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INTRODUCTION
MICHAEL SKAPINKER

Nota Bene

Business innovation occasionally arises out of sheer inspiration but all creatives need the time and resources to explore ideas

One of the drawbacks of an otherwise fulfilling career with a business and financial news organisation is the paucity of stories one has with which to impress schoolchildren. On the Financial Times, we do not often get to interview Beyoncé, Justin Bieber or Zac Efron.

When I speak at schools, I know that students will not be much taken with the chief executives and finance directors I could mention. I usually tell them that I have interviewed Sir Richard Branson, which elicits mild interest, and Lord Alan Sugar, once a computer entrepreneur but now known for *The Apprentice* television series.

In future talks I should mention Arthur Fry, though. Students may not have heard of him, but they will know what he invented. I interviewed Fry nearly three decades ago at the St Paul, Minnesota, headquarters of 3M, one of the world's most innovative companies. Fry had been puzzling about what 3M could do with a weak adhesive a colleague had devised. Few could see the point of a glue that, while it kept its stickiness, did not really stick. Singing in his church choir, frustrated at how the paper bookmarks in his hymn book kept fluttering to the floor, Fry suddenly saw what he could do with that weak adhesive – and the Post-it note was born.

Fry, I observed, could make a fortune talking about the Post-it. He seemed unimpressed. He had a yellow car with a personalised Post-it number plate, and that appeared to be it.

His attitude was typical of 3M. The company, which makes everything from dental implants to carpark software, is quiet and understated. Many who use its products have probably never heard of 3M. But it is inventive.

How does 3M do it? As Vijay Govindarajan of Dartmouth College's Tuck School of Business and Srikanth Srinivas of healthcare consultancy Medecision explained in a Harvard Business Review blog post last year, 3M employees are allowed to spend 15 per cent of their time researching their own projects.

Every company, every country has its own culture. In Israel, the country with the second highest level of innovation after the US – as measured by the value of its start-ups – state institutions play a central role. Many tech entrepreneurs develop skills and pick up contacts in Israeli army intelligence's Unit 8200. The state also plays a role in lending money to promising, but risky, new ventures.

Other countries have had less success. Many of the UK government's attempts in the pre-Thatcher years to support technology winners were disasters, a notable exception being Rolls-Royce, the aircraft engine maker.

There is no one remedy that every company or country can apply. But there are two general principles. The HBR post on 3M said the company spent time identifying customers' "pain points". These are problems the customers have – things that could be done better. But customers do not always know what they need. It was only when 3M sent out packs of Post-it notes that customers realised they wanted them. The second key point is allowing staff, particularly those that deal directly with customers, to develop their products.

Many modern companies distance themselves from their customers, through outsourced call centres and websites with no contact telephone numbers other than those call centres. And many companies appear reluctant to allow employees to think and act for themselves.

Overcoming both those obstacles is today's business and creativity challenge. ■

Michael Skapinker is the editor of FT Special Reports

PHOTO: GETTY

In on the ground

Cities thrive only if they allow creative people to regenerate decaying areas, says Edwin Heathcote

Gravity: London's bohemian centre has shifted to the East End where works like Leonardo Erlich's "Dalston House" can be found aplenty

PHOTO: REUTERS

The idea that the creative quarter is the key to the regeneration of any city has become so entrenched that it has become almost a cliché. The orthodoxy is that it is the cultural pioneers who are best able to turn around decaying districts and transform them from neglected and economically stagnant sites into thriving, hipsterish hotspots. Richard Florida's 2002 book *The Rise of the Creative Class* became the cornerstone of this notion and one that was adopted by planners, sociologists and politicians as a kind of default position. Creative quarters, what's not to like?

But, perhaps, now it is time to reassess the results of this almost obsessive drive to attract creatives, to better understand how this process has worked, and whether it is always positive.

LONDON, with its almost maniacal churn, a city irredeemably in thrall to property prices and with real estate as investment rather than home, is the ideal place to start. The city's bohemian centre has been shifting around for centuries, from Chelsea to Bloomsbury, from Soho to Shoreditch and now on to Hackney and Dalston.

Each of these areas became artistic, literary and design centres and each was, in turn, gentrified as the creative classes made once unattractive areas edgy and seductive, a process that attracted younger, affluent middle classes who wanted to be associated with hipness.

While this kind of regeneration can seem an unalloyed good thing to city boosters and economists, it has its downsides. The speed and intensity of change in London's property market has, in recent years, highlighted those problems. Creative quarters need time to grow. They need to build an infrastructure of the different trades, venues, office and workshop spaces and, most importantly, people, who are then able to embed themselves into the fabric of the city, establishing the kind of network that builds into a specific urban character something strong enough to attract others.

There are no fixed rules for the kinds of infrastructure needed to foster a creative community but there are some features that have consistently helped. Among these is a particular and fine balance between cost and centrality. All the areas above, along with Clerkenwell, Stoke Newington, Peckham, Bethnal Green, Bermondsey and others were blessed with proximity to the city centre and an abundance of cheap space. That kind of loose-fit space, whether it was once industrial or warehouse, dockside or commercial, does not dictate how it should be used. A factory or a printing works, an office block or a warehouse can accommodate big studios or small incubator offices alongside apartments and cafes. Also the grain of historic fabric, even if it only 50 years old, adds an air of authenticity that always seems lacking in the new.

But there should not be too much heritage. Where the architecture is over-protected, rapid change is difficult. Where its use is too prescribed or zoned, again, change and adaptation are stymied. It is precisely in the blend and the flexibility of that particular cocktail of typology, age, disuse and adaptability to changing trends that a quarter's creative resilience can lie.

London's booming property

market, however, ensures that even the cheapest areas are no longer truly cheap and the kinds of spaces that were once attractive only to artists and designers – lofts and converted industrial spaces – have become among the most desirable residential spaces, to the extent that developers now build new domestic buildings to resemble industrial interiors. London's lofts are now, as they are in New York where the trend kicked off, out of bounds to creatives.

Yet their successors are not being built. There is, understandably, no looseness in new development. Uses are ruthlessly prescribed as commercial, residential, retail or cultural – that's it. And the retail streets, once the city's rich incubator of everything from workshops to markets, are being built only to attract the big chains. There are no adaptable spaces, none of the big-scale industrial-type infrastructure that has proved so enduring.

Developers and architects should build more anonymously, creating boxes with less defined uses. It is, of course, difficult to convince a bank of the value in this as-yet-undefined future. Regeneration in Britain is almost always conceived in terms of shops and shopping and apartments with balconies. It is extremely two dimensional.

Is anywhere in Europe doing it better?

MILAN, another expensive metropolis, has done it well. The city might be known for fashion but design occupies an equally prominent role, notably with the Salone de Mobile, the world's biggest design fair, by far. The fair is on the unremarkable Fiera site but the real action goes on in events dotted around the city.

First it spread to the Zona Tortona, the residential and industrial area around the Via Tortona, and then on to Ventura Lambrate, a gritty industrial district on the city's edge. In both areas the design events have seeded workshops, cafes, studios and new cultural buildings, often accommodated in former industrial structures – exactly the kind of framework needed for a creative district. It can manage the difficult but critical shift from high fashion to artsy bohemianism within a single block.

BARCELONA is often held up as the most visionary city and it is difficult to disagree. It is also instructive to see the parallels with London. Both are big port cities with rich historic centres, both are cosmopolitan and tourist centres and both are post-Olympic cities. UK politicians have enthusiastically picked up on Old Street's Silicon Roundabout (a place as unattractive as its name suggests) but Barcelona was in the forefront of developing a digital and innovation district with its 22@, in the former industrial district of Poblenou.

The success of this huge chunk of creative city (equivalent to 115 historic city blocks) has been down to visionary politicians (notably former mayor Joan Clos, now head of UN Habitat), sophisticated urban planning and a clever use of zoning. This mixes residential with commercial, and historic industrial with fine contemporary architecture, so that the blend in types of space is maintained and the kind of gentrification that is so apparent and seemingly unstoppable in London has been halted or decelerated.

It should not be forgotten that the city's infrastructure is almost impeccable: a fantastic metro system ensures one is never more than a few minutes away from a beach or a major station. It is a connected city in every way.

BERLIN had an experience that was different again. As Germany reunited, its new capital found itself with a glut of empty commercial space as state and municipal bureaucracies that had once been duplicated were rationalised. In part, the freeing up of the massive accommodation of the Stasi, East Germany's overbearing secret police, ironically created the space that now houses the city's creatives. East Berlin's

Occupation: (below left) designers take over a former Philips factory in Eindhoven and (below right) a design showcase in Milan's Ventura Lambrate

PHOTOS: CORBIS; GETTY; REUTERS

now-defunct industry, propped up by sales to other communist bloc economies, also left its legacy of generous space.

A relative lack of speculation in the property markets helps Berlin sustain its creativity. Housing is mostly owned by pension funds and big organisations that are keen to secure long-term, hassle-free returns so rent is cheap and the young are able to stay in city centre accommodation as long as they like – although rental and purchase prices have accelerated recently.

After the fall of the Wall it was Mitte and Kreuzberg that took on the creative mantle, followed more recently by one-time workers' district Friedrichshain. Yet even Berlin's coolest districts are not immune to gentrification – though here it tends to be bigger bars pushing out smaller ones and squatters being forced out of blocks that no one previously cared about.

BUDAPEST presents another version of the post-communist creative city. While hardly a global capital of cool, this beautiful city is experiencing a surprising turnround.

Like Berlin, Budapest was left with abundant space after the fall of the old regime but space was never that cheap. Budapest's contribution to the creative city phenomenon is the ruin pub, where young entrepreneurs take on crumbling, usually fin-de-siecle buildings and transform them into complex labyrinths of bars, clubs, private cinemas, restaurants, shops and exhibition spaces.

In style: enjoying a pint in a Budapest ruin pub (above), Barcelona's Poblenou regeneration, (below left) Berlin's former Templehof airport is used for a design festival (below right)

These projects are semi-formalised so that building owners are paid a small rent as the young tenants maintain and improve them.

The ad-hoc aesthetic is even being reproduced in newer buildings, to curious effect. A series of courtyards known as Gozsdu Udvar (the heart of the Jewish ghetto during the Nazi era) is now a teeming nightspot which, during the day, is filled with studios and hipsters on laptops lounging at café tables. The transformation of a once run-down district of elderly residents has been extraordinary.

PARIS should be like London, but somehow is not. Although it has its fashionable districts, the increasingly polarised exclusion of the poor beyond the Boulevard Périphérique makes the city struggle. Once the capital of bohemianism, it is stymied by rigid rules and burgeoning property prices. The area around the Gare du Nord, always rather seedy, provides one of the few city centre spots for creatives.

EINDHOVEN illustrates a radical creative future. Once dominated by Philips' huge factories, it found itself with a glut of empty industrial property that proved a boon to designers and makers.

Spurred by the success of its radical Design Academy, the likes of Piet Hein Eek have bought swaths of industrial space to rent to start-ups who can design and manufacture their wares, making for a far richer and more diverse creative economy. It is still small but truly engaging.

These different narratives show there is no single rule, nor even a set of rules, that guarantees the seeding or the survival of a creative city. Yet, ironically, one of the critical factors may well be failure. Creative economies depend on slack and the kind of redundant space that is the result of economic crisis, political upheaval, the collapse of industry or some other massive change.

In a way this does not bode as well for London or, say, Paris, as it might for Newcastle, Lille or Eindhoven. The potential for revival is there, in the infrastructure, but people need other reasons to come. And at the moment, it is London, Paris and Barcelona that have the cultural riches to attract people in the first place. ■

Creative drive

A surge in innovation is possible but it demands more than tax breaks and education schemes, says **Andrew Byrne**

When Sir James Dyson took the bag out of the vacuum cleaner in 1983, he was dismissed as an oddball with dangerous ideas. Manufacturers and distributors saw his designs as a threat and shut him out of the British market. Development agencies turned down his request for a grant to build a factory in Wales. The former theatre designer turned engineer teetered on the edge of bankruptcy.

Today, Dyson's company employs more than 2,000 people in Malmesbury, Wiltshire, half of them engineers. Much of its production now takes place in Asia but Dyson plans to invest £250m in its base, creating 3,000 science and engineering jobs by 2020.

The Dyson story tells us something troubling about government policy towards creativity and business in Europe, which appears at best inactive, at worst obstructive. For every Dyson that swept to market dominance, how many other creative entrepreneurs have stumbled for lack of support?

Now that only high-end manufacturing remains viable in Europe – and even that may change – governments need to find ways to stoke creative thinking and identify promising creative enterprises at the conceptual stage. Policy makers increasingly talk about Europe's "creative edge" but are governments aware of what is needed to secure the continent's future as the home of world-beating innovation and design?

"Awareness is definitely increasing," says Sir George Cox, former chairman of the Design Council and author of the influential Review on Creativity in Business commissioned by the UK's Labour government in 2005. "But there is still so much that must be done," he adds.

The report declared boldly that "greater creativity is a key to greater productivity" and called on government to champion creativity, not just in artistic fields, but in every sector of the economy.

"I didn't think my report was going to transform the world," says Cox, a former aeronautical engineer and entrepreneur, now a board member of NYSE Euronext, the transatlantic exchanges operator. "But you hope that you can move the thinking and understanding forward a bit."

The report called for three broad actions by government to boost creativity in business: offer incentives for research and development; broaden education to equip students with creative skills; and raise awareness of the value of creativity through centres that showcase creative enterprise.

But Cox admits that a change of government and the recession meant that the implementation of his recommendations has been uneven. "Hard times force you to rethink how you do things – these days we can't compete on price, so we have to earn our living from creativity."

Wheel of fortune: Sir James Dyson, pictured driving his favourite car, the Mini, overcame a lack of government support

For European governments, that means broadening the scope for tax credits in R&D, enabling companies to explore areas with some degree of risk. Almost all EU governments have adopted R&D tax credit schemes and research suggests that these can stimulate $3 of investment for every $1 in subsidy.

But experience across Europe has been mixed. Germany is responsible for much of the increase in R&D spending in recent years and the country is home to Volkswagen – the world leader in research investment – but the German government offers tailored grants rather than R&D tax credits. France and Spain top the chart for R&D subsidy rates but have very different levels of investment.

The OECD warns that R&D tax credit schemes favour established multinational firms at the expense of young, domestic start-ups that pioneer innovative

PHOTO: RICHARD SAKER/THE GUARDIAN

research. Most start-ups do not have enough taxable income to benefit from tax credits but they are often the most creative enterprises and are responsible for almost 50 per cent of new employment since 2001.

Hungarian software company Prezi is a prime example of a young European start-up that has grown into a serious global player, offering a product that is both creative and functional. The cloud-based tool allows users to zoom in and out of presentations online or offline and now boasts more than 40m users, a figure that is growing by 55,000 a day.

Peter Arvai is the co-founder and chief executive of Prezi and from a sun-filled room in Silicon Valley he describes to me over Skype how he and two friends – an artist and a computer scientist – turned a creative idea into an innovative tool with mass appeal.

"It seemed ridiculous at the time when we sat down in a café in Budapest in 2008 to plan this – we wanted to take on Google, Microsoft and Apple. But I'm glad we did."

Arvai's experience illustrates the struggle of young, creative companies trying to attract government and investor support. "We worked for almost a year on the first version of Prezi. This was in 2008 – this was a time of recession so people weren't investing in start-ups in general, but in particular not in companies in Hungary."

Did the enterprising team receive support or interest from the Hungarian government? "No, we did not," Arvai says.

The online company won investor interest with an early prototype, however, and now employs nearly 100 engineers at its headquarters in Budapest and more than 30 staff at its operations in Silicon Valley.

Arvai is frustrated by the failure of governments in Europe to create the conditions for start-ups to emerge.

"The lack of a sense of urgency in Europe is probably its biggest problem. The only way we can address this issue is through a mindset change, not through tax codes or changing company registration rules."

Arvai cites the Estonian start-up Skype: "All of a sudden, Estonians start believing that they could be competitive through pure creativity. As long as they could come up with a product that the world needed and was improving people's lives, then they could compete in that global economy."

Arvai points to a recent survey by the Economist magazine that now ranks Estonia as Europe's most entrepreneurial country.

Around the same time as the Prezi team was sketching ideas in a Budapest café, a number of universities in Dublin were rethinking their approach to educating students. The result was University College Dublin's Innovation Academy, which trains high-flying researchers in creative skills and then connects them with start-ups.

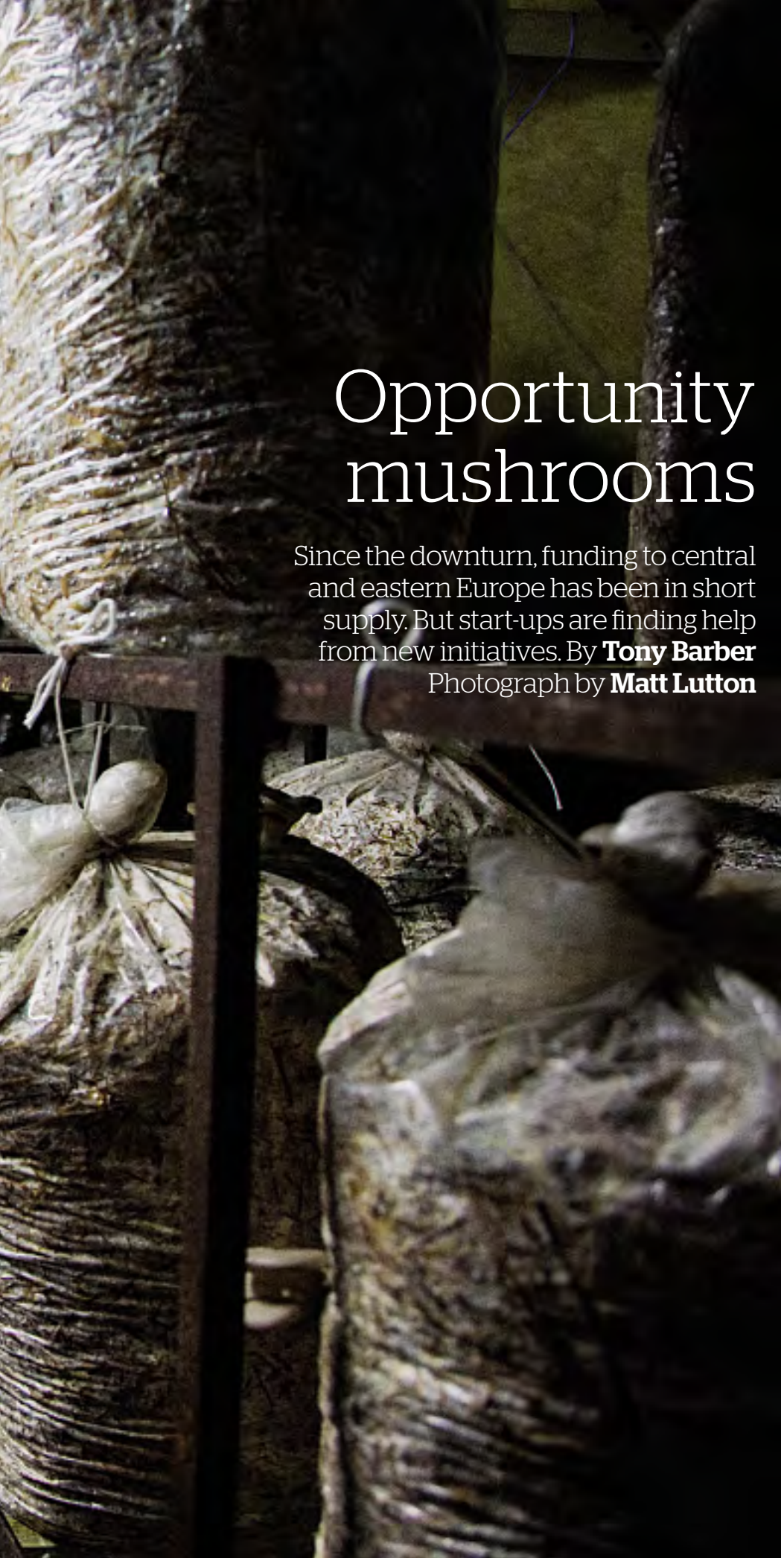
The academy was part-financed by grants from the European Commission and the Irish government, and its staff praise it as a model of education policy that promotes creativity with commercial applications.

"I'm not sure if governments are best placed to drive innovation and creativity," says Dan Hayden, an innovation specialist at the academy. "But institutes like ours can be a real driving force and government support for that is crucial."

Even George Cox admits that the challenge of arming European businesses with creative and innovative thinking demands more than tax breaks and education schemes.

He is convinced that the potential for a creative surge is present in Europe if governments could adopt the solutions in promoting research, seeking out and championing young enterprises and reshaping education. But the risks of inaction are great, and Arvai is forceful on the point: "This is by far the most important thing facing European society in the next five to 10 years. And we have a lot of catching up to do." ■

On a cusp: Ivanka Milenkovic researched and implemented higher levels of efficiency in food production



Opportunity mushrooms

Since the downturn, funding to central and eastern Europe has been in short supply. But start-ups are finding help from new initiatives. By **Tony Barber**
Photograph by **Matt Lutton**

At Serbia's Zvezdara science and technology park, a 21-hectare concrete and glass complex on the outskirts of Belgrade, Ivanka Milenkovic holds up a plate of succulent-looking oyster mushrooms. "Serbia has to play to its strengths. Agriculture is one of them," she says, before revealing that her company has grown the mushrooms entirely from recycled cellulose waste materials.

Milenkovic, a microbiologist by training, is general manager of Ekofungi, one of more than 50 small businesses that are benefiting from financial grants allocated under a €8.4m European Union-inspired project designed to stimulate creativity and the use of innovative technologies in Serbia.

Similar EU initiatives are afoot elsewhere in central and eastern Europe as part of the bloc's long-term effort to raise living standards, promote an entrepreneurial spirit and develop competitive, value-added industries in the continent's former communist half.

The World Bank administers the Serbian project, with the help of several Belgrade research institutes, but the EU provides the financing. The aim is also to accustom administrators and businesses to handling EU aid funds as Serbia gears up for entry into the 28-nation bloc, a prospect the government hopes will happen by 2020. Small and medium-sized companies can win grants of up to €80,000, if they display a potential for creating new intellectual property and for meeting a clear market demand.

Milenkovic is in no doubt about the project's value for Serbia, a country whose economic progress was severely retarded after the fall of

CENTRAL AND EASTERN EUROPE

communism in eastern Europe by a decade of wars, extreme nationalism and financial chaos under Slobodan Milosevic, the late despot who was overthrown in 2000. It was partly Serbia's experience of international isolation and economic dislocation in the 1990s that prompted her to search for ways to increase the efficiency of local food production.

Years of experiments led to the invention of advanced waste technology capable of producing the substrate required for oyster mushroom cultivation. This might never have been converted into a business had it not been for the EU-World Bank's Innovation Serbia Project, which provided finance and technical advice.

Mushroom production based on Milenkovic's patented technology began in June 2013, and she aims to produce 15-20 tons of oyster mushrooms a year for hotels, restaurants, cafés and bakeries.

"For small businesses in Serbia, conditions are very difficult. Just wondering how to survive is today's problem," Milenkovic says.

"But I look after my employees like pearls, because they are so dedicated."

Other companies that benefit from the EU-World Bank project include mBrainTrain, which builds smartphone-operated headgear that records and analyses electrical brain activity, aiding the rehabilitation of stroke patients, and Coprix Media, which is developing an interactive educational application to help pre-school and primary children learn basic mathematics.

"Before the innovation fund existed you had to go to a bank for credit, and either it would be very expensive or you wouldn't even have got a meeting with the bank manager," says Vladimir Kopric, chief executive of Coprix Media. "Now there is a better understanding in Serbia that innovation drives the economy."

Of course, the sums of money available under recent programmes pale into insignificance compared with the tens of billions of euros that poured into the region every year before the onset of the 2008 financial crisis. According to a report published last December by the McKinsey Global Institute, the research arm of the McKinsey management consultancy, net foreign direct investment into central and eastern Europe peaked in 2007 at €33bn, or 5 per cent of the region's annual economic output.

Money flow: investment in central and eastern Europe has concentrated in sectors like the car industry, but agriculture and food processing also show potential

Moreover, in the years between the demise of communism in 1989 and the financial implosion of 2008, roughly 80 per cent of the region's foreign capital arrived from western Europe. Most of this investment was concentrated in sectors such as the car industry, banks and outsourcing, where western European, US and Asian investors saw a chance to take advantage of the well-educated, low-cost labour forces or to acquire assets at bargain prices.

Undoubtedly, these waves of foreign capital drove up overall labour productivity, but the levels attained were still below those of advanced western and Asian economies. Moreover, the benefits of technology transfer and shared management expertise tended to be limited to the industries in which foreign direct investment was most heavily concentrated.

PHOTOS: REUTERS; BLOOMBERG

When the west's financial crisis slammed the brakes on foreign direct investment in central and eastern Europe, the region made two unpleasant discoveries. First, it had abruptly lost one of the principal forces propelling the labour productivity improvements of the previous two decades. Second, its domestic savings rates were too low to compensate for the fleeing foreign capital on which economic modernisation had depended.

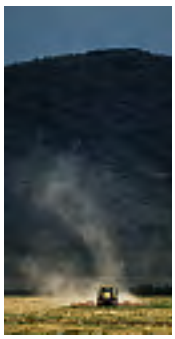
These two factors explain the importance of EU-funded programmes in sustaining investment in the region and in trying to channel it in the direction of business creativity.

A similar role is played by the US Agency for International Development, which, for example, launched a $33m project in March aimed at improving access to capital for innovative agricultural businesses in Albania. "We have to change the mentality of support schemes and agricultural survival, and move towards investments in modern technology through financing from the banking sector," says Edmond Panariti, Albania's agriculture minister.

Indeed, the McKinsey report identified agriculture and food processing as an area of potential for central and eastern Europe. It suggested that, with the help of the larger foreign food processors such as Nestlé and Olam, as well as the involvement of private equity groups, the region could adopt new agricultural technologies and build food research and development centres.

At present, food exports from central and eastern Europe consist mainly of cereal-based products and meat. Targeted foreign investment would enable the region's food processing industry to turn its attention to high value-added products such as dairy items, alcoholic beverages and soft drinks associated with fitness and health.

Beyond the fields and



farmyards, innovation – particularly in the digitally driven knowledge economy – will need more effective collaboration between the region's business communities and technical universities, which despite financial constraints continue to turn out highly skilled engineers and programmers. However, deepening contacts with the world's most advanced economies can be a mixed blessing, as many of the best and brightest graduates seek their fortunes in the US and western Europe, leaving a lack of skilled human resources in their home countries that hampers both public and private R&D investments.

In few countries is the brain drain as acute as in Bulgaria. The number of students at graduate level who went to the US in 2010 was higher than the number from Poland, even though Bulgaria's 7m population is not even one-fifth as big as Poland's 38m.

"Working conditions are not attractive for highly productive researchers," the European Commission's directorate-general for research and innovation wrote in a report last year on Bulgaria.

The brain drain affects Estonia, too, but for Timo Rein, an Estonian-born entrepreneur in California, there are other, more cultural obstacles to innovation. Writing in advance of this year's The Next Web Conference, held in Amsterdam last month, Rein, co-founder and chief executive of Pipedrive, a sales management and training company, said: "With just 1.34m people in the entire country, and the kind of mentality that stifles entrepreneurship, most founders have only had their eyes opened when they've left the country and seen the potential that exists outside Estonia and Europe at large." ■

Go figure

Countries that excel at problem-solving encourage critical thinking as well as factual learning, writes **Jeevan Vasagar**

Maths lessons have changed since Tom Ding was at school. Recalling his favourite subject, Ding remembers: "A big pile of textbooks, the teacher taking you through an example, giving you a bit of context and then telling you what page to open the book at."

So he was surprised to enter a classroom as a trainee maths teacher to find the textbooks on a shelf while pupils grappled with questions such as: "Does speaking a different language mean you count differently?" In another lesson, students debated the best way to represent a number – was it as a fraction, a decimal or a percentage?

Ding, who gave up a career in advertising to train as a teacher with the UK state school chain Ark, says that such questions are a way for students to move beyond rote learning. "If something is learned too much by rote, there's a chance those broader concepts are lost."

Education is under pressure to respond to a changing world. As repetitive tasks are eroded by technology and outsourcing, the ability to solve novel problems has become increasingly vital.

The origin of the word computer is an indication of the shift. The first computers were not machines but groups of people, each working on part of a complex calculation.

As computers have grown more powerful, humans are no longer needed to crunch the numbers. Instead the role of people is to work out which mathematical model approximates best to a real life situation – whether that is the fastest way to deliver Christmas shopping, or organising relief in a disaster zone.

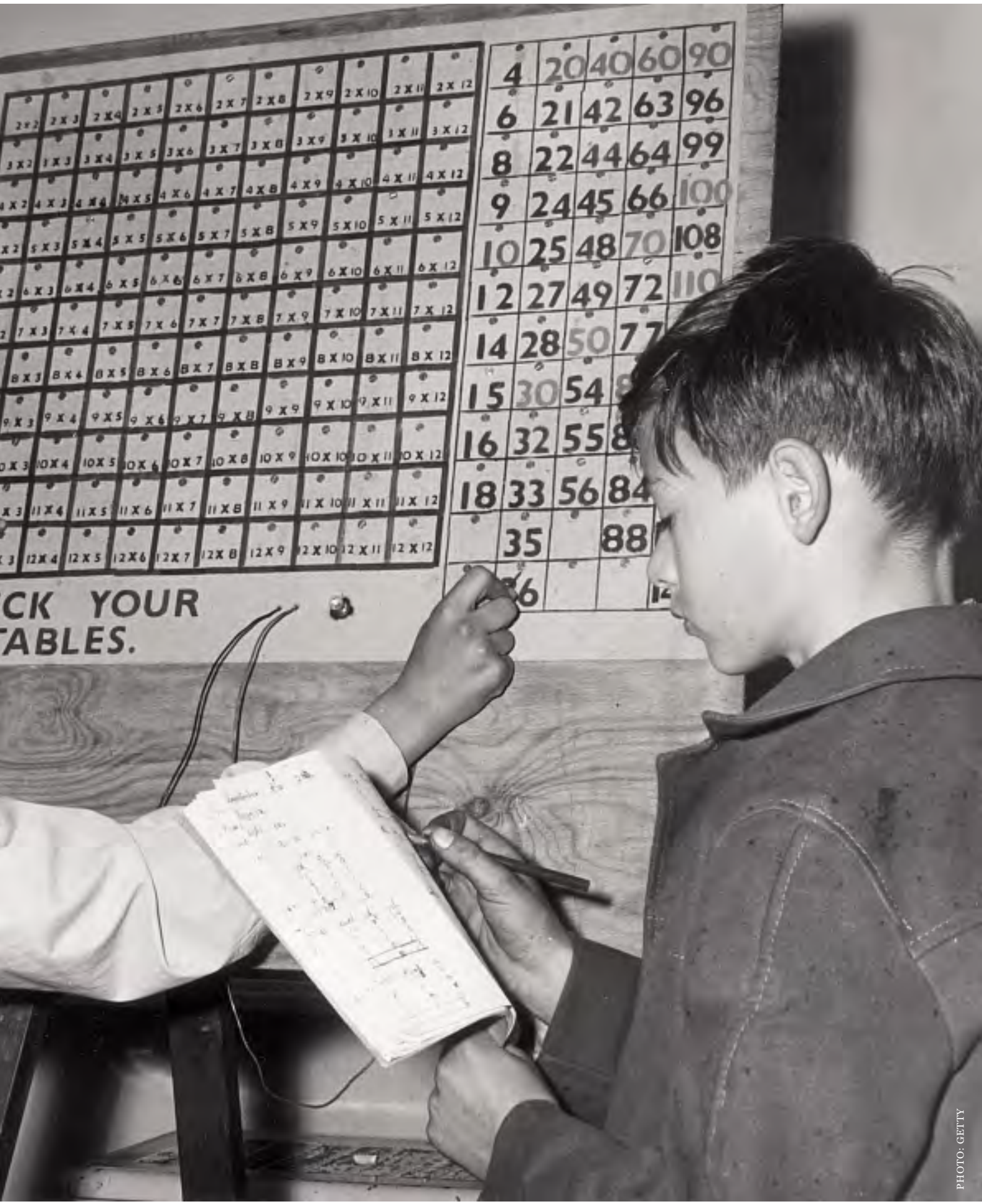
As the rise of tech companies shows, there are high salaries for those most able to organise the world's messy information. The challenge for schools is to combine the teaching of knowledge with the ability to marshal those facts in unfamiliar situations. How well are they doing it? And can they do better?

The first of those questions was answered in April this year, when the OECD published an assessment of the problem-solving skills of teenagers around the world.

About 85,000 teenagers in 44 countries and regions took the tests for the OECD's Programme for International Student Assessment study. The tests expected them to devise strategies for tackling unfamiliar problems. In one, they were shown a map of routes linking the suburbs of a fictional city and asked to suggest a place where three people could meet but no one would have to travel for more than 15 minutes.

They faced situations where the information was incomplete, such as dealing with a new digital device: "You have no instructions for your new air conditioner. You need to work out how to use it."

OK computer: a unique table method helped pupils learn maths in the UK in 1960


4 20 40 60 90
6 21 42 63 96
8 22 44 64 99
9 24 45 66 100
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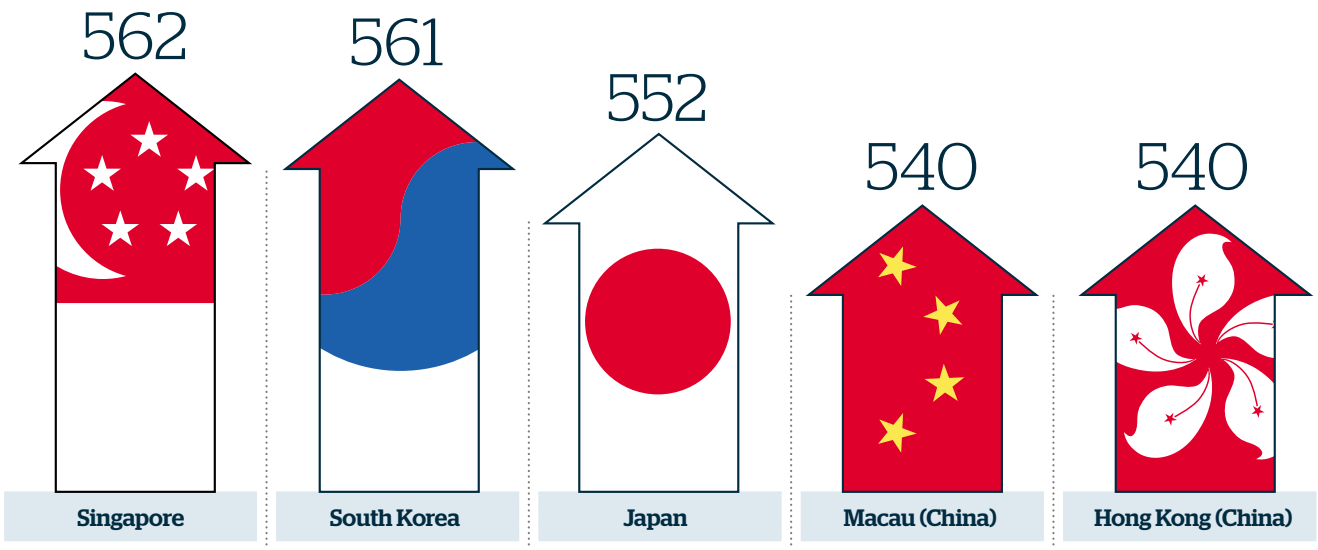
TABLES.

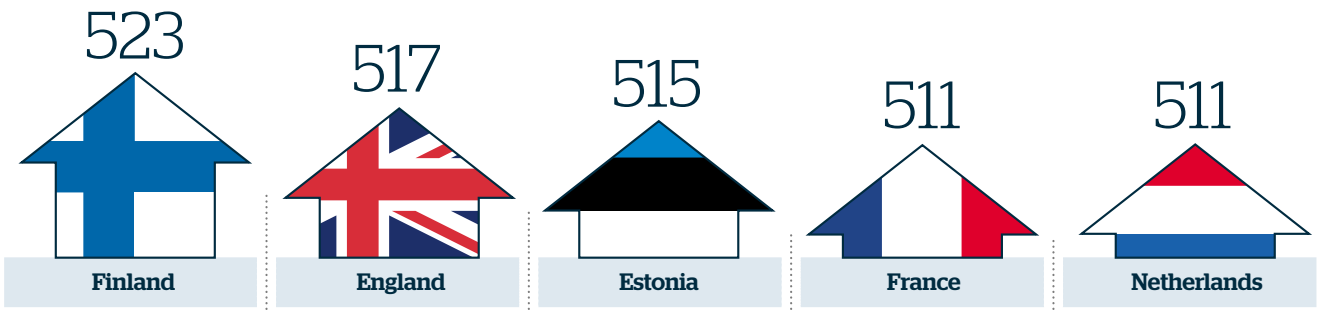
PHOTO: GETTY

How 15-year-olds score at problem solving

Scores in Asian countries/region



Scores in European countries



The score is a mean score that compares with an average of 500 across all the countries of the Organisation for Economic Cooperation and Development. The students were set a number of exercises, as part of the OECD's triennial Programme for School Assessment (Pisa). The 2012 study assessed real-life creative problem-solving skills for the first time. The countries or regions in the chart have the highest scores in Asia and Europe

GRAPHIC: KRIPA PANCHOLI. SOURCE: OECD

And they had to cope with surprises. In another problem, students were told to buy a number of tickets at a concession fare from a ticket machine, only to discover that the concession was not available.

Schools in Europe are frequently criticised by business leaders as "exam factories" that churn out students unable to cope with life beyond the classroom. But the lesson to be drawn from international comparison is that Europe's schools are far better at teaching creative thought than this criticism implies.

Students from the main western European countries – England, France, Germany, Italy, the Netherlands and Belgium – all performed above the average, as did pupils from the Czech Republic and Estonia. In the rest of the rich world, the US, Canada and Australia also performed above average. But the laurels were taken by east Asian territories; Singapore and South Korea performed best, followed by Japan, and the Chinese regions of Macau and Hong Kong.

That result poses a challenge to schools in the west. Critics of east Asian education systems attribute their success at maths and science to rote learning.

But the OECD's assessment suggests that schools in east Asia are developing thinking skills as well as providing a solid grounding in core subjects.

Across the world, the OECD study found a strong and positive correlation between performance in problem solving and performance in maths, reading and science.

In general, the high-performing students were also

the ones best able to cope with unfamiliar situations.

But there were interesting exceptions to the rule. When Japanese students were compared with children in other countries of similar performance in maths, science and reading, the Japanese teenagers showed better problem-solving abilities.

This, the OECD suggested, might be explained by Japan's focus on developing problem-solving skills through cross-curricular, student-led projects.

While there is agreement about the goal, there is a divide over how best to teach children the skill of critical thinking. Daisy Christodoulou, an educationalist and the author of *Seven Myths about Education*, argues that such skills are domain specific – they cannot be transferred to an area where our knowledge is limited.

"Trying to teach abstract strategies that can apply across domains, there isn't much evidence for that," she says.

"The farther away from the original domain you are, the weaker the transfer is. In our lives this does ring true. We all know people who are good at thinking critically about a historical problem, and not very good at thinking critically about a mathematical problem."

Critical thinking is a skill that is impossible to teach directly but must be intertwined with content, Christodoulou argues. Shakespeare, lauded for breaking rules, was the product of a rigidly traditional education.

"We have a good idea of what Shakespeare's education was like," she says. "He would have learned figures of speech by heart, in Latin." And the rhetorical devices that he learned as a schoolboy are deployed with increasing confidence in his plays.

"In his early plays, it is quite mechanical, and as he goes on he is playing with these figures of speech and using them in a creative way. Learning by rote, far from stifling creativity, enabled it," Christodoulou says.

Some argue that placing too strong an emphasis on children acquiring knowledge alone leaves them struggling when faced with more complex problems.

Tim Taylor, a former primary school teacher who now trains teachers, says: "If you front-load knowledge and leave all the thinking and critical questioning until later, children don't develop as effective learners."

There are some generic tools that transfer across disciplines, Taylor argues. "What is reading if not a cognitive tool? And that is clearly 'transferable'."

The style of teaching that he coaches, called Mantle of the Expert, encourages children to pose as experts faced with an imaginary scenario; aiming to engage their imaginations and help them figure out how they would get access to the information they need.

In a class studying the Great Fire of London, for example, pupils will play the parts of experts helping a museum create an exhibition about the fire. "It's a way of making content more meaningful," Taylor says.

The way to teach generic skills is to be "mindful of it as a teacher", Taylor suggests. "You create opportunities to keep that in the forefront of what you are doing – how is this helping us? How can we use this in another context? That is the point of education, to develop a 'growth mindset'," he states.

It is hard to know how much of the advantage east Asian pupils have in international comparisons comes from the academic rigour of their schools, and how much is derived from recent reforms in the countries that have sought to give students a more holistic education.

The OECD suggests that those countries where students do best at problem solving, are not only good at teaching the core subjects, but are good at providing learning opportunities that prepare students well for complex, real-life problems.

Ding, the trainee maths teacher, says the school where he works in north London attempts to sidestep the debate between facts and skills by pursuing both with equal relish.

"On the one hand, our maths lessons begin with times table drills," says Ding. "We put a lot of emphasis on repetition, and frequent testing means students are regularly rehearsing and assessing what they know."

"On the other hand, we also try to use rich, open questions to structure the units of work, making them more enjoyable and memorable for students, and allowing us to avoid shallow rote learning and discuss higher-order concepts along the way." ■

Something doesn't add up: rote learning alone leaves pupils less able to solve problems

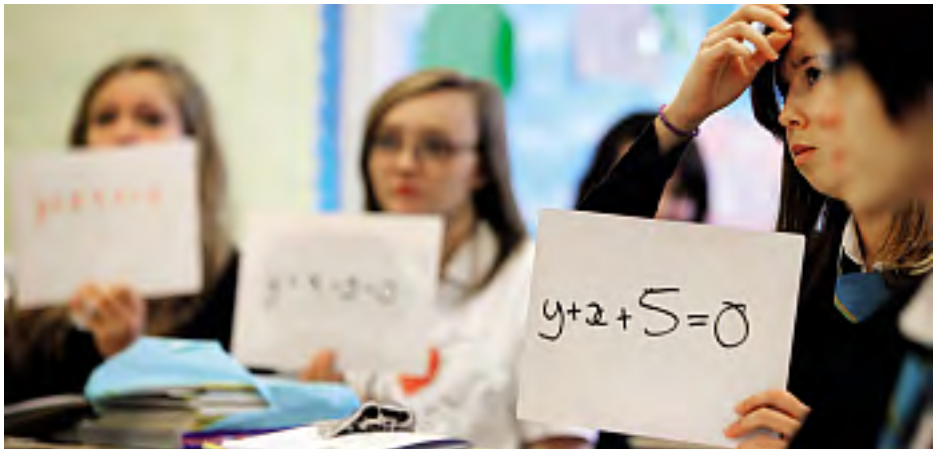


PHOTO: GETTY

Blowing in the wind

How can the EU cash-in on its innovations? The answer is obvious, it must spend more on R&D, writes **Tanya Powley**

In a factory in the small Swedish industrial town of Finspång, high-tech 3D printing machines are melting fine layers of metal powder with lasers to form complex parts of expensive gas turbines.

The technology inside these bulky machines is being used by Siemens, the German electronics and engineering group, to speed up repairs and cut costs within its power generation service and maintenance division. In certain cases, the time taken to repair damaged turbine burners has been cut from 44 weeks to four.

Also known as additive manufacturing, 3D printing is one example of the sort of technological leadership that is seen as key to boosting Europe's manufacturing recovery – and competing against countries with lower production costs.

Siemens is one of the first companies to produce 3D-printed heavy-duty industrial parts for gas turbines but many other heavyweight European manufacturers are exploring how the nascent technology can improve their performance.

BAE Systems, the British defence company, says its RAF Tornado fighter jets have flown the first metal 3D printed flying parts and Rolls-Royce, the UK aerospace company, plans to use 3D printing to produce components for its jet engines.

"The EU's competitive edge will more than ever be based on innovation, productivity and the EU economy's transition into higher-tech and higher-value-added activities," says Bert D'Hooghe, policy adviser at the European Round Table of Industrialists, a leading manufacturing lobby group.

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

However, there are concerns that the continent is lagging behind its competitors on several fronts. It is facing growing competition from the US, where shale gas discoveries are helping to reinvigorate the country's manufacturing sector, and China, which has stepped up its investment into high-value manufacturing, no longer satisfied with just being the workshop of the world.

European industrialists agree that innovation is key but the research and development picture gives cause for concern.

Overall EU R&D spending has remained at about 2 per cent of GDP in the last decade, a long way off the 3 per cent target the EU wants to achieve by 2020. It also lags behind Japan and the US, at 3.4 per cent and 2.8 per cent respectively. Furthermore, the European Commission estimates that China could overtake the EU in absolute R&D spending by as early as 2014.

The share of patent

Big fans: Danish turbine systems company DEIF has 20 per cent of its workers in R&D roles

PHOTO: AFP/GETTY

MASS PRODUCTION

Visit ft.com/creativity-graphene for a look into the UK's stake in graphene

applications – many of which are applicable to manufacturing – also gives a hint of this competitive threat. In the past 13 years, the number of patents filed by companies in the EU has fallen to about 110,000 and jumped from about 25,000 to more than 400,000 in China, according to figures from the World Bank.

Alexandre Affre, director of Industrial Affairs at BusinessEurope, a trade body, believes Europe is missing a "culture of innovation".

"We are not only missing pure innovation in terms of products and processes but also innovation in the decision-making process in Europe," he says. Affre believes that EU legislation is often too prescriptive, restricting the ability of companies to innovate.

Yet some countries in Europe are performing better than others. Finland, Sweden, Denmark and Germany spend the most on R&D in the area.

Christian Diemer, chief executive at Heitkamp & Thumann Group, the world's largest manufacturer of battery components, says innovation is "extremely important". It hired a group innovation director last year to make sure the company concentrated on the right projects and recognised early trends.

DEIF, a Denmark-based niche manufacturer of control systems for wind turbines, also recognises the importance of innovation: 20 per cent of its workforce are engineers employed in R&D. It has managed to keep all of its production in Denmark and 93 per cent of its products are exported, to countries such as China, India and Brazil.

Toke Foss, chief executive at DEIF, believes that part of its success has been in offering an entire service package, rather than selling just a product. This is an area where many European companies have leapt in front of their industrial rivals. Some European industrials now make as much as half their revenues and profits not from producing things, but from providing services to their customers.

"Niche can mean highly individualised production that responds better to clients' needs with production spread around the world," says Uwe Combüchen, director general of engineering industry group Ceemet.

One big consequence of the financial crisis is that manufacturing has jumped up the political agenda in Europe with governments across the continent clamouring to proclaim themselves "pro-manufacturing".

Brussels wants to reindustrialise Europe and aims by 2020 to raise industry's share of EU gross domestic product from 15.6 per cent to 20 per cent. Policy makers and businesses agree there is a need to improve the infrastructure of innovation, from nurturing new ideas to financing high-tech start-ups. "The EU faces a commercialisation gap," says D'Hooghe. "Too often EU inventions/knowledge is not translated into EU-based innovation," he complains.

Brussels is addressing some of these problems through its Horizon 2020 innovation and research strategy, which aims to inject €70bn into European technology-driven industries over the next seven years.

But Europe faces a more pressing concern: a lack of skills. "We simply need to invest more in education and training if we are going to be able to keep up with our competitors," says Combüchen. "Europe is slowly learning – Germany, Austria and Denmark are bright examples of successful systems with high levels of work-based learning." ■

Advantage EU

San Sebastián, best known for surfing and its bite-sized *pintxos*, is also home to a small company at the centre of a global race to take graphene – the so-called wonder material – from the lab to the factory floor.

Graphenea, a Spanish technology company set up in 2010, is one of Europe's main producers of graphene, which promises a range of applications from superfast computers and foldable mobile phones to superstrong aircraft wings.

The material, a layer of carbon a single atom thick, is stronger than diamond but stretches like rubber and conducts electricity better than copper.

But while graphene research was pioneered in the UK almost 10 years ago – when it was isolated at Manchester University, earning Russian-born scientists Andre Geim and Kostya Novoselov the Nobel Prize in 2010 – concerns have grown that the country, along with the rest of Europe, has failed to capitalise on its early scientific breakthrough.

In 2012, there were 7,351 graphene-related patents and patent applications. China made 2,200 of the applications, surpassing both the US and Europe, according to figures from CambridgeIP.

This disparity between producing academic research and commercialisation is dubbed the "European Paradox". The continent is good at producing cutting-edge scientific research, but it is not so good at turning it into marketable products.

But there are signs that Europe

can reclaim the lead. In 2013, the EU launched a €1bn research programme that aims to find ways of commercialising graphene.

San Sebastián-based Graphenea is likely to be one of the main beneficiaries of this 10-year investment push. It is one of a group of small companies making graphene, mainly for research and development. Other players in Europe include Spanish rival Avanzare, and Applied Graphene Materials, a Durham University spinout. "Europe is very well-positioned to lead this emerging sector," says Jesus de la Fuente, chief executive at Graphenea.

The company, which employs 11 people and exports graphene materials to 40 countries, supplies its products to global operations such as Nokia and Philips. It is part of a growing cluster of nanotechnology companies based at the nanotechnology research centre, CIC nanoGune, in San Sebastián.

The UK government is also determined to protect the country's stake in graphene, with plans to open a £61m National Graphene Institute in Manchester next year.

Fuente says research and development spending is "crucial" for Europe's future business success. "Graphene is a new material, market and technology. There is a long way to large adoption of graphene materials and we have to be focused on the long-term competitiveness," he says.

Although a few niche applications, such as graphene-strengthened tennis rackets, are available – and flexible display screens are not far away – the really big applications in electronics are unlikely to be ready until the 2020s.

Andrea Ferrari, professor of nanotechnology and director of the Cambridge Graphene Centre, says Europe already leads the way in graphene science. "Maybe when it comes to the final application at the moment Europe is not leading," he says. "But this investment that we now have is to make sure that the applications of graphene are actually based in Europe." ■

Net gains: graphene-based tennis rackets like the one used by Novak Djokovic are already on the market

Soaraway successes

There are many reasons why clusters of innovation and excellence are developing across Europe, writes **Sharmila Devi**

Trail blazer: LET has produced its L410 aircraft for more than 40 years in the Czech Republic

Brain box: the £500m Francis Crick Institute in London will be Europe's biggest bioscience research centre

The pace of creativity is far from uniform across Europe. Some areas have developed a reputation for producing and developing exciting business ideas.

In cases such as London and bioscience the reasons are easy to understand. The UK capital stands at one corner of a triangle, with Oxford and Cambridge as the other two points, in which the sciences have long attracted some of the best funding and minds in the world. Other cases are less obvious, though, such as the expertise in aerospace engineering in the Czech Republic. During the Soviet years training was excellent, and the current expertise is a direct descendant of that era.

In the same field, Wales had the foresight to offer incentives in a new industry with a great deal of potential.

LONDON: BIOSCIENCE

To explain London's lead as a bioscience cluster, Steve Bates, chief executive of the BioIndustry Association (BIA), uses the example of synthetic biology.

"Synthetic leather, which has never been near a cow, can be grown from cells. Companies doing this here in London can immediately go and talk to the fashion industry to find business applications," he says. "They're not stuck in some science park but in a global city."

The UK has the largest pipeline of any biotech specialist area outside the US, according to a report last year produced by the BIA and financial services consultancy firm EY.

The UK biotech sector had more than 400 potential products in the pipeline in 2013 and was the leader in Europe, with Germany and Switzerland filling the next two positions. Globally, California and Massachusetts have the lead.

London, together with Oxford and Cambridge, helps southeast England to "punch above its weight", says Bates. World-class universities, a long history of scientific innovation, the National Health Service, and London's status as a global city in many other sectors from financial services to fashion all combine to attract talent from around the world.

In April, Boris Johnson, the mayor of London, launched MedCity, a group of academics and business people who will work to attract more life sciences companies to London, Oxford and Cambridge.

Next year, the £500m Francis Crick Institute will open in London for research into the diagnosis, treatment and prevention of disease

PHOTO: HOK AND GLOWFROG STUDIOS

and to generate new economic opportunities for the UK. Alongside the Crick is Oxford's proposed £21m bio-escalator and Cambridge's £212m MRC Laboratory for Molecular Biology.

There are substantial hurdles to be overcome, though, such as a venture capital sector that is small compared with the US; making sure people can get visas to work in the city; and high prices.

And in one way London's success is its enemy, says John Williams, head of clinical activities at the Wellcome Trust, the leading science and research charity.

He says: "Cost-of-living issues pose big barriers to our ability to attract the best young talent."

The jet stream: aerospace companies from across the globe are setting up shop in the Czech Republic

CZECH REPUBLIC: AEROSPACE

Aerospace has long been a significant part of the Czech industrial mix. Over the past 100 years, including several decades of Communism, it has advanced from lower categories of aerospace production to more sophisticated products such as commercial aircraft and military jets.

"In the early 1990s, after the fall of the Iron Curtain, the industry took a significant hit as it had lost essentially all its 'traditional', eastern markets and was not ready to face highly competitive and technologically advanced western markets," says Jan Chmelík, aerospace manager at business development agency Czech Invest.

"However, the Czech Republic was able to build on tradition, technical competence and manufacturing excellence and over the course of 20 years, the aerospace sector is returning to the vanguard of competitive innovation," adds Chmelík.

Most Czech companies are involved in multinational, joint programmes or research projects and co-operate with top corporations such as Airbus Group, GE Aviation, Honeywell, Sikorsky and Embraer.

"We are proud that we had an opportunity to work with companies such as Honeywell, which has manufacturing plants as well as a global research and development centre and a business support service centre in the Czech Republic," says Chmelík.

"Honeywell's Prague laboratory was the first lab that the corporation established outside the US. GE Aviation produces the new H80 turboprop engine in its Prague facility – the first GE engine that was designed and developed outside the US."

Working closely with the aerospace industry to ensure the sector has enough qualified people is a key priority. "Having enough capacity to cope with growing demand and competitiveness is one of the essential issues in the years to come," he says.

The main competition is in Asia. "However, we feel that the Czech Republic has an advantage in such a high-tech sector because even though there may be countries with lower labour costs, the innovation and competence is missing," he says.

"Rather than see Europe as competition, we prefer to feel European and identify opportunities for Czech aerospace companies to contribute to Airbus's leading position in the global market."

WALES: DRONES

The only airspace in Europe where both military and civilian unmanned aerial vehicles, or drones, can be flown alongside normal manned aircraft is in west Wales near the village of Aberporth.

West Wales Airport and, since last year, Newquay Cornwall Airport in the UK's West Country together form the National

Aeronautical Centre, which has helped to boost investment in drone technology by providing the space for companies to test their products.

"We are the gateway to the marketplace. We've done our bit and created the motorway and it's up to the manufacturers to create the cars," says Ray Mann, the entrepreneur who developed the former military airport in Wales.

"Civilian unmanned systems as a market is going to be worth $100bn over the next decade or so and we're right at the front edge."

He points to potential UAV applications such as flying cargo, search-and-rescue operations, patrolling borders, repairing power lines and even carrying broadband capability as part of disaster support.

Companies such as Thales, Selex ES and 3SDL have facilities at ParcAberporth, a Welsh government-owned technology park next to West Wales Airport, where they can test UAVs in 2,000 km over the sea and 500 km over land.

It is also the base where the UK Ministry of Defence is testing the £800m Watchkeeper unmanned aerial system, which has drawn some anti-war and local protesters.

The MoD is looking at ways of extending the number of sites within the UK where it could fly drones but for the time being, West Wales and Newquay form a leading, if unusual, cluster for drone-testing technology.

Droning on: the Remote Piloted Air System during flight trials at Parc Aberporth

LEIPZIG-HALLE: LOGISTICS

Since 2005, a number of leading companies have clustered their logistics operations around the Leipzig-Halle airport, including DHL, AeroLogic and Lufthansa Cargo, creating one of Europe's newest hubs.

"It was a major decision of DHL to relocate its hub from Brussels," says Uwe Arnold, cluster manager for Netzwerk Logistik Leipzig-Halle, which hosts businesses, academia and local administration.

He says the new hub's success is down to three main reasons. First, there is good infrastructure created after the 1990 unification of Germany as well as physical space in the region for companies

PHOTOS: RICHARD SEYMOUR; AFP/GETTY

to expand. Second, it has good proximity to EU markets in central and eastern Europe. Third, the airport is open 24/7 while other cities grapple with residents' objections to expansion because of noise and traffic.

"Two major players, Porsche and BMW, made the decision to concentrate some of their important production facilities in Leipzig," says Arnold. "One of the reasons for this is there is a more skilled workforce compared with Bavaria and southwest Germany. Other companies have followed on this momentum."

Competitors for Leipzig to watch include Nuremberg, Hanover, Munich and Berlin. Outside Germany, the traditional hubs in the Benelux countries, Austria, Switzerland, the Czech Republic and Poland are kept under scrutiny.

"The challenge will be to keep the momentum because we've had such high growth," says Arnold. "We're always trying to improve the tech levels inside the cluster with greater investment in infrastructure such as cloud and web applications for logistics."

That's logistics: DHL was attracted to Leipzig by its excellent geographical links

LONDON: SILICON ROUNDABOUT AND BEYOND

Recent headlines have spoken of a brain drain away from London's Silicon Roundabout, the cluster of tech companies around Old Street, towards Berlin's Silicon Allee because of the expense of living and working in the UK capital and restrictive immigration policies.

But David Slater, director of international business development at London & Partners, the city's promotional organisation, says London as a whole remains pre-eminent for technology innovation.

"Tech is spreading out from Camden to Croydon. If you look at the [recently upgraded] Overground rail line, it provides a map of where there are companies," he says.

London's relative strengths remain in place, says Slater. These include access to customers and markets, the business environment including tax and employment laws and policies, and a large and diverse talent pool.

"London has 40 ethnic communities each totalling more than 10,000 people. Only New York is comparable in diversity."

Slater points to Rekoo, a mobile gaming company and the first mainland Chinese company to announce last year it was moving to London and building a new development team. "Chinese investors tell me they feel welcome in London and they don't feel that in other European cities," says Slater.

London has more co-working space, where desks can be rented singly or in groups, than anywhere in Europe except Spain, and the most incubators, he says. He also cites Greater London Authority figures showing that London has 34,000 tech companies employing around 160,000 employees, which is around 30 per cent higher than five years ago.

"We've stepped up our message to the world that London as a whole is Europe's tech capital," Slater says. ■

Counter intelligence

Europe is declining as a manufacturing power but niche companies that expand and invest wisely can buck the trend, says **Peter Marsh**

The future is far from rosy for many manufacturers in Europe but Roberto Gavazzi, chief executive of Boffi, a top Italian maker of upmarket kitchen and bathroom units, is upbeat.

"I am very confident that the current difficult markets are getting better for the best brands," he declares.

Underlying this sentiment is Gavazzi's belief that Boffi – like many other European manufacturers of a similar mould – has built up strengths not just in product creation but in using service and design skills to offer customers something special that would be hard to obtain from rival businesses.

"Consumers are even more selective – they want to choose only those products that have a real added value," he says. "So [they choose] not only design and function, as is normal for our collections, kitchens and bathrooms, but now they want increasingly to buy something that gives them a very special mood or atmosphere. Here, I think we can do well."

Making marine instruments for jobs such as measuring the salt concentration in sea water or locating underwater objects such as mines is a very different industry sector. But Matthew Quartley is also looking to the future with some optimism.

Quartley is the managing director of Valeport, a UK company that is among the leading businesses globally in its field. It has recently invested £2.5m in a new production and commercial centre at its base in a quiet corner of southwest England, a sign of confidence that the company is ready to continue its substantial growth of recent years.

"We have a staff of 75 while in 2003 we employed only 30," says Quartley. "The new investment has given us room to breathe."

Boffi and Valeport are among hundreds of top manufacturing businesses based in Europe that have eschewed mass market, commodity-style sectors. Instead they have concentrated on narrow "niche" areas of industry where often fairly small enterprises can command a global presence.

Other attributes shared by these manufacturers include reliance on specialist technical skills, an emphasis on product customisation and use of "hybridised" supply chains that combine the far-flung with the local. For example, European businesses keep costs under control by purchasing standardised components and materials from low-wage economies. At the same time they maintain strong links with key local suppliers that make design-intensive components and

Storage wars: the EU can take on foreign markets with high-quality specialist products like Norbert Wangen's kitchen cube design

BESPOKE

Visit ft.com/creativity-robots for a profile of Universal Robots

assemblies that are often crucial to the final product.

But the positions of many of Europe's specialist manufacturers have inevitably been harmed by the deep economic difficulties of recent years, linked particularly to the 2007-08 financial implosion.

Meanwhile the rise of manufacturing in China and other fast-growing economies has greatly reduced the share of leading European countries in global manufacturing output, which (excluding Russia) fell from 28 per cent in 2000 to just over 21 per cent in 2012, according to UN data.

Even Germany dropped from 7 per cent to 6 per cent over the period, while Britain's share halved to just under 2 per cent.

With large swathes of mainstream industry, including cars, white goods and steel, suffering severe falls in demand, manufacturing employment in the EU between 2007 and 2013 declined by roughly 10 per cent, equivalent to a loss of some 3m jobs. Despite a recent recovery it remains sluggish.

It might seem surprising that so many leading specialist companies are feeling cheery. Take Enrico Krog Iversen, chief executive of Universal Robots, a Danish producer of highly adaptable industrial robots that work on production lines around the world.

Universal Robots, which was founded in 2005, has 100 employees and relies on a network of about 25 key suppliers based in Denmark that make many of the crucial engineering assemblies and parts. "Europe has many of the important technical skills and some strong clusters of technology-based businesses. For our sort of manufacturer, I don't see any major challenges ahead," Iversen says.

Such views are not universally shared. Alberto Alessi, general manager of Alessi, the Italian maker of upmarket kitchen goods and other products, says: "I'm not at all optimistic for the future of manufacturing in Europe. In a world where consumer products tend to [move] to industrial commodities without soul or character, high production costs will make the [European position] too difficult."

But the balance of opinion leans towards optimism. So how have the most successful European small to mid-sized production businesses managed to cling on to – and sometimes extend – their global capabilities? One answer is that they have stuck to their key strengths built around specialist products or machines where the relative smallness of the market – plus the difficulties of replicating the required degree of know-how – act as a big barrier to potential competitors.

For instance, Blum of Austria has built up a leading position in the narrow field of hinge and fastener systems for furniture. It holds 1,200 patents covering the esoteric aspects of "motion control" for doors and shelving units and it sells 1,100 different varieties of hinge.

Similarly specialised is Belgium-based IBA, which is the world's biggest supplier of novel machines for treating cancer patients by directing streams of protons at the affected areas. About 25,000 patients have been treated on IBA equipment – which the company says is more than on all competing installations combined – with the cost of a machine plus ancillary equipment varying from $25m to $50m.

Sometimes a company can use its strength in a narrow product area to extend its reach into related fields that rely on the same basic technology but take it into a different market. In this way, Vitronic, a German company that uses laser scanning in instruments that measure the speeds of road vehicles, has moved into areas such as laser-based identification systems for monitoring the movement of goods in warehouses and factories.

The success of some leading European businesses is also linked to their ability to extend their reach on a global level while retaining a strong base in their home country.

Baader of Germany is a leader in the field of fish-processing machines, suited to handling different species of fish and which both automate messy jobs such as removal of bones and extraneous tissue and reduce the risks of contamination. The company has extensive global connections – just over half its 1,100 employees are outside Germany – but the main production is done in Baader's home country.

Sometimes the emphasis in terms of global connections causes the domestic aspect of the company's operations to shrink, while its overseas activities increase. Thus Bisazza of Italy – a leading maker of decorative mosaic tiles – has reduced its workforce in Italy over the past five years while extending its manufacturing and assembly plants in countries such as Mexico, India and China.

More frequently, however, top European manufacturers go in both directions at once. Trumpf, the German company that is the world's biggest maker of laser cutting machines for sheet metal, recently underlined its commitment to overseas expansion through the purchase of JFY, a leading Chinese machine maker. But its key production and development

centre remains in its base in Stuttgart, which employs a quarter of the company's 10,000-strong global workforce.

Nicola Leibinger-Kammüller, Trumpf's president, plays up Germany's strengths in specialist mechanical and electronic technologies. "Germany, and in particular our home region of Baden-Wurttemberg, are for us still the best machine construction locations in the world," she says.

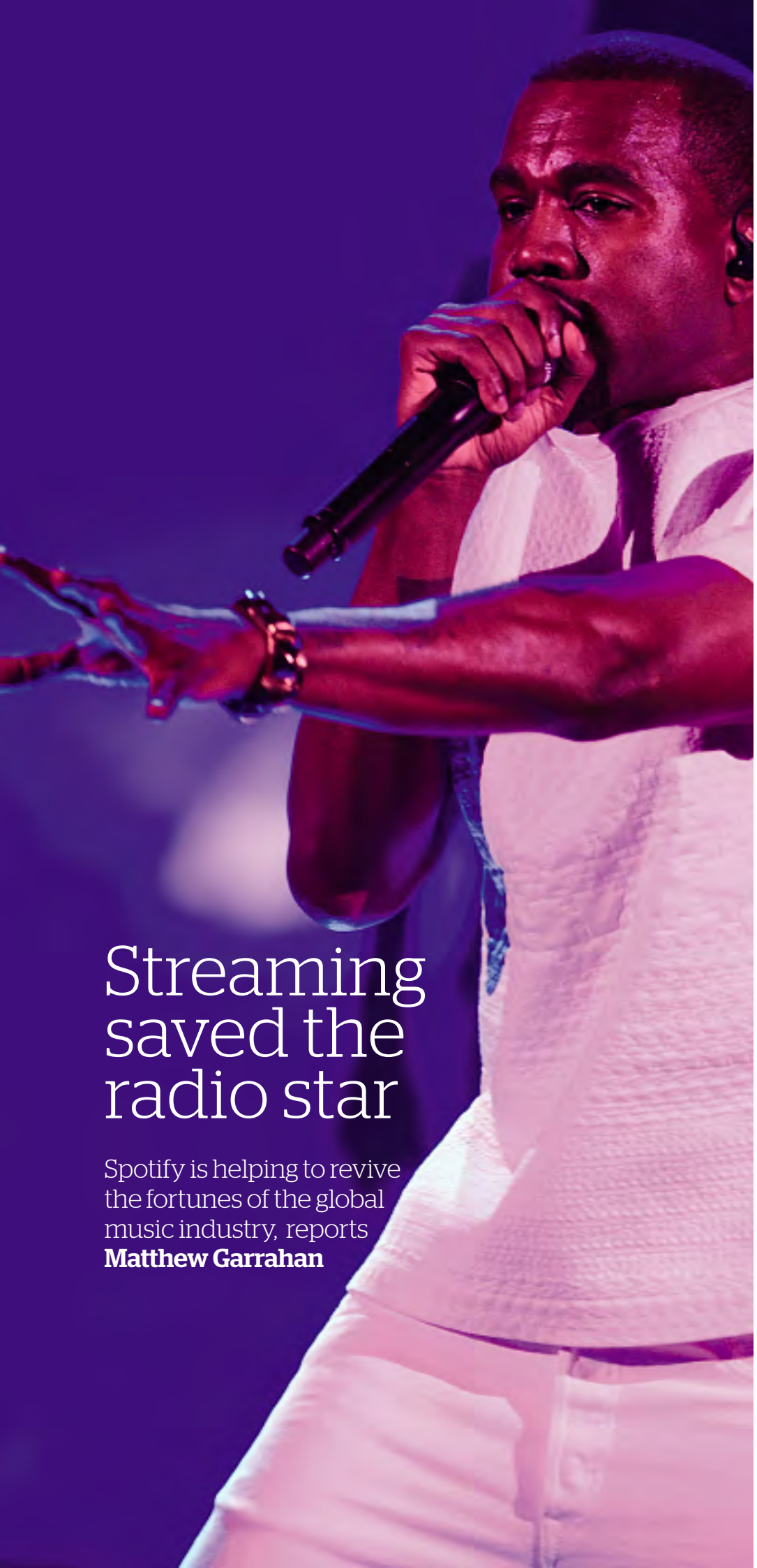
Also, many of the top manufacturers in Europe say that remaining at the highest level in terms of technology capabilities is an essential part of their ability to keep ahead of competitors in other nations such as China and India that may have the benefit of lower costs.

However, Fabio De'Longhi, chief executive of De'Longhi, the Italian company best known for its consumer domestic appliances such as coffee machines and kettles, says that attempting to innovate by channelling money towards research in new materials and electronic control mechanisms is only part of the story. What is needed, he says, is matching these efforts with thinking about the requirements of the customer. "Only those companies capable of delivering meaningful innovation – innovation that improves the consumption experience and delivers benefits that consumers can perceive – will remain ahead of the curve in the future."

Hans Langer, chief executive of EOS, a German company that is among the top producers globally of novel families of 3D printing machines, has a similar emphasis on developing technology while at the same time listening to customers. "In close co-operation with [customers], we will push the technology to the next level," he says. ■

Small fry: Europe produces automatic fish processors, robotic assemblies and luxury kettles

PHOTO: GETTY



Streaming saved the radio star

Spotify is helping to revive the fortunes of the global music industry, reports **Matthew Garrahan**

At first glance, the recent annual report from the IFPI, the music trade body, made for grim reading. Global music sales were down 4 per cent in 2013, a depressing slip for an industry that had hoped to put a decade of decline behind it.

But hidden in the report was a possible key to music's future. Income from streaming services rose 50 per cent to more than $1bn last year, a sign that music fans are moving from digitally downloading music to own in favour of an all-access subscription model.

European music services such as Spotify are leading the innovation charge and record labels are, for the first time in more than a decade, looking to the future with optimism. Subscription music provides a steady and growing revenue stream, instead of a business model built around a cycle of releases by individual artists.

"What the subscription model does is take volatility out of the record business," says Rob Wells, president of global digital business at Universal Music Group, the world's largest music company and home to artists ranging from Kanye West to the Rolling Stones. Subscription, he adds, "makes the industry more attractive to investors".

The picture was a lot less rosy in 2006 when Daniel Ek, Spotify's founder, was kicking around ideas for a streaming music service. The music market in Ek's native Sweden had been damaged by piracy and some of the biggest operators of pirated content, such as The Pirate Bay, were based in the country.

Record labels and music services around the world had struggled to absorb the impact of piracy. Sales of CDs had fallen

PHOTOS: GETTY; KEVIN MAZUR/WIREIMAGE

into inexorable decline while digital downloading, from sites such as iTunes, was popular but not growing fast enough to offset the slump.

Ek envisaged a creative solution to beating the pirates at their own game – making music available for free on an ad-supporting streaming service that served to turn its users into longer-term, paying customers.

"From the outset the notion was that to compete with piracy you have to be free [of charge] and when people fall in love with the service you can get them to pay," says Jonathan Forster, Spotify's managing director of the Nordics.

The launch of the service in 2008 almost coincided with the launch of Apple's 3G iPhone model. The two services were tailor-made for each other: in tech-savvy Sweden, Spotify took off like a rocket and now represents more than 70 per cent of the country's total music revenues; in the UK, it will represent about a third of all music revenues by the end of this year.

Other Nordic countries where Spotify launched have followed a similar trajectory and, as it has rolled out across the world, the expectation is that other markets – including the US – will follow suit in terms of subscription becoming the main way people listen to music. "It's only a matter of time; it's an absolute inevitability," says Wells.

Spotify's most recent public figures reveal 24m users, of whom more than 6m are paying subscribers. Other streaming services have joined the fray, each catering for a different slice of the market. Wimp, which also hails from Sweden, is a paid-for service that offers streaming music in high-definition quality, for example, while other services have targeted more cost-conscious customers. Beats Music, which recently launched in the US, is targeting listeners who want a more curated, personalised service. The company was started by fabled record producer Jimmy Iovine, and hip-hop legend Dr Dre and has backing from billionaires such as Len Blavatnik and James Packer. "There's plenty of room for competition," says Wells. "All of these services are parked in different lanes."

Powered by the iPhone and a generation of listeners that were using mobile devices, Spotify quickly became the fastest-growing music service. When it launched in the US in 2010 it attracted 1m subscribers in its first 16 months, a milestone that took its rival, Rhapsody, 11 years to reach.

The biggest obstacles it faced were ensuring its technology platform worked smoothly as well as convincing the record labels to do licensing deals. "The licensing was hard," says Forster. "I don't think anyone had done it on that scale before."

Spotify and its rivals are now centre stage in an industry that has undergone a dramatic transformation. As sales of CDs and full albums have declined and the industry has grappled with the transition to a digital downloading model, live music and performances have exploded. For top artists, global tours now represent a larger slice of their earnings than sales of recorded music.

Cities and countries once deemed too remote for touring have now become mainstays on the global circuit for the biggest acts. Thanks to social media, the cost of promoting tours has fallen: concert promoters now rely on the biggest acts telling their fans where and when they will be appearing. Promoters can also plan tours using social media data to identify parts of the world where a particular artist may be popular.

Sign of the times: a song by Swedish DJ Avicii was the first to reach 200m streams on Spotify

But for recorded music, subscription streaming and the proliferation of mobile devices show the way forward. Mobile networks eager to boost their credibility and reduce customer churn have signed deals with streaming services such as Deezer and Spotify, while Beats Music launched its service in the US on the back of a partnership with AT&T. Spotify, which has several mobile deals in Europe, recently struck its first deal in the US with Sprint, the mobile network controlled by SoftBank.

With new distributors and creative thinking coming into an industry that has had a miserable decade, music has regained some of its swagger. "I firmly believe we can expand even beyond the glory days of the industry," says Wells. "We can make the music business bigger than it has ever been." ■

PHOTOS: GETTY; INTERFOTO /ALAMY; STEFANO BARZAGHI

Model behaviour

Its heritage is renowned but the design industry must adapt to thrive, says **Edwin Heathcote**

Now, more than ever, design is discussed, disseminated, published and celebrated. Magazines glamorise design and websites provide access to the newest fads. Fairs, festivals, exhibitions, biennials and auction rooms elevate design into a cultural medium on an equal footing with art.

No company in recent years has done more to promote the cult of design than Apple, whose style guru is British designer Sir Jonathan Ive, a quiet but obsessive character whose eye for detail and minimal style has created the highest-impact cult products in a generation. After all, what is Apple but design?

Whether it is the sleek, seamless objects themselves, which would have been unimaginable a decade ago, or those magical apps that appear as if from the ether, Apple has put design centre stage and any company aiming to emulate its premium pricing and cult success is forced to accommodate design at the centre of its strategy.

But has even that measure of success really made a difference? Has it made design as an industry more central? Is design fundamentally at the heart of business or is it still regarded only as an add-on or a luxury? The evidence points to the latter. Despite everything, despite the glamour of design and the clamour to be designers, big business still seems to somehow disdain design. Beyond the rarefied world of high fashion, design remains marginalised.

Europe was traditionally the home of design-centred production and its decline can be seen by comparing a golden age in the 1950s and 1960s with contemporary production.

DESIGN

Think of Ettore Sottsass's extraordinary work for Olivetti (comparable with Ive's work today) or of Dieter Rams' long line of exquisite products for Braun (Rams has been a huge influence on Ive). Think of those companies today and it is impossible not to perceive the steep decline of design.

Similarly if we think of Sir Kenneth Grange, Britain's most revered industrial designer, and his mass market work for companies from Kenwood to Kodak, we can see that, despite all the hype, despite the massive proliferation of design as an idea, design was far more mainstream in the middle of the last century than it is today.

Even the big Italian manufacturers, for half a century the mainstay of the European design industry, are now warning that European production could collapse under intense pressure from Asia. And if that does happen there is a real danger that the industry that sustains design will disappear.

Yet, despite the shakiness of the big picture, there are signs that things could be different. The Netherlands brings a particular understanding to design, an idea that its impact need not be solely on products but on society itself. Judging the Netherlands Design Prize earlier this year I was struck by how far almost all the entries had moved from industrial production. There was social design and conceptual design and a complete lack of the usual chairs and coffee pots.

Instead there were real surprises including Temstem, an app developed for people who hear voices in their heads and which purportedly calms those voices by using the affected language recognition part of the brain to play simple word games. It is a stunningly simple solution to a complex and damaging problem achieved in the most direct way imaginable – with a clearly-designed and freely downloadable app.

Another Dutch entry, Fairphone, presented a design for a smartphone in which all the elements are ethically sourced, environmentally friendly and completely recyclable. It seems extraordinary that this phone, almost indistinguishable from most others, could be manufactured in such a radically different way and for a comparable price.

Denmark has famously embraced design – almost to excess. When every home and every commercial interior is impeccably designed and filled with beautiful design objects, the aesthetic landscape can become almost anodyne. Nevertheless, Danish companies have been successfully building on that rich history of modernist design with firms including Fritz Hansen, Stelton and Kvadrat producing superb, Danish-designed products in Denmark itself.

Italy remains arguably the most intriguing model. Its design industry famously grew from the ruins of wartime production when armaments production was switched to consumer goods, helped by generous Marshall Plan funding. Its manufacturing success was an economic miracle almost to match Germany's, its industry becoming synonymous with everything from motor scooters and fashion to espresso machines and sports cars.

And each of these products was sold on the back of Italy's uniquely seductive design. The country's culture of small and medium-sized family companies proved nimble and perfectly suited to the emerging international mid-century design culture. Even today, a walk around the Milan furniture fair is an extraordinary testament to the skill of the craftsmen who rapidly produce hundreds of prototypes for the exhibitions.

Top gear: Renault has collaborated with sci-fi designer Ross Lovegrove. Below: shelves at Milan's Furniture Fair

In recent years, though, many of the Italian manufacturers have been voicing their concern that things cannot remain the same. Competition and copying from China is crippling their traditional markets. The newer model of commissioning designers from beyond Italy has ensured Italian companies stayed at the forefront of international design but it has also diluted the idea of Italian design, its identity. At the same time the generation of craftsmen is ageing and is not necessarily being replaced.

The current big thing is 3D printing and the idea that we will all be enabled to become small-batch manufacturers of our own designs. But the way in which this may accelerate a loss of crafts skills is little discussed. It is not a Luddite position to express nervousness about diluting the skills that have made European design such a thriving industry and have given it that distinctive edge.

PHOTO: BLOOMBERG

One arena in which Europe has been embracing design is the automotive industry. Prestige manufacturers such as Ferrari and Porsche have always made an issue out of design, celebrating individual talents and design consultants (Ghia and Pininfarina, for example) but the more commercial companies have kept design in-house and anonymous. A big change has been the deliberate association of cars with design.

In April, Volkswagen showcased its neat, diminutive XL1 not at a car show but at the Milan Furniture Fair, just as last year Renault first showed its extraordinary Twin Z concept car with its theatrical brake lights extending across the whole rear and its stunning, organic wheels at the Milan show. For this, Renault commissioned British designer Ross Lovegrove, known for his fluid science fiction designs, to reimagine the small car. This was a brave move but a prescient one, placing the mass car manufacturer among an elite of design companies. In fact it seems odd that more car manufacturers do not work with outside designers – this is precisely the sort of collaboration that can lead not only to breakthroughs and crossovers in technology but also to a kind of brand differentiation that might be critical in the current struggling market.

Britain has had huge success in exporting industrial designers. If the Netherlands is known for its unconventional, eccentric concepts and Italy for its sexy styling, the Brits are known for a robust and elegant functionalism in a tradition that stretches back to Kenneth Grange and beyond. Currently Jasper Morrison is one of the most renowned designers working for a range of international companies but other less familiar names include Sam Hecht and Kim Collin of Industrial Facility, Sebastian Bergne and Barber Osgerby, all working for a remarkable range of international companies and creating a kind of hybrid European design that blends functional, elegant British design with continental European manufacturing flair.

The Belgians have also been a surprisingly strong design presence. Ann Demeulemeester, Dries van Noten and Martin Margiela and Raf Simons have exerted a huge impact on the fashion scene completely out of proportion to their home country's size. They present only the most visible crown of a country in thrall to design.

We have become used to product designers, fashion designers, architects, graphic designers and so on – and their role in any evolution of European design is secure as the continent continues to export its most famous brands. But perhaps where the future lies is in the application of design to less familiar areas.

The emergence of social design and conceptual design, for instance, promises to question, undermine and reinterpret accepted dogma. If designers are able to apply their intelligence to processes as well as products, to society as well as shoes, then real changes might emerge. Corporations are cautious, but it will happen. Some of the more radical and intellectual design practices including Jurgen Bey, Ezio Manzini and Marti Guixe have been positing probing questions.

They have introduced the idea of a critical design that, rather than using design to solve a problem, uses it to begin to illuminate the complex issues around a problem, as well as taking design beyond product and into human behaviour.

In the meantime, social design, the idea that design should contribute to good in the world, is beginning to have an impact on services and delivery in everything from social work to healthcare and education. Perhaps, counterintuitively, an alternative future for design may well lie here. Designers always work in the future with an ability to anticipate change. If industry declines and power shifts, design still may have a future, albeit one that looks very different. ■

Stepping out: Yoko Ono and her River Bed artwork at the Guggenheim in Bilbao

Come together

Business can take up the slack in arts funding, and reap its own reward, writes **Peter Aspden**

A surge of idealism prompted the cultural rebuilding of Europe after the second world war. The political classes took seriously anything that would contribute to a new-found feeling of harmony and goodwill among its member states.

The arts fitted the bill, with a range of initiatives – collaborations, tours, visits – that emphasised the unity of European culture. Prominent was the Edinburgh International Festival, founded in 1947, to provide a "platform for the flowering of the human spirit".

Those words prefigured a golden age for European culture. Its great orchestras and accomplished theatre troupes became accessible to more and more people thanks to generous support from governments that needed to find new, softer ways of expressing national pride. There was a steady rise in museum and gallery attendance; record box office receipts were recorded in the performing arts.

And the arts proved good for business. Companies saw the synergy between the promotion of their corporate values and their association with wholesome cultural projects. Business sponsorship boomed in the UK. In the rest of Europe, it blossomed more slowly but there was nevertheless a growing social consensus around the importance of culture.

This was demonstrated by the construction of the Centre Georges Pompidou in the centre of Paris in 1977, a head-spinning architectural masterpiece by Richard Rogers and Renzo Piano. It took cultural audacity and signalled the arrival of a new phenomenon: the multi-use arts centre, admired for its other-worldy appearance, loved for its

PHOTO: GETTY

When in Rome: Karl Lagerfeld at the launch of the Trevi Fountain project, funded by Fendi

bold and eclectic programming, and used widely as a social gathering space.

French president François Mitterrand planned a series of *grand projets* that would transform the Parisian skyline, and place the arts at the centre of his nation's political discourse.

Today, the attraction of a thriving arts scene is taken for granted. The link between cultural creativity and business success was formalised by American urban theorist Richard Florida, whose work at the beginning of the current century charted the way that metropolitan areas containing "high bohemians" – artists, musicians, technology workers, gay people – prospered because of the favourable environment; which in turn attracted more creative talents, creating virtuous circles of urban regeneration.

In 1997, exactly 20 years after the Pompidou Centre, came the project that most clearly spelled out the newly-lauded link between culture and economic well-being: the Guggenheim Museum in Bilbao.

The Basque city's dilapidated port area was visually transformed by Frank Gehry's remarkable design. But it was also revivified to an extent that no one had imagined. Tourists flocked to see the new building. Visitor spending in the first three years of its opening raised more than €100m in taxes for the regional government.

The phenomenon was labelled the "Bilbao effect" but Gehry had no idea that the effect would become a global template for regeneration through culture. "I remember all these meetings, where people would talk about their hopes for a commercial uplift," he recalled in an interview with the Financial Times last year. "But it didn't register as a possibility with me. I thought that these guys believed in the tooth fairy if they thought a building could do that."

The enduring success of Bilbao, now a tourist attraction bringing in around 1m visitors a year, chimes with another 21st-century intervention from the tooth fairy – the booming interest in contemporary art. This has sparked a new wave of museum building and a burgeoning of art fairs, with European venues prominent: London's Frieze fair, Paris's FIAC, and Art Basel.

The popularity of an art form that was previously seen as difficult and esoteric has encouraged business to align itself with contemporary ideas and values. Brand managers have been quick to identify their clients with the new, open cultural climate, to show off their receptiveness to fresh ideas and their willingness to innovate.

In the spring of 2008 investment bank Dresdner Kleinwort launched a poster campaign that used Jimi Hendrix and Maria Callas, geniuses both, but scarcely noted for the quality of their common sense. The slogan was: "Unexpected viewpoints. Radical thinking. Inspiration. Nothing inspires more than advice you didn't expect." A few months later, came something we really didn't expect: the near-collapse of the financial system.

Notwithstanding that unfortunate example, a new relationship between arts and business has been forged that is perceived as mutually beneficial. For business, the association with arts institutions is a symbolic commitment to a world of intellectual flux. For the arts, business sponsorship provides a much-needed revenue stream.

The UK's mixed funding model, balancing government support with private investment, is widely admired in Europe, although the suspicion in many countries is that cash-strapped governments will use any increase in private sponsorship as a excuse to reduce its own funding commitments.

In Italy, for example, governments have encouraged companies to support national heritage initiatives that are considered unaffordable or politically unacceptable in times of economic hardship: witness the €25m contribution by luxury goods manufacturer Tod's to help restore Rome's Colosseum, and the fashion house Fendi's €2m Trevi Fountain repair project.

The post-war consensus has been replaced by a sophisticated, multi-layered interplay between business, government and the arts that will surely see many more twists. There remains a number of uncertainties.

First, while contemporary art can more than hold its own in the cultural marketplace, the same is not true of more traditional, "high" culture forms that helped make Europe an artistic powerhouse. The Vienna State Opera is never going to be hip, cool or cutting edge. (Indeed, its audiences have a reputation for lustily booing any crass attempts at making it so.) It has been, and will remain, heavily reliant on state support. How long will it continue at present levels?

Second, thanks to technology, the arts world has never been so global in its reach. This raises the spectre of the world's dominant

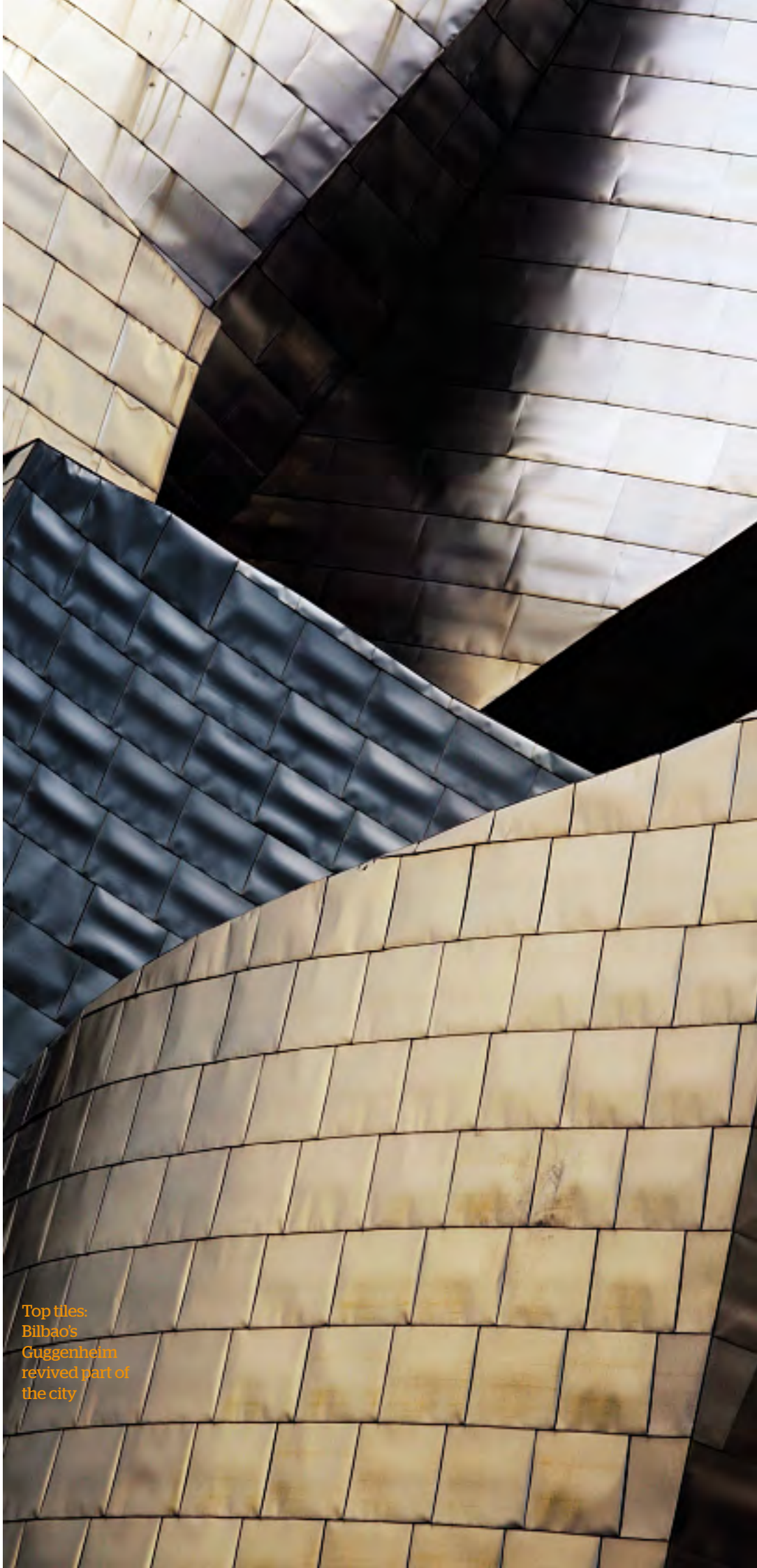
arts organisations becoming global providers of content: New York's Metropolitan Opera raises tens of millions of dollars from its live broadcasts around the world. That world, in any case, is being sharply recalibrated: the most ambitious cultural programme is in Abu Dhabi's Saadiyat Island, which has plans for both a Louvre and a Guggenheim museum. Can Europe keep up?

Third, the changing demographics of most major European cities, which host increasingly itinerant populations, is affecting their attitudes towards their own culture. Civic pride is one of the most important determinants of cultural activity. The success of the Manchester International Festival, established in 2007 and now one of the world's most important arenas for new work, rests on the city's determination to make its illustrious history better known, and has been generously supported by local funding.

Finally, such has been the pace of technological innovation in business, that it is fast becoming the equal, if not dominant, creative force in its partnerships with the arts.

The collaboration between Google Earth and Madrid's Prado Museum, enabling highly detailed scrutiny of the gallery's masterpieces, is as much a technological revelation as an artistic one. The recent David Bowie exhibition at London's Victoria and Albert Museum succeeded because of Sennheiser's contribution of high-quality headphones for every visitor.

This is how an optimistic version of the future looks: the creativity of the artist and the business leader working together, helping to bring a different kind of idealism back to the question of Europe's cultural health. ■



Top tiles: Bilbao's Guggenheim revived part of the city

PHOTOS: GETTY; REUTERS

COMMENT
PETER
BAZALGETTE

Arts counsel

Schools, business and politicians must encourage creative pursuits

Four years ago, the economist Gerard Lyons came up with an insight that will, in time, be as well known as anything said by John Maynard Keynes, Milton Friedman, Friedrich Hayek or, indeed, Jim O'Neill. Lyons told us the countries that will succeed in the future will have cash, commodities or creativity.

While Britain has little of the first two, we are blessed with an abundance of the third. Better still, the rest of the world recognises this. Music exports continue to boom, we account for more than half the global trade in television entertainment formats, we are home to the world's second-biggest advertising and marketing group, our reputation for inventing computer games continues to grow, our fashion industry boasts the internationally acclaimed London Fashion Week... I could go on.

Runway success: London's Fashion Week is a real player on the luxury scene

We seem to be good at this creativity thing. Add the strong sense of humour in our national psyche to a tendency to bolshiness and an expectation that each new generation will challenge the ideas of their parents and you begin to see why.

But I would argue that we have only just begun to exploit this rich national resource. According to the Department of Culture our creative industries have grown at three times the rate of the economy since 2008. Yet the Department for Business Innovation and Skills identifies 11 key sectors for growth including offshore wind but, astonishingly, not the creative industries. In our government policies, in our education system and in the way we run our companies, we need to make the most of our natural advantage.

In 1997, the UK was the first country to identify a sector called the creative industries. But because it is made up of so many disparate elements, many of which depend on small businesses, government struggles to get to grips with it. Recent tax breaks for film, television, the performing arts and computer games have begun to redress this.

The creative sector also needs to speak with one voice in policy matters so government can focus on its needs.

That is why a group of us are now seeking to set up a new representative body (this embryo's working title is The Creative Industries Federation). One of its first campaigns would be to show how critical the visual and performing arts are for a rounded education. Science, technology, engineering and maths are important but are underpowered without the arts. Ask Thomas Heatherwick, who gave us the Olympic cauldron, Sir Jonathan Ive with his iPod or even Sir James Dyson and his vacuum cleaners.

When I was an independent television producer I realised that we need to recruit with creativity in mind and identify the creative leaders in companies. There are established ways of doing this, practised for years by our advertising industries. We all need to steal their clothes.

Now I chair Arts Council England and I've come to realise what a vital incubator arts and culture are for the broader creative industries. That is how Steve McQueen goes from art student to Turner Prize winner to Oscar-winning movie director. That is why new galleries like Margate's Turner Contemporary and Nottingham Contemporary have clusters of creative businesses growing around them.

Our investment in the performing and visual arts is first and foremost about defining our culture and curating the national conversation. But it is also how we empower the next generation of creatives. It was Keynes who actually founded the Arts Council. He got it. ■

Peter Bazalgette is chairman of Arts Council England and was a television producer for 30 years

PHOTO: GETTY; ROSIE HALLAM

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