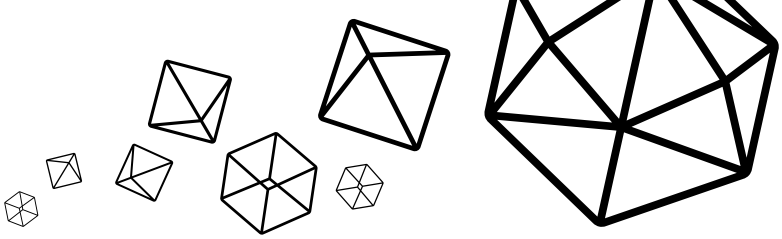
TI/24 / **Published:** May 2008

Policy Briefing



NESTA Making Innovation Flourish

Total Innovation: Harnessing all forms of innovation to maximise competitive advantage

Innovation is about more than product breakthroughs resulting from scientific and technological research. It is as much about new services, business models or organisational forms, and can occur in all sectors of the economy. Many of these activities are 'hidden' in that they are not captured by our traditional innovation indicators, which remain heavily focused on science and technology.

'Total innovation' is what businesses across all sectors of the UK economy do to stay competitive, drawing on both traditional and hidden innovation activities. Intensifying international competition has made total innovation increasingly important, as businesses strive to avoid becoming 'locked-in' to existing technologies and business models.

Policymakers and industry should work together to develop Total Innovation Strategies for the UK's most important industries, informed by new measurements that capture total innovation. Government should ensure that people have the opportunity to develop the capabilities needed for contemporary innovation, including interdisciplinary skills and strategic business expertise.

Innovation is critical to the long-term competitiveness of the UK

Innovation is a major source of competitive advantage

Variations in levels of innovation reflect economic growth and trade performance.[1] New processes, products and services – coupled with expansion into new markets – are critical if UK businesses and organisations are to thrive in a globalised economy; they also create social benefits, by generating wealth and employment.[2]

Innovation is necessary to tackle social and environmental challenges

Many of the most pressing issues facing the UK are defeating conventional approaches to solving them. Climate change, the challenges of an ageing population, security and the rise of obesity and mental health problems amongst the population at large will all require radically new solutions – often combining traditional science-based innovation with social innovation and behaviour change.[3] In the past, NHS Direct and *The Big Issue* have represented breakthrough 'social innovations' that have delivered substantial social and economic benefits to the UK.

Policymakers have identified innovation as a priority area

Innovation has been recognised as a priority across the UK

The last ten years have seen innovation become a high priority for UK policymakers. The UK government identified innovation as one of the five drivers of productivity[4] and "essential to the UK's future economic prosperity".[5]

The Scottish Government has recognised innovation as vital to the long-term competitiveness of the Scottish economy.[6] Northern Ireland and Wales have identified innovation as a central driver of economic and social growth with policies to boost their innovative capabilities.[7]

Policymakers have focused on science and technology

As a consequence, considerable effort has been devoted to developing 'innovation policy'. However, since innovation policy emerged from science policy, following the large-scale 'big science' projects of the mid-20th century,[8] it has tended to build on a similar model and neglect the important differences between different types of innovation. Over time, science and formal Research and Development (R&D) became analogous to innovation.[9]

Over the past three decades, the UK government has introduced a wide range of initiatives to support research in science, engineering and technology (SET).[10] Mechanisms have included support for R&D through tax credits, the promotion of knowledge exchange between academia and businesses through Knowledge Transfer Partnerships (KTPs) and Knowledge Transfer Networks (KTNs), and collaborative technology research programmes. Scotland, Wales, Northern Ireland and the English regions have reflected a similar emphasis on SET, R&D in advanced technologies, and university-business collaborations in their initiatives.

1. Metcalf, J. S. (1998) 'Evolutionary Economics and Creative Destruction.' London: Routledge; Fagerberg, J. (1987) A Technology Gap Approach to Why Growth Rates Differ. 'Research Policy.' 16. pp.87–99; and Fagerberg, J. (2002) 'Technology, Growth and Competitiveness: Selected Essays.' Cheltenham: Edward Elgar.

2. DTI (2003) 'Competing in the Global Economy: The Innovation Challenge.' London: DTI.

3. The Young Foundation (2006) 'Social Silicon Valleys: a Manifesto for Social Innovation.' London: The Young Foundation.

4. HM Treasury has identified five drivers of productivity: investment, innovation, skills, enterprise and competition. HM Treasury (2005) 'Globalisation and the UK – strength and opportunity to meet the economic challenge.' London: HM Treasury.

5. DIUS (2008) 'Innovation Nation.' London: DIUS. p.12.

6. Scottish Executive (2001) 'A Smart, Successful Scotland, Ambitions for the Enterprise Networks.' Edinburgh: Scottish Executive.

7. DETINI (2003) 'think/create/innovate – the Regional Innovation Strategy for Northern Ireland.' Belfast: DETI; Welsh Assembly Government (2006) 'A Science Policy for Wales.' Cardiff: WAG.

8. Hughes, J. (2003) 'The Manhattan Project: Big Science and the Atom Bomb.' Princeton: Princeton University Press.

9. This has been formalised by the codification of the OECD's definition of R&D in the *Frascati Manual*: any project to resolve 'scientific or technological uncertainty.' OECD (2002) 'Frascati Manual 2002 – Proposed Standard Practice for Surveys on Research and Experimental Development.' Paris: OECD.

10. NESTA (2006) 'The Innovation Gap.' London: NESTA.

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However, despite such efforts, the UK's innovation performance appears mixed

Traditional innovation metrics show the UK lagging behind its competitors in innovation performance

Traditional innovation indicators, such as investment in formal R&D or the number of patents registered, suggest that the UK performs poorly and has made little recent progress. The UK's 'R&D intensity'[11] was 1.8 per cent of GDP in 2005, below Japan (3.31 per cent), the United States (2.74 per cent), and France (2.2 per cent).[12] UK businesses consistently spend less on R&D than their US, French and German counterparts, and below the OECD average.[13] Given this, it is no surprise that the UK produces fewer patents.[14]

But all sectors of the economy innovate

Traditional indicators suggest that the UK fails to invest in innovation. Yet, the UK remains one of the world's most successful economies.[15] It is difficult to imagine that the UK economy could be so successful without some strengths in innovation.

The UK's high-technology sectors are highly innovative

Focusing on aggregated figures for national investment in R&D fails to acknowledge the different patterns of specialisation in different countries.

The UK leads the world in some high-technology areas and retains strengths within the six sectors that represent the majority of R&D expenditure in the UK: pharmaceuticals; aerospace; telecommunications; software and IT services; electronics and IT hardware; and automotive. This includes globally-renowned firms such as GlaxoSmithKline (GSK), Rolls-Royce and Vodafone.

Much of this has been achieved by moving to higher-value-added activities in the face of competition from lower-cost countries. But having fewer large technology firms contributes to the UK's comparatively poor showing in aggregated R&D figures.[16] Yet, the UK's pharmaceutical sector's R&D intensity is higher than 15 per cent; only the US and Japan spend more on pharmaceuticals research than the UK. The UK aerospace industry is the second largest in the world, with an R&D intensity of 12.7 per cent.[17]

Traditional metrics under-represent services sector innovations

Traditional innovation indicators also do not reflect the structure of the UK economy, which is dominated by services.[18] NESTA has looked at innovation in those service sectors which typically perform poorly on traditional innovation indicators.[19]

NESTA's research shows that traditional R&D spending is generally less important for services businesses than having highly skilled workers, using ICT and building strong relationships with other businesses (particularly those within the supply chain).[20] Moreover, in some services, innovation is more common than in the manufacturing sector. Average 'product innovation'[21] is more common in research and development services, and computer services, than in manufacturing.[22]

Services also innovate in how they do things. The rate of process innovation[23] is higher in some services than in manufacturing.[24] Computer services, research and development, financial intermediation and business services change their processes regularly.[25]

The public sector also innovates

Although rarely acknowledged, the public sector is also a source of innovation.[26] Some public service innovations evolved well ahead of their equivalents in the private sector. For instance, in the 1960s the UK government created the Open University (OU) using broadcast media.[27] Public sector innovation can take various forms: new organisations (such as Public Private Partnerships), or new ways of rewarding people (such as performance-related pay).[28]

There is a gap between the way innovation happens and the way innovation is measured

Traditional innovation indicators neglect the extent and diversity of innovation activities in the UK, and so produce an unfairly negative analysis as well as being weak measures of an increasingly complex process.

Innovation is often understood as a 'linear process'

The linear process of innovation assumes that innovation begins with scientific discovery and basic research; passes through applied research, engineering, and manufacturing activities; and ends with the production and diffusion of a new product or process.[29] However, innovation is wider than scientific and technological research and does not always move from 'laboratory to market place' within a single business organisation.[30]

Traditional indicators do not reflect the changes in the nature of innovation

Unfortunately, policymakers usually measure innovation using instruments reflecting this 'linear model'.[31] Internationally-agreed innovation indicators such as R&D expenditure, patent production and numbers of science and technology graduates,[32] conceptualise innovation primarily as a new product or process developed through technological advancement. But this is relevant to few innovation activities in the UK.

However, innovation is becoming more complex for businesses of all sizes and all sectors

Innovation is becoming more widely distributed and collaborative. Both at home and abroad, a growing number of businesses are sharing

11. A country's R&D intensity is the total expenditure on R&D as a percentage of its national GDP.
12. OECD (2007) 'OECD Science, Technology and Industry Scoreboard 2007.' Paris: OECD.
13. OECD (2005) 'OECD Science, Technology and Industry Scoreboard 2005, Briefing Note for the United Kingdom.' Paris: OECD.
14. The UK was granted 3 per cent of triadic patent families in 2005, far lower than the US (31 per cent) but also lower than Germany (11.9 per cent) and Japan (28.8 per cent). OECD (2007) 'OECD Science, Technology and Industry Scoreboard 2007.' Paris: OECD.
15. The UK's level of gross domestic product (GDP) per capita is the third highest in the G7. OECD (2007) 'Economic Survey of the United Kingdom 2007: Making the Most of Globalisation.' Paris: OECD.
16. DIUS and BERR (2007) 'The 2007 R&D Scoreboard.' London: DIUS/BERR.
17. NESTA (2008) 'Total Innovation – Why harnessing the hidden innovation in high-technology sectors is crucial to retaining the UK's innovation edge.' London: NESTA. pp.12-13.
18. In 2004, manufacturing accounted for only 14 per cent of UK output. Office for National Statistics (2006) 'United Kingdom Input-Output Analyses.' London: ONS. p.23. In 2002, 40.5 per cent of UK gross value added (GVA) came from knowledge-based activities: 6.2 per cent in high technology manufacturing and 34.3 per cent in knowledge services. HM Treasury (2007) 'The Race to the Top: A Review of Government's Science and Innovation Policies.' London: HM Treasury. pp.16-17.
19. NESTA (2007) 'Hidden Innovation.' London: NESTA; NESTA (2008) 'Taking Services Seriously – How policy can stimulate the 'hidden innovation' in the UK's services economy.' London: NESTA.
20. NESTA (2008) 'Taking Services Seriously – How policy can stimulate the 'hidden innovation' in the UK's services economy.' London: NESTA. pp. 21-24.
21. The Community Innovation Survey 4 defines product innovation as "the market introduction of a new good or service or a significantly improved good or service with respect to its capabilities, such as quality, user friendliness, software or subsystems". See DIUS website.
22. NESTA (2008) 'Taking Services Seriously – How policy can stimulate the 'hidden innovation' in the UK's services economy.' London: NESTA. p.18.
23. The Community Innovation Survey 4 defines process innovation as "the use of new or significantly improved methods for the production or supply of goods and services". See DIUS website.

knowledge with universities, suppliers and small firms, rather than relying on in-house knowledge.[33] As a result, collaboration and networking (often across geographical boundaries) are playing an increasingly central role in innovation processes.[34] This change is reflected in the new innovation strategies being implemented by firms such as GSK[35] or Procter & Gamble.[36]

The innovation that matters in most of the UK economy is 'hidden'

'Hidden innovation' describes those activities not reflected in traditional indicators.[37] Despite sometimes going unmeasured, hidden innovation is often the innovation that matters most to an organisation's bottom line. For instance, it includes new drilling techniques in oil production, back-office technologies in financial services, or more successful programmes for the rehabilitation of offenders.[38]

Detailed analysis reveals four types of hidden innovation[39]

- **Type I hidden innovation** is very similar to traditional innovation but is not included in its measurement. For example, the effective use of new composite materials in Boeing's new aircraft requires learning 'on the job' (not in the lab) about their manufacture. Yet such practical research often lies outside formal R&D processes – particularly in small firms.

- **Type II hidden innovation** happens in non-scientific and technological forms such as new organisational structures and business models. For example, some large pharmaceutical firms have reorganised to reflect the structures of more entrepreneurial small biotechnology firms. GSK has created new semi-autonomous business units called Centres for Excellence in Drug Discovery (CEDDs) to support interaction and reduce bureaucracy so that each unit acts with the flexibility and responsiveness of a smaller biotechnology firm.

- **Type III hidden innovation** comes from the novel combination of existing technologies and processes. Because some of these technologies aren't new-to-the-world, the innovation is excluded from traditional metrics. For example, official definitions of R&D only acknowledge software development that represents a 'scientific and technological advance'. Yet much software development involves the creative use of existing functions and routines to deliver new services.

- **Type IV hidden innovation** takes place 'under the radar' of many surveys. Many small-scale engineering problems and challenges are dealt with outside R&D programmes. For example, the Toyota Production System (TPS) represents a highly successful approach to generating such 'micro-innovations'. TPS organises manufacturing and logistics to eliminate waste and inconsistency in products through an emphasis on continuous improvement, teamwork, and becoming a 'learning organisation'. Through this, Toyota generates one million new ideas each year (3,000 each day).

To different degrees, all sectors draw on both traditional and hidden innovation

Businesses and organisations that depend more on traditional innovation activities also require hidden innovation to remain competitive

These four types of innovation can be seen across high-technology sectors, but in the face of increased globalisation, there is a danger that established UK firms become 'locked-in' to existing technologies and business models. Much traditional R&D slowly augments existing 'platforms' instead of creating radical new designs which would lead to the fundamental changes often needed to meet global competition.[40]

Remaining competitive in the 21st century demands 'total innovation'. By seeking to integrate innovation in new technologies, products and processes (traditional innovation) with innovation in business models, organisational forms and market positioning (hidden innovation), firms create profits and protect their market position. This combination of traditional and hidden innovation is 'total innovation'.[41]

Businesses and organisations more dependent on hidden innovation still use traditional innovation

Total innovation is not the preserve of high-technology manufacturing. Other sectors rely on both traditional and hidden innovation. For instance, the financial services sector spends nearly as much as the manufacturing average on R&D while also investing in new services and organisational forms to respond better to its customers.[42]

The public sector also relies on total innovation. In 2006-07, the NHS spent £659 million on research and development[43] (traditional innovation), but has also developed more than 300 new genetic tests through informal research since the mid-1980s (hidden innovation).[44]

However, UK innovation policy remains focused on traditional innovation activities

Policy has begun to recognise 'hidden innovation'

Innovation Nation – the Department for Innovation, Universities and Skills' (DIUS) White Paper – moves innovation policy somewhat beyond the 'linear model'.[45] In particular, the White Paper highlights hidden innovation and innovation in services.[46]

24. NESTA (2008) 'Taking Services Seriously – How policy can stimulate the 'hidden innovation' in the UK's services economy.' London: NESTA. p. 20.
25. Op cit.
26. NESTA (2007) 'Ready or Not? Taking innovation in the public sector seriously.' London: NESTA.
27. Ibid. p.7.
28. Ibid.
29. Bush, V. (July, 1945) 'Science: The Endless Frontier: A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development.' Washington: United States Government Printing Office.
30. NESTA (2006) 'The Innovation Gap.' London: NESTA.
31. R&D statistics first emerged in the 1930s in countries such as the UK, the US, and Canada, but their subsequent development and adoption internationally owes much to the OECD, in particular the *Frascati Manual* which established a standard methodology for data collection. Godin, B. (2002) The Number Makers: Fifty Years of Official Statistics on Science and Technology. 'Minerva.' 40 (4), pp.375-397.
32. OECD (1997) 'Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data.' Paris: OECD.
33. Chesbrough, H. (2003) 'Open innovation: The New Imperative for Creating and Profiting from Technology.' Cambridge, MA: Harvard Business School Press.
34. Ibid.
35. NESTA (2008) 'Total Innovation – Why harnessing the hidden innovation in high-technology sectors is crucial to retaining the UK's innovation edge.' London: NESTA. Appendix A.
36. NESTA (2007) 'Connect, Collaborate, Innovate.' London: NESTA.
37. NESTA (2007) 'Hidden Innovation.' London: NESTA.
38. Ibid.
39. Ibid.
40. NESTA (2008) 'Total Innovation – Why harnessing the hidden innovation in high-technology sectors is crucial to retaining the UK's innovation edge.' London: NESTA. pp.23-25.
41. Ibid.
42. NESTA (2008) 'Taking Services Seriously – How policy can stimulate the 'hidden innovation' in the UK's services economy.' London: NESTA. p.22.
43. Hansard, 23rd January 2007, Column 1750W.
44. NESTA (2006) 'The Innovation Gap.' London: NESTA. p.24.
45. DIUS (2008) 'Innovation Nation.' London: DIUS.
46. Ibid.

The former Department of Trade and Industry commissioned research on innovation in services; its main successor, the Department for Business, Enterprise and Regulatory Reform (BERR), established the Innovation in Services project in partnership with NESTA to assess the scope for effective government intervention to stimulate and support innovation in services.[47]

'Non-innovation policy' also has an influence on innovation
Four layers of policy impact on innovation – only one of which is generally recognised as 'innovation policy'.[48]

- The first includes traditional innovation policies, but has limited impact on most of the economy because science-based innovation only focuses on a few sectors.
- The second indirectly supports hidden innovation, frequently by establishing or supporting intermediary organisations or networks, such as the Innovation Unit in education.
- The third reflects the way in which government itself can act in more innovative ways, including through new market-based systems of procurement.
- The fourth includes non-innovation policy – such as taxation, regulation, and public sector performance targets – that affect the framework in which innovation occurs.

Policy should promote 'total innovation'

Government and industry should develop Total Innovation Strategies for strategic industries and sectors
The UK should invest in the development of its most important industries and economic sectors, and develop comprehensive strategies for them. Particularly important are the UK's current high-value-added industries and those identified as having realistic potential to become so – our 'innovation edge'. 'Investment' in this context means economic and political commitment to their development.

These strategies should have three main elements. They should chart likely changes in the environment where these industries and sectors operate. Industry and government should then apply this understanding to the UK's current positioning and identify a small number of likely routes to competitive advantage. Finally, these strategies should set out a plan for passive and active government support, ensuring greater co-ordination of policy.

The appropriate departments and agencies – including DIUS, BERR, HM Treasury, the Technology Strategy Board (TSB), devolved administrations and relevant agencies such as regulators and sector skills councils – should work jointly with industry to develop Total Innovation Strategies for each industry.

The changing nature of innovation requires stronger and broader skills
The performance of the UK economy will be undermined if there are not enough people with technical and scientific skills. So we need more teachers who can teach these subjects creatively, more 'enquiry-based learning', and continued improvement in the communication of SET careers to students.[49]

Education and training must also develop the capabilities necessary for contemporary innovation, specifically more interdisciplinary skills and stronger strategic business skills. The new UK Commission for Employment and Skills (UKCES) should build on the work of the sector skills councils to provide government with an industry-based analysis of the extent and quality of 'innovation-ready' skills in the UK. The Commission should also advise on how schools and colleges could do more to develop these skills.[50]

Furthermore, universities and colleges should provide students with greater opportunities to develop interdisciplinary skills and awareness, for example drawing on approaches such as NESTA's Crucible and Universities United initiatives.[51]

Policy should be informed by new measurements that capture total innovation
The extent and importance of hidden innovation in all sectors of the UK economy demonstrates the inadequacy of relying on research-focused indicators alone. This will require a new set of indicators to guide policy.

- First, R&D and other indicators related to research will remain important, but only as part of a broader set of measures, and understood through their relative significance for each sector.
- Second, more indicators need to be developed for forms of hidden innovation such as in services or new organisational forms and business models.
- Third, policy requires more suitable and accurate indicators to assess the strength of business performance in higher-value-added sectors.
- Fourth, there could be greater prominence given to measures of customer satisfaction and how these relate to new products or services.
- Finally, social and environmental performance outputs could be incorporated as measures of innovative performance.

Such measures will be considered as part of NESTA's work on a new Innovation Index for the UK.

47. DTI (2007) 'Innovation in Services.' Occasional Paper no.9. London: DTI.

48. NESTA (2007) 'Hidden Innovation.' London: NESTA. p.21.

49. For example, in England, the government has recognised the importance of improving science education. DCSF Press Release (24 January 2008) '£140m boost to science and maths teaching in schools.' See also NESTA (2005) 'Real Science, Encouraging Experimentation and Investigation in School Science Learning.' London: NESTA; and NESTA (2007) 'Science: An Engine of Innovation.' London: NESTA.

50. The UKCES is intended to play a critical part in securing a highly skilled, productive workforce and increasing employment levels, particularly for those from disadvantaged backgrounds. It will: advise government on strategy and policies relating to employment and skills; assess progress towards achieving national employment and skills ambitions for 2020; and have responsibility for the performance of sector skills councils, advising government on re-licensing. See UKCES website.

51. Crucible offers early-career researchers in science, technology, engineering and social sciences an opportunity to develop new collaborations across disciplines; Universities United is a pilot project to test an interdisciplinary approach to innovation with a particular focus in developing innovations for social benefit. See NESTA website.