

# Inventions & Patents

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## European bloc struggles as Beijing goes high-tech

China is the highest climber in the European Patent Office rankings, reports *Tanya Powley*

Robotic equipment fills every nook and cranny of a laboratory at Imperial College in central London. In one corner is a mock-up resembling an old-school arcade video game that uses 3D eye tracking technology to enable paralysed people to translate their thoughts into actions. Nearby, a soft robotic arm that could safely interact with humans is being developed.

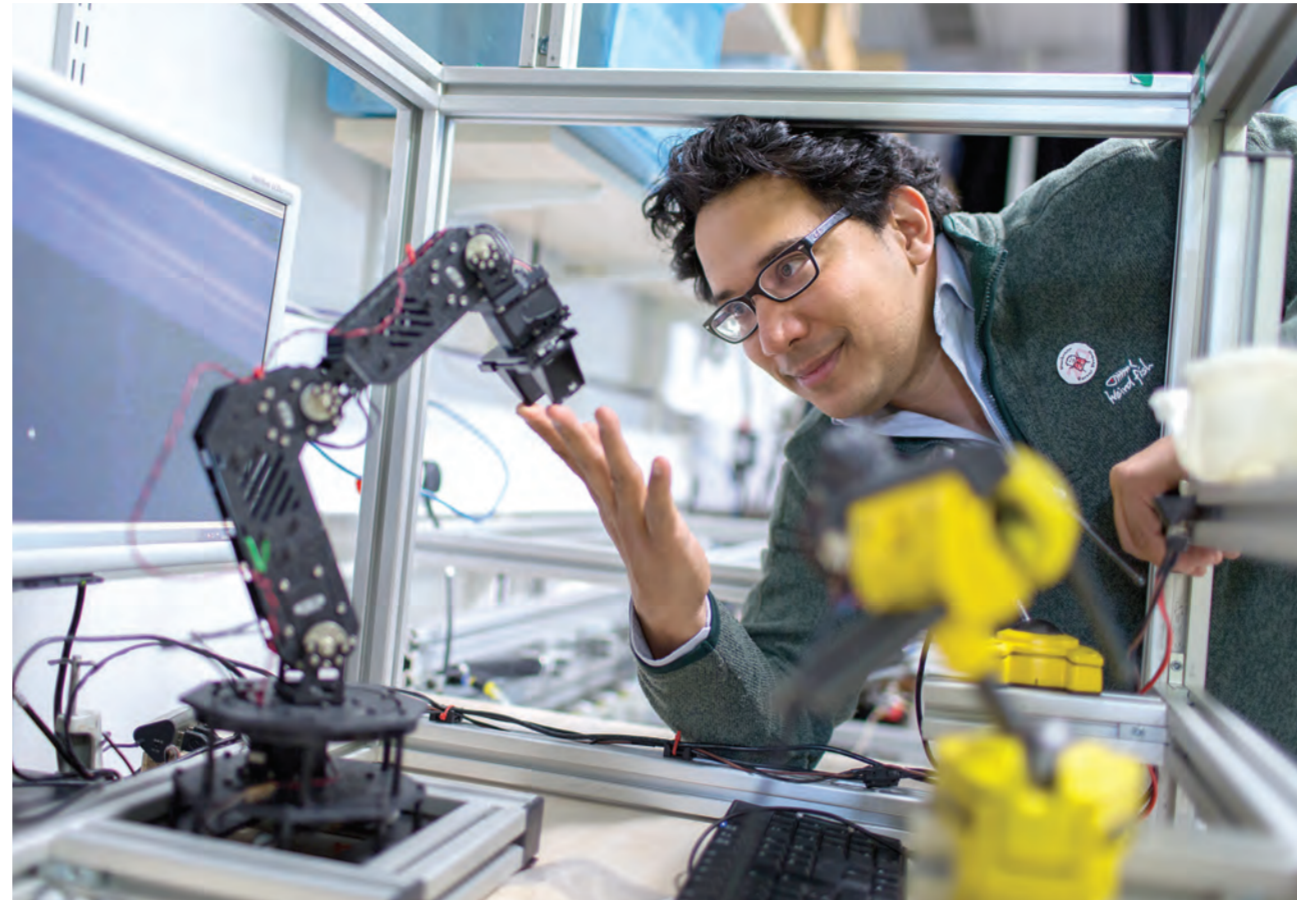
Investment in technologies of the future is seen as crucial for driving innovation and economic growth around the world.

In 2014, about \$1.6tn was spent globally on research and development

(R&D) in a range of engineering-related disciplines from robotics to social media, according to estimates by Battelle, the US science and technology development group.

Aldo Faisal, a senior lecturer in neurotechnology at Imperial who runs the Faisal Lab, says innovation is crucial when it comes to capturing a share of a rapidly growing market such as robotics. He recently started work on a €4m project funded by the European Commission's Horizon 2020 programme, to develop assisted robots that can interpret the needs of elderly or paralysed people from their eye movements.

"This was one of four projects funded



Working with robots: Aldo Faisal, a senior lecturer in neurotechnology at Imperial College, London

in the field of new ways of interfacing with robots," says Dr Faisal. "A key thing for personal robotics is that it has to be personal. So, how can you personalise a robot? How can a robot learn from you? That's one thing we are interested in and the other thing is how can you control and guide interactions with the robot or the other way round, how can the robot

read your mind to do the things you want it to."

Over the past 40 years, global R&D has largely been dominated by Europe, the US and Japan. However, other countries – in particular China – are stepping up their game. In 2011, China surpassed Japan's overall R&D spending.

By 2018, Battelle believes China could overtake the combined spending of Europe and, by about 2022, exceed the investments of the US in absolute terms.

In May, the Chinese government published a sweeping "Made in China 2025" strategy, that detailed plans to move from mass-market manufacturing to high-tech industries such as space, green energy and bioengineering.

"R&D funding and capacity for R&D performance are the origins of innovation and commercialisation," says Brett Bosley, vice-president of technology commercialisation at Battelle.

"The advancement of technology in society has accelerated the rate of patent applications and scientific publications – leading indicators of innovation – in China, and Asia's share of Nobel Prizes in science and medicine has been growing at the expense of the US and Europe."

Evidence of China's innovation push is noticeable in European patent activity for 2014. Filings from the US, Japan and China accounted for 53 per cent of

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## EUROPEAN INVENTOR AWARD 2015 THE EUROPEAN PATENT OFFICE CONGRATULATES THIS YEAR'S WINNERS



### INVENTORS ARE THE HEROES OF THE 21ST CENTURY ECONOMY

Innovation creates competition, dynamic markets, jobs, prosperity and growth. Ingenious inventions in such technologies as healthcare, transport and communication can improve our lives and protect our environment. Inventors are the champions of progress, refusing to accept the status quo and harnessing the forces of nature to create new products and processes.

The European Patent Office protects inventions with patents. From a field of many thousands of patentees, the European Inventor Award recognises – for the tenth time – truly exceptional individuals or teams.

These inspirational inventors secure our future. Many of them dedicate their entire lives to improving ours. We thank them for their contribution to technology, society and the economy.

### THIS YEAR'S WINNERS

**INDUSTRY 1A** Franz Amtmann **1B** Philippe Maugars Near Field Communication (NFC) technology **SMEs** **2** Laura van 't Veer and team Gene-based breast cancer test **RESEARCH 3** Ludwik Leibler Vitrimers – a new class of polymers **NON EUROPEAN COUNTRIES** **4A** Akira Koshio **4B** Sumio Iijima **4C** Masako Yudasaka Carbon nanotubes **LIFETIME ACHIEVEMENT** **5** Andreas Manz Microchip-sized analysis system **POPULAR PRIZE 6** Ian Frazer and Jian Zhou† Vaccine against human papillomavirus (HPV)

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## Inventions &amp; Patents

## Introduction of unitary system comes a few steps closer

## EU regime changes

Various obstacles have been overcome and procedures are being hammered out, reports *Clive Cookson*

Slowly but surely, a single European patent system – first discussed more than 40 years ago as a way to smooth out the continent's fragmented intellectual property (IP) protection – is moving towards fruition.

Last month, the EU Court of Justice removed the last big legal obstacle, when it dismissed challenges from Spain against the new "unitary patent" and the accompanying "unified European patent court".

For those unversed in the IP world, the complex European patent scene

takes some getting to know. The European Patent Office was set up in Munich in 1977 as an international treaty organisation outside the EU; there are currently 38 member states. The EPO examines and grants patents, but holders then have to register and enforce these at the national level.

The new system, set in place at the end of 2012 under the EU's "enhanced co-operation" rules, will be grafted on to existing EPO procedures.

The EPO will continue its search, examination and granting activities, both for the present system and for the new unitary patent, which will apply only to EU member states that sign up for it. Applicants will have the option of seeking patents under either the old or the new system.

The timetable for introducing unitary patents is slipping – an inevitable consequence, perhaps, of all the work needed to set up an entirely new legal

system to administer it. A couple of years ago, optimists were talking about starting early in 2015.

Now, says Alan Johnson, IP partner with London lawyers Bristows, "even the most optimistic estimates are not talking about a start-up before October 2016 and some time in 2017 is more realistic. The Commission had an utterly unrealistic timetable originally. "As the UK Intellectual Property Office has argued from the beginning, it is better to proceed slowly and get things right than to rush in."

Benoît Battistelli, EPO president, still hopes the unitary patent package will come into operation in the course of 2016.

The unified patent court, which will provide legal enforcement for the new system, will have a decentralised structure designed to spread the work around the EU. Patent disputes will be heard initially in a Court of First

Instance with a central division in Paris and sections in London (looking after chemicals, pharmaceuticals and life science) and Munich (engineering and physical sciences), as well as local and regional divisions.

There will be a Court of Appeal and a registry, both in Luxembourg.

The court will also have a patent

Italy and particularly Spain. Italy has dropped its initial opposition and now plans to join.

Meanwhile, a lot of work has taken place, recruiting and training judges and establishing procedures that represent a workable compromise between the very different legal traditions of different EU countries, particularly the UK and Germany.

"We are currently on draft 18 of the procedural rules," says David Wilson, IP partner at Herbert Smith Freehills of London, "and we're expecting a final draft this year."

At least 13 countries, including France, Germany and the UK, have to ratify the treaty setting it up before it can take effect. So far seven have done so, including France, leaving six, including Germany and the UK.

Though the ratification process is taking longer than expected, observers expect it to proceed – and not become

caught up in the new Conservative government's planned renegotiation of the UK's EU membership.

One of the biggest decisions yet to be made is how much applicants will have to pay to obtain a unitary patent and then if necessary defend it through the unified court. Fees must be high enough to finance the system, but low enough to tempt inventors to choose it instead of continuing to file under existing procedures.

Direct costs of filing, renewing and defending patents will be one issue for companies deciding whether to go for unitary patents. Another will be the risk of putting all their eggs in one basket, because if they lose a patent through court action under the new system their protection will disappear throughout Europe.

If they file country by country, they may still be able to maintain the patent in some jurisdictions.

13

Minimum number of countries needed to ratify the new treaty

18

Number of drafts to date of the proposed procedural rules

mediation and arbitration centre with seats in Ljubljana and Lisbon and a training framework for judges with facilities in Budapest. English, French and German are the languages of the new patent system. This follows existing EPO practice, but offended

## Gaps in drugs pipelines spark a flurry of takeover activity

**Pharmaceuticals** The threat of a flood of generic versions spurs a spending spree, says *David Crow*

The pharmaceuticals sector has been gripped by a mergers and acquisitions frenzy for the best part of two years, with some of the biggest names in the industry fighting over hot new drugs.

Last year was a record for dealmaking in the sector and 2015 is also off to a strong start, with healthcare transactions worth \$193.9bn announced since the beginning of January, according to Thomson Reuters.

As the value of deals has shot up, so has the premium that buyers are willing to pay to secure novel and potentially lucrative medicines. In March, Pharmacyclics, a biotech company that makes a single blood cancer drug, was bought by AbbVie for \$21bn, a premium of nearly 50 per cent over what the California-based group was worth before it emerged it was up for sale.

This month, Alexion, a rare-disease drug developer, agreed to acquire smaller rival Synageva Bio-Pharma for

\$8.4bn, a 139 per cent premium on its market value before the deal was announced.

For many, it was another sign that valuations in the sector are spiralling out of control. One of the main reasons companies are paying such big premiums is because they are facing the loss of exclusivity on some of their best-selling drugs. Since 2011, many of the biggest pharmaceutical companies have been faced with a "patent cliff", prompting them to buy drugs to fill gaps in their pipelines of treatments under development. For instance, AbbVie's main drug, Humira, which accounts for more than half its sales, will start losing patent protection by the end of 2016, partly explaining why it was willing to pay so much for Imbruvica, the drug made by Pharmacyclics.

Deals are not the only way of protecting a drug's revenue base: some companies have also adopted a more vigorous approach to managing their intellectual property (IP). However, they are



**Drug wars:** Actavis has tried to lessen the impact of generic medicines

encountering fierce resistance from those who fund healthcare systems, who often see "copycat" generic medicines as one of their best weapons in the fight against rising drug costs.

Once a patent expires and a drug loses its exclusivity, the market is usually flooded with a wave of generic versions. The makers of these generic drugs are allowed to bring their medicines to market without putting them through lengthy and expensive clinical trials, enabling them to undercut the price of the original version.

Actavis, the US pharma group, had hoped to lessen the impact of the introduction of a generic version of Namenda, its Alzheimer's drug, by securing a so-called "hard switch". It tried to remove its twice-a-day Namenda IR from pharmacy shelves and move patients to a newer once-daily version, Namenda XR, which has a longer patent.

If patients and doctors had become used to the newer drug, they would be

less likely to move to the generic, which is due to launch in July – or so the theory went. However, Eric Schneiderman, the New York attorney-general, this year secured an injunction that prevented Actavis from pulling Namenda IR off the market.

"A drug company manipulating vulnerable patients and forcing physicians to alter treatment plans unnecessarily simply to protect corporate profits is unethical and illegal," he said.

Actavis appealed, but at the end of May a US appeals court upheld the decision. According to Ronny Gal, an analyst at Bernstein, the research and brokerage company, the ruling does not bode well for other drugmakers seeking to emulate Actavis' strategy.

"The direction set by the district and appeals court suggests it would be increasingly difficult to 'hard switch' products," says Mr Gal. "Companies will probably have to demonstrate no hardship for patients and a business rationale, which differs from attempting to

force the market to accept their new product."

Policy makers are not the only ones targeting drugmakers' IP. Kyle Bass, a hedge fund manager who runs Hayman Capital Management, has started challenging what he sees as spurious drug patents, while simultaneously betting against or "shorting" the stock of the company that makes the medicine.

Mr Bass has created the Coalition for Affordable Drugs and plans to target about 15 companies with a combined market capitalisation of \$450bn using the Inter Partes Review process, introduced by the US government in 2012 to allow fast-track patent challenges.

He has promised to focus on hard switching and another type of patent management known as "evergreening", where a company secures a new patent by making a minor change to a drug.

Mr Bass told investors: "Companies that are expanding patents by simply changing the dosage or the way they are packaged are going to get kneecapped".

'Companies that are expanding patents by simply changing the dosage are going to get kneecapped'

## Studying the biology of a tumour changed treatment regimes

## Gene-based testing

*Naomi Mapstone* talks to an award-winning researcher whose work has stopped women being subjected to unnecessary chemotherapy

Away from the laboratory, Laura van 't Veer finds her focus on the water.

The inventor of a gene-based test for breast cancer that can save almost a third of breast cancer patients from unnecessary chemotherapy has rowed her way through more than 25 years of research and development.

"It helps me to relax, to focus," says Prof van 't Veer, shortly after finishing a 30km tournament around all of Venice's islands. "The Vogalonga [tournament] is not about who finishes first, it's about the fun and the joy and the craziness."

Professor van 't Veer's choice of sport requires the same kind of discipline and perseverance that has marked her out in science.

The co-founder and chief research officer of Agendia, the 14th biggest molecular diagnostic company in the world by revenue, first started working on the molecular diagnostics of breast cancer at the Netherlands Cancer Institute in the late 1980s.

In 2001, Prof van 't Veer and her team at the Institute identified 70 genes that

were key to determining whether a breast cancer was likely to recur.

"My discovery has changed the way diagnostics of breast cancer is done, by not only relying on vectors such as age of a patient and diameter of a tumour, but by looking into the biology of the tumour, the biology of the genes to really understand whether the cancer is aggressive or slow-growing," Prof van 't Veer says.

Her work also determined that chemotherapy is not required for slow-growing tumours.

"Depending on the country, a first-diagnosis breast cancer is treated with chemotherapy in 40 per cent to 90 per cent of cases," she says. "Whereas, with first diagnosis breast cancer, we know it only returns in 25 per cent to 30 per cent of patients. . . . You are overtreating the majority."

But in a minority of cases, doctors

'My discovery has changed the way diagnostics of breast cancer is done'

were undertreating aggressive cancers because they were judging tumours by size, she adds. "Some of the small tumours were the aggressive type."

Prof van 't Veer and her research partner René Bernards co-founded Agendia with the patent for the MammaPrint



Better diagnosis: Laura van 't Veer

test, and took it to market in the US in 2004. The test measures the activity of cancer-specific genes in a tissue sample with the help of a microchip. Within 10 days, it predicts how aggressive the cancer will be.

Prof van 't Veer and her team recently went back to the original sample of 78 women who determined the 70 key genes and found that, even after 25 years, the low risk cancer group had an extremely low recurrence rate.

More than 40,000 women in Europe, the US and parts of South America have now received the test. Breast cancer is the most common form of cancer in women, according to the World Health Organisation, with some 1.7m women diagnosed each year.

Prof van 't Veer is now focused on finding a way to determine the best treatments for the 30 per cent to 40 per cent of patients who have an aggressive form. The work has led to her team being this year's recipient of the European Patent Office's small and medium-sized enterprise inventor award.

## Oil price fall and limits on the use of crops leave industry struggling

## Renewable energy

The amount invested globally in biofuels is the lowest in a decade, writes *Pilita Clark*

The past year has brought a welcome surge in investment and growth for the renewable energy industry – with one very large exception: biofuels.

The amount of money invested globally in the fuels hailed as the answer to climate change and high oil prices sank to \$3bn in 2014, the lowest level in a decade. That was down from a 2007 high of nearly \$30bn, according to Bloomberg New Energy Finance, a research company, and it was not the sector's only gloomy piece of news.

Last year also saw the number of patent applications made globally for biofuels fall for the first time since 1999, according to the European Patent Office. Biofuel applications hovered below 1,000 a year until 2003, says the EPO, which holds data for countries around the world.

The number rose above 3,000 in 2009 and topped 4,000 in 2011. But in 2014, they fell back to 4,019 from more than 4,300 the year before.

The figures underline the divided nature of an industry that has achieved striking success in some countries, especially the US and Brazil, but is struggling in many other places.

Those two countries are the top producers of ethanol, one of the two most common forms of biofuel. The US

typically makes it from maize; Brazil from sugar cane. The other type is biodiesel, derived from vegetable oil, animal fat, or even recycled cooking grease. It is used more in Europe, where diesel vehicles are more common.

Biofuels may seem a very modern source of energy but were already around more than a century ago when Rudolf Diesel, the German inventor, was developing the engine that carries his name. One early diesel engine ran on peanut oil and Henry Ford thought his Model T car would run on ethanol. But the rise of the oil industry provided such vast quantities of cheap, reliable gasoline that biofuels fell out of favour.

That started to change after the 1970s oil shock, when a spike in crude prices spurred interest in homegrown alternatives to imported oil, and climate change concerns began to drive the development of renewable energy sources. At least 64 countries now have policies to encourage the use of biofuels, and although the fuels only account for about 3 per cent of the world's transport fuel, the International Energy Agency

Claire Curry of Bloomberg New Energy Finance says the biofuels sector is relatively stagnant



has estimated that figure could rise to as much as 8 per cent by 2035.

In the US, ethanol accounts for 10 per cent of the gasoline supply and is blended in more than 97 per cent of the country's gasoline, according to the US Renewable Fuels Association. Some

types of ethanol were priced as much as \$1 a gallon below gasoline for much of 2014, the association says.

But oil prices crashed from \$115 a barrel last June to about \$45 in January, sending a shiver through a biofuels industry facing battles on other fronts.

The most notable is the growing debate over whether biofuels derived from food crops drive up commodity prices and encourage poor countries to destroy their tropical forests. That worry helped push the EU to decide in April to limit the use of crop-based biofuels.

Many companies now pin their hopes on so-called second generation, or advanced, biofuels such as cellulosic ethanol, which is derived from materials such as corn husks or fast-growing grasses that do not compete with food.

There are now six cellulosic ethanol plants operating around the world, says Peder Holk Nielsen, chief executive of Novozymes, a Danish supplier of the enzymes used in biofuel production. That is only a tiny fraction of the nearly 1,200 bioethanol plants Novozymes says are in operation and the newer industry faces logistical hurdles, such as obtaining large volumes of suitable feedstock.

But the industry needs to start demonstrating it can work soon, says Claire Curry, an analyst at Bloomberg New Energy Finance. The first-generation biofuels sector is relatively stagnant, she says, and is yet to be replaced by a next-generation fuel industry that offers promise but is struggling to scale up.

"It is facing a challenging environment and only has another year or two to prove itself," she says.

## Inventions &amp; Patents

## China raises its profile in intellectual property

**Europe** The majority of applications now come from outside the continent, reports *Emily Cadman*

The statistics are straightforward: European inventors are falling behind in the global patent rush. What is far less clear is whether this matters.

For most of the past 50 years, the leaders in patent filing were without doubt Japan and the US, with Europe bumping along in third place. But from the early 2000s, China began to emerge as a significant force, and each year since 2011 more patent applications have been filed in China than in any other intellectual property office around the globe.

The initial rush was for domestically filed patents, but Chinese companies soon began looking for international markets, with the latest data from the European Patent Office (EPO) putting China fourth in the volume of patents filed in the EU last year, up from 12th less than a decade ago.

The majority of applications for patents in Europe now come from outside the continent, with Germany the only European country to make it into the top five. In total, more than 274,000 patents were applied for at the EPO last year, an all-time high.

For Denis Keseris, patent attorney at Withers & Rogers, the answer to the question of whether this matters is simple: yes. "Some companies are not getting to grips with the importance of intellectual property," he says, adding that for Europe's share of innovation "we should be filing a lot more patents".

While the UK's filings to the EPO grew at the fastest rate in three years, it still lags behind most large European economies (with the exception of Italy) in terms of filings per head of population.

Matt Dixon, another patent attorney, speaking on behalf of the Chartered Institute of Patent Attorneys in the UK, says: "British businesses need to wake up and realise that patents are not just for wild-haired inventors, but are a key



part of everyday innovation strategy". Without legal protection for their products, businesses are leaving themselves open to being copied.

Part of the reason for the burgeoning number of Chinese patents in Europe is a need to catch up. China's stock of international patents remains small compared with its research and development (R&D) spending. If Chinese companies are to compete for business in Europe, they will need to ensure that the IP underpinning their technology is owned by them and legal in the EU.

As an indication of the importance that the Chinese government attaches to the issue, in 2012 it began offering subsidies for foreign filings in addition to those it offers for domestic filings. The often repeated charge that many

British businesses need to wake up and realise that patents are not just for wild-haired inventors'

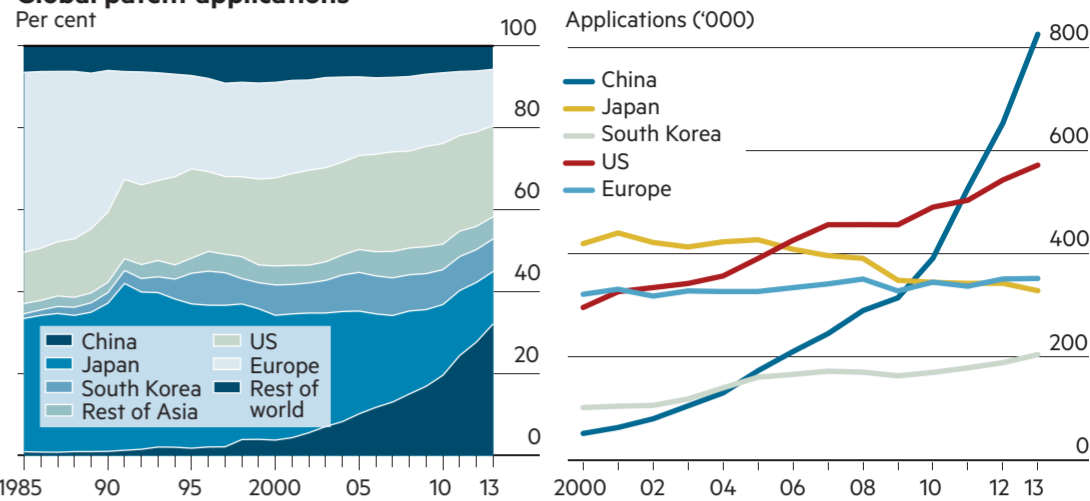
of the patent applications from China are of low quality has some support in the data. While China accounts for about 10 per cent of patents filed to the EPO, when it comes to patents granted the proportion drops to 2 per cent.

The more knotty question is whether patent applications — or even those that are granted — tell us anything meaningful about the comparative state of innovation between countries.

The UK's Intellectual Property Office, which is responsible for overall UK intellectual property policy as well as granting UK patents, trademarks and design rights, thinks not.

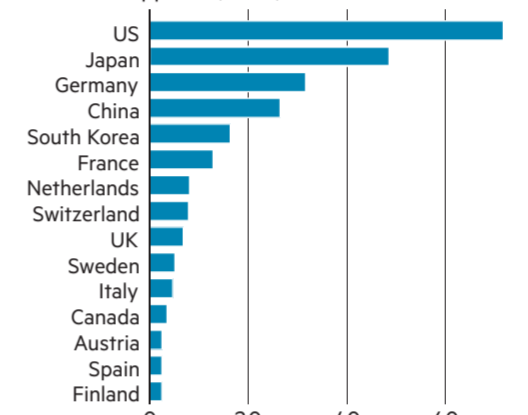
"To approximate a level of innovation purely on patent numbers would be a one-dimensional, and woefully inadequate, way to understand the breadth of

## Global patent applications

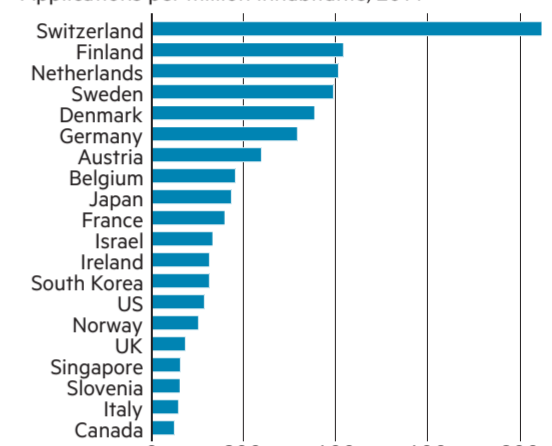


## European patents

Patents filed by country of residence of the first named applicant, 2014, '000



Applications per million inhabitants, 2014



FT graphic. Source: WIPO; European Patent Office. Ph to: Dreamstime

activity that characterises innovation," according to a spokesman for the Office.

Stressing that patents themselves are not the only way to protect innovations, the official added that patents "provide formal protection but do not account for unregistered inventions, for example trade secrets, nor do they consider non-invention-based innovation".

Elena Novelli, lecturer at Cass Business School in London, is more measured, saying: "Certainly, the number of patents filed is a metric, but it is not the ultimate metric."

There are no hard and fast statistics on how many patents actually make money, but Bloomberg Business says that of 1.5m US patents in effect in the mid-2000s, only about 3,000 were commercially viable. Dr Novelli stressed

that even among those which make money, their value can be very skewed, with a high number of inventions turning out not to have much value and only a few being of high value.

One attempt of many to try to look at innovation in a wider economic context is the Global Innovation Index, created by Cornell University, Insead, the business school, and the World Intellectual Property Organisation (WIPO).

Alongside variables such as spending on R&D and licence fee receipts, it also includes such things as video uploads on YouTube and Wikipedia monthly edits in each country. Europe can rest far easier on this metric: the top five places are taken by Switzerland, the UK, Sweden, Finland and the Netherlands. China is down in 29th place.

## Battle over IP rights could hold back next-generation technology

## Smartphones

*David Crouch* reports on changes that look set to benefit consumers but some companies argue they will cost them dearly

A bitter dispute over billions of dollars of compensation for intellectual property rights threatens to hold back the development of 5G telephony and other wireless technologies, industry insiders say, after divisions emerged between bodies that rule on standards in the telecommunications sector.

The split reflects divergent views in the industry. Some leading companies warn that royalties from key patents could be slashed, discouraging investment and innovation. Others insist consumers will benefit from lower prices.

The dispute comes after the Institute of Electrical and Electronics Engineers (IEEE), one of the leading organisations that decides industry standards for WiFi and other advanced technologies, revised its patents policy.

Instead of royalties being calculated as a percentage of the price of the finished product, fees for IEEE approved patents would be based on the price of the components to which they contribute. Moreover, patent holders would be obliged to offer licences to all applicants and discouraged from taking licensees to court over royalty levels.

"This disturbs the balance of power between the licensor and licensee," says Dirk Weiler, head of standards management at Nokia Networks, the Finnish telecoms equipment group, and chairman of the European Telecommunications Standards Institute, which develops technology standards.

Mr Weiler says that lowering the incentives for innovators to make intellectual property available to competitors creates the risk that technologies essential to raising the performance of a product across an industry will not be shared.

"We fear this may lead to a situation in which standards are no longer the best technologies, while companies try to keep back their high-quality intellectual property for themselves," he says. "This is a danger we clearly see for 5G."

Gustav Brismark, vice-president for patent strategy at Ericsson, the Swedish



Revolutionary: Andreas Manz

## Prof of small things

As a boy Andreas Manz had an interest in small things.

"I collected insects, moths, butterflies — I realised they had their own energy, their own computing systems," the Swiss nanoscientist and analytic chemist says. "Engineering is far behind that."

This early fascination with "chemistry at the micrometre scale" shaped Professor Manz's career, leading him to invent a millimetre-sized "laboratory-on-a-chip" that has revolutionised diagnostics and led to his winning this year's European Inventor Award for lifetime achievement.

Professor Manz's first device, in 1990, merged microelectronics with chemistry to replicate a series of laboratory sequences that once took weeks.

Suddenly, a drop of blood could be analysed in seconds by Prof Manz's chip, increasing the speed of analysis 100-fold. In time, analysis may be 10,000 times faster.

His work has sparked a wave of innovation — from the continuing development of microsystems for the diagnosis of diseases such as dengue fever, cancer, malaria, HIV and genetic conditions to glucose measurement kits for diabetics, to a USB device that decodes human DNA in minutes.

Prof Manz, is head of the microfluidics group at the Korea Institute of Science and Technology in Saarbrücken, Germany, and a professor of microfluidics for life sciences at Saarland University. **Naomi Mapstone**

telephone equipment maker, says: "This new policy shifts the balance much more in favour of the users of the standard, so that it will facilitate companies who choose to hold out and refrain from negotiating in a fair manner to get the rights [to patented technology]."

InterDigital, the San Diego-based intellectual property group, and Qualcomm, the US mobile chip company, have also complained.

"In a nutshell, they don't want developers to be paid much, and they've also made it as hard as possible for them to get paid at all," wrote Bill Merritt, chief executive of InterDigital, in March this year. But other companies, including Cisco, Dell, Intel and Hewlett-Packard have backed the IEEE or are neutral. Cisco, the US networking company, has called the shift "a significant victory for consumers" that would help ensure patent holders could not "obtain unreasonable royalties".

Owning a patent for an industry-standard technology is highly lucrative — Qualcomm made some \$50bn in global licensing revenue from its 3G technologies, the European Patent Office (EPO) says.

In Europe, so-called "standard essential patents" — those relevant to technology adopted across an industry so that its products work in different countries and with other devices — are supposedly licensed by patent holders at "fair, reasonable and non-discriminatory" rates.

But the IEEE objects that there is no clear definition of a "reasonable" compensation rate, leading to costly disputes and fuelling litigation, while creating disincentives to innovation.

"If there is no hint what 'reasonable' is, then there is no guidance, which means the policy is totally vague," says Konstantinos Karachalios, managing director of the IEEE Standards Association. "A totally vague policy is worse than no policy at all."

The IEEE was "company agnostic" in deciding to change its policy, he says: "The essence is that the value created by the patent should not be appropriated by any single player."

Standard setting bodies are seeing the first patents that are trying to define the foundations of 5G. There will be an explosion of 5G patents and royalties, says Mr Karachalios. "Everyone will gain, even those who are complaining."

The EPO declined to comment on the dispute.

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## Inventions &amp; Patents

## Successful US innovation ecosystem is now under threat

## COLUMN

David Winwood

Innovation ecosystems are complex entities, feeding from multiple sources and providing sustenance to multiple stakeholders. Academic research has been a vital contributor to the growth and transformation of the US from agrarian economy in the 19th century to the technological powerhouse of the 21st. Now that system is under threat.

In 1860, Abraham Lincoln, himself a patent holder, acknowledged the value of patents, saying they “added the fuel of interest to the fire of genius in the discovery and production of new and useful things”.

Two years after making that speech, Lincoln signed the Morrill Act into law, codifying the role and expectations of US universities in applying scientific and engineering approaches to the challenge of building a new nation.

US research universities continue to play a central role in creating a better future. They do this not only by educating almost 600,000 graduate students in science and engineering every year, but by performing more than 15 per cent of US research and development in 2011 and, according to 2012 National Science Foundation data, accounting for 53 per cent of national basic research: creating technologies, products and services, medicines, diagnostics, and giving rise to new industries.

Some 120 years after Lincoln’s “fuel of interest” speech, the Bayh-Dole Act codified the roles and expectations of US universities in translating basic research into economic output.

Widely mimicked by other nations, it formalised how universities manage their inventions, so there is a clear path from basic discovery to commercial implementation.

Obtaining a robust patent is a crucial part of that process of technology transfer. Without strong intellectual property (IP) protection, most inventions will never see the light of day.

Why is that? The answer is simple: the costs of developing most of them into a marketable product are significant. Without proper patent protection, no one will invest in the mere promise of an invention.

Yet we now find ourselves confronted by attempts to change the US patent system in ways that would probably eviscerate the very activities that have made the US so successful.

In 2013 alone, US institutions accounted for more than 24,000 inventions

In an attempt to combat the abuse of the US patent system by a small number of patent trolls, lawmakers in Washington DC have introduced legislation that threatens the existence of the productive innovation ecosystem that has supported the introduction of new products and services since the advent of Bayh-Dole.

Abusive litigation practices should be

punished – and preferably, stopped – but not at the expense of the US patent system and the established value chain from basic discovery research in universities to translation and commercialisation by small businesses.

The success of Bayh-Dole in providing a path from bench to marketplace is documented by several groups, among them the Association of University Technology Managers (AUTM), a US-based, international organisation of technology transfer practitioners.

It has carried out a survey of members every year since 1991. The findings are compelling.

In 2013 alone, the AUTM reported that US institutions accounted for more than 24,000 inventions that resulted from \$65bn in research funding – with almost \$40bn coming from US federal sources.

The pursuit of IP protection, such as copyrights, trademarks and patents, follows a similar pattern. In 2013, there were about 15,000 patent applications by participating universities.

The AUTM data show that close to 10,000 patented products are currently

marketed that originated in academic research laboratories.

A recent study commissioned by the Biotechnology Industry Organisation further documents the impact of academic technology transfer on the US economy. “The Economic Contribution of University/Nonprofit Inventions in the United States: 1996-2013” estimates that during this period, academic-industry patent licensing bolstered gross industry output by up to \$1.18tn, GDP by up to \$518bn, and supported up to 3.82m jobs.

Small businesses rely on robust patent protection as leverage to secure the financing needed to expand their operations and, in turn, they rely on universities as their source of licensed IP. If small businesses and universities are excluded from participating in the patent system, the consequences for growth and innovation are bleak.

David Winwood is chief business development officer at Pennington Biomedical Research Center in Louisiana and president-elect of the Association of University Technology Managers

## Europe struggles as Beijing goes high-tech

Continued from page 1  
The 274,000 new patents in Europe, according to the European Patent Office (EPO). China was the highest climber in the rankings, reaching fourth spot after an 18 per cent year-on-year increase in patent filings.

The telecoms company Huawei was indicative of Chinese companies’ attempt to catch up with competitors: it filed 49 per cent more patents than in 2013, making it the fifth most active applicant. Only one European country made it into the top five for patents: Germany was ranked at number three behind the US and Japan.

European business groups admit there is a challenge for the EU to catch up in the innovation race. The bloc’s competitive edge will more than ever be based on innovation, productivity and its transition into higher-tech and higher value-added activities.

“European leaders need to take action to ensure that Europe stays a top innovation location,” says Kurt Bock, chief executive of BASF, the German chemicals group, and chairman of the European Round Table Competitiveness Working Group.

Europe is a world leader in areas from aerospace and car manufacturing to chemicals, and its focus on high-tech niches – which are less subject to low-cost competition – remains a source of strength.

However, it faces growing competition from the US, where shale gas discoveries have helped reinvigorate the country’s manufacturing sector, and China, which, no longer satisfied with just being the workshop of the world, has stepped up its investment in high-value manufacturing.

The emerging field of biotechnology is one area where European companies dominated in 2014, largely because of the continent’s position as a world leader in biofuel technologies.

\$1.6tn

The sum spent globally on R&D in engineering-related disciplines

12%

The rise in biotechnology patent filings in 2014

The EPO says there was a 12 per cent annual rise in the number of biotechnology patent filings to 5,905. DSM, the Dutch biotech company, filed almost three times more patents than its closest competitor as it moves forward in the development of advanced biofuels made from waste products such as husks, leaves and corn cobs.

Meanwhile, the US dominated the medical technology sector in Europe, the area recording the highest volume of patent activity in 2014 – up 3.2 per cent to 11,124 filings. The US made almost four in every 10 medical technology patent applications, from pacemakers to surgical robots.

Brussels wants to reindustrialise the EU and aims by 2020 to raise manufacturing’s share of GDP from 15.6 to 20 per cent. Businesses and policy makers agree on a need to improve the infrastructure of innovation, from nurturing ideas to financing high-tech start-ups.

Jérôme Chauvin, deputy director-general at BusinessEurope, Brussels’ biggest lobby group, comments: “Innovation may begin with an idea, but it is only complete when its results reach the market. Intellectual Property is the necessary ‘currency’ that makes this commercialisation process possible.”

Battelle’s Mr Bosley says: “The specific role of technology varies by industry, but innovation is a universal imperative.”

## Creating whole human organs remains at best a long way off

**Bioprinting** The technique also has potential in speeding drug development, writes *Tanya Powley*

Three dimensional printing is already being used to manufacture everything from simple plastic figurines to complex metal aircraft parts. But the industry has a bigger target in its sights: creating living human tissues layer by layer.

Bioprinting offers the ability to accelerate drug development and testing and lower the cost. One day it may also produce replacement organs for patients in need of a transplant. The technology works by taking a patient’s cells to form a bioink, which is then placed into cartridges that contain a syringe fitted with an extrusion nozzle for printing.

The bioprinter deposits a pattern of cells in layers, interspersed with a water-based gel – called a hydrogel – that is used as a kind of scaffolding for the cells. The printed tissue is then left to grow naturally, and the hydrogel removed. Scott Collins, chief technology officer at US start-up TeVido Biodevices, a 3D bioprinting company, says: “We’re putting the cells in the right place, but then biology takes over and helps it develop into the tissues.”

While conventional 3D printing of plastics has been around since the 1980s, bioprinting is in the early stages of development. The first patents for bioprinters and their materials were filed only in the past 10 years. Currently, printed tissues are mainly being used

for research, but several companies are attempting to commercialise the production of bioprinted tissues.

US-based start-up Organovo, the world’s first publicly traded 3D bioprinting company, has developed living liver tissue for medical research and clinical trials.

This year, the company has already signed research partnerships with Merck & Co, the pharmaceutical company, to use its liver tissue service, and L’Oréal, the cosmetics group, to develop 3D bioprinted skin.

TeVido Biodevices, a US start-up, is using 3D bioprinting to reconstruct a woman’s nipple tissue following breast cancer surgery. The company raised \$30,000 through crowdfunding this year to patent its technology, which it is at early prototyping stage. It hopes to launch its product in about six years, once it has conducted clinical trials and received the regulatory go-ahead.

Bioprinting could save pharmaceutical companies a lot of money, according to Fanny Sie of MaRS Innovation, a Toronto-based company. The company has developed the PrintAlive Bioprinter, which can print skin that could be used to treat people with large scale burns. The printed tissues could be used by pharmaceutical companies to test the toxicity of new drugs, and help them decide if it is worth starting costly animal and then human clinical trials.

**Start-up: Organovo has developed living liver tissue for medical and drug research and clinical trials**

“Bioprinting is a very active area of development in terms of pre-drug screening. If you have 20 drugs, before you start testing on animals, you can at least get it down to five with this new screening method,” she says.

3D printing accelerates the tissue-making process and makes it more precise. Previously, scaffolds were created by hand – or 3D printed – and then the cells were positioned by a handheld pipette.

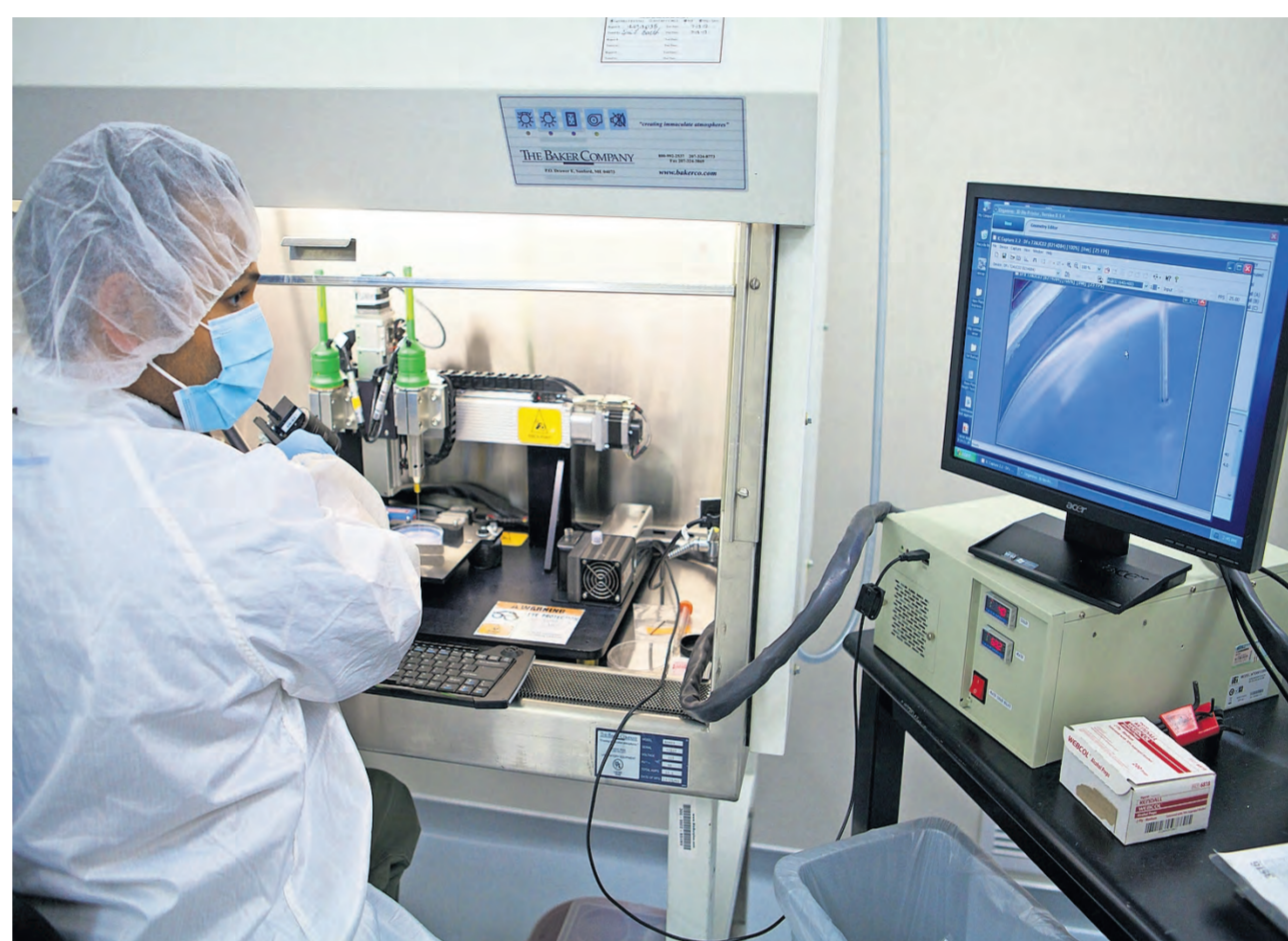
Ms Sie says: “The hope is that there is efficiency in placing them together closer than they would be without the printer, so the interactions can happen faster. We’re not trying to take over mother nature, we’re just trying to facilitate the interaction.”

Printing whole organs remains a long way off, however. “I think the timelines have been hyped up a lot,” says Dr Collins. “People have talked about print-on-demand hearts or kidneys in five to 10 years, but that’s unrealistic. We might see it in 20 to 30 years.”

One of the main obstacles to printing entire organs has been the need for vascularisation, the 3D printing of veins and arteries, that provide nutrients to keep the organs alive.

A team of Harvard university bioengineers has made progress in this area, revealing this year a 3D printing method that creates functional vascular networks – a holy grail problem of tissue

‘We’re not trying to take over mother nature; we’re just trying to facilitate the interaction’



## ‘We were singularly focused on finding the answer’

## Vaccines

The vaccine has already prevented HPV and related cancers in more than 125 million people around the world, says *Naomi Mapstone*

Ian Frazer has global ambitions.

The co-inventor, with Jian Zhou, of the vaccine against human papillomavirus (HPV), the precursor to cervical cancer, wants the treatment to reach as many people as possible.

“All vaccines are for the public good,” says Prof Frazer. “You get the full value out of them only when they are effectively deployed across the planet.”

The HPV vaccines Gardasil and Cervarix, which were the result of more than 25 years of research by the two men, have already been administered to

more than 125m people globally, and the World Health Organisation (WHO) recommends the vaccine for women aged from nine to 25.

Australia has also introduced a government-funded vaccination programme for boys, after it recorded a sharp drop in the rate of genital warts linked to HPV since it began using the vaccine in girls, and a marked decline in the rate of high-grade cervical abnormalities in teenage girls.

The University of Queensland, which holds the patents for the vaccine, has waived royalties for its sale in the developing world. About 85 per cent of all deaths from cervical cancer occur in low or middle-income countries, according to the WHO.

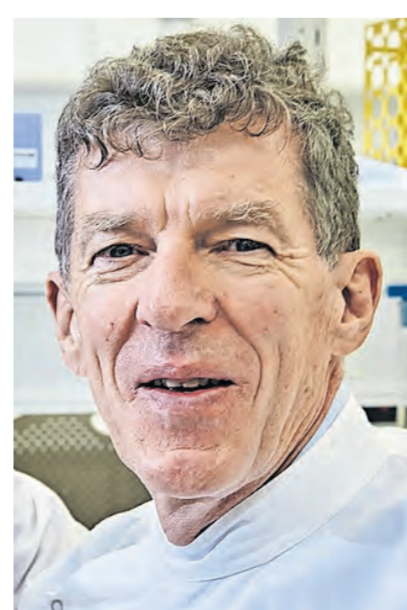
“The drug has the potential to make a big difference in the developing world, where cervical cancer is common,” says Prof Frazer. “But we still have to make sure it gets there.”

Dr Zhou, a Cambridge immunologist who paved the way for the vaccine by cloning HPV surface proteins on to a separate virus that served as a template, died at the age of 42, before the vaccine could come to market. His wife, Dr Xiao-Yi Sun, who worked as Dr Zhou’s assistant, remembers those years well.

‘We know that research is a long-haul game — you do it for your children’

“Jian and Ian would often leave the lab only to go home, shower and change their clothes and grab a couple of hours sleep. In those days, we were all much younger, determined and singularly focused on finding the answer.”

Dr Sun says that Dr Zhou, a modest man, tended to look for the nearest exit



**Breakthrough: Ian Frazer (pictured) and co-inventor Jian Zhou believed the vaccine was for the public good**

at black tie events celebrating scientific achievement, but he would have been happy to have prevented the premature deaths of so many women.

Prof Frazer continues his research as director of the Translational Research Institute in Australia. His therapeutic vaccine for patients already diagnosed with HPV is currently in human trials.

“We recognise that research is a long-haul game – you do it for your children. Twenty years development time for the cervical cancer vaccine is about normal for most new treatments, particularly for vaccines where you have to be really sure the vaccine is going to be safe.”

This can be a challenge for scientists and for governments in terms of resource allocation, as they tend to be influenced by short-term electoral cycles, he says.

Prof Frazer and Dr Zhou won the popular prize – via an online public vote – in the European Inventor Award.

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