year.

The player's international heritage has been reflected in sales, 43% of which are from outside the US.

Welcome to *IQ*

We know that we need to change how we innovate in order to compete as knowledge-based economies in an increasingly open world of global competition.

Innovation Quarterly sets out to accelerate this change by describing the business advantages of well-managed, well-connected research and development, discussing the best ways to organise the process and highlighting its successes.

IQ is a global and open publication. It believes that businesses compete most effectively when they organise themselves to apply the best ideas the world can offer, wherever these ideas are found.

IQ is produced by the European Industrial Research Management Association with the support of America's Industrial Research Institute. It draws on the tremendous experience of our member companies, discussed and developed in our programmes. This is our first issue – let us know what you think by emailing feedback@eirma.asso.fr

Professor Hans de Wit, EIRMA president

Only connect

Making the right links is vital to R&D, says Andrew Dearing

The success of a business depends on its ability to meet customer needs more effectively than its competition. Businesses use R&D to sharpen their skills and focus their technologies, to connect with customers and suppliers and so to gain a better insight into their markets.

So why, with a growing science base and better tools for applying technology and know-how, is there a crisis in R&D? Why do European governments wrestle with stagnant research investment, and research directors worry about how little value their companies place on R&D? Why are public research workers going on strike and young people losing interest in science and engineering? And why are these concerns shared by companies and governments around the world?

This first issue of *Innovation Quarterly* looks at the main forces driving industrial R&D today. Globalisation and open innovation are two sides of the same coin. Today's value-added products and services are too complex to create single-handedly, so collaboration is essential. New markets create opportunities to focus technology on to local needs, but this requires the insight that only close partnerships can achieve.

The knowledge economy is like any other. What you know is only valuable when you apply it. Businesses can only protect their unique knowledge by bringing all their resources to bear on applying it in a way that helps them stay ahead of the competition. Those that try to copy the successful approaches of others are likely to end up their pale imitators. Businesses should concentrate instead on honing their skills, so they can apply their R&D to remain ahead in their value chain.

More people are becoming sufficiently educated and connected to make meaningful contributions at the frontiers of knowledge. The most important task for those working in R&D is to make more productive connections throughout the knowledge economy. The linear model of R&D no longer applies. Basic research can no longer be relied on to drive applied research, which in turn will drive development and production. Instead, the problem and the opportunity lies in bringing advanced knowledge together in new ways to achieve products and services which add real value. Apple's iPod is a beautiful illustration of the point – it took a hardware company with a great feel for its customers to build the online music marketplace that record companies couldn't.

A key challenge is to make the best use of the entire research system and combine it with skills from design, marketing and manufacturing. European universities created the fine tradition of liberal thinking that equips graduates with the skills to produce world-class knowledge. Today, we need to gain more benefit from these skills and knowledge. This is why EIRMA, together with sister bodies in academia and public research, places so much emphasis on getting industry-university collaboration right. Solve this, and the universities' special role in pre-competitive research will be strengthened and their futures assured.

A second challenge is to achieve the conditions in which new companies grow to world scale. Creating more spin-offs from the science base is useful but these must then thrive. Europe is weak in this respect, because of the lack of connections between companies of all sizes. Creating vibrant clusters of excellence and 'technopoles' in Europe is much more about ensuring effective markets and world leadership for the products of R&D than about how much a region spends on research.

R&D is the only way to ensure that businesses will be able to adapt, survive and succeed. But today it is connections that make this R&D worthwhile.

Andrew Dearing is secretary general of EIRMA
adearing@EIRMA.asso.fr

Another man's treasure

Donating intellectual property to universities can have unexpected benefits, says Ross Armbrecht

"One man's trash is another man's treasure" is a great way of describing an emerging practice among US businesses: the donation of intellectual property rights (IPR) to universities and non-profit organisations. It's part of the growing discipline of active IPR management.

Active IPR management derives income, and sometimes a lot of it, from selling and licensing non-core IPR, as well from the use and enforcement of the patents on which the business rests. It cuts costs by abandoning patents that the company can't use. But it holds on to IPR whose existence will discourage a competitor from entering a promising nearby technology space. US businesses have usually held and maintained these patents, but not applied them. More recently, they have begun to realise they can create a three-way win by donating some of their valuable but unused patents and know-how to universities or medical centres.

Recipients find these donations have multiple benefits. On the financial side, IPR portfolios are enlarged, with the donor occasionally paying for the maintenance of the new property. New areas of inquiry open up and intellectual property is created as academics gain insight into underlying principles. Because the background IPR belongs to the organisation, businesses may be created in incubators or by entrepreneurs that license or buy rights from the university or medical centre.

In addition, equipment is sometimes donated along with the IPR. Professors get a better understanding of how basic research is turned into societal value. Students can try both basic and directed research and then make better career decisions based on experience.

Society also benefits from the new products, techniques and jobs that result from the donated IPR. The competitiveness of the regions where the recipient organisations are based may also improve. Donors benefit from improved relationships with academics working close to their fields of inquiry. The best students, who now understand the company's technologies, become potential employees. And the donated technology is controlled by the university until it is sold or licensed, rather than being immediately abandoned to the competition.

Shareholders may ask how companies can give away such valuable property. The answer lies in the nature of the research process. First, industrial researchers often uncover interesting phenomena that fall outside their research plan and the company's current business. The company may not have the time, money or skills to develop the technology to a point at which it can be sold or licensed.

Second, early-stage research demands that companies try many ways of solving societal problems economically. Companies then protect the most promising lines of inquiry with patents. Which of these lines, eventually, to commercialise depends not only on the underlying technology's strength but also on the company's competitive market position, its access to supply and distribution chains, its manufacturing capability, capital constraints, and so forth. The IPR of the lines not taken to market becomes an archived estate of knowledge with untapped potential for economic, educational and societal benefit.

Managing IPR through donations is a valuable strategy. But businesses must recognise it takes time to prepare the donation portfolio, effort to identify the right recipient and cost to have it valued. In the US these costs can be partially offset by deducting the value of the donated IPR from taxes, which makes it easier to justify to shareholders.

The Industrial Research Institute is currently educating the US Congress on the value to society of IPR donation, so that the enabling tax break survives Congress's efforts to cut the deficit. If this governmental incentive is not available in Europe, perhaps it should be encouraged for the health of business, academia and the local economies.

FM Ross Armbrecht Jr is president of the Industrial Research Institute
armbrecht@iriinc.org

UNILEVER

A global phenomenon

Companies are looking further afield to supplement their in-house research, writes Luke Collins

There's nothing new about companies supplementing their in-house research through academic relationships, contracts with commercial labs and business partnerships. What is new is that they now search the world for partners. Research is going global and businesses are working hard to understand how best to respond.

What's interesting here is that the search for partners represents a return to the past, with a twist. As the 19th century drew to a close, around 20% of corporate research was handled by third parties. This proportion dropped steadily during the 20th century, to less than 5% in the early 1970s. Businesses believed they could create sustainable labs in which Nobel laureates would do work that met their needs.

The central role of corporate labs is waning as the industries in which they were most successful mature. Today's products demand the integration of knowledge from many disciplines. Creating sustainable added value means businesses must turn strengths in production, design, responsiveness, services and R&D to their own benefit.

Globalisation is also strengthening competition in research. Well educated workforces in the former Eastern Bloc, China and India are joining the fray, thanks to deregulation and improved communications. These regions are attracting businesses that believe the emerging economies can help them improve research effectiveness without increasing costs.

So how should business adapt its research to the pressures of globalisation? How do you decide where to put an offshore research centre? What does it take to manage it? And will it save money?

The response from big pharma

Novartis Pharma faces the same issue as the rest of the pharmaceuticals business: it is a long, risky and difficult process to develop a new drug. According to Dr Romeo Paioni, head of scientific and external affairs at Novartis, bringing a new drug to market may involve a two- to four-year research effort in which up to 100 000 compounds are tested. Of these, on average, six to eight may enter a development and trials phase that can last up to seven years. Eventually a single drug makes it to market, up to 11 years after work on it began, at a cost of up to $800m (€650m).

Novartis wants to launch, on average, three new drugs a year. So it needs to keep its innovation pipeline filled by accessing new expertise, broadening its existing discovery platforms and exploring new hypotheses. This takes access to top scientists, which Novartis has achieved by building research labs in the US, Europe, Japan and, recently, in Singapore.

Above: Local research can help localise global brands
Below: Novartis has formed global collaborations

NOVARTIS

Novartis is backing the BioValley project, a tri-national biotechnology research cluster in the Upper Rhine Valley, to access the people and technology that emerge from the region and to foster the development of small to medium-sized enterprises. Two of its major global pharmaceuticals competitors are present in BioValley, along with four major universities, 30 life-science institutes and more than 450 small- to medium-sized life-science companies. BioValley is serviced by a network of government and commercial agencies dedicated to its success.

Novartis has also formed research collaborations with pharmaceuticals companies and academic institutes worldwide, activity which is now absorbing up to 30% of its $3 billion annual research and development budget.

The pharma giant spreads its technology-sensing network yet wider by using a venture fund to invest in life-science start-ups. This strengthens its ability to take advantage of emerging technologies, as well as helping it track the changing interface between traditional pharmaceuticals and biotechnology. The goal is to keep the Novartis innovation pipeline fed with discoveries that may lead to attractive therapies fulfilling major unmet medical needs.

Think – local

IBM, in contrast, is using globalisation to help it to develop as much of its research in-house as possible. Its annual R&D budget of $5 billion (€4 billion) sustains more than 3000 researchers in eight research laboratories, plus many more developers in 24 development laboratories worldwide.

IBM overall now employs more people outside the US than within and its research division has labs in India, China and Japan, as well as Europe. Dr Krishna Nathan, director of IBM's Zurich Research Laboratory, says IBM does research in India and China for much the same reasons it does research in Europe. The European labs help IBM understand the local market, access the local talent and technology specialisms, form relationships with academic and industrial partners and get close to technology clusters. It's not about cost.

"The cost of research is mainly in setting up a lab and creating the tools and technologies to do sustainable top quality work, rather than in the local labour rates," he said.

IBM's China Research Laboratory in Beijing was its first in a developing country and now employs 80 researchers and 15 support staff. Although it started out developing voice recognition software for simplified Chinese, work at the lab has broadened out into pervasive computing and other widely applicable technologies.

IBM's India lab is based at the Indian Institute of Technology campus in Delhi. Established with 26 staff in 1998, it currently employs 80 researchers, 35% of them with PhDs and 40% with Masters degrees. Local projects include Hindi speech recognition; machine translation for local languages; weather forecasting and work on the infrastructure for electronic governance. Like the Beijing lab, the India lab is also working on projects of global relevance, in e-commerce and in extracting value from unstructured information.

Managing each lab is different, Nathan says. The Beijing lab hires locally to access the best Chinese talent. The Delhi lab hires globally, competing with well-founded local IT companies on salaries as well as opportunities.

"Bringing a new drug to market may involve an 11-year effort"

Paioni

"The cost of research is in setting up, rather than in the local labour"

Nathan

"Global products need global knowledge"

Biggs

"You don't invest in poor researchers"

Norton

IBM

Do's and don'ts of globalising research

- do make offshore labs equal partners in your global network
- do globalise to access pools of talent
- do globalise to access local expertise
- do make strong links with local government, institutions and academia
- do ensure all research labs can share knowledge easily
- don't treat offshore research labs as second best
- don't expect wages to stay low
- don't be surprised to have to compete for staff
- don't globalise to cut costs – it's the wrong motivation

Nathan says that for both labs, relationships with local government and industry have been critical. Strong leadership and project management skills are vital, as is the need to stay connected to the rest of the company. But what appears to be most important is the attitude with which the labs were formed: "This is not off-shoring; they are equal partners," Nathan said.

Green tea (and other things) in China

IBM launched a lab in India based on its experience with the China lab. Unilever has done the opposite, using a positive experience of its two labs in India to give it the confidence to set up in Shanghai. Like IBM, though, Unilever is globalising its research to reach both pools of talented people and the knowledge embedded in the local culture.

Unilever sets aside around 10% of its R&D budget for a 'blue-sky' fund, controlled by the board. In 1996 it decided to use the fund to establish a research presence in China. It chose Shanghai because Unilever has a business there and because it is a dynamic city with a strong academic presence in chemistry, natural materials and traditional Chinese medicine.

Unilever recognised local relationships would be vital and so started off by forming a joint fund with the Shanghai Commission for Science and Technology, to back publishable scientific research through grants and studentships. The general shortage of organic chemists in Europe then led Unilever to work with the Shanghai Institute of Organic Chemistry (SIOC), to create Unilever Research SIOC (URSIOC), as part of the Institute.

Prof Ian Norton, chief scientist at Unilever's Colworth R&D laboratory, says that, reflecting its truly global outlook, the company appointed the head of its India lab to form the China lab, working with a Chinese person who had been employed by Unilever in the US.

As work at URSIOC began to pay off, Unilever's foods group became interested in traditional Chinese medicine and formed a research program to study its potential health benefits. In 2001 the board reviewed its five-year experiment and decided to focus its work on traditional Chinese medicine and ageing. This led to the founding of Unilever's sixth global R&D lab, in Shanghai in 2003.

Norton says the China experience has taught Unilever the value of being connected to the local powers-that-be, employing good local leadership and of communications. And it has taught the company about cost.

"Never globalise research in terms of cost but in terms of quality, focus and delivery," he said.

From small beginnings...

Unilever's blue-sky fund has enabled it to experiment with globalising its research in China. But you don't have to be big to benefit from the best talent and relationships that the world offers your industry. Pixology, a 32-person digital-imaging software company, has shown it is possible for small companies to form global research relationships.

Pixology started as a software company serving the image-processing industry. In 1997 it realised that its image-recognition software could be offered as a standalone product to help retailers sell the new digital cameras. Deals with Kodak, CompUSA and other major chains followed and the software did well, until it became too difficult to keep up with all the different models available in the digital camera market worldwide.

Nigel Biggs, founder of Pixology, says the lesson was simple: "Global products need global knowledge," which is difficult for small companies to sustain. But even as the retail software was being left behind by a rapidly changing market, Pixology's ability to reduce 'red-eye' effects in flash photography was exciting interest from Japanese camera makers.

Biggs found that selling red-eye correction software to camera makers put him in direct competition with their research labs. But a deal with US chipmaker Texas Instruments (TI), to

embed the software into digital camera chips, offered a way forward. TI provided engineering support from India, Japan and the US to help Pixology embed the software into camera chips.

The resulting solution will be applicable to digital still cameras, camera phones and camera PDAs. Biggs said: "I want our software to be the Dolby of the photography industry."

The experience has taught Biggs about the mismatch of expectations between small companies and large when it comes to working together. Biggs says small companies often see themselves as too small to work with a large company, or fear their ideas will be stolen. Large companies may feel they can ignore small companies because they haven't heard of them, don't have that problem or are already working on it in their labs.

"Every failure [to exploit] a good idea that would have been profitable is a loss to the community and the economy," said Biggs. He advocates the use of enterprise hubs to act as trusted intermediaries between academia, small companies and large enterprises to ensure good ideas are taken up.

Lessons for Europe

It's clear that globalising research can save some costs. But to globalise research simply because it is cheaper abroad doesn't make sense.

"You might as well put your money in the middle of the room and burn it," said Prof Norton.

Instead, companies should use globalisation to seek out pools of talented people and regional expertise, especially when the two can be combined as Unilever has done with its research into traditional Chinese medicine.

Businesses should make strong links with regional authorities and institutions wherever they want to set up a research lab, and treat each lab as an equal partner in their global research effort. With the increasing importance of multi-disciplinary research, labs must be able to share knowledge effectively worldwide.

Norton says that although costs offshore are about ten times lower than in Europe, that isn't the issue. "The danger from China is not the cost, it is the quality and the inventiveness. If the R&D function in Europe is not of the right quality, [the work] will move."

The challenge to European research organisations is the same as it has ever been – to compete with the world's best. Perhaps, as with the return to outsourcing, Europe is now in the same situation as it was at the end of the 19th century, facing a new wave of competition. Only this time the upstart is not a newly emerging America, but the rest of the world.

PIXOLOGY

What does the globalisation of research mean for Europe?

- governments must foster continued investment and economic development
- companies must understand how the intersection of disciplines can lead to innovation
- universities must nurture the right skills
- people must be able to move from one country to another more easily
- labour laws must become more flexible
- risk-taking and entrepreneurship must be encouraged
- failure must be respected as a valuable learning experience
- … we must keep innovating

Source: Dr Krishna Nathan, IBM

NOVARTIS

Top left: IBM's lab, based at the Indian Institute of Technology campus in Delhi
Top right: Pixology showcased its software at a key Las Vegas trade show
Right: Novartis is backing the BioValley project in the Upper Rhine Valley

Closer relationships between companies and academic institutions are changing the way research-led innovation takes place, writes Andrew Dearing

Moving from open science to open innovation

Remarkable changes are under way in research-led innovation. Companies are becoming more concerned about their links with universities, because the development of modern products and services brings together more disciplines and therefore demands greater co-operation.

Governments are also recognising the need for closer collaboration. They are developing policies to encourage stronger public-private research partnerships and to improve the value that comes from public investment in R&D.

Yet companies, universities and public research and technology organisations (RTOs) emerge from very different traditions. How can they work closely and effectively, without losing their distinct roles?

Current strategies

The Netherlands has an approach that appears to work well. Technology transfer initiatives work through virtual research institutes, where the needs of industry and of universities are combined. Half the finance for the resulting projects is provided by government, with a quarter each coming from the industrial partners and the universities. The industrial partners have the biggest say in project selection.

Rolls Royce has developed another collaboration model over the last decade, using strategic research partnerships with a tight group of leading universities to take the place of a large corporate R&D effort.

Both approaches aim to create a long-term commitment between partners. By establishing frameworks that emphasise industrial requirements and build trust, everyone stands to gain. And it's as challenging to solve a scientific problem for industry as for the love of knowledge. Other benefits also emerge from solving these problems jointly. A virtuous circle is created and everyone gains as more brains are applied and more people see the importance of finding good solutions to industrial problems.

Or that's the theory.

Senior delegates from European companies, universities and RTOs met in February to discuss which of these approaches really work. Many thought they would spend their time discussing the details of research contracts. Instead, the meeting came up with a belief that industry and universities can work together for mutual benefit, and produced a set of guidelines to help make it happen.

Three models of knowledge transfer

Universities, especially in Europe, have traditionally practised 'open science'. This means doing research and retaining the rights to publish the results, but leaving the application of whatever is discovered to industry. The approach is intellectually 'clean', but wastes a lot of the potential economic value of the new knowledge. Either it goes unused, or it is disclosed in ways that dissipate its value. More than half of the potential intellectual property (IP) that universities create is lost in the first stages, according to some studies.

Universities that are trying to make the most of their IP face another hurdle. Industry expects to have strong rights to use

the intellectual products or services that it pays for. So universities need to sort out the legal and procedural issues that enable this and develop the skills and systems to sustain them.

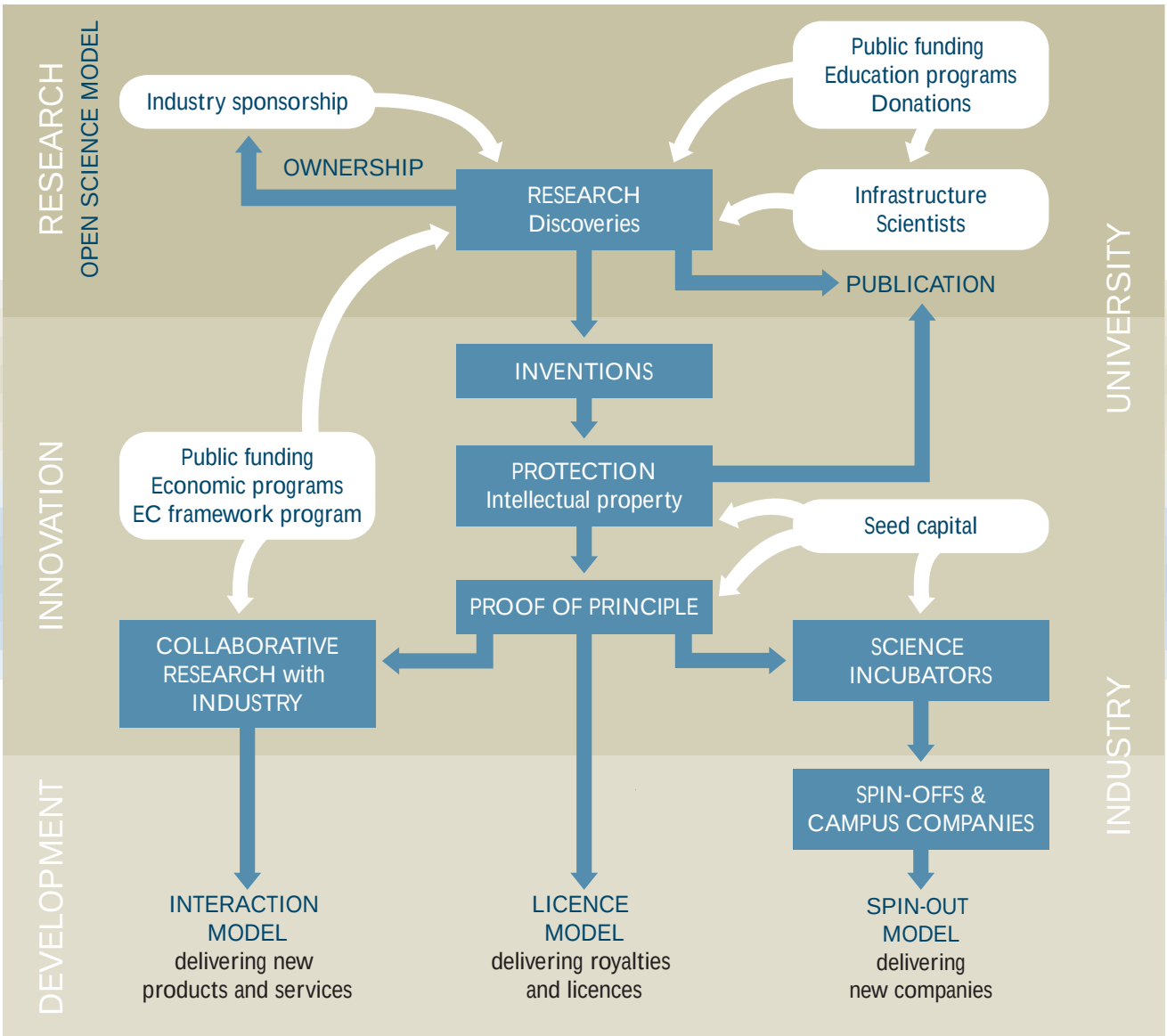
Three ways to transfer knowledge are being tried out to overcome the shortcomings of the traditional approach to university research (see figure).

In the licensing model, institutes manage their own IP and generate revenue as a result. This has been applied by leading American institutes for some time, but does not work well in Europe for a variety of cost, attitudinal and legal reasons. Recent US studies show it doesn't work well there, either. Few university-granted licences in the US earn more than they cost to set up and manage.

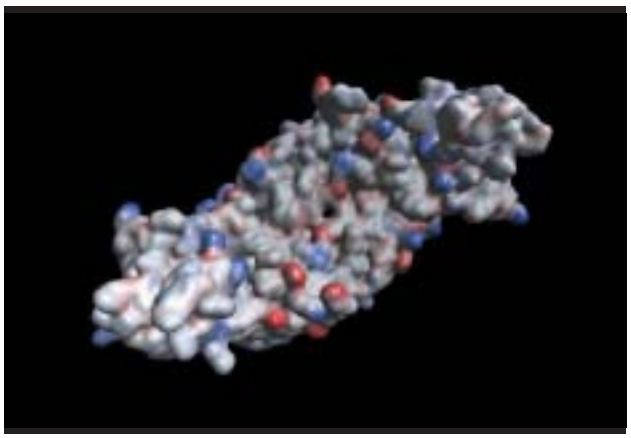
A second approach to knowledge transfer is for universities to help create spin-out companies, often led by their academics. This means that researchers must play a more active role in showing that their discoveries work. The approach is being applied in Europe, but slowly and with little spontaneity.

The third approach, and the focus of the February conference, is to encourage universities and industry to collaborate more. It builds on existing university strategies such as licensing and active IP management but encourages both sides to see innovation as an interactive process.

Many delegates at the February meeting believed that the approach already works in Europe, but can be improved. They identified ten guidelines (see box overleaf) which, if followed, should improve the value and quality of collaborative R&D. Applying the guidelines means changing the way people behave within companies, universities and RTOs, so that the organisations can embrace open innovation. ▶



Three ways in which industry can engage with the open science of academia



UNIVERSITY OF OXFORD

The cancer-beating properties of molecules like this are being investigated by a company spun out of Oxford University

Two principles: responsible use; maximum beneficial use

The logic behind the guidelines is to develop a sense of the mutual benefit and responsibility that comes from a well-functioning system for bringing knowledge to market. Putting the guidelines into practice requires a common commitment.

Two principles have been put forward to help turn these guidelines into a consistent system for managing collaborative R&D.

The first principle is dubbed *responsible use* and is derived from the voluntary *responsible care* programme that the chemical industry has adopted to raise standards and win greater trust. It implies that companies recognise and acknowledge the contribution that others play in determining their success, and take steps to explain and manage how they work with universities and public research institutes.

The second principle, *maximum beneficial use*, acknowledges that universities also have vested interests in the application of new knowledge by society at large and will take steps to ensure that this happens.

Companies, universities and RTOs all want to know how to select effective research partnerships and with whom. These principles and guidelines suggest that it is possible to make substantial improvements to the effectiveness of collaborative R&D between the public and the private sector, and that the professionals involved know how to do so.

The key to encouraging partnerships lies in making it easier to identify sources of innovation and industrial requirements and making it easy for partnerships to work. The resultant improvements will have knock-on benefits throughout the innovation system, including strengthening the research purposes that universities exist to serve. Getting collaborative R&D and knowledge transfer right lies at the heart of ensuring Europe remains a leading knowledge-based economy.

Ten guidelines for collaboration between industry and universities

Recognise a common interest in having strong, well connected academic institutions
Universities and companies have different roles in society. Acknowledging this lays the foundations for effective collaboration.

Decide and communicate how collaboration is expected to help the mission of the company or the university
These decisions should come from the top, to ensure they are consistently understood and applied.

Identify common interests and needs
Organisations should invest time and effort in identifying the right strategic partners, understanding what they offer and what they need, and forming durable approaches for managing and delivering results.

Organise for long-lasting relationships
Making a long-term commitment to fund research depends on developing trust that the results will match expectations. Universities that handle this well will strengthen their positions and improve the relevance and recognition of their work.

Use professional skills to support your policies
Collaborative R&D needs support from professionals with a rich mix of skills. Universities and companies should jointly commit to training people to have this mix of skills. They should also ensure that the role of staff with this mix of skills is trusted and understood, so that they are called upon to apply them. Academics and business managers should be taught the importance of managing IP to create value, but these support professionals and organisations should not be seen to drive your main mission.

Start collaborations by identifying expectations
Stating your objectives at the start makes clear what you want and eases contracts and project management.

Talk to each other!
This helps develop standard processes and shares good practice, and should be central to management development.

Aim for quality, not quantity, of IP
Patenting must not become a 'catch-all' tool for protecting IP.

Extend university courses to develop the skills for open innovation
University degree courses provide a safe learning environment in which students can explore and develop entrepreneurial skills without risk.

Encourage a cross-disciplinary view of innovation within university courses
Modern innovation means combining many technical, sociological, design and other creative elements. University courses should reflect this so they develop people with the skills to integrate many disciplines.

Nanotechnologists call for return to Renaissance thinking

Nanotechnologists should lead a return to Renaissance thinking about science, according to speakers at a colloquium held in Brussels at the end of April.

Michael Roco, key architect of the US's National Nanotechnology Initiative, said that disciplines such as biology, micro-electronics and cognitive science can converge at the nanoscale.

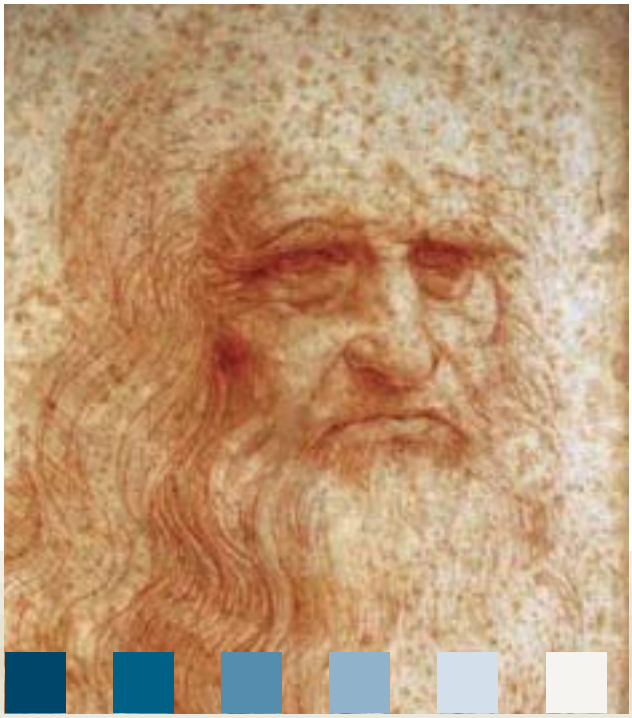
"We want to develop an integrative approach for converging science and engineering from the nanoscale and the systems level," he said. "The Renaissance considered the unity of matter and the nanotechnology age represents a return to that thinking, a transition from considering discontinuous matter to considering continuous matter."

Professor Carlo Montemagno, chair of the bioengineering department at UCLA, demonstrated Roco's point. He described how he has been able to get cardiac cells to grow at fixed positions on a wishbone-shaped silicon 'skeleton', built using techniques borrowed from microelectronics.

The skeleton incorporates a micro-generator that creates power when the wishbone arms move. By changing the culture conditions Montemagno was able to get the cardiac cells to develop into muscle fibres, attached to the skeleton at fixed positions. Feeding the cardiac cells with glucose caused them to contract and relax, generating up to 1μW.

Michael Roukes, director of the Kavli Nanoscience Institute at Caltech, discussed techniques for doing mass spectrometry by weighing individual molecules using nano-cantilevers. His team has already produced cantilevers that can resolve down to atto-grams (10^{-18}g). He wants to apply the same techniques in fluids.

"The motivation is to do therapeutics on individual cells for individual patients," he said.



Common market plan to boost European research

The European Commission will create a 'common market' for research in a bid to meet targets set in 2000 to help create the world's most competitive knowledge-based economy by 2010.

The European heads of state said then that the EU should spend 3% of gross domestic product (GDP) on research by 2010. Latest figures show the actual investment is 1.9% of GDP.

"We want to create a real internal market for research," said Robert-Jan Smits, interim director in DG Research responsible for structuring the European Research Area (ERA). This means easing technology transfer across borders, making it easier for researchers to move between countries and developing a European patent.

"We will use the sixth Framework Programme as a tool to create the ERA, spending more on instruments of co-ordination and structuring as well as projects to increase competitiveness," Smits said.

The Commission wants to link national research efforts into community-wide programs and will provide financial incentives for those who do so. It is also planning to increase its spending on research, from €17.5 billion now to a proposed €40 billion for 2006 to 2013.

"It shows that research and technology have become primary policies, alongside issues such as competition and social affairs," said Smits.

The money will be used to co-ordinate national programmes, support technology platforms and to set up a European Research Council. Existing support strategies will be developed and sustained.

There are similar responses at national level. The UK government plans to increase its spending on science and technology more quickly than GDP grows until at least 2008.

Finance minister Gordon Brown used his March budget to unveil a plan to create a ten-year investment framework for science and innovation and to strengthen medical research.

He also committed to increase National Health Service funding for R&D by €150m by 2008. This will boost the budget for medical research and for R&D within the NHS to around €1.8 billion a year by 2007/08.

Why patent quality matters...

... and what can be done to improve it. By Dominique Guellec

Society grants patents to encourage the invention and sharing of technology, so it makes sense for patent systems to try to ensure that the patents they grant are of high quality.

But what is a high-quality patent?

A good patent encourages useful inventions and provides its holder with revenue to compensate for the money spent and the risk taken to create it. A good patent also enables an invention to disseminate through licences and allows innovation by third parties.

Patents used to be seen as providing an incentive to invent, but they are now also being seen as helping technologies to be applied by those best placed to do so, who are not necessarily the inventors. Patents are now both a reservoir and a vector of technology.

You can understand what makes a good patent by considering what makes a bad one. There are various types of bad patent: ones that are not really inventive; that give their holders excessive licence fees; or that do not clearly state what they protect.

Why does quality matter? Bad patents send the wrong signals, making inventors focus on seeking licence revenue and low-risk activities instead of inventive and competitive ones. This is bad for economies since it slows economic growth and distorts the way income is distributed.

The patent office has traditionally used two major instruments to produce high-quality patents: the inventive step and the scope of protection. The inventive step defines a minimum level of inventiveness. Granting patents to small inventions undermines larger ones, because they are quickly overtaken. Small inventions are also often inexpensive, so will be exploited anyway.

Patents are also defined by the scope of protection they provide. Too broad a scope reduces competition and impedes technological progress by third parties. Too narrow a scope provides too little revenue to make the innovation worthwhile.

The patent offices must also ensure granted patents are clearly drafted, to avoid ambiguity being used to deter competitors. Ambiguous patents also undermine a key principle of patents, which is to disclose new technology.

Technical and legal criteria are used to decide whether to grant a patent, rather than economic criteria that are difficult to assess. Economic considerations are only implicit in the standards of patentability. As such considerations become more important, research is needed on considering them explicitly in the patent system.

So what can be done to improve patent quality? Patent offices need to be properly resourced so they can undertake high-quality searches and examinations. The European Patent Office (EPO) has adapted its working methods to ensure it can continue to offer high quality patents, despite a surge of applications in the late 1990s.

Patent offices should also take a broader approach to quality by evaluating the economic aspects of a patent. The issue then becomes how an institution such as the EPO could do this. Patents shouldn't be granted with over-extensive claims, but should the same apply to published patent applications? Should the patent system prevent patents from closing a market or blocking a line of technological development? The practicalities are difficult but should be addressed.

Applicants also need to do their part by making high-quality applications. The EPO faces a flood of low-quality applications, which have been badly drafted, or made claims that are too broad or too numerous (almost 9000 in one case). Dealing with poor-quality applications costs the EPO and ultimately the applicants and their customers.

It is in the interest of society and applicants to cut the number of low-quality applications. We need to act at all levels: in the rules of patenting, in the way the patent office works and in the way applicants manage their filings.

Dominique Guellec
Chief economist
European Patent Office
dguellec@epo.org

Dr Markus Bayegan

chief technology officer, group R&D and technology, ABB

Dr Markus Bayegan leads a small team of managers and a wider research organisation that provides a steady stream of innovation to ABB, the global power and automation technology company. Between half and two-thirds of the products and services ABB sells (depending on market), are based on innovations made in the last five years. With $18.8 billion (€15.5 billion) of revenue in 2003, that means a huge demand for effective R&D and knowledge transfer. How does he do it?

A typical working day for Bayegan starts with breakfast in a hotel "somewhere in Europe, the US or Asia". This is followed by meetings with ABB's local sales and marketing organisations as well as research staff from business areas and group R&D. The agenda covers technology, new product launches, customer and market requirements, competitor products and what that means for R&D.

Early afternoons are spent with a university or giving a conference presentation. A late-afternoon visit to an ABB factory may be followed by dinner with local politicians, university professors or press. The day ends with a late flight to another round of meetings, or home.

ABB spends $95m (€78.3m) on group R&D, $520m (€429m) on product development and a further $320m (€264m) on order-related engineering. With around 7500 engineering staff worldwide and a further 700 research scientists, it's no surprise that one of Bayegan's main concerns is the effectiveness with which these resources are applied.

"The greatest challenge is always the issue of efficiency in R&D. Are we creating enough value out of what we invest?" he said. An important issue is which research ABB does itself, and which can be outsourced.

Bayegan is rapidly globalising ABB's research to match its business base.

"Globalisation is a matter of survival for most industries," he said. His strategy is to optimise the value created by each R&D dollar. This means tapping in to intellectual assets from around the world.

Other overarching concerns for Bayegan include maintaining an active knowledge network that can help evaluate technology trends and provide outsourcing partners. This is so important that the responsibilities for strategic and operational management in ABB's labs have been split, so staff can spend more time looking outside ABB.

All these efforts have to be aligned with the annual strategic planning effort, which analyses customer needs, competitive trends, emerging technologies and intellectual properties. Its output is detailed technology road maps, strategic directions for R&D and a set of research projects, with a balance of short-, mid- and long-term goals.

This is where the R&D manager's particular skill comes in.

"The most difficult part is in the front end, where you make strategic decisions to move into a new technology or leave it," said Bayegan. "That's when you make the most expensive mistakes. There is no planning tool that guarantees the outcome. The final decision has to be made by human expertise."

But risk is vital, he says. If you're not failing occasionally, then you're not taking enough risks. It means you are not doing the relevant things. ABB also needs to cope with outsourcing parts of its R&D. ABB works with more than 50 well known universities, and its prerequisites for success are matching projects to the right people and universities and professional follow-up.

So what drives Bayegan?

"I have taken the job because I like doing it," he said. "It's a great pleasure and satisfaction to me to work with technology and entrepreneurs. It's about people who want to use technology to change things, which can shape the future of our world and life." ■

Looking backwards

Maths, law, patents and politics

In 1913, a Mr Harold Potts wrote to *Nature* setting out a process for assessing patent quality. He proposed that inventiveness *I* depended on incremental ingenuity *i* and manufacturing process *M*, so $I = M + i$, demonstrating his method using developments in chemical dyes, glass furnaces, and ladies' hats. Mr Stafford Cripps, a future British finance minister, said the equation was useless.

"Potts seems to have chosen a rather complex method of setting out a few of the chief principles of patent law," he said.

Would we like to see this sort of debate today? Perhaps not: Cripps was widely seen as a killjoy. "Wherever Stafford has tried to increase the sum of human happiness," a colleague noted, "grass has never grown again."

Looking forwards

In our next issue

- Why has entrepreneurship become important in business R&D?
- What does it mean in an environment where team effort is so important?
- What is an R&D entrepreneur?
- How can you encourage people to behave this way?

The September issue of *IQ* will examine these questions and look at companies that are handling them well.

Forthcoming EIRMA events

- Increasing the entrepreneurial spirit of R&D
- Addressing climate change within R&D
- The European Research Area: towards the seventh framework programme
- The environment for business R&D in eastern Europe
- Business area processes for shortening timelines
- From project to multi-project management

The 2005 programme will cover:

- Radically new ways of doing R&D
- Benchmarking R&D effectiveness with the US and Japan
- The global versus the local approach
- Effective transfer to the market
- Creating an attractive environment for R&D and innovation
- The role of technopoles in innovation networks
- Learning groups will be organised on:
  - portfolio planning
  - technology monitoring
  - market intelligence
  - roadmapping

For full details visit our website, www.eirma.asso.fr

About EIRMA

"The best management development happens when experienced managers come together to learn from each other, to discuss common concerns and visit each other's companies" – *Financial Times*, 31 March 2004

The European Industrial Research Management Association (EIRMA) has 150 member companies based in more than 20 countries. Collectively they fund the major proportion of business enterprise investment in R&D in Europe.

EIRMA is an independent, not-for-profit organisation, which aims to enhance innovation through more effective market-oriented research and development. Unique features of the Association include the networking and personal contact that the *Financial Times* recommends. It's been offering this forum for nearly 40 years.

EIRMA provides a platform for discussing ideas and exchanging practical experience. Its activities support companies in benchmarking and improving their innovation processes through well-managed and well-organised research and development. These establish EIRMA as a natural first point of contact for policy makers and others seeking the business community's insight.

Facts and figures

- China now counts more researchers than Japan and is on its way to overtaking the EU, a huge expansion since 1999. *(OECD)*
- China's share of patent grants or applications at the US Patent and Trademark Office and the European Patent Office is still small. However, the proportion of patent applications that are co-owned by foreign residents and foreign co-inventors is higher for China than for other major economies. *(OECD)*
- More than half of start-up companies in California's Silicon Valley are founded by Indians and Chinese. *(OECD)*
- There are sharp differences in the numbers of people working in R&D: 5.7 per thousand of the workforce in the EU (but 13.8 in Finland), 9.1 in Japan and 8.1 in the USA. But children who live in countries with high R&D employment tend to have the most negative views about science and technology. *(EU surveys)*

Credits

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