

knowledge
nomads
why science
needs
migration

Natalie Day
Jack Stilgoe

First published in 2009
© Demos. Some rights reserved
*Magdalen House, 136 Tooley Street,
London, SE1 2TU, UK*

ISBN 978 1 906693 08 4
Copy edited by Susannah Wight, London
Series design by modernactivity
Typeset by Chat Noir Design, Charente
Printed by Lecturis, Eindhoven

Set in Gotham Rounded
and Baskerville 10
Cover paper: Arctic Volume
Text paper: Munken Premium White



© **Mixed Sources**

Product group from well-managed
forests, controlled sources and
recycled wood or fiber

www.fsc.org Cert no. CU-COC-804101
© 1996 Forest Stewardship Council

knowledge nomads

Natalie Day
Jack Stilgoe

Open access. Some rights reserved.

As the publisher of this work, Demos wants to encourage the circulation of our work as widely as possible while retaining the copyright. We therefore have an open access policy which enables anyone to access our content online without charge.

Anyone can download, save, perform or distribute this work in any format, including translation, without written permission. This is subject to the terms of the Demos licence found at the back of this publication. Its main conditions are:

- Demos and the author(s) are credited
- This summary and the address *www.demos.co.uk* are displayed
- The text is not altered and is used in full
- The work is not resold
- A copy of the work or link to its use online is sent to Demos

You are welcome to ask for permission to use this work for purposes other than those covered by the licence. Demos gratefully acknowledges the work of Creative Commons in inspiring our approach to copyright. To find out more go to *www.creativecommons.org*



Contents

Acknowledgements	6
Introduction: global jobs for global workers	9
1 Imperial College London	23
2 Pfizer	37
3 UKIBC	59
4 Manchester	73
Conclusions and recommendations	81
Notes	83
References	87

Acknowledgements

Our interest in Knowledge Nomads began with our work on China and India in the first phase of the Atlas of Ideas project (www.atlasofideas.org). We would not have been able to explore the issue without the support of our project partners – the National Endowment for Science, Technology and the Arts (NESTA); Pfizer; the Department of Innovation, Universities and Skills (DIUS); Imperial College London; Manchester: Knowledge Capital; the UK India Business Council (UKIBC); the Institute of Engineering and Technology (IET); and the London Development Agency (LDA). We are hugely grateful not only for their financial and in-kind support, but in the case of the four case studies, for their willingness to open their doors to us so we could learn about the importance of nomads in different organisations. Naturally, we are also grateful to the knowledge nomads themselves. There are too many to mention them by name here, but their insights and journeys led to many fascinating discussions and we wish them all the best for whatever and wherever might be next for them.

At Demos, we have also had invaluable contributions from Richard Reeves, Peter Harrington and Peter Bradwell. Tamsin Chislett, Caeli Christianson, Stephanie Shankland and Anna Wilkinson all provided superb research support.

Special thanks are due to our former colleagues, Kirsten Bound and James Wilsdon. Kirsten, following her work in India and Brazil, coined the phrase ‘knowledge nomads’ and inspired this project. And without James’ passion, determination and guidance, this project would not have been possible. This report is the last in our Atlas of Ideas programme. We have thoroughly enjoyed exploring the changing geography of science. This pamphlet is dedicated to all those who worked on science and innovation policy at Demos over the past five years. Mistakes and shortcomings are of course entirely ours.

Natalie Day
Jack Stilgoe
January 2009

Introduction: global jobs for global people

The road to Damascus (via Tokyo, Ohio and Manchester)

Imad Naasani is a knowledge nomad. With a pharmacy degree from his homeland of Syria, Imad was interested in the idea of moving and was initially drawn to Japan. A PhD at Hokkaido University took him to a research post in a cancer institute at the University of Tokyo, but the career prospects for immigrant scientists didn't appear great, so he started looking elsewhere. An approach by Ohio State University took him to the US. Despite the scientific opportunities, Imad felt uncomfortable with US culture. After eight years there, Nanoco, a small start-up in Manchester, approached him. Imad and his family visited, enjoyed the feel of the city and were impressed by a small, vibrant company that appeared to have potential. The opportunity to do world-class science sealed the deal.

Imad eventually plans to return to Syria, before or after retirement, but for now he is part of the UK's innovation system, working for a small company with a global reach. There is no typical knowledge nomad, but Imad's story has familiar elements: a variety of jobs in research institutes, academia and the corporate sector; a variety of places, spanning four continents; and moves for a variety of reasons, through networks that are largely invisible to policy makers. In modern knowledge economies, people like Imad are increasingly important.

In this pamphlet, we ask what role knowledge nomads play in our economy. We look behind the headlines on immigration and innovation to find out who these knowledge nomads are, what drives them and what they mean for the UK. These are highly skilled and highly mobile people, open-minded in their choice of home and comfortable moving between different cultures. Building on previous work by Demos on science and innovation,

through the Atlas of Ideas project, our focus here is on nomadic scientists. We argue that nomads are increasingly vital for innovation, particularly in the domain of science and technology. Scientists have always travelled in search of new collaborations, new possibilities and new ideas. Science and innovation now function as global networks, created without design from the interacting activities of thousands of highly skilled people. The movement of these people enables these networks to grow and function. For the UK, the challenge is to recognise and foster these opaque connections, attract the best people and encourage more UK-born knowledge nomads to begin their own journeys.

Globalisation from below

Policy debates over globalisation focused initially on flows of multinational trade, business and finance and the role of ICT advances in opening up global communications for organisations of all shapes and sizes. These highly visible trends can give the impression that globalisation happens *to* people rather than *because of* them. But globalisation is all about the movements and interactions of people. And the globalisation of innovation is about people like Imad.

The idea of ‘globalisation from below’ runs with the grain of scientific culture, but the top-down view of policy makers often impedes its potential. In a recent book, Caroline Wagner describes how contemporary science is characterised by a ‘new invisible college’ of self-organising networks. These networks, motivated by the bottom-up exchange of scientific insight, knowledge and skills, span the globe, and are changing the focus of science from the national to the global level. Wagner argues that policy makers have in the past misunderstood the nature of these collaborations, tending to overemphasise research investment to the detriment of ‘linking’ policies that foster networks. Science, as a bottom-up activity, is fuelled by the connections made by scientists.¹

Traditional flows such as trade, foreign investment and government interaction remain vital, but the balance of

economic power across countries increasingly depends on connections of people, through formal and informal channels, ethnic diaspora communities, professional communities of shared interest and virtual global networks.² Globalisation from below creates fresh challenges and opportunities, in which ‘knowledge nomads’ will play an important role.

Who are you?

We know by looking at innovation hotspots such as Silicon Valley that the migration of skilled and talented people is vital for innovation. But we still don’t know much about these people. There are currently no agreed definitions of ‘highly skilled’ workers at an international level and there is a severe lack of internationally comparable data that captures the flows of such talent.³ This is perhaps not surprising. If we just consider the UK, a knowledge nomad might enter the country under the ‘highly skilled worker’ migration category, some form of professional sponsorship, open EU migration channels, ancestry visas, or thanks to a spouse visa – making it virtually impossible to track highly skilled migration and even harder to understand motivations.

There is data on stocks of people with scientific and technological skills, principally sourced from censuses and labour force surveys. But, as we will see throughout this pamphlet, even if such data is accurate, it is limited by uncertainties about definitions. To count formal qualifications is to exclude people and activities that make innovation possible. The difficulties of measuring highly skilled migration provide particular headaches for policy makers trying to measure the effects of their policies and can further muddy the debate.⁴

The Organisation for Economic Co-operation and Development (OECD) provides some insight into the migration trends of highly skilled people around the world. In 2001 the US, Canada, Australia and the UK attracted the largest numbers of highly skilled expatriates from OECD countries, followed by France and Germany.⁵ Most of the UK’s 4.5 million foreign-born adult population were born in Europe (1.5 million) while almost

1.5 million came from Asia and over 760,000 came from Africa. Of these 4.5 million, 34.8 per cent had a university-level education, 53.3 per cent were women, and almost 30 per cent had been in the UK for less than ten years. Among these migrants, approximately 19.5 per cent were scientists, many of whom came from emerging economies such as China and India.⁶

In 2007 an estimated 577,000 people came to live in the UK for at least a year, down from 591,000 in 2004, with Poland overtaking India as the most common country of last residence. Immigrants are increasingly dispersed across the UK. Although London remains the most popular destination with 29 per cent of immigrants to the UK now settling there, this proportion has fallen significantly from 43 per cent in 1999. There is no data with which to identify what proportion of these people are highly skilled, but the *International Passenger Survey* of 2006 found that around 18 per cent of new arrivals cited employment opportunities as their main incentive for coming to the UK.⁷ More than one-third – 39 per cent – arrived with a definite job offer or with the aim of looking for work.

Mixing up the world

Migration is nothing new, but the combined effects of globalisation, liberalised labour markets and ease of international travel means that it is now occurring at an unprecedented rate. Almost one in ten people living in developed parts of the world are migrants.⁸ For countries that depend on imported skills, migration is becoming more competitive and complex.

Although countries vary in their approaches to managing migration, common themes and priorities are shared among those nations to which large numbers of people move. Countries such as the US, Australia, Canada, France, Germany and the UK are all experiencing skill shortages in key sectors of their economies including IT, health, education and other professional sectors. They are all competing with each other and elsewhere to attract highly skilled foreign workers to fill their labour market gaps.⁹

But those countries that compete most fiercely for the affections of highly skilled people are also those that typically attract economic migrants without formal skills or qualifications. These countries depend on immigration, while having to manage it tightly.

Most European countries as well as the more developed Asian economies have not introduced special measures to attract highly skilled workers, rather choosing to rely on existing work permit schemes. The European Union is currently considering introducing an EU Blue Card, which essentially enables highly skilled non-EU nationals to access the entire European labour market.¹⁰

The UK, following the example of Australia, Canada and the US, has made significant policy advances in the last few years, introducing targeted policies to attract skilled workers based on the perceived benefit to national economic growth. Through a new tiered system of migration, potential highly skilled migrants are assessed via a comprehensive points-based system with points awarded based on education, experience, age and past earnings. The government has consciously chosen to target highly skilled migration while at the same time cracking down on other forms of migration, which do not provide such measurable and obvious economic benefits.

Draining, gaining, circulating

Debates about highly skilled migration can be traced back over many decades. They remain dominated by a fear of ‘brain drain’ – the movement of skilled workers away from their birthplace to countries with greater opportunities. Britain has in the past struggled to stem the drain of its top brains to the US. In the 1950s and 60s Britain was perplexed by the number of top scientists emigrating, leading the then Minister of Science, Lord Hailsham, to attack the ‘parasitizing of British brains’.¹¹ By the end of the 1960s Britain began to recognise that the brain drain was simply one of the growing pains of globalisation, mitigated to an extent by immigration.¹² But the shadow of brain drain, and its effect on national

success, still looms over debates about highly skilled migration.

When we think about flows rather than stocks of people, our story becomes more interesting. One study looking at the movement of 'star scientists' around the world suggests that, over the last 25 years, many of Britain's best scientists have continued to leave. Out of the world's richest countries, the UK has had the largest net scientific emigration, but much of this is explained by the sheer quantity of scientists emanating from the UK and the resulting rate of the flow abroad. Of 424 top UK scientists, 70 left between 1981 and 2004, but 43 arrived from other places to settle in the UK, second only to the US. Over the same period, 122 of the world's top 1,000 scientists were based in the UK at one time or another,¹³ and the rate of flow through the country has been five times greater than through the US. The UK also ranks second in the world in terms of the number of foreign students coming through its universities.¹⁴ For all the talk of brain drain, it seems that the UK is a vital junction in the travels of scientists around the world.

The work of economic geographer AnnaLee Saxenian has illuminated debates about brain drain and the movement of skilled diaspora, particularly looking at China, India, South Korea and Taiwan. Saxenian argues that the old patterns of one-way flows of technology and capital from the core to the periphery are breaking down, creating far more complex and decentralised two-way flows of skills, capital and technology. Notions of 'brain drain', she argues, have now been superseded by a recognition of the value of 'brain circulation', as knowledge nomads return home to start new companies or take up senior positions in academia or business, while maintaining useful links back to the US or Europe.¹⁵

It is not just the emerging superpowers that are reversing their recent brain drains. In the competition for talent, Ireland has a complex past but is now an aggressive player. High unemployment and political instability in the 1980s led many of Ireland's best and brightest to move away. This trend was reversed during the economic boom of the 1990s when unprecedented levels of prosperity meant that Ireland, for the

first time in its history, had to develop strategies to boost the inflow of migrants to satisfy the economy's demands, while also seek to encourage its own to return. In the ten years between 1997 and 2007 the proportion of immigrants in Ireland grew more than it did in Britain over the last 50 years and helped to fuel the Celtic Tiger's economic boom.¹⁶

The current enthusiasm for the idea of brain circulation can suggest that there are no losers in the global war for talent. But in developing countries, problems of brain drain remain acute. Migrants from developing countries are generally more likely to stay permanently in their new home than return to where they came from, where the opportunities are fewer but the need for highly skilled people is much greater. The brain drain away from developing countries has attracted particular attention in the medical profession. Doctors and nurses from Ghana, Kenya, Nigeria and elsewhere have flocked to the UK to join the expanding NHS workforce. But brain drain also applies, albeit less visibly, to scientists, who are vital for countries looking to build their own research capacity, but readily seduced by the opportunities at universities and companies abroad.

Valuing diversity

The UK is not alone in becoming increasingly selective in its approach to highly skilled migration, by adopting more restrictive policies towards general migration. This is a difficult balance to achieve as it is impossible to separate a country's ability to attract highly skilled people clearly from more general debates about immigration and skills. They are all intrinsically linked and interconnected.

During times of economic recession, governments are often more inclined to crack down on immigration to avoid the perception that migrants might be taking scarce jobs from domestic workers. But a recession is also a time when diversity is most needed to stimulate new ideas, innovations and networks, which can counter the effects of an economic downturn.

Immigration advocates like Philippe Legrain argue that the shift against mass immigration is fundamentally flawed. Legrain

argues that foreign workers, whether skilled or unskilled, make the economy more dynamic, flexible and adaptable, enabling job shortages to be filled more quickly and stimulating greater productivity while protecting against inflation.¹⁷ In turn, all of the highly skilled professionals depend on a whole array of other workers from cleaners and taxi drivers to nannies and waiters – jobs often filled by migrants.¹⁸

As Charles Leadbeater points out, immigrants to the UK have been responsible for some of the country's most iconic landmarks and brands: Madame Tussauds, Schweppes, Moss Bros suits and the Triumph car company were all created by people who moved to the UK.¹⁹ Yet under today's stricter immigration regime, many of these same migrants might not have made it past the borders.

In a variety of studies, increased diversity has been shown to drive innovation through the introduction of new ideas. One study found that 'a 10 per cent increase in the share of foreign graduate students was correlated with an increase of 4.8 per cent in US patent applications and a 6 per cent rise in patent grants earned by universities'.²⁰ And these migrants build the links that allow globalisation to flourish. There is a clear correlation between migrants and bilateral trade and investment. One OECD report estimates that a 10 per cent increase in the number of migrants from a particular country boosts bilateral trade with that country by 0.9 per cent and bilateral investment by 1.7 per cent.²¹

There are many arguments for introducing a more liberalised migration system to enable the benefits of diversity to flourish, but these debates are not the focus of this report. Whatever the pros and cons of wider changes to immigration policy, it is also a legitimate goal of government to attract more highly skilled people because of the contribution they can make to the country's economic prosperity and skill base. The challenge is to get the balance right between beckoning the highly skilled with one hand, while shunning 'unskilled' potential migrants with the other. Highly skilled migration policies are intimately bound up with issues of immigration in general, and perceptions of the UK within the world. The extent to which a country is welcoming

matters as much to highly skilled migrants as it does to others, so the general tone and language of migration debates are an important factor in attracting or repelling talent.

The new tiered system for skilled migration is an appropriate policy direction, but as we will argue in this report, it still requires significant improvements to capture more fully the diverse array of skills that are fundamental to building a thriving and innovative economy. As it stands, the system works reasonably well for scientists, but for young entrepreneurs, innovators and the creative industries, where measurements of economic value are less tangible, the system is inadequate.

Importing and building skills

Debates focusing on immigration and skills inevitably overlap with concerns about the UK skills base. Are we producing enough skilled people in the UK? Are they the ‘right skills’ to drive economic growth for the coming decades? How do we know what skills we will need in the future? At a global level, we need to consider whether domestic and imported skills are interchangeable, or whether they interact in a more complex fashion.

The Leitch Review and reports from the Royal Society, the Confederation of British Industry, the Association of the British Pharmaceutical Industry, the BioSciences Federation and others have highlighted the skill challenges the UK faces, particularly in many of Britain’s innovative sectors.²² The story they tell is familiar and can seem a little parochial. But equally we could argue, as others have, that governments focus too much attention on attracting highly skilled migrants ‘as a quick fix to fill specific gaps in the labour market and as an excuse to refrain from adapting and equipping education systems for the demands of the knowledge economy’.²³

Highly skilled migrants and highly trained locals are not interchangeable and thinking of skills in this way is to misunderstand how innovation occurs. Despite talk of ‘skills gaps’, innovation demands people who create new opportunities rather than plug predefined holes. As part of the national

innovation ecosystem, UK skills and imported skills should be seen to reinforce one another. Highly skilled migrants play an increasingly important role in a national economy, not only by adding to the skill base but also through their international connections and diverse range of skills and experiences. As we describe in this pamphlet, particularly when it comes to science, learning and moving around the world often go hand in hand. Highly skilled people are generally attracted to places where there are other highly skilled people. If we are serious about the role that people play in innovation, we should look to highly skilled people not to fill gaps, but to open up new opportunities.

The new geography of science

Our analysis aims to be applicable across all highly skilled areas of the economy. But our starting point is science and the role played by science in innovation.

Science is inherently global. The pursuit of scientific knowledge and innovation for the public good has long operated above and beyond national barriers and cultural differences. Equipped with a shared scientific language and underpinned by norms of curiosity, enquiry and openness, the world of science has long been globalised and is growing more so. Sociologist Robert Merton argues that the value of scientific knowledge is realised when it is distributed.²⁴ Scientists, as holders of tacit knowledge, need to draw new connections in order to build their own knowledge and cumulative scientific knowledge. Simply put, scientists need to move around.

Mobility contributes significantly to the creation and diffusion of knowledge not only in the production and dissemination of codified knowledge, which is relatively fluid, but also in transferring tacit knowledge, which is 'sticky'.²⁵ The scientific world is not flat, so scientists become valuable when they move around and learn from different people, different institutions and different networks. They might move for long periods, like many of our knowledge nomads, or just for the occasional international conference.

This is why we should encourage our brightest scientists to travel and spend time abroad, in order to connect and learn. The challenge for governments, business, academia and policy makers is to regard scientists as free agents for whom national citizenship is secondary. This challenges those science policies that aim to advance more narrowly defined national objectives. As Demos previously argued in *The Atlas of Ideas*, the global landscape of science and innovation is changing. Places that were on the margins of innovation ten years ago are now essential stopping-off points in the continuous flow of people, ideas and technologies around the world. Countries like Britain and the US cannot afford to retreat into techno-nationalism. With people and global networks now recognised to be increasingly vital, Britain needs to embrace what we have described as ‘cosmopolitan innovation’.²⁶

Methodology and case studies

This report looks at the flows of skilled people into and out of the UK, starting with the individual stories of those people who have decided to come and stay. Our research is based on four case studies that explore different contexts in the interplay of immigration and innovation. We studied four locations: the chemistry department of Imperial College London; Pfizer’s European research and development headquarters in Sandwich; the UK India Business Council; and innovation networks in the city of Manchester. In each case, we conducted interviews – more than 60 in total – with knowledge nomads and the scientists and managers with whom they work. We asked about their motivations, future ambitions and the obstacles that they had encountered. We also asked them to reflect on the attractiveness of the UK as a destination for talented people.

Our first chapter takes the case study of Imperial College and describes the ‘new invisible college’ of science in action at one of the world’s leading academic institutions. We explore the tension between bottom-up networks of research and the need for top-down governance. We also describe the challenges for global

universities as they seek to attract the best people from around the world while supporting the national skill-base.

The importance of scientific networks is developed in our Pfizer case study. As models of pharmaceutical innovation change, the people in places like Sandwich have become more diverse. This diversity creates opportunities and challenges. Many of Pfizer's best researchers are drawn to Sandwich primarily for the quality of the research. We ask what this means for companies faced with tough markets, the need for predictable outputs and an unending demand for highly skilled people.

In chapter four we turn to the UK India Business Council and broaden our view of innovation beyond science to learn from the experiences of entrepreneurs. Against the backdrop of the relationship between India and the UK, this chapter looks at UK mechanisms for migration compared with other countries. It describes some contradictions between the UK's ambitions to foster a thriving creative and innovative economy and its policies to allow talented and creative people to come to the country.

Finally, we travel to Manchester, to consider the role of place in attracting talent. Local organisations in Manchester realise that the world of innovation is full of peaks and troughs. Urban theorist Richard Florida argues that 'place' is potentially the most important influence over almost every aspect of a person's life, so what can the city of Manchester do to attract and retain knowledge nomads?

Viewed through the lenses of a firm, a city, a university department and an entrepreneurs' network, this pamphlet aims to explode some myths that surround issues of highly skilled migration and provide suggestions for policy makers, governments, businesses and universities to secure the UK's position as a magnet for talent. We argue that the need for highly skilled immigrants cannot be separated from debates about immigration in general. The tone of migration debates do matter and innovation should provide a distinctive rationale for immigration. An excessive focus on what Prime Minister Gordon Brown memorably described as 'British jobs for British people' misses the vital significance of global flows of people for knowledge economies.

Science is historically and instinctively nomadic. But rich countries that are confident in their scientific achievements need to let go of old assumptions about brain drain and instead actively encourage their best scientists to move. Attracting scientists to the UK means building on our world-class science base, while also learning to let go. Good scientists often leave; sometimes they return and sometimes they don't. Either way, the country can benefit. Science is in many respects universal, but as we see in this report, different nomads bring distinctive types of knowledge. Diversity is vital. Just as UK science learns from foreign science, the UK needs to rethink how it governs science and how it trains scientists so that its own nomads become a more central part of how the country relates to the rest of the world.

And of course, science is just one, hugely important, piece in the jigsaw of UK innovation. Policies for innovation in general can learn from the movements and networks of scientists, but if they only target scientists, they may impede innovation in finance, the creative industries and elsewhere. What is clear from this report is that in a wide range of sectors, nomadism needs to become the norm.

1 Imperial College London

Science from the bottom up

The overriding challenge of making policy for science and innovation is that science resists control. Science grows from the bottom up, fuelled by uncertainty and the quest for knowledge. This desire to explore and intervene in the unknown leads to unpredictable outputs and impacts. Attempts to manage science tightly from the top down are likely to stifle innovation and produce unintended consequences. Yet science, at some level, needs to be governed.

The first task, however, is to understand what contemporary science looks like. We went behind the scenes at Imperial College, a world-class science institution, to ask how the people who come through its chemistry department build a critical mass of scientific research. The management of contemporary science has to deal with some important tensions. In order to understand these tensions, we need to look at the networks and the people that constitute scientific research. Talking to knowledge nomads, who travel from countries around the world to London, we can observe the following tensions: first, between scientific autonomy and a desire for top-down control; second, between the professed universality of scientific knowledge and local cultural differences; and third, between formal scientific communication and the informal reality of scientific practice. As universities become global, they need to acknowledge these tensions and be humble about the limited role of institutions in building networks in order to retain their reputations around the world.

Imperial College is crammed into Kensington's stuccoed streets, somewhere between the recently refurbished Science Museum and the Victorian splendour of Hyde Park. Imperial College's appearance, a combination of old and new, reflects a familiar tension in British universities – between building on

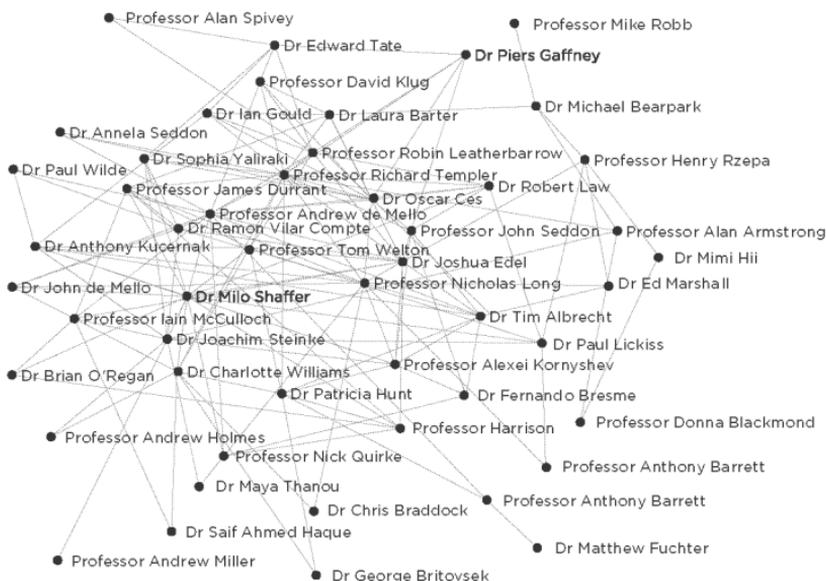
established reputations and reinventing institutions to compete globally. Within the department, some of the offices need updating, but the staff are typical of those in cutting-edge contemporary science.

Science relies on individual effort and inspiration, but it is richly collaborative. Within a particular discipline, the combined and cumulative efforts of thousands produce incremental advances in knowledge and occasional Eureka moments – the breakthroughs that disrupt thinking and set research off in new directions. According to philosopher of science Thomas Kuhn, knowledge advances in waves of what he called ‘normal science’, punctuated by revolutions or ‘paradigm shifts’.²⁷ But the historical picture Kuhn paints is individualist. It draws on the contributions of lonely and heroic figures such as Galileo, Copernicus, Newton, Freud and Einstein.

World-class science is about more than world-class individuals. The chemistry department of Imperial College is big: 159 staff, of whom 52 are permanent academics. We know that for science and innovation to take off there needs to be a critical mass of innovative people.²⁸ But the people are only half of the story. Contemporary science is networked, defined by its relationships, which might be anything from formal, joint research projects to an informal exchange of ideas. These collaborations often leave their own paper trail, in the form of jointly authored scientific publications. But the best way to understand collaboration is still to allow people to describe it themselves. To try to understand the shape of the science going on in the chemistry department, we mapped its network of collaborations. We asked each permanent researcher to identify their collaborations with others. The network map that emerged (Figure 1) tells us something about the collaborative nature of research in the 21st century.

The network in Figure 1 reveals no obvious centres of gravity, although some in the department clearly act as collaborative hubs. Its shape illustrates its emergence: this network could not have been designed. It is the product of interactions borne of scientific interest and informal connections. Those scientists who collaborate promiscuously might be professors or they might be

Figure 1 **Collaboration between staff in the chemistry department, Imperial College London**

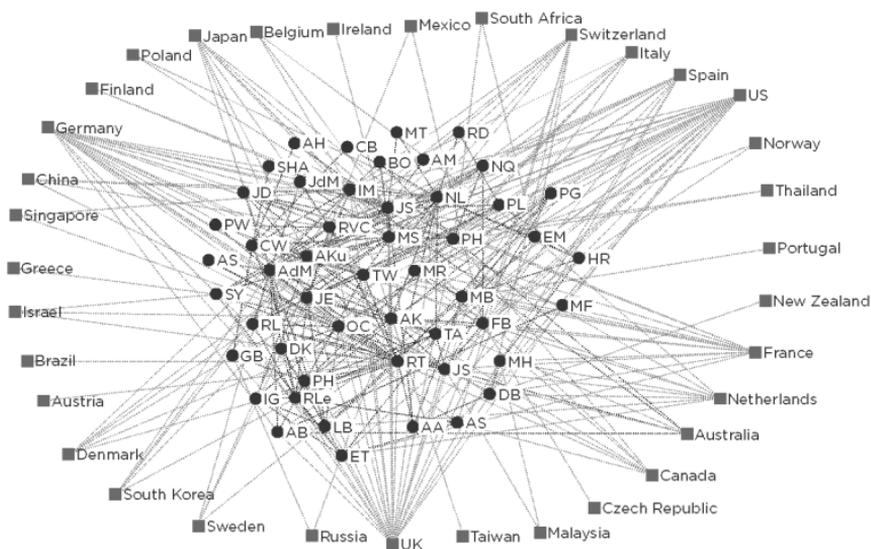


research fellows. Junior and senior staff are collaborating on research projects within and across teams, with little regard for hierarchy.

This is all a long way away from the image of the scientist as lone genius. The interconnectedness of this department, at all levels, reminds us that modern science is built on relationships. But collaborations within this busy department themselves tell a very limited story. Collaborations are taking place everywhere: with other departments, with other UK universities and with universities in other countries.

To lift the network to the global level, we asked our scientists to tell us what countries' scientists they are collaborating with (Figure 2). The global network map makes visible one corner of what Caroline Wagner calls the 'new invisible college of researchers, who collaborate not because they are told to but because they want to...because they can offer each other complementary insight, knowledge or skills'.²⁹

Figure 2 **Collaboration combining departmental staff and different countries**



The myriad links between scientists at Imperial College and scientists in countries as diverse as Thailand, Italy, Israel and China are typical of science at the highest level, but they are not arbitrary. Scientists are collaborating with acknowledged centres of excellence in chemistry research such as France and countries with large chemical industries such as Switzerland, Germany and Japan. Some are collaborating with emerging economies such as China, Malaysia and South Africa. Many of them are also collaborating with countries to which they have historical or cultural ties.

Chemistry at Imperial College, in common with other leading universities, has a cosmopolitan mix of scientists from around the world. Of the employees in the department, only 60 per cent are British and many of these are support staff or temporary researchers. There are eight Germans, seven Chinese

people, five Americans, five Spaniards, four French people and three each from Italy, Greece and Australia. This picture hasn't changed much in the last five years. In 2003 the largest foreign contingent was of nine scientists from France. When each of these nomads arrived at Imperial College, they brought with them a connection to a country that has in most cases been solidified into a formal scientific collaboration.

Take Ramon Villar. With a chemistry degree from the Universidad Nacional Autonoma de Mexico, he travelled to London in the mid-1990s to study for a Chemistry PhD at Imperial College. He became a lecturer at the university before moving to Spain for a two-year research stint and returning to Imperial College in 2006. He arrived at the university just before the chemistry department's influx of foreign scientists.

Ramon is a self-avowed 'citizen of the world'. His parents are Spanish and his roots are in Mexico, but he thinks of loyalty towards institutions rather than countries. As a young scientist, he searched pragmatically for global options. He admits that 'the UK is second in most overseas students' minds. Of the ten best groups in my area, eight are in the US.' But Ramon, like many of his colleagues, had positive reasons for choosing London over the US. He was attracted to London by a combination of the city itself and by a research project. The group that he came to work with had an international reputation and his Mexican government scholarship would only allow him to study at one of the UK's top five universities. In London he met his future wife, a Cypriot, and has now settled in Europe.

But despite Ramon's insistence that 'good science is not dependent on nationality... good scientists go where the good science gets done', his work is to an extent a reflection of his global links. The two countries in which he has worked – Spain and Mexico – have now become points of collaboration, along with China, Switzerland and other universities in the UK. Ramon admits that scientific collaboration is not just driven by science. Given the effort required to build links with researchers abroad, a bit of passion helps. In Ramon's case, he is driven by a long-standing interest in Mexico's ability to conduct world-class science, so he looks for opportunities to help build Mexican

research capacity. The rest is about mutual scientific interest. Ramon has tried to encourage the university to build strategic partnerships with similar institutions in Mexico, but the obvious common ground that exists at the level of individual scientists and research groups around the world makes little sense at an institutional level. Collaboration, which seems so natural for scientists, is instinctively bottom-up.

The global university

Universities increasingly recognise the need to think globally. For some, this means adopting radically new models of engagement with emerging economies. In Ningbo and Semenyih, Nottingham University has created new campuses to spread its brand and attract ambitious Chinese and Malaysian students. Dubai is putting the finishing touches on its International Academic City, which brings together branches of universities from around the world. Countless different models are emerging and it is not yet clear which is best suited to global innovation. For all universities, curricula and student bodies are becoming increasingly international and research is judged according to its international impact.

Imperial College is one of the UK's few universities with a genuinely global reputation, which acts as a magnet for potential students and staff from around the world. But as global competition for the best people intensifies, the university now recognises the need to locate itself more strategically within a rapidly changing world. Its first challenge is to understand what is already happening within its walls. The university's international office explains that, even though many of the university's departments are already richly international, they are often so driven by a universal vision of science that is blind to location that they do not appreciate their international potential. The university is currently trying to map the international activities of its thousands of scientists so that it can learn from and nurture good global science.

One of the areas in which the university feels it can help its science departments is recruitment. Most strategic moves

towards the internationalisation of universities are driven by a focus on students and education. The staff, and the research they conduct, tend to globalise by accident. One of the chemists told us that, when it comes to international recruitment, ‘there is nothing explicit that is done. Someone comes to the department because they are the best possible candidate.’ The department is known around the world and its gravity is strong enough to attract the best people, regardless of their country of origin. The scientists’ opinion is that an active attempt to recruit people from abroad strategically would run counter to the networks that define both their research and their global community. One researcher told us that actively recruiting scientists from around the world ‘would feel artificial’. Another told how there was already ‘too much top-down stuff within the university’. Scientists, we were told, needed to be left alone to craft their research and their departments.

The scientific Premier League

Even without active targeting of foreign staff, Imperial College is now so international that it transcends its location in London, the UK and even Europe. More than a third of its staff come from abroad, from all continents and from all backgrounds. Its achievements and its challenges have become remarkably similar to those faced by leading football teams. Six miles north east from the university, Arsenal football club has, alongside a few rivals, grown from being a consistently top-four UK club to become a world leader. Imperial College and Arsenal have the same identity crisis. Are they local institutions representing distinct places, or are they global competitors with grander ambitions?

The similarities are striking. Both Arsenal and Imperial College are internationally famous. They compete for achievements and people on a global stage. British football in general has rapidly become cosmopolitan. Fifteen years ago, ten per cent of players in the best British teams were from abroad. Now it is more than half. Inevitably, as money has flooded into Arsenal football club from around the world, it has had its pick

of the world's best players. The teams it fields now have a minority of British players and occasionally none at all. But Arsenal is still a British football team and it is still a London football team. Science is similarly a global game that is tied to local contexts and particular institutions. A Nobel Prize might be equivalent to winning the Champions League. In each case, regardless of the nationality of the individuals, the glory goes to the country, the town and the team.

With football, global teams offer huge benefits, but they also present new challenges. A 2007 report by the Professional Footballers' Association took issue with the internationalisation of the UK's football leagues, arguing that it was having a detrimental effect on the training of homegrown talent.³⁰ Global universities, especially if they are allowed to operate in an open market, face similar tensions, with affluent students and highly skilled staff from abroad potentially crowding out local people.

However, unlike football, where success is no guarantee that a club will have the sort of academy that trains younger players, at a university good research and good teaching tend to go hand in hand. Imperial College's chemistry department is large and it is a hive of activity. The university's undergraduate chemistry degree has 160 students in its first year alone. Importing skills and building scientific capacity for the UK are not mutually exclusive. At their best, good research and good teaching reinforce each other. Given that people are not perfectly nomadic, building UK science skills is vital to preserve the UK's status as a key science hub. Good science depends on a combination of homegrown and imported talent. Finding the best scientists from around the world, rather than pushing UK talent aside, should raise everyone's game and expose students to a wider range of high quality teaching.

Peripatetic scientists

In global networks of science, it is becoming increasingly clear that good science is now based on global experience. When scientists end up at Imperial College, or when they leave the university for new pastures, they are not just looking for the best

opportunities to do their research. They are also looking to learn. Science has always been global and it has always been peripatetic. Good scientists move about, looking for new people, new knowledge and new connections. As science becomes more global and its networks more complex, we heard how it is more important than ever that scientists travel.

Like other world-class institutions, Imperial College is keen to attract and retain the best possible people from around the world. But scientists do move, and often they move for the sake of moving. The staff in the chemistry department have a paradoxical approach to their junior colleagues. They know that good science is global science and that a straight line from PhD to researcher to professor at one institution is rarely the best approach to a scientific career. Joachim Steinke, from Germany, told us that with researchers of genuine talent, ‘Science is not about easy options. I would advise them to go abroad, even if it is to my detriment.’ Sophia Yaliraki is another long-standing nomad at Imperial College, originally from Greece, via Harvard and MIT. She sees contemporary science as being about building international reputations. She makes a distinction between a straight line traditional career progression and a web. Scientists now need to move about:

I send all of my students abroad. When you're training, it's very important that you do this. It's the American style. You think you're the greatest and you go to another lab and everyone's better than you. It broadens your horizons. In a new place, you have to prove yourself again. Each group works differently. They do science in a new way, on new topics, with new skills.

This attitude is part of the culture of global science, based on an implicit understanding that it is in everyone's interests to move, and it predates our current fascination with globalisation. While the university worries about attracting the best people from around the world, the scientists within the chemistry department are relaxed about the fact that Imperial College is one stop on the global conveyor of science. However, not everyone is a nomad and few people are nomads forever. When

we suggested to one of the department's Russian scientists that he was nomadic, he justifiably took offence, claiming that the term ignored the roots he had put down, the links he had drawn and the impact he was making on the students, colleagues and community around him. Scientists exist in networks and they move through networks, but these networks are sticky. The challenge for Imperial College is to encourage scientists to stay long enough to benefit from their presence.

How flat is the world of science?

Scientists are happier than most to buy into the freedoms of globalisation. They claim that science is universal, that it is unconstrained by location and that it is increasingly easy to be part of research teams that are thousands of miles apart. One of the reasons that science is cosmopolitan is that it is ruthlessly meritocratic. Without immodesty, the scientists we spoke to told us how they were authors of their own destiny. According to one, 'If you are the best, geography doesn't exist.' Science, like football, is a global game played according to the same rules in every country. Imperial College provides them with opportunities to do what they want. But science is also, in intangible ways, culturally specific.

Scientists often talk about how the culture of science transcends other cultures. In the words of one, 'science breaks a lot of cultural barriers. Russia, Iran, Spain, it doesn't matter.' Of course it helps the UK that the language of this universal culture happens to be English. But when pressed, our scientists spoke about how the scientific culture of Imperial College was a product of its cosmopolitanism, as well as a cause. One scientist from Spain explained:

This is an engaging atmosphere for a scientist – we want to do things. There are people from many different places with many different backgrounds and they use these backgrounds to create interesting problems.

The diversity of the group, combined with a critical mass of interesting colleagues that comes with science, produces an

environment that is conducive to interesting science – ‘a synergy between good people and good ideas’, as one of the scientists told us. Tom Welton, the department’s head, thinks that the mix is vital for creative research: ‘Homogeneity will kill science. We’d all end up becoming technicians. Fresh ideas come from diversity.’

Globalisation is flattening science in general, but this has the effect of making the lumps even more pronounced. A quick skim of recent scientific success from around the world suggests that people can do science anywhere. But it is too easy to ignore the huge, informal, tacit knowledge that makes science work. Science is as much about conversations in corridors as it is about papers in journals. Places and institutions, insofar as they bring people together, will always be vital. And institutions that also provide a platform for global, networked science will continue to succeed and attract the best people.

So does this mean that all that is left for policy makers and universities to do is support scientific research and let the scientists get on with it? There is certainly a long-held view, rooted in the thinking of chemist Michael Polanyi, that any attempt to control science and scientists will be ineffective at best and counterproductive at worst. Polanyi insisted: ‘You can kill or mutilate the advance of science, you cannot shape it.’³¹ However, as the opportunities and uncertainties of science grow, and it attracts more public money, we now recognise that science needs to be governed and guided, while not being stifled. The individual actions of scientists do not inevitably lead to the best science, nor do they address social needs for innovation and global challenges.

First, therefore, scientists need to be enabled to build the global networks that increasingly characterise science. This means appreciating science’s informal aspects, the serendipity of moving about and bumping into new ideas and new people. One scientist told us that one of his most valuable experiences was a short, inexpensive trip to Germany, paid for by the Royal Society under their International Joint Projects Scheme.

Second, scientists occasionally need to be encouraged out of their own comfort zones. Donna Blackmond is an Imperial

College professor who divides her time between the chemistry and chemical engineering departments. Her journey to Imperial College has taken her through America, France and Germany, and through industry and academia. She senses that her engineering colleagues have more developed networks even than those of the chemists. Her approach to science is pragmatic, that it should be judged on its outputs as well as the quality of the research. Governments around the world increasingly agree. They are putting more and more pressure on science to deliver as part of innovative economies. It is the role of good governance to encourage scientists to build new links and take new opportunities, while ensuring that the uncertain benefits of basic research are not diminished. For universities, this means helping departments reach out, as Imperial College has started to do. It means helping them with recruitment, encouraging scientists to look even further afield and beyond their own networks. It means identifying what the university calls 'hotspot regions and hotspot fields' of emerging strategic as well as scientific interest. And it means fostering interdisciplinarity.

Finally, universities and governments need to appreciate that science does not necessarily speak for itself on the global stage. Global universities need to let the world know who they are and what they do. And, as we have described previously, the UK needs to consider its scientific pitch to the world. This means that UK universities need to think carefully about how they appear abroad. One scientist told us that, as with British football, international students are obsessed by league tables. The perceived ranking of a university matters. But, as we heard from other scientists, there is little point in having a global reputation if the best people from around the world are then unable to come and study, research or teach. For a global university, UK and European rules about PhD funding begin to look restrictively parochial.

Universities, particularly those universities skewed towards science, have to strike a delicate balance as they globalise. Science emerges from the bottom up, and in many senses it is blind to place. But science also needs direction. Going behind the scenes, we can see that science is personal and cultural.

Where scientists come from, what they bring and who they work with all matter to the practice and products of research. Scientists need reminding that, though they may be instinctively global in their outlook, they need to continue to look in new places for new ideas and new connections. Universities, acting above and on behalf of their researchers, need to compete in the global market for research, students and staff, while recognising that homogeneity stifles innovation. The challenge is to foster diversity while building a global reputation.

2 Pfizer

Open Sandwich

Sandwich is an unlikely location for Europe's largest research and development facility. On the easternmost edge of Kent, it is nearer to France than it is to a big UK city. It is an accidental product of a gradual transformation from a pharmaceutical manufacturing plant to a research hub. But as the home to the European research headquarters of Pfizer, it provides a fascinating example of how the people who conduct research reflect the changing shape of corporate innovation and its new location within global scientific networks.

At the Sandwich site, members of staff have recently taken part in a 'diversity and inclusion' week. Downstairs in the canteen, people were invited to stick pins into a huge world map to indicate their origins. The map provides an indication of how cosmopolitan Pfizer's research team currently is. The countries of Western Europe are obscured by pin-heads with outcrops as far apart as Africa, India and China. Sandwich, it seems, has gone global.

It has become a cliché to argue that a business is no more than the sum of its people. In the case of Pfizer, and the Sandwich site in particular, this is more true than anywhere. Pharmaceutical companies are built on research, involving thousands of researchers. The company's challenge is to make the most of these people, to link their efforts with the demands of a global marketplace. As the people who make up the research facility at Sandwich have changed, so has the science.

One scientist told us that when she arrived a decade ago she was one of only a few non-UK dots in the map. Another early European arrival explained that, in the eight years since he began at Pfizer, the culture has changed immeasurably. Talking

to employees with long experience and new recruits who have heard secondhand, the picture they paint of Pfizer at Sandwich is one of British boffins working in isolation, dreaming up the next big thing. As a European outpost of a global company, the Sandwich site saw its value in bringing the best of British science to an American business. One of the senior Sandwich team, who has been at the site for decades, described to us the unique culture: ‘We’d never hype things up – the classic Brit mentality. We hardly knew we were an American company.’

Now, as the Sandwich site becomes an increasingly diverse place, employees are not allowed to forget their global parents. The culture of global Pfizer, we were told, ‘permeates the whole organisation’. But people at the Sandwich site still see a distinct advantage in being the company’s only large non-American research site. According to one, ‘Sandwich reminds Pfizer that it shouldn’t forget the rest of the world.’ One nomadic European scientist has seen the lab change around him: ‘When Americans say global they often mean American,’ he told us, ‘[The Sandwich site is] not American, not British – I feel comfortable here.’ The Sandwich site is rapidly becoming a melting pot for multicultural science, and it presents the company with a new vision for global R&D. They have lost some of their aloof Britishness, which tended to answer novel ideas with ‘been there, done that’. They are now taking advantage of the mix of people to mix up processes, cultures and disciplines.

Pipe dreams

The pharmaceutical industry works on long timelines. Existing products are constantly superseded, or they fall out of patent. For companies to survive, there needs to be a queue of medicines ready to replace them. This queue has traditionally been imagined as a pipeline. Research resources are squeezed into one end and products emerge from the other. Across the industry, however, anxiety is growing that pipelines are becoming leakier. Relative to the investment in their creation, fewer drugs are seeing the light of day and those that do are more and more specific.

Back in the early 1990s, scientists at the Sandwich site began to investigate an exciting new compound, codenamed UK-92,480-10. According to one patent, the medicine seemed effective against a number of illnesses, ‘including stable, unstable and variant (Prinzmetal) angina, hypertension, congestive heart failure, atherosclerosis, conditions of reduced blood vessel patency’.³²

As the medicine made its way through the thickets of development and testing, it was discovered that it had a pronounced side effect. Sildenafil citrate was recast as a treatment for erectile dysfunction and christened Viagra in 1998.³³ In a world in which medicines were becoming more and more specialised, with smaller and smaller potential markets, Viagra is a rare billion-dollar blockbuster.

Alongside Lipitor, a statin that has rapidly become the world’s top-selling branded drug, and a few others, Viagra has taken Pfizer to the top of the list of global pharmaceutical companies in terms of sales and R&D spending. These blockbusters have raised expectations, but look hard to replicate. For every successful drug that emerges through the Sandwich site’s factory gates, the outside world doesn’t see the research programmes that have hit dead ends and the hundreds of molecules that have failed to impress. Following Viagra, the Sandwich facility has produced, among other drugs, Maraviroc, an HIV treatment that will make a huge difference to patients’ lives, but is unlikely to boost Pfizer’s coffers in the way that Viagra did.

Pharmaceutical companies have their roots in the chemicals industry. They have tended to be based at nodes of chemistry expertise and to employ chemists. As the model of one-size-fits-all medicines begins to disintegrate, the future of companies like Pfizer is in more sophisticated understandings of human biology. But as well as opening up some new avenues, biological medicines present new complexities for science and businesses.

Genomics has given pharma companies the illusion of control. Sir Richard Sykes, former chair of leading competitor Glaxo, argued, ‘the past in drug discovery was about serendipity;

the future is about predictability.⁷³⁴ However, the more scientists know about the complexity of the human genome, the harder it seems to find a blockbuster drug to target genetic illness. Taking advantage of the theoretical predictability of biological medicines requires very different sorts of expertise. Chemists need to join biologists, mathematical modellers, clinicians and computer scientists in the hunt for new compounds.

The new uncertainties of drug development and the new possibilities of biotechnology have forced pharmaceutical companies to look up from their work and look out. Companies are starting to experiment with models of innovation that are more web than pipeline, where leaks are not seen as a bad thing but as a natural part of the process of doing research. As well as technologies falling out of the innovation process, others are invited in, bought from or inspired by external research centres. So rather than just pushing money into one end of the pipe and squeezing drugs out of the other, drug companies need to build networks of interactions. At Sandwich and in La Jolla, California, Pfizer are taking a strategic approach to investing in vaccines research. At Sandwich they have been told to create a unit that operates like a 'small biotech within big pharma'. Half of the group has been assembled from within Pfizer and half from outside, including leading scientists from recently acquired companies such as Powdermed.

The vaccines group has had to gather momentum and activating, building and borrowing networks of expertise rapidly as they go. They comprise a mix of experience levels and disciplinary backgrounds. And they are truly cosmopolitan – with team members from Spain, China, Sweden and Germany as well as the UK. Pfizer has actively pursued scientists from around the world through a mix of networks, advertisements and headhunters. The hope is that this diverse team of new perspectives will give the company vital new innovation opportunities.

Only connect

As the single pipeline model of research starts to look less and less reliable, pharmaceutical companies the world over are

looking to diversify their approaches to innovation. R&D as usual is being replaced by new networks of innovation. These new networks are built of new people with new connections. At Sandwich, the scientists are quick to point out that theirs is not a tick-box model of diversity. One research leader described how, in some countries, an emphasis on ethnic and gender diversity for its own sake means that ‘they’re missing the value of true diversity, which is diversity of approach and diversity of thinking’.

Pfizer in the Sandwich site is at the early stages of a journey towards genuine cognitive diversity. Over the last decade, more and more companies have realised that if they are to be truly innovative they need to mix things up a little. In *The Wisdom of Crowds*, James Surowiecki explained how, when people taking decisions or holding discussions share the same perspectives, there is a danger of ‘groupthink’. Genuine innovation often comes from people asking questions that seem unimportant or irrelevant to people who have homogenous expertise.³⁵ Scott Page, drawing on cognitive science and organisational theory, extends Surowiecki’s argument and maintains that, under certain conditions, diversity trumps individual excellence when it comes to problem solving. His lesson is that ‘rather than being on the defensive about diversity, we should go on the offensive. We should look at difference as something that can improve performance, not as something that we have to be concerned about so that we don’t get sued.’³⁶ Charlie Leadbeater, writing about ‘the difference dividend’, explains how the diversity that comes from migration is a vital part of what keeps economies innovative.³⁷

Appreciation of this diversity requires a degree of humility. For all the world-class science going on at the Sandwich lab, there will always be more taking place outside their walls. And despite recruitment efforts, the world’s best scientists at any one time will probably not work for Pfizer. The challenge is therefore to connect with the global network of potentially relevant science, to collaborate promiscuously across disciplinary and international borders and to tap into the best university science available. In the last ten years Pfizer UK has published research

with more than 300 external bodies, including universities, charities and other companies. Almost a quarter of its research has been published in collaboration with the US and about the same proportion with other European partners.³⁸

The scientists at Pfizer know that they are being challenged by small biotech companies as much as their big pharma competitors. For a company that has spent the last ten years building its economies of scale, growing its research base and boosting its in-house R&D spend, the turn to open innovation can be difficult. But if big pharma is going to reinvent its models of innovation, it has to start with its people. This means searching out new perspectives around the world and actively disrupting current research practices. At Sandwich they are starting to get used to looking out. A huge amount of development work – clinical trials especially – is outsourced to contract research organisations, many of which are in emerging economies. At the other end of the pipe, much of the basic research on which medicines depend still takes place in universities. But as the pipe starts to spring leaks all over the place and innovation genuinely opens up, companies have to consider the shape of their internal workforce. As in-house R&D consolidates and collaborates, what sorts of people do big companies need?

According to the scientists we spoke to, the search is now on for what some called ‘the deep thinkers’. David Fox is a Pfizer scientist seconded to the Royal Society of Chemistry to focus on the UK’s skills base. He explains that ‘we are asking much more of our permanent colleagues in terms of problem-solving, innovation and development of new technologies’.³⁹ At universities, the bottom-up nature of science has traditionally meant that much research is driven by an *expertise push*. Scientists are encouraged to develop their own specialisms and research is narrow but deep. The old cliché characterises scientists as knowing ‘more and more about less and less’. At Pfizer, however, science is ruthlessly driven by a *needs pull*. There are few presumptions about what might be the relevant areas of expertise that should be brought to bear on a target illness. One researcher told us that scientists can be ‘encumbered by

knowledge as well as enabled by it'. Solutions are likely to be complex and interdisciplinary.

The future is T-shaped

This model of science presents an enormous recruitment challenge. Building a team from scratch to develop new vaccines requires access to the world's best immunology, pathology, virology and microbiology. Within Pfizer, they need people with expertise in all of these areas and more. But they also need people who can draw connections between them. Management theorist Dorothy Leonard calls these people 'T-shaped'. Innovative companies need people who, in addition to their deep expertise, are able to connect across other disciplines.⁴⁰

For Pfizer's recruiters, the search for these people means casting ever-wider nets around the world and relying on the networks that already exist around their scientists. Great scientists in important disciplines, subdisciplines and microniches are likely to be friends of friends of people within Pfizer. But they are more likely to work in China, France, the US or India than in Kent. While Pfizer's collaborative efforts might allow the Sandwich site to operate global networks of research, there is no substitute for bringing the best people into the office. One scientist explained to us that, for all the possibilities of virtual communication, 'science works best face to face'.

Pfizer recruits scientists with years of university research experience; the company trains school leavers to become scientists and lab technicians and recruits at all levels in between. Pfizer needs a huge range of skills across different levels and proudly proclaims that, where other companies make do with what they get, Pfizer need the best people. Skills, one senior scientist told us, 'are a stranglehold on the business'. Without the people, they can't do the science.

Pfizer is justifiably anxious about UK skills. The company works with universities and policy makers to try to ensure that the UK education system produces the people that the industry needs. It is commonplace to suggest that the UK's hard science

skills are in decline. As Pfizer's science becomes more complicated and its search for skills becomes more specific, it is inevitable that it will be disappointed with the people it finds nearby. They know that it is not the job of a university to produce a steady stream of Pfizer employees, but they are increasingly aware of a skills gap.

The Sandwich site is not Silicon Valley, it is not Oxford and it is not Bangalore. Persuading the world's scientists to move to what one senior scientist described as 'the nether regions of east Kent' is not easy. For a young immigrant scientist, Sandwich seems remote, hours away from a big city and without a nearby airport. The Eurostar railway line to the continent is the only major transport link. The Human Resources people at Sandwich have tried to turn this impression around. 'We were very apologetic for a long time,' they told us, and now they realise that Sandwich has its advantages. Older scientists told us that they appreciated the quality of life they found in the area – lots of space, good schools and beautiful surrounding countryside. It seems to be a place in which to settle down. And when scientists settle, they create their own centre of gravity. Drive to one of the surrounding villages such as Ash or Wingham and chances are the people you meet will work for Pfizer. There are schools in the area whose chemistry classes are full of the children of Pfizer chemists. Sandwich is a tiny town with what is essentially a small university on its outskirts. Young scientists arrive at Pfizer and, although they are in a small town in a Kentish backwater, the culture is melting pot of scientists from different countries and disciplines.

The site has tried to help its influx of foreign scientists settle. Networks of foreign staff make it easier for new arrivals to adjust. Some of these have been created by Pfizer and some have emerged organically. When one talks to the nomads who are recent arrivals at Pfizer, each tends to start by explaining that their story is not typical. It rapidly becomes clear that there is no typical story. People end up in Sandwich for all sorts of reasons. Some moved to come to university in the UK – as undergraduates or postgraduates – and came on to Pfizer afterwards. Others came from Europe after a few years doing

postdoctoral research in universities. And others came via Pfizer outposts in Japan or the US. For some of these people, Sandwich was the latest stop in a career that had already landed in three continents.

Living for the science

Despite their varied backgrounds, the reasons for scientists coming to Sandwich are remarkably similar. Employees replied that they came for the science (managers told us that salaries are secondary). Sandwich is seen as one of the best possible places to do pharmaceutical science. No matter how cosmopolitan the place becomes, the people are united by science. Scientific journals, graphs and datasets compete with internal Pfizer advertising to cover the walls. Small teams gather round low tables to talk through their latest ideas and hunches are tested in labs and offices. One man's T-shirt quotes Indiana Jones: 'Nothing shocks me, I'm a scientist.' In many ways, science is taking place exactly as it would at a leading university. But the demands are very different.

There is a clear tension within any science-based company between bottom-up research and top-down market demand. But Pfizer is experiencing another tension that illustrates the broader challenge of the globalisation of research. On one hand, it needs a critical mass of scientists conducting world-class science on site. This ensures that it will continue to be able to conduct science across the whole length of the R&D pipeline. As its science grows more complex, it will necessarily search further and build more cosmopolitan research teams and inevitably have to conduct more in-house training to compensate for limited domestic skills. On the other hand, as innovation inevitably spreads through global networks, aspects of research will continue to be outsourced, ideas will be hoovered up from outside and the balance of research conducted under Sandwich's roof will change. This tension is between the flat world of globalised communication and the lumpy reality of scientific practice, in which ideas are generated through the close interactions of diverse individuals.

Institutions, companies and universities included, will have to strike a delicate balance. Global R&D is in flux and the instinct for some companies will be to consolidate and centralise, to stick to what they know and place safe bets. But this will ultimately stifle innovation. An alternative approach embraces the reality of science, appreciating its emergence and its networks. This means that global companies like Pfizer need to learn to let go.

In our research, the company's professed approach to innovation was often not reflected in the opinions of Pfizer's younger scientists. They told us that the company was not benefiting from the huge diversity of skills and backgrounds in the organisation – that people still tended to be assimilated rather than being able to contribute their potential. They talked about how collaboration with universities was held back by a lack of funding. This meant that, although they were able to engage with university research through reading scientific journals, they couldn't have their own work criticised and built on in the same way. Nervousness about intellectual property interrupts the free flow of ideas. As projects develop within Pfizer and begin to look more promising, they tend to take on a life of their own, shutting out discussion and debate with the outside world.

What next?

If Pfizer wants to make the most of its scientists and build on Sandwich's reputation as the best place in the world to discover drugs, it needs to open up in practice as well as rhetoric. Scientists, even in companies, are free agents: they have little loyalty to place or company and tend to follow what they think is interesting. Scientists are also constantly learning. Part of this learning is about building skills, but part is about learning from continuous collaboration with other scientists.

When scientists arrive at Pfizer, they trail behind them an invisible network of links to the outside world. When they arrive from outside the UK, these links are potential connections to new pockets of research, new talent pools and new markets.

Pfizer needs to learn how to tap into these networks. As science becomes increasingly collaborative, a scientist's network becomes part of their identity. If people are going to continue to want to come to Sandwich and want to stay at Pfizer, these networks need to be nurtured. As in small biotech start-ups and increasingly in other areas, scientists may increasingly want to straddle Pfizer's boundary, working part-time for Pfizer while also conducting university research, or conducting more radical projects for a percentage of their employed time.

Despite the best efforts of any employer, good people will leave; skills will be lost and have to be replaced. Pfizer is big enough to have a sizeable diaspora and, as with any diaspora, it has the potential to benefit the company. In many cases, people will head to competitor companies, making onward collaboration difficult. But if people enter academia, the links back to the company are potentially hugely valuable. As with a country or region coming to terms with being just another station on the global brain circulation, the Sandwich site needs to appreciate that it may in many cases be a stepping stone for talented people. Some will come from abroad, using Sandwich as a gateway before moving somewhere else in the UK. Others will move within the company, to Pfizer's other locations around the world (one scientist proudly told us that they 'constantly feed Pfizer's US sites from Sandwich').

If we see scientists as nothing more than sets of skills plugging skills gaps, the continuing brain circulation of which Sandwich is a part rapidly becomes a counsel of despair. But if we focus on scientists as networked individuals, we see untapped potential. Taking advantage of this is hugely complicated, but the first step may be learning to let go. Japan may provide a cautionary tale. Following decades of groundbreaking pharmaceuticals research, companies have recently begun pulling out, including Pfizer. Asked to explain the collapse, a former president of the Science Council of Japan put it down to culture: 'Foreign drugmakers may see Japan as unattractive... Japanese people are less interested in moving overseas and don't have a culture of accepting people returning from overseas. You need diversity in R&D.'⁴¹

3 UKIBC

From India to the world: the blank canvas nomad

It is relatively easy to identify scientists and attract them to the UK. It is less easy to identify, target and attract other innovative people. The Pfizer and Imperial College case studies are heavily focused on the role played by scientists in innovation, but working with the UK India Business Council (UKIBC), we sought to learn from the experiences of other innovators. The entrepreneurs we spoke to at UKIBC innovate through creative industries, new business models and with service-led innovation. They are not filling particular skill gaps but are creating new opportunities. Their experiences highlight some deficiencies in the current migration system that need to be addressed if the UK is to attract a new generation of innovative people. In this chapter, we also consider how the UK's migration mechanisms compare with similar countries and extract some lessons for the UK in attracting talent from India.

When asked to compare the Indian diaspora of today with that of 40 years ago, one knowledge nomad told us that the two simply don't relate to each other. And why would they? The diaspora of 40 years ago largely came as traders, servants or tradesmen, looking for economic security. Today's diaspora are entirely different. As one nomad succinctly explained, 'We are [a] generation from India that is now chasing a career. We want to go where the canvas is broad and rich, and we will follow opportunity.' For today's diaspora, opportunity is undoubtedly the driving force, and no matter how settled they are in the UK, this is a group of nomads for whom geographical boundaries mean little. According to one,

Personally, I view the UK as home because I have been here for the past ten years. I have strong associations through friends and contacts, but would go without hesitation.

So why then did many of these knowledge nomads choose the UK? For many nomads from emerging economies, there is a clear desire to go where the best practices are so they can learn, and then apply them back home. The cultural and historical connection between the UK and India is one of the key influences for nomads. Indians are now the largest ethnic minority group in the UK, forming 22.7 per cent of the UK's 4.6 million ethnic minority population.⁴² Being able to connect with existing networks of family and friends makes the transition much easier, and provides comfort to the family back in India. Maintaining a sense of identity is also important. As one nomad explained, 'you don't have to lose your identity just because you move to the UK.' In the US, these nomads see a pressure to assimilate and conform.

Education is another important attractor to the UK. In 2007 Indian students were second only to China as the biggest source of international students, rising to almost 24,000 in 2006–07 from 19,000 in 2005–06.⁴³ The UK has a reputation for providing quality education and in a world where university rankings are becoming increasingly important, the UK scores well, with four universities in the top ten of the Times Higher Education Ranking and two in the Shanghai Jia Tong university ranking. For many entrepreneurs and young professionals, the fact that many UK universities offer a one-year Masters degree is a key reason why they come to our shores. Similar courses in the US are usually at least two years in length.

But of the total percentage of Indian students studying overseas, the UK does not compare well with the US. In 2006, 123,000 Indian students left to study overseas – almost double the number in 2001 – and more than 60 per cent per cent of them headed for the US.⁴⁴ And it is not just students. For most Indian knowledge nomads, the US is their first choice.

Stars and stripes but not forever

When Gordon Brown made his first visit to India as prime minister in January 2007, British-born Dalbir Bains was in the audience at one of his major speeches. A young, impressive and

brave woman, Dalbir left a high-flying job in the UK's fashion industry to open a lingerie business in downtown Mumbai. She claims always to be flying the flag for the UK as a next step for young Indians, but it's a definite battle against the US:

When he was in India, I heard Gordon Brown saying 'make the UK your first port of call' but it struck me that this was the first time I had seen the UK presenting itself. There just isn't the media coverage or events or anything to showcase that the UK is welcoming. The US and Australia are really making visible efforts in India to lure talent – the UK needs to make more of a conscious effort.

It was a sentiment echoed among many nomads. The US is notorious for its aggressive engagement with India, sending the message through universities and companies that talented Indians are welcome. The UK is criticised for being more complacent, relying on historical and cultural ties to attract talent. Our nomads claimed that, all things being equal, the UK would definitely be the first choice for Indians because of this historic familiarity, but things are not equal.

Perceived cultural differences also play a part. Some suggested that British people are seen as genuine but because they are often reserved and introverted, they can be misinterpreted as being unwelcoming. In contrast, Americans are seen as positive, enthusiastic and overly welcoming – an image perhaps reinforced by the growing and powerful influence of US content through media and entertainment within India. If based on media presence alone, older generations might naturally feel a closer connection to the UK. But in 1992, the launch of satellite TV in India meant that the window to America was opened in Indian lounges, presenting an image of the US that has become increasingly attractive and powerful, particularly to younger Indians.

'Making migration work for Britain'

Indian migration to the US is seen as vital by companies but hampered by legislation that restricts immigration with quotas

under its H-1B system. Even with an offer from a university or large company, only 65,000 visas are allocated each year.⁴⁵ In 2007 Microsoft announced it was opening its new software development centre in Vancouver, Canada, so it could employ much need foreign-born skilled workers who were stalled by US immigration quotas but admitted under Canada's more welcoming policies.⁴⁶ In a statement, Microsoft sent an unambiguous message to the White House stating that its new centre in Canada would 'allow the company to continue to recruit and retain highly skilled people affected by the immigration issues in the United States.'⁴⁷

In comparison, the transparency of the UK visa system is seen as an advantage. As long as you can tick all the right boxes, you can be confident of getting in. In 2005 the UK government released its five-year strategy for asylum and immigration, *Controlling Our Borders*. The plan was:

*based on the principles of enforcing strict controls to root out abuse, ensuring that Britain continues to benefit from people from abroad who work hard and add to our prosperity, and putting forward solutions to provide a migration framework which is in the best interests of the country.*⁴⁸

The following year, a new tiered system for migration was announced with five separate tiers, applicable to highly skilled migrants, skilled workers with a job offer, low skilled migrants, students, and finally youth mobility and temporary workers.⁴⁹ The new system is designed to be simpler and quicker for employers and educational institutions to bring in the migrants that they need, while also providing more certainty for prospective migrants about whether they can come to the UK. It is also designed to take into account the effects of the expanded European Union, which provides access to a growing mobile workforce who are rapidly closing gaps in employment.

This new tiered system attempts to attract migrants who are highly skilled, while enabling migrants to enter the UK to fill key jobs. A comprehensive Highly Skilled Migration Policy was first introduced in the UK in 2002. Australia established a similar scheme as early as 1984, with Canada and the US

following suit soon after. In its first year, the UK received only 2,400 applications and accepted just 1,155. The system has undergone significant change since then, moving to a points-based system with points awarded based on education, experience, age and past earnings. By 2005 the number of applications had grown to over 23,000, while the number of accepted applications almost doubled between 2004 and 2005 from 7,370 to around 14,130.⁵⁰

But there are growing tensions within the UK in relation to immigration. On the one hand, government, business lobbies and universities champion the UK's diversity, economic prosperity, liveability and welcoming culture as mechanisms to attract the highly sort after 'international talent'. On the other hand, an increasingly aggressive stance by government and the media on other types of migration promotes an environment in which many potential migrants may not feel particularly welcome.

In a climate of increasing anxiety about immigration, 'Britishness' is making a remarkable and perhaps untimely resurgence at the expense of celebrating diversity. In some comments that were later withdrawn, the new Immigration Minister, Phil Woolas, claimed in October 2008 that 'the easiest thing for an employer to do is to employ an immigrant. We need to help them to change that. We need a tougher immigration policy and we need to stop seeing it as a dilemma.'⁵¹

The balancing act

Calls for tougher migration policy are more increasingly common discourse. In September 2008 a Joint House of Commons Committee, led by Labour MP Frank Field and Conservative former minister Nicholas Soames, called on the government to slash the number of non-EU migrants who are allowed to stay in the UK. The report *Balanced Migration* proposes that there should be a cap on the number of non-EU citizens given the right to permanent settlement by bringing the number of immigrants settling permanently into line with the number of emigrants.⁵²

Although the government has ruled out such a cap, this joint parliamentary report is evidence of a growing UK arrogance in the competition for talent. Such reports constantly stress the privilege of working in the UK with little acknowledgement of the skills and qualities that immigrants and diversity brings to the UK. The tone of voice of these debates has broader implications for the UK's international reputation, and attitudes to immigration have a strong influence over a country's ability to attract highly skilled people. In a world of globalised media, the UK's domestic agenda permeates into the media of other countries, thereby undermining efforts to lure the talented.

But not all knowledge nomads we spoke to were critical of the migration climate of the UK. Some understood the dilemma. The UK is already home to over 60 million people and predictions suggest the UK population will rise to 71 million by 2031.⁵³ It is understandable that the government wants to draw the line somewhere and it is reasonable for policy makers to target highly skilled people given their potential contribution to the UK's economic growth and skills base. But we need to reconsider how and where the lines are being drawn. By focusing on what can be easily measured, many of the most innovative and creative parts of the economy are left vulnerable.

Can I see your creative licence?

There is no doubt that the government's reforms have simplified the system, bringing the number of categories for migration from 80 to just five. But the system is becoming focused on a particular type of migrant – the well-paid professional from established countries, from established fields like law, engineering, science and finance, making it difficult for the more entrepreneurial and creative sectors.

Britain prides itself on its creative industries – a sector in which two million people are employed and which contributes £60 billion a year, or 7.3 per cent of the British economy.⁵⁴ The government, in its recent report *Creative Britain*, recognises that the sector is in a strong position but that global competition is growing and thus the UK's creative industries need 'the best

possible business support structures in place and an abundant pool of talented people with the right skills'.⁵⁵ Yet some organisations, such as the Immigration Law Practitioners' Association, argue that the new points-based system fails to address the UK's desire to attract the very best individuals in these sectors:

*Those whose contributions are measured in terms of creativity and culture have been over-looked in the new system in favour of box-ticking economic assessment criteria. Financial contribution can be more easily measured... whereas the arts arguably make a more profound and important contribution to the richness of life in the UK but are more complex administratively and evidentially to measure.*⁵⁶

It's a sentiment echoed by knowledge nomads themselves. At our focus group of UKIBC entrepreneurs, those from the creative sectors were quick to highlight to their colleagues from KPMG, Deloitte and other established firms that it is difficult for entrepreneurs and those in the creative sectors:

It's a double-whammy for the creative sector – the UK doesn't have the best colleges compared to the US, and you don't earn the high salaries that enable you to get in here. It contradicts what the government is saying about wanting to support creative industries – it's only helping big companies.

Amogh Kalyanpur – Creative Connexions

There is some truth to Amogh's argument. The average salary of a medium-tier management consultant in the UK is £50,000, while a similar level chartered accountant can expect up around £40,000.⁵⁷ Such salaries attract the highest level of points in the new points-based system – reaching to 45 points. Comparatively, the average salary of a graphic designer in the creative sector is only about £25,000, while an artist earns just £28,000, which only attracts 20 and 25 points respectively.⁵⁸ In a system where potential nomads must accrue 95 points across just five categories, the salary assessment is a critical factor. Similarly, the unconditional requirement that overseas applicants have at least £2,800 at their disposal consistently for over three months

prior to applying is another significant obstacle for those from the more creative and innovative sectors who do not earn large salaries.

There is a sub-tier within the highly skilled migrant category specifically targeting entrepreneurs, but this too requires substantial financial backing. A variation of the more general points-based system, potential nomadic entrepreneurs must have access to no less than £200,000, as well as maintenance funding of £2,800 for themselves and at least £1,600 per dependent.⁵⁹ Requiring such a significant amount of capital is contrary to the spirit of entrepreneurship and undermines the importance of fostering new ideas and innovation. Entrepreneurial activities are also substantially different across different sectors, and for many entrepreneurs this requirement is simply unachievable.

The system, based on crude income as a measure of value, simply does not work for many key sectors of the economy, to the UK's detriment. From our analysis, the UK needs to adapt its immigration system to be more flexible and open to all types of skills and backgrounds rather than focusing too narrowly on more easily measurable sectors or trying to handpick those that will best suit the economy. Similarly, the risk-averse entrepreneurship category seeks to lure only established and 'safe' entrepreneurs with no flexibility to attract new, young but untested start-ups.

Just passing through - brain circulation

The overwhelming sense among many knowledge nomads is that they are just passing through, ready to embrace the next opportunity wherever it may be. This is reflected in national migration statistics. The general trend is for people to migrate to the UK temporarily. In 2006, of those migrants specifying a length of stay, 48 per cent stated an intention to stay for one or two years compared with 39 per cent in 1997. Approximately 31 per cent stated an intention to stay for more than four years, down from 37 per cent in 1997.⁶⁰ These statistics suggest that India's 'brain drain' is being replaced by 'brain circulation' as more and more Indians return home to take advantage of

increasing opportunities, often starting new companies or taking up senior positions in academia or business.

Many of our Indian-born entrepreneurial nomads constantly ask themselves, ‘what am I getting in the UK or the US that I can’t get in India?’ The question becomes less and less easy to answer. The quality of life in India can be higher than in the UK, where a reasonably successful person can afford a cook, a cleaner and a chauffeur. As the Indian economy continues to grow, the opportunities for entrepreneurs, scientists and innovators will only continue to expand, making it increasingly difficult for the UK and other developed countries to retain talent and attract new people. The UK must think creatively and ambitiously, appreciating the fluidity of people movement and using the networks and skills of those who do reside here, even if only for as short time.

The importance of networks

Earlier, we explored the importance of global networks in science. Although not as easily measurable through joint papers or patent applications, entrepreneurs’ networks are also important tools for the promotion of bilateral trade links and connecting people through opportunity and exchange. For many of our knowledge nomads, such networks are extremely useful for meeting other diaspora and networking. But they are also avenues for finding inspiration and seeking business advice from role models who may have followed a similar route – arriving in the UK filled with ideas and entrepreneurial flair but not sure where to turn and how to go about it. It is an important service, particularly given the UK’s historically risk-averse culture:

A lot of the mentality in the UK is not geared to start-ups, but more to individual professions. The need to appreciate and celebrate failure is missing in the UK, but if the UK was more accepting, it would attract more people.

Comment in focus group with Indian nomads

The majority of highly skilled migrants to the UK do enter companies or established organisations rather than start up their

own companies. Entrepreneurial ecosystems like Silicon Valley tend to attract a far larger number of entrepreneurs, but as our analysis found, the current migration system is also not conducive to attracting new entrepreneurs and innovators either through the general tiered system or the specific entrepreneur category. To counter this, our entrepreneurs told us that the UK needs to build a system that understands the value of entrepreneurs. Entrepreneurs' networks are key to achieving this, but they cannot achieve this vision without strong support from government, business, universities and the community more generally through more flexible migration policies, entrepreneurial education, venture capital and support for start-ups.

But what can entrepreneurs' networks do to attract more talent to the UK? Just as we described in the Pfizer case study, such networks (like those in science) have access to impressive numbers of knowledge nomads, each with their own extensive networks and connections in their home country and often across other parts of the world. Most members of entrepreneurs' networks straddle the two worlds: their home and their new home, and therefore are important advocates for the UK aboard. Their stories of achievement and career advancement are vital if the UK is to attract more talent, and entrepreneurs' networks are ideally placed to promote such success stories in India and beyond. In this regard, many knowledge nomads argue that organisations like the UKIBC need to do more in their target countries to counter perceptions that the UK is 'closed' or 'unwelcoming'. By hearing success stories that potential knowledge nomads can relate to and be inspired by, the UK would be far better placed to attract talent.

4 Manchester

Manchester was once the world's most innovative city. In the late eighteenth century, Manchester was a powerhouse of free trade at the centre of the Industrial Revolution. 'What Manchester says today,' the proverb went 'the rest of the world says tomorrow.' Much of the world's cotton came through Manchester, enabled by immigrant Flemish textile workers. The growth of the cotton industry, and Manchester's emergence as the first industrialised city, led to new business models, new economics, new models of society and new scientific insights. The city proudly asserted its independence from the capital, an independence that can still be sensed today. According to Dave Haslam, Manchester historian and former DJ at the seminal 1980s club, Hacienda:

Within the first decades of the nineteenth century, the city's merchants had worldwide contacts, with no dependency on the largesse of London. They had created their own wealth, become economically self-sufficient... In the era of rock & roll this would be just as crucial as in the days of cotton and coal.⁶¹

The Manchester of Dalton, Arkwright and Engels has had to reinvent itself, to locate itself within a rapidly changing world. The city is now more famous for sport and music than for cotton and coal. But as it seeks to identify new opportunities for innovation, it relies more than ever on flows of innovative people. While Manchester United has no issue attracting the best players from around the globe, the city's ability to attract international talent is far more complex.

In this chapter we build on debates about innovation and place by exploring the role of a city in the global competition for talent. By looking at Manchester, we aim to learn broader lessons

for the UK. Within a city of more than 450,000 people, 100,000 students and five universities there are a range of ways to attract highly skilled people. In our case study, we focus on the experience of knowledge nomads within spin-out companies in and outside Manchester's growing Science Park and situate these within the broader innovation ecosystem.

Innovation and place

Innovation in the twenty-first century is a competitive sport, and it is increasingly cities and regions rather than countries that are competing.⁶² It is a paradox of globalisation that as transportation and communications technologies continuously improve and production and innovation networks become more distributed, cities and their regions have become more rather than less important. This is largely due to three main factors: first, proximity – the powerful knowledge spillover effect that comes from interaction between clustered institutions and organisations; second, diversity – the boost provided to innovation and problem-solving capacity by economic and social variety; and third, population – as concentrations of human capital, cities are the engines of the knowledge economy.⁶³

As the role of cities has become more central, city regions have increasingly become an important scale at which to coordinate economic development, planning and policy implementation. As a result, city regions are now both able and expected to take more responsibility for aligning strategies for retaining and attracting talented people to their own distinct economic development needs.⁶⁴ Some cities and regions have proven that they are better able to absorb ideas, attract talent and create opportunities than others. Biopolis in Singapore; the Golden Horseshoe region in Ontario, Canada; the life sciences cluster of Medicon Valley which incorporates Copenhagen in Denmark, and the Skane region of southern Sweden; and the Thames Valley in the UK are just some examples.⁶⁵

More broadly, Boston, San Francisco, Vancouver and Melbourne are increasingly being recognised as leading 'creative cities', thanks to indexes like the Economist's 'World's most

liveable city' and the work of Richard Florida.⁶⁶ Such examples provide lessons and inspiration for aspiring cities, but they are not easily replicated elsewhere. Such characteristics are often organic, leaving policy makers powerless.

Cities, under pressure to act quickly, have often fallen into the trap of adopting successful economic development policies without consideration of the uniqueness of the locality. In the 1980s and 1990s, countless cities ambitiously proclaimed their aim to become the 'Silicon Valley' of their country based on some large injection of funds into the ICT sector and a piecemeal strategy with little regard for the city's intellectual and physical infrastructure. The majority have failed. It takes more than an advertising campaign and money to establish a cluster of innovation in a particular field and attract international talent.

Despite the increased competition between cities, the number of truly significant 'players' is still comparatively small and concentrated. The innovation landscape is full of peaks and troughs. Significant long-term investment in science and innovation has long been the preserve of rich nations. In 2004 just 15 countries spent 90 per cent of the world's R&D dollars,⁶⁷ and in each of those 15 countries, scientific capacity is also highly concentrated. California, for example, accounts for more than one-fifth of America's spending on R&D and two-thirds of US R&D occurs in just ten states.⁶⁸

Relying on such simple models of measuring innovation is problematic. They do not capture the broader elements beyond patenting and licensing that play a part in the development of new innovations, nor do they capture the broader creativity and innovation that exist in particular cities. Today, cities are recognising that in addition to fostering capabilities in science and technology-led industries, there is an equally compelling case for focusing on the creative economy.

Growing creative cities requires an interdisciplinary approach, with complementary sectors and skills collaborating to stimulate innovation in the wider economy. Policy makers are only just beginning to grapple with how to identify and encourage more creative activity. Equally challenging is how to measure creative activities robustly, rather than just measure

creative industries. A city's creative activity is becoming an increasingly important tool in talent attraction.

Location, location, location

Richard Florida's influential book *The Flight of the Creative Class* put creativity on the radar of leading policy makers.⁶⁹ More recently Florida's work has reinforced the growing importance of cities in a knowledge economy in arguing that 'place' is now more important in a global economy than ever. He argues that as we live in a highly mobile society, we now have a much greater say over where we live. At the same time, places are more diverse and specialised, 'from their economic makeup and job market to the quality of life they provide and the kinds of people that live in them'.⁷⁰ Where you live, Florida argues, can greatly affect your career, your love life, your finances, your housing situation, your children's future, your health and just about every other aspect of your life.

The UK is highly urbanised. In 2005, 77 per cent of England's total employment concentrated in city-regions, and 90 per cent of knowledge workers (including those working in engineering-based manufacturing, manufacturing, knowledge intensive service and creative industries) were employed in cities rather than rural areas. But levels of innovative capacity and economic performance vary significantly between cities, affecting their attractiveness to skilled people within the UK and internationally.⁷¹

The National Endowment for Science, Technology and the Arts (NESTA) argues that 'urban hubs' and 'local links' are useful frameworks through which to assess a city's innovative strengths. Urban hubs equate to urban assets, market size and business networks. Local links are the role of institutions, knowledge networks and public-private collaboration.⁷² Urban hubs and local links are 'magnets' – features which attract a stream of external resources – new people and businesses which enlarge a region's pool of skills and talent. But equally important is what Rosabeth Moss Kanter calls 'glue'.⁷³ Physical and social infrastructure – roads, communication systems,

human services, voluntary groups, cultural outlets and a pleasant urban environment – is also a key factor in making decisions on location.

But what more can cities do to attract talent? As cities increasingly seek to uncover and measure the value of local innovation and creativity, how can this knowledge be used to attract more people? What role can global networks like the ones rooted in Imperial College play?

‘Manchester’s got everything except a beach’

Ian Brown from The Stone Roses provided this update of Manchester’s industrial revolution hubris. But others agree that a lower cost of living, a high quality of life, an international airport, good schools, good companies and a high-quality cultural offering stack up well against London

It may all sound like an advertisement from a government investment agency, but one thing that Manchester should be proud of is the fact that all of its key agencies seem to point in the same direction. Unabashed in its drive ‘to make Manchester one of Europe’s most innovative cities’, Manchester has over five agencies working to strengthen the city’s innovative image and capability.⁷⁴ The effectiveness and accessibility of all of these agencies may vary, but there is no doubt that they all believe strongly in the potential of Manchester as a central node on the international innovation stage.

Institutions and agencies can do a lot to improve a city’s innovation capabilities in order to attract the best people. In all of our case studies, one undisputable way to attract international scientists is by offering the opportunity to do interesting world-class research, at world-class universities or world-class businesses. But ultimately people move for a wide variety of reasons, which are often difficult to identify and are beyond policy control.

The nomads we spoke to confirmed that the ‘glue’ matters. The city must provide physical and social infrastructure, which will enable a high quality of life, as well as a sufficiently robust economic market to ensure that a talented new arrival could

pursue a job elsewhere if the original job does not meet expectations. Understanding this, Manchester has worked hard to attract and grow scientific companies and institutions while working to ensure the University of Manchester's place as one of the top five universities in the UK.

Spinning out

Nanoco Technologies Ltd is a spin-out company from the University of Manchester's chemistry department. It leads the world in a very specialised area of nanotechnology – fluorescent semi-conductor nanoparticles called quantum dots, which are 80,000 times smaller than the width of a human hair.⁷⁵ 'We figured out how to mass produce this stuff,' explains CEO Michael Edelman, and now, thanks to Nanoco, this efficient, solid-state lighting is being used in cutting-edge applications like ultra-thin TV screens, medical imaging and next-generation solar cells.

It is a highly specialised field, so they have to recruit from all over the world. In a staff of 30 people, there are nine nationalities including scientists from China, Japan, Syria, the US, Germany and Spain as well as the UK. It would be easier if they could find people in the UK, Michael admits, particularly given the costs of getting people interested and flying them over to consider the company and Manchester, but he confidently boasts that 'we get the people that we want.'

For Nanoco, Manchester has more positives than negatives, particularly compared with London, which is prohibitively expensive while apparently offering no additional benefits to the company. The University of Manchester has improved significantly over the past few years. University of Manchester Intellectual Property Limited (UMIP), the managing agent for university spin-outs, has been extremely supportive and it is a big help to Michael that his company can use the university facilities next door – both in terms of brainpower and analytical equipment. In London, the equivalent resource would be Imperial College where finding support and an office would be far more difficult and expensive.

We have already introduced Imad Naasani in our introduction. Another Nanoco nomad is Ombretta Masala. When Ombretta came to Manchester ten years ago to study her PhD, she imagined she'd be back home again in Italy in three years. But after her PhD, Ombretta decided to do a post-doctoral fellowship in California and considered applying for a working position in the US. But visa barriers, geographical distance and cultural differences led Ombretta and her husband back to Europe. The UK offered more positions in both of their fields than anywhere else. 'With my type of skills', she told us, 'you can't be so choosy. There aren't many companies doing interesting work in my specialisation.'

After two years at a company in Oxford, an old connection from Ombretta's university days in Manchester, Nanoco's Chief Technical Director, approached Ombretta to join the ever-expanding Nanoco and she is now happy to be back in her old university. 'I almost didn't recognise Manchester when I came back,' she said. 'It has changed a lot in the last five years with so much urban regeneration.'

Ombretta sees Manchester as a much more cosmopolitan city, attracting people from all over the world. With the benefits of good social life, the convenience of an international airport and proximity to the Lake District, she now claims to have settled in Manchester.

A walk in the park

Science parks are usually less exciting than they sound. But if you go in and talk to people like Mike Campbell, you get some of the excitement back. Mike is the Chief Executive Officer of Oxyrane, a company based at the Manchester Science Park that develops highly specialised glycan-controlled therapeutic proteins and antibodies.

Established in South Africa in 2004, Oxyrane recognised it lacked connections to specialists in the area and started to seek out hubs of relevant knowledge that might present better opportunities. Availability of talent wasn't initially important because Oxyrane works in such a specialised area that they

expect to have to recruit from all over the world. ‘We’re like the UN here,’ Mike claims, ‘we’ve got a Russian, a Pole, a South African, a Bulgarian, a Frenchman, two South Americans and two North Americans.’ What was important, though, was the need to move somewhere other people would be willing to live.

They lived in France, Belgium and the Netherlands before the UK. And they could have ended up anywhere:

The UK put forward the worst case of all the countries considered. Belgium (via Invest Flanders) offered a much smoother package, but we decided to move to the UK because our investor network feels more comfortable in an English-speaking country and it’s more centrally located.

Mike claims that the ‘UK package’ just wasn’t as compelling: ‘Its one thing to pitch a story, but it’s the follow-through that matters,’ he said. Frustrations around basic relocation necessities like establishing bank accounts, demonstrating credit history, buying a car and a highly bureaucratic migration process make the transition unnecessarily painful: ‘They claim to be international, but they just have no idea how to deal with people not from the UK.’

As for Manchester, ‘it has got all the pieces of the puzzle, but not the integration. There are just too many agencies, they overlap and it’s difficult to work out what they do, so now I just use the Manchester Science Park to help navigate the system.’ Mike is quick to add that he would still encourage people to move to Manchester, citing the university and the centres of excellence as key partners in their success, but he thinks these teething issues need to be resolved.

But Mike says he is constantly re-evaluating the value proposition of Manchester compared with other places and is regularly approached by the likes of Singapore, Hong Kong, Ireland and Flanders. Oxyrane is not going anywhere just yet, but it demonstrates the heightened competition there is for such mobile companies and talent in today’s world. While seeking to attract new players and new talent, Manchester and the UK more generally must also support its existing tenants.

But as in most things in life, everyone's experience is different. Dr Jason Lee from ProteinTech, a US company with an office in the Manchester Science Park, could not be more positive about the role of organisations like MIDAS, Manchester's inward investment agency, and SinoVentures in easing the transition to Manchester. Jason heard about Manchester's drive to attract innovative bright companies from the municipal government of Wuhan in China while visiting ProteinTech's manufacturing plant there. He saw that Manchester presents itself as an eager, motivated and driven young city – characteristics which are attractive to a young start-up.

'We'd never heard of Manchester before, but when we arrived we saw that the people are very energetic about creating a future for the city,' Jason told us. To attract more investment like ProteinTech and therefore international talent, Jason argues that sister-city type relationships are extremely important, as is the need to identify companies that are looking to establish a European presence and then to provide such high level personalised service as they received. According to him, if ProteinTech and MIDAS had not met through the unlikely match maker of the Wuhan government, they would not have known that Manchester was an option.

It's not just about science

As cities place greater focus on their 'creative' capabilities, ensuring the integration of research and scientific activities with the other innovative elements of the city is vital. According to one study, cities that 'partition their research and scientific activities in separate enclaves divorced from the people in the city and separate from businesses and the market are unlikely to win the race for increased innovation.'⁷⁶ Spin-out companies like Nanoco, ProteinTech and Oxyrane all benefit from and add to the city's broader innovation system – the universities and research institutions, the local business and entrepreneurial community, the social and creative hubs, as well as the local agencies. It is their combined innovation eco-system that becomes attractive to potential knowledge nomads.

Alasdair Rawsthorne, the founder of another successful university spin-off, Transitive, is passionate about the need to generate more cross-fertilisation across the city as a means of attracting more talent to Manchester:

There is so much interesting work happening in the digital and creative sectors, in sport, in manufacturing. We need to somehow capture this activity into everyday life to enable more collaboration and exchange, and create a richer 'intellectual life' of the city. At the moment, it still feels very siloed.

Just like Dave Haslam, Alasdair believes the early industrial days proved Manchester's capacity to foster new social innovations and business models. The challenge is to identify ways to do this which are appropriate for the twenty-first century. He cites 'Café Muse' as an interesting and welcome experiment. Café Muse is based at the Manchester Museum within the University of Manchester, and it aims to provide a place where anyone can explore the latest ideas in science, culture and the arts through facilitated workshops and events.

Within Transitive, Alasdair believes that the key to attracting good people is by offering an outlet for their creativity in research, but he also believes that the company's location in central Manchester is also extremely appealing. Transitive staff are often found discussing their latest findings in central Manchester's Caffè Nero and are testimony to Alasdair's desire to integrate innovation into the city's everyday life.

I wanna be a big big star

Manchester owes much of its capacity to attract international talent to the dramatic transformation of the city over the last decade. The city has worked hard to transform its reputation, particularly within the UK, from a dark industrial city where it rains all the time to an innovation hub. The rain might persist, but the 1996 IRA bomb provided the opportunity for the city to rebuild and regenerate. Thanks to strong government support and regional leadership, there is growing recognition nationally

of the city's progress and the challenge now is to translate this to the international stage. Manchester: Knowledge Capital's Cathy Garner explains:

Manchester is a city with international components, but it's not yet recognised as an international city. Establishing the international reputation of Manchester isn't something you can do with a few adverts, but we do have a number of important international components; we're an important node on the international circuit and we're not trying to be something that we're not.

Only by capitalising on the city's strengths and promoting these 'international components' will Manchester be able to attract more foreign talent. The universities are undoubtedly one of the biggest magnets for talent. According to a recent NESTA report, universities are key to generating the knowledge needed for innovation, developing the necessary skills and opportunities for knowledge exchange, while also acting as regional leaders as a key hub in the international network of knowledge.⁷⁷

In 2002, with the merger of the Victoria University of Manchester and the University of Manchester Institute of Science and Technology, Manchester sent a clear signal that they wanted to come together 'to compete successfully with the world's leading institutions.'⁷⁸

The number of international students and international collaborations are on the increase, in line with the rest of the UK. But the challenge remains to provide a better link for these international networks into the fabric of Manchester – making international talent more likely to come or return, or enable future collaborations. This extends far beyond the narrow role of universities in enabling technology transfers from university research into business. By supporting new networks and stimulating social interaction across the local community, universities can add a significant amount to the attractiveness of the 'place' in the attraction and retention of talent. In addition to pursuing international students and research collaborations, universities must also stage international conferences and workshops, establish entrepreneurial outlets for exchange and

promote the engagement of their current and past students in the local neighbourhood.⁷⁹

International students are an obvious area in which to start building such networks. Under the new visa laws, international students are now able to stay for up to two years after graduation to gain employment experience. But according to Professor Rod Coombes, a leading innovation thinker from the University of Manchester, employers do not yet recognise the value of international students as potential door-openers to strategic markets and networks, or appreciate the more tactical skills they bring in offering alternative approaches and thinking to the workplace.

What's next for cities?

In many ways our knowledge nomads in Manchester confirmed a lot of the now common understandings about cities in the global competition for talent. As Florida argues, 'place' does matter. Cities must provide 'magnets' such as leading-edge research through their universities, science parks and spin-out companies, as this is undoubtedly the biggest attractor for talent. Equally important is the 'glue' – the softer physical and social infrastructure to make a city somewhere that is conducive to a good lifestyle for the knowledge nomad and their family, and this includes ensuring that the transition into the city is as smooth as possible.

So what is next? The challenge now is not only to continue to build capacity in 'magnets' and 'glue', but also then to extend and advance their role in the city's innovation ecosystem through more creative and interdisciplinary approaches. As the competition to attract talent evolves, potential knowledge nomads will increasingly turn to a city's ability to demonstrate its creativity, flexibility and connection into the broader global network as key measures of the city's appeal.

This means encouraging more cross-fertilisation between areas of expertise across a city. Here local agencies and universities could play a far greater role in facilitating dialogue between other aspects of the city and identifying new ways that various sectors could complement each other.

Cities also need to establish a greater appreciation of the global networks and connections that are already in place across the city, and then build on these relationships. Ombretta, Jason and Imad all came to Manchester because of their networks. As Imperial College shows, universities also have extraordinary networks around the globe. Although global networks cannot be forced, international students, the connections established through international research collaborations and, importantly, the networks of knowledge nomads themselves are often under-used tools in attracting talent.

Realistically, not every city will become a peak in the new global innovation landscape, but cities like Manchester have a very compelling case. The key is being flexible enough to leverage the skills, institutions, knowledge networks and people at a city's disposal to respond to new and changing opportunities. National policy must empower cities like Manchester to open their doors to new ideas, networks and people from elsewhere, and the city must be ready to adjust accordingly.

Conclusions and recommendations

Imad Naasani would not have come to Manchester if he had not met Nanoco through his networks in the US. Ramon Vilar was drawn to Imperial College because it had one of the few relevant research groups around the world that was offering an interesting research project. Pfizer has attracted a few of the world's leading immunologists through forming a highly specialised vaccines team and promising the opportunity to conduct cutting-edge research.

The nomads that we met frequently came to the UK because they were following links in their highly specialised networks. The reasons that they have stayed have been more complex still: most like their work, some like the pay, some enjoy the countryside and some have found love and started families.

Science and innovation are becoming increasingly global and transcending national borders and national allegiances. In *The Atlas of Ideas* we introduced the term 'cosmopolitan innovation' and encouraged governments like the UK to avoid any retreat into techno-nationalism and instead embrace the pursuit of global knowledge for global goals. This message becomes more relevant as the landscape of science continues to shift, with new players, new places and new ideas challenging European and American dominance. At Demos we have already explored how the rise of China, India, South Korea and Brazil will remake the innovation landscape. But countries such as the United Arab Emirates, Malaysia and Rwanda are also emerging players, investing strategically and demanding closer consideration.

If the UK is to thrive in a world of innovation powered by people and networks, it needs to be clear what it wants from immigration. Policy makers must recognise their own limits in engaging with the myriad reasons for the movement of people. Caroline Wagner argues that no government, agency or

institution can assure membership of global science, ‘but learning the rules, norms and mechanisms that govern networks can improve policy outcomes’.⁸⁰ For this to occur, the UK needs more joined-up thinking across policy debates around immigration, innovation and skills, while appreciating that the ‘soft bits’ – the social and physical infrastructure needed to make a ‘place’ attractive – are important too.

UK policy must nurture innovation networks, focusing on functions which facilitate knowledge creation and absorption. As our nomads have shown us, people will come for the science and follow opportunities wherever they may be. The UK needs to transmit a clear message about its contribution to global science. This means going beyond seeing science as an indistinct driver for innovation, articulating instead a vision of science imbued, as we have argued elsewhere, with broader forms of social and public value.⁸¹

Our recommendations for how Britain should embrace this new era of ‘globalisation from below’ are challenging, but the rewards will be well worth it.

Understanding what we’ve got

The increased focus on highly skilled migration in recent years has resulted in huge improvements in the data on international stocks and flows of highly skilled people. But the data still has a number of shortfalls because of the lack of internationally comparable data; the complexity and variations of immigration definitions, policies and systems between countries and – as our research has highlighted – the reality that talented people move under various different guises and within different visa categories that are not immediately obvious for statistic purposes.

Australia is one of the few countries to collect information on persons leaving as well as arriving and as a result has a far richer knowledge of the types of skills and capabilities of the people entering and exiting their country and can tailor their migration policies accordingly. This is obviously far easier for a country of only 21 million people that is geographically isolated and independent of blocs such as the European Union, but such

knowledge is powerful in developing more targeted policies. The UK needs to find a mechanism for improving the quality of data about the sort of people that are coming in to the country, under which categories and why. The International Passenger Surveys are a good starting point, but they – along with national labour surveys, the population census and other migration procedures – are currently underused tools in collecting such valuable data on patterns of highly skilled migration. HM Revenue and Customs, in its administration of the national insurance number scheme, could also be another avenue through which to collect information from new arrivals.

Equally important is establishing a greater understanding of emigration from the UK. Too often the debate focuses on immigration, where the information is commonly over-inflated and confused, with little analysis of who is leaving, where they are going, what their motivations are and for how long they intend to leave. Having mechanisms in place to provide a more robust understanding of the UK's contribution to global 'brain circulation' would enable governments, universities and other policy makers to think more strategically about how to connect better with diaspora networks.

We recognize that implementing such mechanisms for more precise data on immigrants and emigrants is not without challenges. As a starting point, we recommend that the UK Border Agency, through its administration of the new points-based system for highly skilled migrants and business sponsorship, starts to collect and publish data on the levels of tertiary education of migrants, types of professionals entering, where they are coming from, and their intended period of stay. Emigration data is more difficult to capture but a coordinated 'exit' survey issued by a government agency but coordinated by the human resources departments of universities, companies and other employers is an option that deserves further exploration.

Opening up

Talented people enter the UK under a variety of guises for a variety of reasons, many of which lie beyond the control of policy makers. Allowing for this, the migration system needs to be flexible enough to provide a number of avenues for entry. Given the increasing competition to attract elusive nomads and the difficulties in separating highly skilled from other forms of migration, it is a legitimate goal of government to introduce targeted migration policies, which facilitate and encourage the movement of talented people into the UK.

The new tiered points-based system has simplified migration procedures and works for many of the key professions that the UK is trying to attract, like scientists. But unfortunately the system doesn't work for other innovators because of its emphasis on measures such as on salary levels and formal education, which can fail to capture the potential of those in less formal sectors. Meanwhile the entrepreneurship category fundamentally misunderstands the value and realities of entrepreneurship. Requiring applicants to have significant personal collateral as a condition of entry assumes that the majority of people seek to move permanently. As our analysis shows, this is no longer the case and it is questionable whether such a security blanket is necessary.

The tone of migration debates is also important because highly skilled migration is intimately bound up with more general attitudes towards immigration. Perceptions of how welcoming a country is to migrants matters a great deal to highly skilled people. In the US, the September 11 2001 attacks triggered a raft of policy changes which tightened the immigration system, making it far more difficult for migrants – particularly from parts of the Islamic world – to enter. Imperial College's Dr Sophia Yaliraki believes this creates a significant opportunity for the UK to present a more welcoming environment for talent from countries that have been misrepresented or misunderstood in the post 9/11 climate.

The UK is one of only a relatively few countries with migrant policies which specifically target highly skilled migrants. This is changing as more and more countries recognise their value. The EU's discussions around the introduction of a 'blue card', which

enables highly skilled, third country nationals to have instant access to the entire European labour market, should be welcomed and the UK should not resist such measures in favour of their own systems. Ways to ensure that the two systems complement each other must be found, particularly in the context of the UK's more positive and welcoming approach to knowledge nomads. Although we recognise that brain drain is an issue with such initiatives, the reality is that many talented people from developing countries tend to migrate regardless. Therefore we need to get better at sending our talented people to the developing world and ensuring a more concerted approach to capacity building within these countries.

We recommend that the UK re-examines its new tiered points-based system to place less focus on salary levels and enable more flexible analysis of the value proposition offered by different sectors and skills, particularly in the creative industries. The entrepreneurship tier must also be reformed to reflect more closely the spirit of entrepreneurship and its value to the UK. More recent reforms which require significant personal collateral for highly skilled migrants are unnecessary and counter-productive, and should be removed.

The UK government needs to articulate clearly the value of migration and to promote the UK as a welcoming next step in any knowledge nomad's travels. Embassies, High Commissions, research councils and institutions like the British Council will be key to communicating this new direction, while the government's response to initiatives such as the EU's 'blue card' will also send important signals. We also recommend that more organisations should be enabled to act as independent 'immigration brokers', as UKIBC does, encouraging people to consider the UK and then helping them to navigate the system.

Scientists without borders

Our chemists at Imperial College insisted that they encourage their students to leave the UK when they have finished their studies. Why? Because it broadens their minds, challenges their

thinking and makes them better scientists. The new geography of science means that more hotspots of innovation are emerging, with more than one way to approach scientific research.

If the UK is to continue to be a scientific leader, its scientists should be encouraged to move more freely through this new geography. Equipped with a more global perspective, expanded networks and diverse experience, these scientists return more valuable than before. For those who do not return, the UK needs to capture their value from afar by ensuring that they act as ambassadors for British science and maintain links with this country.

As we noted in the introduction, increased mobility of skilled people presents acute challenges for developing countries, where brain drain remains a very real problem and brain circulation is hampered by a lack of domestic scientific capacity. As part of the UK's approach to global science, the government needs actively to encourage its own scientists to move and collaborate with developing countries. Working to advance science on malarial diseases in southern Africa could be as rewarding and challenging as doing a stint in the best labs of Stanford University, and UK science would be hugely enriched by such scientists with such experiences. By ensuring our best and brightest go to parts of the globe that are less scientifically advanced, the UK's reputation as a leader in the promotion of global science will be reaffirmed, while also making a significant contribution to capacity building in these regions.

At a time of economic recession, with science budgets inevitably under pressure, the institutional reflex might be to close ranks, cut down on risky collaboration and discourage foreign travel and networking. This would misunderstand the nature of contemporary science and be a costly long-term mistake.

We recommend that the systems that currently support publicly funded research in the UK should actively encourage scientists to travel to and collaborate with developing countries. The Research Excellence Framework, which will replace the Research Assessment Exercise, should recognise and reward this activity as part of a redefinition of

scientific ‘excellence’. At the same time, the research councils should direct more research funds towards such collaborations.

Mobilising the nomads

As the UK actively embraces brain circulation, we need also to consider how to make the most of those knowledge nomads who have chosen to come here. Current and past nomads are an enormous untapped resource. They comfortably straddle different countries and cultures, providing the links that global science needs to flourish. In some universities, these links lead to fruitful collaboration. In companies, they are often sidelined by the pressure to compete.

Scientists are comfortable talking about their global movements, but they are in general too quick to say that science is the same all over the world. This often means that we don’t make the most of the diversity that already pervades British science. As we have described, more diverse scientists can make for more diverse, creative and innovative science and policy makers should encourage scientists to recognise their own diversity.

We have heard from our nomads that they are usually keen to maintain scientific and informal links with their home countries. In many cases they have come from countries such as India, Mexico, China or Brazil that are seeking to build their scientific capacity. These nomads are keen to contribute but unsure where to start. Universities, government, research funders and companies can help.

Science is also an important tool in ‘soft power’ between nations, and knowledge nomads are instrumental in building awareness and understanding about UK science, and in strengthening wider relations between countries. This is particularly vital in countries where there is currently a trust deficit with the UK, for example those in the Islamic world. As countries such as Qatar, Saudi Arabia and Iran continue to invest rapidly in their scientific capacity, the UK must harness the power of cultural diplomacy through science to build trust and

understanding. And we should encourage more nomads from these countries to spend some time in the UK.

We recommend that the UK government, through the Department for Innovation, Universities & Skills' Science and Innovation network (SIN), should support nomadic scientists in the UK to strengthen links with their original countries. The SIN should provide a hub through which scientists can communicate and connect, to learn more about scientific activity in their home country, to support collaboration with the UK, and to contribute to building global capacity for research.

Notes

- 1 Wagner, *The New Invisible College*.
- 2 Mahroum et al, *UK Global Innovation*.
- 3 The closest thing to an internationally agreed framework is the 'Canberra Manual' developed jointly by the OECD and Eurostat to measure 'human resources devoted to science and technology (HRST)'. The basic definition is people who have either successfully completed tertiary level scientific education or have worked in a science and technology occupation where such qualifications would normally be required. See Aurol and Sexton, *Human Resources in Science and Technology*; and OECD, *International Mobility of the Highly Skilled*.
- 4 ICMPD, 'Highly skilled migration', presented by the International Centre for Migration Policy Development at the Fourth Coordination Meeting on International Migration, UNHQ, New York, 26–27 Oct 2005, in preparation of the High-Level Dialogue on International Migration and Development in 2006.
- 5 OECD, *The Global Competition for Talent*.
- 6 OECD, *A Profile of Immigrant Populations in the 21st Century*.
- 7 Office for National Statistics, *International Passenger Survey 2006*.
- 8 Home Office, *Controlling Our Borders*.
- 9 McLaughlan and Salt, *Migration Policies Towards Highly Skilled Foreign Workers*.
- 10 Ibid.

- 11 Quoted in Balmer, Godwin and Gregory, ‘The Royal Society and the “brain drain”’.
- 12 Godwin, Gregory and Balmer, ‘The anatomy of the brain drain debate, 1950–1970s’.
- 13 Zucker and Darby, ‘Location and mobility of star scientists, regional and national’.
- 14 Cervantes and Dominique, ‘The brain drain’.
- 15 Saxenian, *The New Argonauts*.
- 16 Seaver, ‘Ireland – from the brain drain to the Celtic ‘Tiger’.
- 17 Legrain, ‘The House of Lords don’t have a clue’.
- 18 Ibid.
- 19 Leadbeater, *The Difference Dividend*.
- 20 Cited in Leadbeater, *The Difference Dividend*.
- 21 OECD, *The Global Competition for Talent*.
- 22 See Leitch, *Prosperity For All in the Global Economy*; Royal Society, *A Higher Degree Of Concern*; CBI, *Taking Stock*; and ABPI and Biosciences Federation, *In Vivo Sciences in the UK*.
- 23 Rudiger, *Towards a Global Labour Market?*
- 24 Merton, ‘The Matthew Effect in science, II’.
- 25 OECD, *The Global Competition for Talent*.
- 26 Leadbeater and Wilsdon, *The Atlas of Ideas*.
- 27 Kuhn, *The Structure of Scientific Revolutions*.

- 28 Zucker et al, 'Minerva unbound'.
- 29 Wagner, *The New Invisible College*.
- 30 The Professional Footballers' Association, Meltdown report.
- 31 Polanyi, 'The republic of science'.
- 32 World Intellectual Property Organisation, '(WO/2001/019827) A novel process for the synthesis of sildenafil citrate'.
- 33 The drug has since been relicensed for the treatment of pulmonary arterial hypertension under the brand name Revatio.
- 34 Quoted in Pratley, 'Drugs cocktail is a downer'.
- 35 Surowiecki, *The Wisdom of Crowds*.
- 36 Page, *The Difference*.
- 37 Leadbeater, *The Difference Dividend*.
- 38 Unpublished bibliometric analysis by Evidence Ltd on behalf of Pfizer.
- 39 Royal Society of Chemistry, 'Discovering chemistry'.
- 40 Leonard, *Wellsprings of Knowledge*.
- 41 Matsuyama, 'Merck exit from Japan research hurts government goal'.
- 42 Office for National Statistics, 2001 Census.
- 43 Gill, 'UK sees 24% rise in Indian students'.
- 44 White, 'Indian students flock to the US'.
- 45 Smith, 'Pressure mounts for action on US immigration laws'.

- 46 Finkle and Dowd, 'Microsoft expands in Canada amid US visa crunch'.
- 47 Ibid.
- 48 Home Office, *Controlling Our Borders*.
- 49 Home Office, *A Points-Based System*.
- 50 Home Office, www.workpermit.com/uk/highly_skilled_migrant_program_approval_statistics.htm.
- 51 Thomson and Sylvester, 'Phil Woolas'.
- 52 Balanced Migration – A new approach to controlling immigration, see www.frankfield.co.uk/uploads/upload22.pdf (accessed 3 Feb 2009).
- 53 Office for National Statistics, *Population Estimates and National Projections*.
- 54 DCMS, BERR and DIUS, *Creative Britain*.
- 55 Ibid.
- 56 Immigration Law Practitioners' Association, 'The ILPA submission to the Home Affairs Committee Enquiry into Managed Migration'.
- 57 See Prospects, at www.prospects.ac.uk.
- 58 See Workhound, at www.workhound.co.uk/salary.
- 59 Home Office UK Border Agency, 'Points-based system Tier 1 (Entrepreneur)'.
- 60 Office for National Statistics, *International Migration*.
- 61 Haslam, *Manchester, England*.

- 62 Athey et al, *Innovation and the City*.
- 63 Porter, *The Competitive Advantage of Nations*.
- 64 Bound, Beunderman and Mean, *The Place Race*.
- 65 Mahroum et al, *UK Global Innovation*.
- 66 Economist Intelligence Unit, 'World's most livable city ranking'; and Florida, *The Flight of the Creative Class*.
- 67 Wagner, *New Invisible College*.
- 68 Ibid.
- 69 Florida, *The Flight of the Creative Class*.
- 70 Florida, *Who's Your City?*
- 71 Athey et al, *Innovation and the City*.
- 72 Ibid.
- 73 Kanter, *World Class*.
- 74 'Innovation Manchester: A city of ideas, a city of action', Manchester: Knowledge Capital. See www.manchesterknowledge.com.
- 75 UK Trade & Investment, 'Nanoco Technologies Limited'.
- 76 Garner and Ternouth, *Knowledge Cities as Innovation Hubs*.
- 77 NESTA, 'Five ways universities drive innovation'.
- 78 Dr John Beacham quoted in Utley, 'Manchester universities enter alliance to take on US giants'.
- 79 Garner and Ternouth, *Knowledge Cities as Innovation Hubs*.

80 Wagner, *The New Invisible College*.

81 Wilsdon, Wynne and Stilgoe, *The Public Value of Science*.

References

ABPI and Biosciences Federation, *In Vivo Sciences in the UK: Sustaining the supply of skills in the 21st century* (London: Association of the British Pharmaceutical Industry, 2007), available at www.abpi.org.uk/publications/pdfs/invivo_brochure.pdf (accessed 18 Jan 2009).

Athey, G, et al, *Innovation and the City: How innovation has developed in five city-regions* (London: National Endowment for Science, Technology and the Arts, 2007), available at www.nesta.org.uk/assets/Uploads/pdf/Research-Report/innovation_and_the_city_report_NESTA.pdf (accessed 18 Jan 2009).

Aurol, L, and Sexton, J, *Human Resources in Science and Technology: Measurement issues and international mobility* (2001), available at www.ricyt.org/interior/normalizacion/V_taller/schaperdoc.pdf (accessed 18 Jan 2009).

Balmer, B, Godwin, M, and Gregory, J, 'The Royal Society and the "brain drain": natural scientists meet social science' (London: University College London, 2007).

Bound, K, Beunderman, J, and Mean, M, *The Place Race* (London: Demos, 2008).

CBI, *Taking Stock: CBI education and skills survey 2008* (London: Confederation of British Industry, 2008), available at www.cbi.org.uk/pdf/eduskills0408.pdf (accessed 18 Jan 2009).

Cervantes, M, and Dominique, G, 'The brain drain: old myths, new realities', *OECD Observer* (2002).

DCMS, Department for Business, Enterprise & Regulatory Reform and Department for Innovation, Universities & Skills,

Creative Britain: New Talents for the new economy (London: Department for Culture, Media and Sport, 2008), available at www.culture.gov.uk/images/publications/CEPFeb2008.pdf (accessed 18 Jan 2009).

Economist Intelligence Unit, 'World's most livable city ranking', available at: www.economist.com/markets/rankings (accessed 16 Jan 2009).

Finkle, J, and Dowd, A, 'Microsoft expands in Canada amid US visa crunch', Reuters, 5 Jul 2007, available at www.reuters.com/article/technologyNews/idUSNo536902120070705 (accessed 18 Jan 2009).

Florida, R, *The Flight of the Creative Class: The new global competition for talent* (New York: HarperBusiness, 2005).

Florida, R, *Who's Your City?: How the creative economy is making where to live the most important decision of your life* (New York: Basic Books, 2008).

Garner, C, and Ternouth, P, *Knowledge Cities as Innovation Hubs: The role of gatekeepers in their success* (Manchester: Knowledge Capital, 2009).

Gill, J, 'UK sees 24% rise in Indian students', *Times Higher Education*, 27 Mar 2008, available at www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=401182&c=1 (accessed 16 Jan 2009).

Godwin, M, Gregory, J, and Balmer, B, 'The anatomy of the brain drain debate, 1950–1970s: witness seminar', *Contemporary British History* (June 2008).

Haslam, D, *Manchester, England: The story of the pop cult city* (London: Fourth Estate, 1999).

Home Office, *Controlling Our Borders: Making migration work for Britain – five year strategy for asylum and immigration*, Cm 6472

(Norwich: HMSO, 2005) available at: www.archive2.official-documents.co.uk/document/cm64/6472/6472.pdf (accessed 16 Jan 2009).

Home Office, *A Points-Based System: Making migration work for Britain*, Cm 6741 (Norwich: HMSO, 2006), available at www.homeoffice.gov.uk/documents/command-points-based-migration?view=Binary (accessed 16 Jan 2009).

Home Office UK Border Agency, 'Points-based system Tier 1 (Entrepreneur)', available at www.ukvisas.gov.uk/en/howtoapply/infs/inf24pbsentrepreneur (accessed 16 Dec 2008).

Immigration Law Practitioners' Association, 'The ILPA submission to the Home Affairs Committee Enquiry into Managed Migration: the points based system', July 2007.

Kanter, RM, *World Class: Thriving locally in a global economy* (New York: Simon and Shuster, 1995).

Kuhn, T, *The Structure of Scientific Revolutions* (Chicago, IL: University of Chicago Press, 1962).

Leadbeater, C, and Wilsdon, J, *The Atlas of Ideas: How Asian innovation can benefit us all* (London: Demos, 2007).

Leadbeater, C, *The Difference Dividend: Why immigration is vital to innovation*, Provocation 06 (London: National Endowment for Science, Technology and the Arts, 2008), available at www.nesta.org.uk/assets/Uploads/pdf/Provocation/differencedividendprovocationNESTA.pdf (accessed 16 Jan 2009).

Legrain, P, 'The House of Lords don't have a clue', available at www.philippelegrain.com/legrain/2008/04/ (accessed 3 Apr 2008).

Leitch, Lord S, *Prosperity For All in the Global Economy – World class skills*, Leitch Review of Skills, Final Report (Norwich: HMSO, 2006), available at

www.dcsf.gov.uk/furthereducation/uploads/documents/2006-12%20LeitchReview1.pdf (accessed 18 Jan 2009).

Leonard, D, *Wellsprings of Knowledge: Building and sustaining the sources of innovation* (Boston, MA: Harvard Business School Press, 1995).

Mahroum, S, et al, *UK Global Innovation: Engaging with new countries, regions and people*, (London: National Endowment for Science, Technology and the Arts, 2008), available at www.nesta.org.uk/assets/Uploads/pdf/Research-Report/globalisation_report_NESTA.pdf (accessed 18 Jan 2009).

Matsuyama, K, 'Merck exit from Japan research hurts government goal', *Bloomberg.com*, 27 Oct 2008, available at www.bloomberg.com/apps/news?pid=newsarchive&sid=a1I06l57Tg20 (accessed 19 Nov 2008).

McLaughlan, G, and Salt, J, *Migration Policies Towards Highly Skilled Foreign Workers: Report to the Home Office* (London: Migration Research Unit, Geography Department, University College, 2002), available at www.geog.ucl.ac.uk/research/mobility-identity-and-security/migration-research-unit/pdfs/highly_skilled.pdf (accessed 16 Jan 2009).

Merton, RK, 'The Matthew Effect in science, II: Cumulative advantage and the symbolism of intellectual property', *Isis* 79, issue 4 (1988).

NESTA, 'Five ways universities drive innovation', policy briefing (London: National Endowment for Science, Technology and the Arts, 2007), available at www.nesta.org.uk/assets/Uploads/pdf/Policy-Briefing/universities_policy_briefing_NESTA.pdf (accessed 18 Jan 2009).

OECD, *The Global Competition for Talent: Mobility of the highly skilled* (Paris: Organisation for Economic Co-operation and Development, 2008).

OECD, *International Mobility of the Highly Skilled* (Paris: Organisation for Economic Co-operation and Development, 2002).

OECD, *A Profile of Immigrant Populations in the 21st Century* (Paris: Organisation for Economic Co-operation and Development, 2008).

Office for National Statistics, *International Migration*, 2006
www.statistics.gov.uk/downloads/theme_population/MN33.pdf
 (accessed 14 Dec 2008).

Office for National Statistics, *International Passenger Survey 2006*,
 available at www.statistics.gov.uk/STATBASE/Product.asp?vlnk=15054 (accessed 14 Dec 2008).

Office for National Statistics, *Population Estimates and National projections*, available at www.statistics.gov.uk/cc/nugget.asp?id=1352 (accessed 15 Dec 2008).

Page, SE, *The Difference: How the power of diversity creates better groups, firms, schools, and societies* (Princeton, NJ: Princeton University Press, 2007).

Polanyi, P, 'The republic of science: its political and economic theory', *Minerva* 1 (1962).

Porter, M, *The Competitive Advantage of Nations* (New York: Free Press, 2008).

Pratley, N, 'Drugs cocktail is a downer', *Guardian*, 24 Jul 2002,
 available at www.guardian.co.uk/business/2002/jul/24/businessofresearch.research (accessed 18 Jan 2009).

Professional Footballers' Association, Meltdown report (2007),
 available at www.givemefootball.com/pfa/about-the-pfa/meltdown-report (accessed 3 Dec 2008).

The Royal Society, *A Higher Degree of Concern*, policy document 02/08 (London: Royal Society, 2008), available at <http://royalsociety.org/displaypagedoc.asp?id=28988> (accessed 18 Jan 2009).

The Royal Society of Chemistry, 'Discovering chemistry', 1 Apr 2008, available at www.rsc.org/AboutUs/News/RSCnews/Features/2008/DiscoveringChemistry.asp (accessed 18 Nov 2008).

Rudiger, K, *Towards a Global Labour Market? Globalisation and the knowledge economy* (London: The Work Foundation, 2008).

Saxenian, A, *The New Argonauts: Regional advantage in a global economy* (Cambridge, MA: Harvard University Press, 2006).

Seaver, M, 'Ireland – from the brain drain to the Celtic tiger', *Christian Science Monitor*, available at www.csmonitor.com/2007/0905/p06s02-woeu.html (accessed 26 Nov 2008).

Smith, D, 'Pressure mounts for action on US immigration laws', Reuters, 22 Jan 2007, available at www.reuters.com/article/politicsNews/idUSN1940953020070122 (accessed 18 Jan 2009).

Surowiecki, J, *The Wisdom of Crowds: Why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations* (New York: Doubleday, 2004).

Thomson, A, and Sylvester, R, 'Phil Woolas: lifelong fight against racism inspired limit on immigration', *The Times*, 18 Oct 2008, available at www.timesonline.co.uk/tol/news/politics/article4965568.ece (accessed 16 Jan 2009).

UK Trade & Investment, Investment Services, 'Nanoco Technologies Limited', case study (2007), available at: www.ukinvest.gov.uk/Investor-case-studies/4031047/en-GB.html (accessed 16 Jan 2009).

Utley, A, 'Manchester Universities Enter Alliance to Take on US giants', *Times Higher Education Supplement*, 8 Mar 2002, available at www.timeshighereducation.co.uk/story.asp?storyCode=167692 (accessed 18 Jan 2009).

Wagner, CS, *The New Invisible College: science for development* (Washington, DC: Brookings Institution Press, 2008).

Wagner, *New Invisible College*.

White, A, 'Indian students flock to the US', *Forbes magazine*, 13 Aug 2007, available at www.forbes.com/2007/08/05/india-america-students-oped-cz_aaw_0813students_print.html (accessed 18 Jan 2009).

Wilsdon, J, Wynne, B, and Stilgoe, J, *The Public Value of Science* (London: Demos, 2005).

World Intellectual Property Organisation, '(WO/2001/019827) A novel process for the synthesis of sildenafil citrate', available at www.wipo.int/pctdb/en/wo.jsp?IA=IN1999000045&DISPLAY=DESC (accessed 18 Jan 2009).

Zucker, LG, and Darby, MR, 'Location and mobility of star scientists, regional and national: summary and extension of NBER Working Paper No 12172', prepared for presentation at the NBER/Sloan Conference [on the] Career Patterns of Foreign-Born Scientists and Engineers, Trained and/or Working in the US, The Science and Engineering Workforce Project of the NBER, 7 Nov 2007, available at <https://nber15.nber.org/c/2007/SEWPO7/zucker.pdf> (accessed 16 Jan 2009).

Zucker, LG et al, 'Minerva unbound: knowledge stocks, knowledge flows and new knowledge production' *Research Policy* 36, no 6 (2007).

Demos - Licence to Publish

The work (as defined below) is provided under the terms of this licence ('licence'). The work is protected by copyright and/or other applicable law. Any use of the work other than as authorized under this licence is prohibited. By exercising any rights to the work provided here, you accept and agree to be bound by the terms of this licence. Demos grants you the rights contained here in consideration of your acceptance of such terms and conditions.

1 Definitions

- A **'Collective Work'** means a work, such as a periodical issue, anthology or encyclopedia, in which the Work in its entirety in unmodified form, along with a number of other contributions, constituting separate and independent works in themselves, are assembled into a collective whole. A work that constitutes a Collective Work will not be considered a Derivative Work (as defined below) for the purposes of this Licence.
- B **'Derivative Work'** means a work based upon the Work or upon the Work and other pre-existing works, such as a musical arrangement, dramatization, fictionalization, motion picture version, sound recording, art reproduction, abridgment, condensation, or any other form in which the Work may be recast, transformed, or adapted, except that a work that constitutes a Collective Work or a translation from English into another language will not be considered a Derivative Work for the purpose of this Licence.
- D **'Licensor'** means the individual or entity that offers the Work under the terms of this Licence.
- C **'Original Author'** means the individual or entity who created the Work.
- E **'Work'** means the copyrightable work of authorship offered under the terms of this Licence.
- F **'You'** means an individual or entity exercising rights under this Licence who has not previously violated the terms of this Licence with respect to the Work, or who has received express permission from Demos to exercise rights under this Licence despite a previous violation.

2 Fair Use Rights

Nothing in this licence is intended to reduce, limit, or restrict any rights arising from fair use, first sale or other limitations on the exclusive rights of the copyright owner under copyright law or other applicable laws.

3 Licence Grant

Subject to the terms and conditions of this Licence, Licensor hereby grants You a worldwide, royalty-free, non-exclusive, perpetual (for the duration of the applicable copyright) licence to exercise the rights in the Work as stated below:

- A to reproduce the Work, to incorporate the Work into one or more Collective Works, and to reproduce the Work as incorporated in the Collective Works;
- B to distribute copies or phonorecords of, display publicly, perform publicly, and perform publicly by means of a digital audio transmission the Work including as incorporated in Collective Works; The above rights may be exercised in all media and formats whether now known or hereafter devised. The above rights include the right to make such modifications as are technically necessary to exercise the rights in other media and formats. All rights not expressly granted by Licensor are hereby reserved.

4 Restrictions

The licence granted in Section 3 above is expressly made subject to and limited by the following restrictions:

- A You may distribute, publicly display, publicly perform, or publicly digitally perform the Work only under the terms of this Licence, and You must include a copy of, or the Uniform Resource Identifier for, this Licence with every copy or phonorecord of the Work You distribute, publicly display, publicly perform, or publicly digitally perform. You may not offer or impose any terms on the Work that alter or restrict the terms of this Licence or the recipients' exercise of the rights granted hereunder. You may not sublicense the Work. You must keep intact all notices that refer to this Licence and to the disclaimer of warranties. You may not distribute, publicly display, publicly perform, or publicly digitally perform the Work with any technological measures that control access or use of the Work in a manner inconsistent with the terms of this Licence Agreement. The above applies to the Work as incorporated in a Collective Work, but this does not require the Collective Work apart from the Work itself to be made subject to the terms of this Licence. If You create a Collective Work, upon notice from any Licensor You must, to the extent practicable, remove from the Collective Work any reference to such Licensor or the Original Author, as requested.
- B You may not exercise any of the rights granted to You in Section 3 above in any manner that is primarily intended for or directed toward commercial advantage or private monetary

compensation. The exchange of the Work for other copyrighted works by means of digital file sharing or otherwise shall not be considered to be intended for or directed toward commercial advantage or private monetary compensation, provided there is no payment of any monetary compensation in connection with the exchange of copyrighted works.

- c If you distribute, publicly display, publicly perform, or publicly digitally perform the Work or any Collective Works, you must keep intact all copyright notices for the Work and give the Original Author credit reasonable to the medium or means you are utilizing by conveying the name (or pseudonym if applicable) of the Original Author if supplied; the title of the Work if supplied. Such credit may be implemented in any reasonable manner; provided, however, that in the case of a Collective Work, at a minimum such credit will appear where any other comparable authorship credit appears and in a manner at least as prominent as such other comparable authorship credit.

5 Representations, Warranties and Disclaimer

- A By offering the Work for public release under this Licence, Licensor represents and warrants that, to the best of Licensor's knowledge after reasonable inquiry:
 - i Licensor has secured all rights in the Work necessary to grant the licence rights hereunder and to permit the lawful exercise of the rights granted hereunder without you having any obligation to pay any royalties, compulsory licence fees, residuals or any other payments;
 - ii The Work does not infringe the copyright, trademark, publicity rights, common law rights or any other right of any third party or constitute defamation, invasion of privacy or other tortious injury to any third party.
- B except as expressly stated in this licence or otherwise agreed in writing or required by applicable law, the work is licensed on an 'as is' basis, without warranties of any kind, either express or implied including, without limitation, any warranties regarding the contents or accuracy of the work.

6 Limitation on Liability

Except to the extent required by applicable law, and except for damages arising from liability to a third party resulting from breach of the warranties in section 5, in no event will licensor be liable to you on any legal theory for any special, incidental, consequential, punitive or exemplary damages arising out of this licence or the use of the work, even if licensor has been advised of the possibility of such damages.

7 Termination

- A This Licence and the rights granted hereunder will terminate automatically upon any breach by you of the terms of this Licence. Individuals or entities who have received Collective Works from you under this Licence, however, will not have their licences terminated provided such individuals or entities remain in full compliance with those licences. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this Licence.
- B Subject to the above terms and conditions, the licence granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different licence terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this Licence (or any other licence that has been, or is required to be, granted under the terms of this Licence), and this Licence will continue in full force and effect unless terminated as stated above.

8 Miscellaneous

- A Each time you distribute or publicly digitally perform the Work or a Collective Work, Demos offers to the recipient a licence to the Work on the same terms and conditions as the licence granted to you under this Licence.
- B If any provision of this Licence is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this Licence, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.
- C No term or provision of this Licence shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.
- D This Licence constitutes the entire agreement between the parties with respect to the Work licensed here. There are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from you. This Licence may not be modified without the mutual written agreement of Demos and you.

This project was supported by:



Department for
Innovation, Universities & Skills



NESTA Making
Innovation
Flourish



UK INDIA
BUSINESS COUNCIL

LONDON
DEVELOPMENT
AGENCY

The debate about highly skilled migration can be traced back over many decades. But fears about 'brain drain' are being challenged by the idea that people flow can be good for global science and innovation. In this pamphlet we identify a new, global breed of scientist: the 'knowledge nomad', exploring who they are, what motivates them and why their movement around the world is so important.

Knowledge nomads are highly skilled and highly mobile people, open-minded in their choice of home and comfortable moving between different cultures. They are increasingly vital for knowledge economies. Science and innovation now function as global networks, created from the interaction of thousands of highly skilled people. The movement of these people enables these networks to grow and function. They also bring valuable knowledge and expertise home.

This pamphlet looks at four case studies where knowledge nomads play a vital role – Pfizer, the UK India Business Council, the city of Manchester and the chemistry department of Imperial College London – arguing that nomads are essential for science and innovation in the UK and beyond. Scientists have always travelled in search of new collaborations, new possibilities and new ideas. We set out how the UK can recognise and build these connections, attract the best people and encourage UK-born nomads to begin their own journeys.

Natalie Day and Jack Stilgoe are senior researchers at Demos.

ISBN 978-1-906693-08-4 £10

© Demos 2009

