Industrial Strategy Green Paper 2017
Nesta formal submission

Introduction

- Since our establishment, Nesta has been researching how innovation contributes to economic growth and can help to solve the big challenges of our time. Much of the debate is over the role that governments can play in this, and there has not always been a receptive audience in the UK government for these ideas - nor, indeed, universal acceptance that government needs an industrial strategy at all. The launch of the Industrial Strategy Green Paper indicates that we now have a government that have, at a high-level, taken innovation and industrial strategy seriously.

- In general we think the Green Paper published on 17 January 2017 is a good policy document, and a promising start on developing a 21st Century industrial Strategy for the UK. It is comprehensive in covering the areas of policy that affect innovation and business competitiveness. It proposes policy solutions, but also recognises past successes and flaws, and asks for more input and questions.

- Any substantive policy document of this sort will be the result of compromise. However, we feel that there are a few areas where more could be done. The publication of the green paper was just the start of this process. Now that the Government has set out its intentions, the next six months will be crucial in getting the detail right. These are our thoughts on each of the 'pillars' within the green paper with areas we think that need further work (some of them acknowledged as work in progress in the document itself), alongside references to relevant Nesta research and policy ideas.

1. Investing in science, research and innovation

1.1. The green paper rightly acknowledges that much is going right in UK innovation. We perform very well in international rankings – such as the INSEAD Global Innovation Index[1], where we are ranked third. Innovate UK is becoming more streamlined and customer-focused. There are good incentives for venture capital, a generous system of tax credits for R&D and, not least, a world-leading research base. We have strong

[1] The Global Innovation Index 2016, Winning with Global Innovation [Available at: https://www.globalinnovationindex.org/gii-2016-report]

clusters of fast-growing, innovative companies across the country, and a regulatory environment that is favourable to business investment. One consequence of this is relatively high intangible investment (a proxy for innovation across the economy, especially in services).

1.2. But the UK also faces many challenges: low business R&D leading to low GERD, relative to other countries, even when we adjust for the sectoral structure of the UK economy. We lack large systems-integrator companies that both innovate themselves and encourage innovation in their supply chain. We do little with some policy levers, including government procurement and regulation, to encourage disruptive innovation. Our capital markets do not support the long-term growth of innovative companies, and our venture capital sector, while good by international standards, is some way off that of the US or Israel. Parts of the UK have very low R&D, and a disproportionate clustering of publicly-funded R&D in a few parts of the country (in particular London and Scotland).

1.3. We welcome the consultation on how to prioritise spending the additional £4.7bn of Research & Development funding. It will be important that a significant amount of this additional cash goes towards helping businesses to be more innovative, channeled through Innovate UK for concentrated impact.

1.4. It was encouraging to see a definition of innovation is beyond science and technology, and research commercialisation. To generate broad growth, we need to support both emerging industries and existing companies. Indeed, only 3 per cent of innovative British companies cite universities as a source of innovation[2].

1.5. Current official definitions of R&D used by governments worldwide exclude the arts, humanities and social sciences. Consequently, much R&D in the creative industries – which is reliant on the arts, humanities and social sciences – is not recognised and does not qualify for targeted R&D support[3]. As the Government seeks to increase its R&D investment through measures like the new Industrial Strategy Challenge Fund, new Innovate UK programmes and R&D tax relief, it should ensure its R&D definitions do not neglect the very areas where the UK has international strengths, like the creative industries.

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[2] Community innovation survey 2016 [Available at: https://www.gov.uk/government/collections/community-innovation-survey#documents]

[3] R&D in the creative industries [Available at: http://www.nesta.org.uk/blog/rd-creative-industries]

Industrial Strategy Challenge Fund

1.6. The creation of the new Industrial Strategy Challenge Fund (ICSF) offers a huge opportunity to fund innovation differently. But the Government must be decisive early on in the fund design process as to how the ISCF is used. Ambitions must be set high by adopting a truly challenge-led approach to support the development of technologies and industries in which the UK could become a world-leader - like tidal power, for example - at a time when it needs it most. Importantly, it should stimulate innovation from the more unusual quarters of our society and economy, as well as from the usual suspects.

1.7. Nesta would like to see up to 10 per cent of the Industrial Strategy Challenge Fund earmarked for open innovation and challenges. Only a tiny fraction of the UK's R&D spending is allocated using open innovation methods. We cannot define technologies before they are invented, but we can define what we want them to do, and the problems they need to solve.

Commercialisation and IP

1.8. Intellectual property is an important enabler of innovation. Design rights, patents and other IPR encourage innovators to invest their resources, by offering some security that they - rather than imitators who have borne little risk - will garner the benefits. The fact that these rights can be transferred, through licensing or assignment, also means that the processes of creation and invention may be separated from the processes of exploitation, so enabling a division of labour which is potentially beneficial. For instance, many universities and research institutions are engines of IP creation but often not well established to exploit all the inventions that arise. Conversely, industry may be better positioned to exploit specific ideas but not as well equipped to undertake the initial research.

1.9. There is much discussion about the effectiveness and suitability of the existing system of university technology transfer offices (TTOs), and whether these perform as effectively in the UK as in the US. This is a complex issue, complicated by significant differences in the maturity of TTOs, university policies, size of national markets and richness of surrounding startup ecosystems - all of which make direct comparison difficult.

1.10. One way to begin to address the issues surrounding IP from universities is with better information and improved information flow. Invariably, better information enables better markets, and standards for communicating that information digitally make the processes of gathering and disseminating much easier. For instance, a more uniform way of describing licensable inventions (not only a core patent, if any, but the associated know-how plus technology readiness level, and so on) and harvesting that information digitally, could enable more rapid dissemination and significantly reduced search costs.

1.11. Of course, IP does not just come from academic sources. Encouraging recognition of innovation investment by financial markets (see section 6), would make it more likely that businesses will invest in IP assets.

Better use of data for innovation policy

1.12. Industrial policymakers and researchers have become increasingly frustrated with traditional data sources when it comes to measuring, analysing and informing policies to support new and innovative sectors. Such datasets, which include business surveys, R&D spending and volumes of scientific and technological outputs, such as academic publications and patents:

- are ill-suited for the analysis of businesses and jobs in new industries;
- fail to capture networks of collaboration which we know are critical for innovative success;
- may involve substantial time lags between data collection and publication, making it hard to capture real time development of emerging clusters and industries;
- anonymise business information in a way that makes it hard to target interventions and match data across sources (e.g. in order to analyse the impact of a policy intervention on a given business).

1.13. Policymakers have had little reliable information about the performance of sectors, different technologies, or the economies of local areas. This makes it hard to decide where and how to invest, or for decision-makers to have confidence in investment decisions; it also makes it hard to keep an eye on how policies are working. In the absence of timely, relevant data, inertia wins the day: investment happens in the south east, we fail to focus our resources on promising industries or technologies, potentially damaging acquisitions are waved through with no challenge.

1.14. The data revolution is creating new opportunities to address some of these challenges. We can use social media data to map innovation networks, and public and open datasets to obtain a more comprehensive view of local innovation systems and the businesses that operate in them.

1.15. Nesta has for the last three years been building tools to analyse industrial and innovation ecosystems, understand the relative performance of different technologies, and map sectors and clusters; we are currently working with the Welsh government to build a tool to help shape industrial strategy in Wales[4]. In this, we have worked with leading start-ups and researchers to build data sources on the economy that would have been impossible or prohibitively expensive five years ago.

1.16. Nesta would like to see the UK Government investing in and using these techniques and data sources to build a much more nuanced picture of where innovation is happening, throughout the UK, identifying where support for innovation is really needed and then tailoring policy accordingly.

Building capability for developing innovation policy

1.17. The context in which innovation policy is being made is changing quickly. Our societies and economies have become increasingly complex, as have the challenges that we look to solve through innovation (for example, around creating new and sustainable sources of economic growth, or responding to the complex health and care needs of aging societies). These broad challenges can rarely, if ever, be addressed by one department acting on its own or by groups of people with one specific skillset - a much more open and distributed approach is required, involving collaboration and learning across and outside government, and with international partners.

1.18. Governments and innovation agencies are only just starting to think about what these developments mean in terms of the way they structure themselves, the way they design and execute policy and, crucially, the people they recruit and collaborate with to achieve their objectives. While there has been some research on approaches to

[4] Arloesiadur: An innovation dashboard for Wales [Learn more at: http://www.nesta.org.uk/project/arloesiadur-innovation-dashboard-wales]

managing research and innovation[5], this has tended to be either quite technical - focused on management systems - or fairly general - focused on best practice principles, but without much consideration of the messy day-to-day reality of making innovation policy and the skills required to navigate politics, budget constraints, evidence limitations and the challenges of collaboration.

1.19. Effective delivery of this industrial strategy will depend on capable, experienced people both within and outside government. Germany's industrial strategy depends on sophisticated and well-established industry bodies and local government to help shape strategy. France has built a cadre of officials with experience of business, technology and investment. And perhaps unsurprisingly, Britain has developed strong policy expertise in dealing with the financial services sector, including high quality officials who have spent time both in government and in the sector itself.

1.20. The Government should set out now to build a cohort of policymakers who can help shape industrial strategy, for example in the establishment of the new UKRI. Training programmes like the Global Innovation Policy Accelerator,[6] run by Nesta with the Universities of Manchester, Oxford and Cambridge offer a good model to follow.

Creating the right institutional setup for innovation policy

1.21. It is very hard to predict which technologies, sectors and businesses are going to grow, but the Government already has functions that should allow it to identify and focus on the right technologies at the right time. The integration of Innovate UK into UKRI is an opportunity to concentrate governmental skills and expertise in one place. This could reduce duplication, improve capacity to develop specialist knowledge, and create the opportunity for more rapid responses. As Innovate UK shifts to focus on delivering responsive programmes for business innovation, its more strategic functions such as emerging technology analysis could be placed alongside other existing innovation analysis and horizon scanning functions to create a smarter

[5] Effectiveness of research and innovation management at policy and institutional levels [Available at: https://www.oecd.org/sti/Effectiveness%20of%20research%20and%20innovation%20management%20at%20policy%20and%20institutional%20levels_Meek%20and%20Olsson.pdf]

[6] Global Innovation Policy Accelerator [Learn more at: http://www.nesta.org.uk/project/global-innovation-policy-accelerator]
Global Innovation Policy Accelerator, Final Conference [Available at: http://www.nesta.org.uk/blog/global-innovation-policy-accelerator-final-conference]

centre. Some of the distributed functions could come from existing projects and teams in Government.

This 'smart centre'[7] would:

- Systematically assess new areas of technology development
- Create new (and use existing) networks of external experts (e.g. those within GO Science) Identify areas for priority innovation investments across Government (this might include new Innovate UK platforms, and new Catalyst programmes).

In some fields the centre would then recommend adjusted spending priorities, or new areas for exploration. In fields where there are major opportunities around disruptive business models it could work with people from the emerging sector to identify regulatory obstacles, how well existing public support interacts with disruptive firms, and what public benefit might arise from the innovation (see 1.24). In fields where government can itself pioneer new approaches it could commission much more dynamic and entrepreneurial teams, building on examples like Genomics England, or India's UID project, which largely bypass existing bureaucratic structures.

Regulation

1.22. In many fields of technology, market mechanisms work well with little role for government. But in a few of the really important fields of technology development, the ability of government to shape regulation and policy around emerging innovations can make a decisive difference. These fields include transport, energy and healthcare - all areas where government is a significant actor, funding research and innovation, and where long-term planning is needed. There are immediate opportunities in areas from driverless cars to personal health data where greater co-ordination and clear strategy could help the UK to become a leading centre for new approaches and new businesses.

1.23. A key challenge of radical innovation is that existing systems are not designed to take account of it. Regulation will sometimes ban an innovation completely (equity crowdfunding in Germany, for example), or in other cases leave it utterly unregulated in a way that creates uncertainty for customers (for example, any number of health

[7] How to make a 'strategic brain' for innovation policy [Available at: http://www.nesta.org.uk/blog/how-make-strategic-brain-innovation-policy]

apps). Where public funding is at stake, they may fall between funding streams. Or they may sit awkwardly between different professional organisations or cultures.

1.24. The system can get in the way of more radical change, whether by not being permissive enough, or by being too unstructured (since most innovations depend on a host of social conditions to flourish) – or sometimes both. The government has an important role to play, since it sets some of these rules directly, through regulation and policy, and can affect others indirectly.

1.25. Nests has proposed a Dynamic Entrepreneurial Market Initiative (DEMI)[8] - a process for quickly reviewing and responding to potential sources of disruptive change, and identifying the changes needed in the system.

1.26. For each technology or challenge, a minister with some responsibility for the area would take responsibility for making the country the best place in the world to do business in that emerging sector. The minister would then set up a light-touch review, bringing together people from the emerging sector to identify regulatory obstacles, how well existing public support interacts with disruptive firms, and what public benefit might arise from the innovation. This will require judgment – the government will need to differentiate between proposals that legitimately improve market access and those that represent special pleading by the new entrants. There are already examples of initiatives that have demonstrated this type of approach. The Sharing Economy review played an important role in improving UK government policy on the collaborative economy. HM Treasury and increasingly the FCA have made serious efforts to help the growth of the Alternative Finance sector (peer-to-peer lending and crowdfunding).

1.27. We will also need careful consideration of the wider, and long-term impact for society. For example, in the fast growing field of algorithmic decision making, Nesta has suggested the establishment of a Machine Intelligence Commission[9]; a public institution with the purpose of representing the public interest in the development of "new generations of algorithms, machines learning tools and uses of big data". The Machine Intelligence Commission would have powers of

[8] DEMI: a small policy initiative to encourage disruptive innovation [Available at: http://www.nesta.org.uk/blog/demi-small-policy-encourage-disruptive-innovation]
[9] A machine intelligence commission for the UK [Available at: http://www.nesta.org.uk/blog/machine-intelligence-commission-uk]

investigation and recommendation rather than regulation; thus would manage key stakeholder relationships between companies, regulators and the public.

1.28. UK Regulators are already looking at new ways of working, for example FCA's Project Innovate[10], where the regulator is working to support businesses in bringing innovative financial products and services to the market. Another example is Ofcom's reservation of specific radio-spectrum bands for experimental use. We would encourage regulators to expand and embed these more agile approaches.

2. Developing skills

2.1. We welcome the long overdue recognition that skills development is as important to growth as infrastructure, investment and trade.

2.2. The Green Paper contains a welcome pledge for investment in technical and STEM skills - a critical part of the UK skills pipeline[11]. This is an area of policy that has been neglected for some time, falling outside the science ringfence, and receiving the brunt of previous round of BIS departmental budget cuts. However, this investment needs to be in the context of a strategy that should be looking at not just industries but jobs and skills for the future[12].

Moving beyond automation: Employment in 2030

2.3. Predicting future jobs and skills demand over a fifteen-year horizon is a daunting task. Think of the controversies that have arisen just around the effects of widespread automation, with estimates of the share of the US workforce at high risk ranging from 47 per cent in Michael Osborne's 2013 study with Carl Benedikt Frey[13] to 9 per cent in the case

[10] Learn more at https://www.fca.org.uk/firms/innovate-innovation-hub
[11] UKCES Employer Skills Survey 2015: UK report [Available at: https://www.gov.uk/government/publications/ukces-employer-skills-survey-2015-uk-report]
[12] Employment in 2030: skills, competencies and the implications for learning [Available at: http://www.nesta.org.uk/blog/employment-2030-skills-competencies-and-implications-learning#sthash.mTnwqhem.dpuf]
[13] The Future of Employment: How Susceptible Are Jobs to Computerisation? [Available at: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf]

of a recent OECD study[14]. In our forthcoming research, Employment in 2030, we are taking a more comprehensive look at the drivers of jobs, including technological progress beyond computerisation, socio-demographic change and the turn towards more flexible and remote working practices. We will tease out how these drivers interact with each other when assessing their labour market impacts.

2.4. By combining historical analysis, qualitative foresight and quantitative machine learning techniques in this novel way, we hope to present more accurate predictions about future jobs and skills demand than would be the case if we relied on any one of the approaches alone.

2.5. The implications of this research for education are clear. Consider one popular estimate [15]that 65 per cent of children entering primary school in 2016 will by the time they are economically active (in 15 or so years) work in completely new jobs that do not exist today. This makes it all the more important that we set learning priorities for young people today that are grounded in a rigorous assessment of what skills will be required of them when they enter the workforce.

2.6. As well as developing a better understanding of changing skills needs over time, we need better information on local labour markets and the variation of skills needs in different places, to develop talent pipelines for more equitable, UK wide growth. As such, putting the issue of lifelong learning back on the agenda is a welcome development. UK public funding for adult education has fallen over a third since 2010[16] and historically, employers have under invested in skills development, particularly for lower skilled workers. By supporting employers to innovate in the delivery of adult education and professional development, government will ensure that the benefits of better employment are shared, and that the UK is able to adapt to the changing skills needs of the future.

<u>The impact of automation on UK jobs</u>

[14] Automation and Independent Work in a Digital Economy [Available at: http://www.oecd.org/employment/Policy%20brief%20-%20Automation%20and%20Independent%20Work%20in%20a%20Digital%20Economy.pdf]
[15] 10 jobs that didn't exist 10 years ago [Available at: https://www.weforum.org/agenda/2016/06/10-jobs-that-didn-t-exist-10-years-ago/]
[16] Government cuts could 'decimate' adult education by 2020, AoC warns [Available at: http://feweek.co.uk/2015/03/25/government-cuts-could-decimate-adult-education-by-2020-aoc-warns/]

2.7. Nesta research shows that creative jobs will be at much less risk of automation[17] in the future than other UK jobs. Government should therefore prioritise support for the creative economy[18], and reassess the role of creative and arts education alongside technical and science disciplines.

2.8. Nesta's Creativity vs. Robots[19] finds that 21 per cent of US employment is highly creative – that is, has a probability of more than 70 per cent of being creative. These creative occupations include artists, architects, web designers, IT specialists and public relations professionals.

2.9. Relative to the United States, the UK has a higher fraction of creative employment, constituting around 24 per cent of the workforce - this suggests that the UK is in a globally strong position when it comes to creative talent, reflected in the exceptional growth rates of the sector, as previously discussed.

2.10. The results strongly support the intuition that creative occupations are more future–proof to technologies like machine learning and mobile robotics. Given the broad concept of creativity adopted in the analysis, our estimates of creative employment are, as expected, bigger than official estimates. In the US, 86 per cent of workers in the highly creative category are found to be at low or no risk of automation. In the UK, the equivalent number is 87 per cent. Economies like the UK and US where creative occupations make up a large proportion of the workforce may be better placed than others to resist the employment fallouts from future advances in computerisation. Again, this suggests that the government should continue to support skills development throughout the talent pipeline, to ensure that workers have the skills they need to thrive in a labour market that will be increasingly influenced by technological advances and automation.

2.11. At the regional level, we see that places with a higher proportion of the workforce in creative jobs, most obviously London, are also more immune to automation. The Geography of Creativity in the UK[20] uses the latest data and official definitions to map the creative industries in

[17] Creativity vs. Robots: The creative economy and the future of employment. [Available at: http://www.nesta.org.uk/publications/creativity-vs-robots]
[18] The creative economy and the future of employment. [Available at: http://www.nesta.org.uk/publications/creative-economy-and-future-employment]
[19] Creativity vs. Robots: The creative economy and the future of employment.
[20] The Geography of Creativity in the UK: Creative clusters, creative people and creative networks. [Available at: http://www.nesta.org.uk/publications/geography-creativity-uk]

the UK. The objective of this research is to provide a data resource to demonstrate the economic significance of the creative industries across the country, and inform policies to strengthen them further.

2.12. We found that the creative industries are becoming more important in local economies across the UK. Between 2007 and 2014 they became more important in local business population in 9 out of every 10 locations. We identified 47 creative clusters across the UK. London and the South East are important components of the UK creative industries, but so are the North, Scotland, Wales and Northern Ireland. These clusters grew their creative employment by 28% between 2007 and 2014.

2.13. The UK's geography of creativity isn't only about 'hip creative cities'. We have also identified clusters in creative conurbations across the country. Creative communities in different parts of the country are working together across cluster and administrative boundaries. The geography of the UK creative industries is an interconnected system.

2.14. By understanding local industrial composition and the skills required for creative jobs, government can support the development of creative clusters outside London and the South East.

Securing the right skills for the data driven economy

2.15. Nesta welcomes the government's recognition, particularly the Digital Strategy, of the importance of data skills and we will be working with the Data Skills Taskforce to implement recommendations in Analytic Britain, a joint Nesta and Universities UK report.

2.16. We know that data is transforming the economy, increasing efficiency and creating new opportunities for innovation. We are constantly generating data, from changes in how we shop, communicate and meet, to the clothes we wear and the gadgets we use, and businesses and government are becoming more adept at creating value from this.

2.17. The UK is particularly well–placed to benefit.[21] But if data is the new oil, logically, it won't be useful to business until refined. That requires analytical skills - which the UK is currently lacking.

[21] The Connected Kingdom: How the Internet Is Transforming the UK Economy.' [Available at: http://www.bcg.com/documents/file62983.pdf]

2.18. That much has been made clear in recent years by an extensive body of independent research by Nesta into the experience of the 'datavores' – those businesses that make heavy use of data for driving their business decisions – as well as the work of academics and other public bodies like the Tech Partnership.[22] Such research shows a strong link between data, business innovation and productivity. Nesta's recent report, *Skills of the Datavores*, finds that data–driven companies are over 10 per cent more productive than 'dataphobes' – firms that don't exploit their data – controlling for other determinants of productivity.

2.19. However, the data–driven companies we have surveyed are struggling to find suitable talent. Two–thirds of datavores who tried to recruit analysts in the previous 12 months struggled to fill at least one vacancy. A recent employers survey by the Tech Partnership shows that big data analytics is the tech occupation with the biggest skills gaps.[23] While data may be part of the answer to the UK's productivity gap with other countries, it appears that barriers to accessing analytical talent are preventing businesses from fully harnessing its potential. By and large, the problem is finding people with the right *mix* of skills: the data scientists who combine technical skills, analytical and industry knowledge, and the business sense and soft skills to turn data into value for employers are very hard to find – so much so that some people refer to them as 'unicorns'.[24]

2.20. In *Skills of the Datavores*[25], we also found that there isn't a one-size fit all to creating value from data. Our research reveals three types of 'Data active' businesses: Datavores who base their decisions on data and analysis, Data Builders working with big datasets, and Data Mixers

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[22] Rise of the Datavores: how UK businesses can benefit from their data [Available at: http://www.nesta.org.uk/publications/rise-datavores-how-uk-businesses-can-benefit-their-data]
Inside The Datavores, How data and online analytics affect business performance [Available at: http://www.nesta.org.uk/sites/default/files/inside_the_datavores_briefing.pdf]
Model Workers: How leading companies are recruiting and managing data talent [Available at: http://www.nesta.org.uk/publications/model-workers-how-leading-companies-are-recruiting-and-managing-data-talent]
The Tech Partnership big data analytics reports [see for example: https://www.thetechpartnership.com/globalassets/pdfs/research-2014/bigdata_report_nov14.pdf]
[23] The Tech Partnership - Employer Insights: skills survey 2015 [Available at: https://www.thetechpartnership.com/globalassets/pdfs/research-2015/tec_employer_skill_survey_web.pdf]
[24] Data scientists: 'As rare as unicorns' [Available at: https://www.theguardian.com/media-network/2015/feb/12/data-scientists-as-rare-as-unicorns]
[25] Skills of the Datavores: Talent and the Data revolution 2015 [Available at: https://www.nesta.org.uk/sites/default/files/skills_of_the_datavores.pdf]

who combine data from different sources. We also find 30% of 'Dataphobe' businesses who seem to have given the data revolution a pass - these companies tend to work with few, small datasets, and rarely use analysis to make decisions. We find all Data Groups present in all industries, consistent with the idea that data analytics has features of a General Purpose Technology, in that it drives innovation and growth in many different sectors.

2.21. Data-active companies are recruiting more analysts, and combining more disciplines to build a data science capability. But this isn't proving easy, for instance, two thirds of Datavores struggled to fill at least one vacancy. 80% of them identified problems in at least one skills area. Data-active companies are particularly concerned about the lack of domain knowledge in analysts, the lack of people with the right mix of skills and the lack of experienced analysts. Technology is changing fast in the data space, so as well as recruiting, employers are keeping the skills of their data analysts fresh through a variety of approaches. 80% do internal training. Significant proportions (between a third and two thirds) are using innovative training methods like data competitions, online courses and meetups. But only a fifth use universities to train their staff.

2.22. In the absence of such unicorns, businesses are building their analytical capability through multidisciplinary teams. Members of a team may have a number of core skills in common, and individuals will have specialist skills developed within particular disciplines. This underscores the need not just for multidisciplinary working, but for data analysts with strong teamwork and communication skills.

2.23. The stakes for the UK economy cannot be understated. If, for example, in our sample of firms all the Dataphobes were to behave like Datavores, our results suggest this would be associated with an overall 3 per cent uplift in productivity. To put this into context, at the macroeconomic level a 3 per cent uplift could, according to OECD statistics,[26] represent roughly one-fifth of the UK's productivity gap with the rest of the G7.

2.24. In recognition of this skills shortage, Universities UK has undertaken research into how data skills are taught in undergraduate degrees across subject areas. We find that training in data analytics is found in

[26] This estimate is based on http://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV

most STEM and social science courses, but the extent of provision varies by institution and degree subject. To meet the current and future needs of the UK economy, we must do more to embed data skills as a core component of more degree programmes.

2.25. The data revolution has implications not only for experts with advanced analytical skills (i.e. data scientists), but for the entire workforce. We all need to become more data literate to operate successfully in increasingly 'data–rich' environments. This is a key lesson from *Count Us In*, the British Academy's review of the UK landscape for quantitative skills.[27] Our recommendations reflect the diversity of analytical skills levels which are needed, and also suggest creating early 'touch points' between young people and data, acknowledging that in some cases these will mark the beginning of a life–long analytical career, while in others it will involve raising awareness and confidence in using data, whatever the occupation.

2.26. Regarding the overall scope of our recommendations, our assessment of the current situation in the analytical talent pipeline is broadly optimistic. The data revolution has created analytical skills shortages, which are being particularly felt by those companies that are most innovative with their data, but there is a rapidly increasing awareness of those issues, and a willingness by educators and the government to act upon them. Much good work is already taking place in schools, universities and skills development agencies. The challenge therefore is to step up significantly the response so that it is commensurate with the scale of the opportunities.

Understanding skills needs of the Creative Industries

2.27. As part of the Industrial Strategy, the creative industries are one of five sectors that have been invited to reach a sector deal with the Government. This deal will require the creative industries to show how they plan to harness each of the ten pillars to boost productivity and enhance competitiveness. In singling out the creative industries, the Government clearly recognises their importance to the UK economy.

[27] Count Us In: Quantitative skills for a new generation, 2015 [Available at: http://www.britac.ac.uk/policy/count_us_in_report.cfm?frmAlias=/countusin/]

Between 2011 and 2015, employment in the creative industries grew by 19.5%[28], compared to growth of just 6.3% in the wider UK economy.

2.28. Understanding creative talent has become even more pressing in light of the UK's decision to leave the European Union. Many creative sub-sectors rely on non-UK talent to fill skill shortages. In 2015, approximately 5.5% of workers in IT, software and computer services were from EU nations and 8.4% from outside of Europe. For Publishing, 9.5% of the workforce is from Europe, while 4% is made up of non-European talent.[29]

2.29. The creative industries employ individuals in an enormous range of creative occupations, from software developers to museum curators. As such, the skills needs of creative talent varies considerably.

2.30. This is evidenced in our interactive data visualisation, which explores the skills needs of creatives[30]. This research aims to identify the skills used by workers in creative occupations. The focus is on workers in creative occupations, as opposed to workers in creative industries. The latter includes non-creative jobs (e.g. accountants working for museums). The former includes creatives who work in non-creative industries (e.g. graphic designers working for accountancy firms).

2.31. Thousands of skills were extracted from online job advertisements provided by Burning Glass Ltd. These skills were grouped into clusters using a community detection algorithm. The five key skill clusters are Support skills, Creating & design skills, Tech skills, Marketing skills and Support skills.

The economic returns to combining arts and science skills

2.32. Nesta research has shown that firms that combine arts and science skills outperform those that use one or the other, on many measures[31].

[28]Creative Industries: Focus on Employment [Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/534305/Focus_on_Employment_revised_040716.pdf]
[29] Skilled migration and the UK's Creative Industries. [Available at: http://www.nesta.org.uk/sites/default/files/skilled_migration_and_the_uks_creative_industries.pdf]
[30] A closer look at Creatives [Available at: http://data-viz.nesta.org.uk/creative-skills/index.html]
[31] The Fusion Effect: The economic returns to combining arts and science skills. [Available at: http://www.nesta.org.uk/publications/fusion-effect-economic-returns-combining-arts-and-science-skills]

2.33. The ability of UK firms to access skills for growth has long been a national policy priority. While the importance of skills is widely studied in terms of the relationship between human capital, skills and performance, there is rather less work considering the combinations of skills used by firms and their implications for firm performance. Our research aims to address this by considering the relationship between science and arts skills and firm performance.

2.34. Research in a number of fields has highlighted the benefits of different disciplinary, intellectual and personal backgrounds within groups on creativity at the personal, group and organisation level.7 This literature suggests that working with people from different backgrounds provides a range of distinct perspectives that broadens search, provides better identification of opportunities and gives unique ways of taking advantage of these opportunities.

2.35. We explored the performance implications of the combination of STEM and arts skills to measure the impact of these combined skills on firm growth and innovation performance throughout the economy. In doing this, we expand on previous findings from the Brighton Fuse project, extending and further exploring these findings using representative, official data covering a representative sample of UK firms with more than ten employees.

2.36. Our main research question therefore asked whether the combination of arts and science skills produces performance dividends in terms of growth and innovation. In doing so our aim was to explicitly identify the contribution of 'fused' firms to the economy and to generate evidence on their economic performance. While previous studies have highlighted effects at the cluster level, ours is the first to generate evidence of an arts and science 'fusion' effect at the national level.

2.37. This report highlighted important outcomes from the fusion of STEM and art skills in UK businesses:

- We estimate that these organisations employed over 3.5 million people and generated £500 billion turnover in 2011.
- Although STEAM firms only make up 11 per cent of the population of non-micro firms, we estimate that they generate 22 per cent of employment and 22 per cent of turnover.
- While fused firms are widely perceived to be present in 'high-tech' and creative industries, we find them to be common in 'low-tech' and 'mid-tech' industries too.

2.38. We find that firms combining arts and science skills, other things being equal, outperform those firms that utilise only arts skills or science skills:

- They show 6 per cent higher employment growth and 8 per cent higher sales growth than other firms.
- They are 3 per cent more likely to bring radical innovations to market.
- They are 10 per cent more productive than the average firm, though they are somewhat less productive than science skills-only firms.
- These positive effects hold across the entire economy, and are particularly strong for smaller firms.
- There is evidence that the broader the set of skills a firm uses, the higher its level of innovative performance and future growth.

3. Upgrading infrastructure

3.1. In recent years, the government has made good progress in the area of infrastructure and its potential to enable technological development and innovation. However, there are still a number of improvements that can be made, and we believe the UK needs a flexible and responsive system to enhance infrastructure investment decisions.

3.2. We note that, despite a generally higher levels of digitisation, the UK still does not compare favourably with European neighbours on many measures of broadband speed and availability. We should be ready to support ultrafast roll out that reaches speeds beyond hundreds of megabits, and into the tens of gigabits, that are already being tentatively rolled out across the UK by innovative commercial providers.

3.3. Following the example of driverless cars, one method of further developing new technologies and testing how they interact with the wider world is to set up test-beds in localised areas.

4. Supporting businesses to start and grow

Patient Capital Review

4.1. The Patient Capital Review announced in the green paper is a welcome start on addressing one of the critical barriers to firm growth

in the UK. Innovation often requires investment and our capital markets do not support the long-term growth of innovative companies, both during startup and when they are established.

4.2. Crucial here is the recognition of intangible versus tangible assets, as evidenced in Nesta's Innovation Index. Banks need to change their financing and lending policies to enable lending against intangible assets, many of which can now be valued since they are traded on open markets.

4.3. In a modern globalized economy with much investment being in intangible assets, promoting more investment will need the following:

- Stability in the policy environment so entrepreneurs can take risks
- The cost of capital needs to be competitive. For this to happen the banking system has to be functional and tax rates on capital have to be internationally competitive
- Exit from a failed business must not be too expensive. If entrepreneurs are going to undertake investment in a risky environment, at least some of it will be a failure. Locking-in investors with costly labour contracts will reduce investment
- Particular attention needs to be paid to the credit needs of small businesses with rapid growth and innovation potential
- There is good evidence that at least some public investment "crowds in" private investment. Such public investment includes spending on the public science base and also on basic education, which in turn crowds in training by firms.

4.4. Working with the ACCA, the Government of Malaysia, and businesses in the UK and Malaysia, Nesta has designed a tool to allow public companies to report innovation investments in a fair and comparable way[32].

4.5. Nesta has previously proposed some ideas about how to tackle short-termism in financial markets:

- Work with LSE and European VCs to establish new board or market for innovation friendly companies with reporting of rigorous innovation metrics and (possibly) longer holding periods
- Launch campaign of institutional investors to encourage long-term decision-making and reporting of innovation metrics.

[32] Why the PM should put innovation collaboration at the core of his strategy for the ASEAN region - and 3 ways he can do it [Available at: http://www.nesta.org.uk/blog/why-pm-should-put-innovation-collaboration-core-his-strategy-asean-region-and-3-ways-he-can-do-it]

- Speed up HM Treasury's analysis of the case for a move to equalise the tax treatment of debt and equity.

4.6. The green paper also alludes to whether this issue is being propagated through institutional behavioural patterns. There are some potential solutions to this:

- Influential institutional equity investors should publicly pressure the boards of quoted companies to adopt a more long-termist outlook and invest appropriately in innovation
- An explicit endorsement for this by specific fund managers and a system of remedies if companies feel pressure to behave in any other fashion.
- The message about long termist behaviour to be further broadcast by influential bodies such as IA, Investor Forum, NAPF, and AMNT.

Entrepreneurship Review

4.7. We also welcome the review of entrepreneurship policy and look forward to working with Tim Dafforn on how the government can support UK businesses to startup and scale. In our view, it is necessary to focus on both the starting and scaling of firms: without a suitable pipeline of new startups, it will be difficult to produce a number of quality 'scale-ups'. Nesta's previous research on this includes suggestions of how policymakers can support digital entrepreneurs (particularly at a local level - see section 10 for more detail) and how corporates can better collaborate with startups to help them scale[33].

4.8. On the matter of promoting corporate-startup collaboration, Nesta believes that this has significant potential for mutual benefit, offering, on the one hand, a mechanism for large companies to innovate (e.g. developing new products or refreshing their internal culture), and on the other hand, providing important resources for startups (e.g. industry insight, routes to market, technical knowledge or investment). Nesta has previously proposed ideas of how to promote this, including:

- Promoting model agreement templates, potentially based on the Lambert Toolkit. (We note and welcome the suggestion of business-to-business model agreements to support collaboration).
- Promoting collaboration skills (see section 2).

[33] Winning Together: a guide to successful corporate-startup collaborations [Available at: http://www.nesta.org.uk/publications/winning-together-guide-successful-corporate-startup-collaboration]

- Persuading grant-making bodies to reserve a portion of funds for collaborative initiatives
- Enforcing existing late payment regulation and promoting consistency in terms passed down supply chain to smaller suppliers (see also section 5 below).
- Examining whether tax incentives might be used to promote further corporate-startup collaboration.

4.9. On behalf of BEIS, we have also recently published mapping of accelerators and incubators across the country[34]. This indicated that accelerators were spread quite inhomogeneously throughout the UK and that many accelerators and incubators are in receipt of public funding. In our view more evidence is needed to determine whether there are gaps in support and also whether this is the most cost-effective use of public money.

4.10. With regard to Prof. Dafforn's review, we note that for startups every action typically has a very significant opportunity cost. Any consultation process which seeks to involve entrepreneurs should therefore take this into account; this may mean expending extra effort to reach out to entrepreneurs and/or using suitable networks of intermediaries, rather than relying on responses to a consultation.

4.11. One critical step will be linking this review to the Patient Capital review (see above). Venture capital is essential fuel for startups (and hence a critical component of innovation finance). The UK venture capital sector, while good by international standards, is some way off that of the US or Israel: total capital is smaller, as are average sizes of individual funds, which influences their behaviour. Given that the time to market for many innovations may be 10-20 years, it is also important that funds are able to wait this time before seeing a return on investment. Many VC funds are currently closed-end funds with fixed periods: this means that they may avoid certain types of investment or else wait until a technology is more mature (and hence more derisked) before investing.

Supporting Alternative Finance

4.12. Alternative finance - such as crowdfunding - is an increasingly-used option for many startups. Thanks to relatively light-touch regulation, the

[34] Business incubators and accelerators: the national picture [Available at: http://www.nesta.org.uk/blog/incubators-and-accelerators-updated-directory-uk]

UK is currently a global leader in the development of crowdfunding platforms. In our view, the benefits of such an approach currently outweigh net risks to consumers and/or systemic risk to the financial system.

4.13. Nesta's study[35] of the growth and dynamics within the online alternative finance market showed that in 2015 the sector turned around £3.2 billion worth of loans, investments and donations a year. 2015 was also the year where equity crowdfunding showed further signs of its popularity with start-ups and investors. In addition to growing to more than £245 million, equity crowdfunding also saw its first two exits and we estimate that equity crowdfunding made up around 16% of all seed and venture-stage equity investment in the UK in 2015. However, 25% of all loans in the £2.2 billion P2P market were funded by institutions in 2015. We are likely to see incumbents playing an increasing role: both mainstream financial institutions, who are seeking to learn from their new competitors, and institutional funders, who will continue to provide significant amounts of the funds available on a growing number of platforms.

4.14. One potential method for making government money go further is through matchfunding, where institutional funding is matched with crowdfunding on an online platform is attracting increasing amounts of interest from public and philanthropic funders interested in understanding if a match fund can make public grant money go further, get more people involved in developing and supporting projects and use the knowledge of 'the crowd' to test public demand for projects.

4.15. Finally, every year the Government spends £10 billion[36] in different forms of business support. Despite recent initiatives such as the What Works Centre for Local Economic Growth or the Nesta-led Innovation Growth Lab, we still know very little about what works and what doesn't. More experimentation with new support schemes and better evidence on their effectiveness should be an important priority, and there are several actions that the Government could take to achieve that (from setting up an experimentation fund for innovation and

[35] Another year of growth for P2P lending and crowdfunding in the UK [Available at: http://www.nesta.org.uk/publications/pushing-boundaries-2015-uk-alternative-finance-industry-report]
[36] How much does the UK spend supporting its businesses? [Available at: http://www.innovationgrowthlab.org/blog/how-much-does-uk-spend-supporting-its-businesses-updated]

growth to making much better use of Government-held data)

5. Improving procurement

5.1. Although we welcome the inclusion of procurement as a 'pillar' of this Green Paper, this section does seem to be missing some acknowledgement of the scale of the challenge here and the potential reward of getting the procurement system to support innovation.

5.2. There are two main reasons why progress on innovation procurement has been slow. The first reason is inertia: transforming the behaviour of thousands of procurement officials across government is, like any major change project, very hard. The second reason is that procuring for innovation is not always as cost-free as it looks. If it encourages officials to buy a more expensive product that turns out to be no better than the off-the-shelf option, or if the risks inherent in picking an innovative solution result in the government receiving goods or services that work badly, procuring for innovation may be more expensive than the alternative. This is particularly true where there are tried-and-tested solutions available to meet a particular need. More generally, if managerial bandwidth is limited, a drive to encourage officials to think about innovation when making procurement decisions may distract them from focusing on value for money. These incentives are especially powerful when amplified by the inherent risk aversion in spending public money: the potential downside of a failed project is far greater than the upside of a successful, innovative procurement, thus encouraging the safe option.

5.3. One suggestion we have for addressing expertise capacity and departmental coordination is what we named the Systems Innovation Accelerator[37]: the establishment of new teams within a small number of departments to link innovation spending to policy and regulation - promoting innovation to meet the department's needs, and to grow the ability of businesses (and civil society) to help meet them.

5.4. These teams would a) tie together innovation policy efforts in a particular department or field with wider policy goals, so as to encourage radical innovation b) reshape regulation and policy to

[37] If not DARPA then what? [Available at http://www.nesta.org.uk/blog/if-not-darpa-then-what-advanced-systems-agency]

enable innovations to flourish and c) support local or city based demonstrations and testbeds to showcase new systems, as is happening on a small scale with driverless cars.

5.5. In practice, their tasks should include a mix of: Horizon scanning on future challenges and opportunities to identify key areas where systems change could unlock big new opportunities for business and for the public; linking together key sources of knowledge and advice; identifying policies, regulations and other tools that could be critical to nurturing new business opportunities; using the full array of other tools to accelerate innovation, from existing funding streams to SBRI competitions and procurement of innovative solutions.

5.6. The Accelerator will also need a good balance of skills (see 1.16). It will need technical expertise, to evaluate new technologies and innovations; it will need to build networks across businesses and government; it will need to understand how the machinery of government and the civil service works to get things done; and it will need to bring in knowledge from outside government to ensure that the strategy is closely connected to the needs of the sector at large. Many of these skills are already present inside departments, but could achieve more with greater critical mass and a closer link to both departmental strategy and innovation spending decisions.

5.7. In our view, procurement (both public and private) often imposes significant obligations on suppliers which are difficult for young firms to meet; examples include demands for ISO certification, sizeable indemnities, or evidence of previous supply relationships. Whilst these are intended to minimise risk for the procuring party, the net effect may reduce innovation by driving away startups and other young firms which struggle to comply. Whilst management of risk will inevitably remain a core function of procurement, we believe that new approaches to this could help promote innovation and enable novel supply relationships.

5.8. The Review of SBRI is welcomed and Nesta is happy to work with David Connell (based on our previous research into SBRI[38])

[38] Buying Power? [Available at http://www.nesta.org.uk/publications/buying-power]

8. Cultivating world-leading sectors

Sector Deals

8.1. Asking industries to organise themselves, to come to Government with an 'ask', should ensure that support matches business demand. However, it will be important to get this process right so that the voices of all sectors have a chance of being heard.

8.2. This approach has worked well in the past for established, defined sectors such as aerospace and automotive, where their Councils are good examples of well-functioning trade bodies that have helped shape government policy. Industry councils are not appropriate for all industries: they make more sense when a sector has well established supply chains and is not undergoing disruptive innovation. However, there are many other industries where there is more scope to build capability.

8.3. Emerging, fast changing sectors, such as digital and tech, tend to be less defined, comprised of smaller businesses and as a result may find it more difficult to respond to the Government's call. These sectors could be responsible for creating the jobs of the future, requiring early stage support to reap longer term benefits. It will mean working with these industries to get the right regulatory framework in place and to harness Government procurement to drive their growth.

8.4. A model these sectors might like to emulate is that of the creative industries, a diverse group of businesses spanning content like film, music and games to services like design, publishing and advertising. These industries, Nesta's research suggests, are the ones that will thrive in an automated future where creativity and imagination are more highly prized. Work by the Creative Industries Council, a joint forum between the creative industries and government, and the Creative Industries Federation, a national membership organisation, has resulted in a strategy setting out a vision for future development, and articulating the steps that the Government and industry should take to get there. It is fitting that this work has been rewarded with one of the early sector deals announced in the strategy.

8.5. As the government seeks to use its increased R&D Funding through the ISCF, further HEIF funding to increase the commercialisation of basic research, expanded KTPs and new funds to promote experimental development in areas of local and sectoral strength, it should ensure its R&D definitions do not neglect the very areas like the Creative Industries where the UK has international comparative strengths.

9. Driving growth across the whole country

9.1. One of the failures of past strategies has been in balancing local growth with national priorities, with London and the South East seeing more R&D investment.

9.2. Analysing local economies using new data sources and techniques could really help in gaining a better understanding of where innovation is happening, and prioritising Government investment accordingly (see 1.16 above).

9.3. For example, Nesta's research into the geography of creativity in the UK shows that the creative industries are becoming more important in local economies across the UK [39]. Between 2007 and 2014 they became more important in local business population in 9 out of every 10 locations. We identified 47 creative clusters across the UK. London and the South East are important components of the UK creative industries, but so are the North, Scotland, Wales and Northern Ireland. These clusters grew their creative employment by 28% between 2007 and 2014.

9.4. The UK's geography of creativity isn't only about 'hip creative cities'. Our research has also identified clusters in creative conurbations across the country. Creative communities in different parts of the country are working together across cluster and administrative boundaries. The geography of the UK creative industries is an interconnected system.

9.5. Government should commit to supporting the development and growth of sustainable local creative ecosystems in targeted areas across the UK, in order to:

- Support the development of clusters outside of London and the South East

[39] The Geography of Creativity in the UK [Available at http://www.nesta.org.uk/publications/geography-creativity-uk]

- share the benefits of London's status as a global creative industries hub across the UK
- Local Enterprise Partnerships and universities should consider what more they can do to address the strengths and weaknesses within their particular area, such as an over reliance on large firms or growing links between graduate talent pools and creative clusters
- Networks of UK creative industries should strive to maintain their global reach.

10. Creating the right institutions to bring together sectors and places

10.1. To realise the full benefit of the 'devolution revolution' for innovation-led growth across the UK, it will be essential to support the infrastructure of Government at a sub-national level. This involves strengthening the capability of local policy-makers to use new powers to full effect, including better use of geographical and sectoral data for decision-making. We need a more nuanced understanding of how nationally-set innovation policy interacts with other policies in one place i.e. how well does Government support to help businesses innovate mix with planning, transport and housing policy to come together holistically to promote growth in an area.

Creating and scaling new businesses

10.2. The starting and scaling of new ventures is of such importance to our economic wellbeing that it must be on the agenda of policymakers at all levels. Digital entrepreneurship is particularly significant given the role of digital technologies in enabling innovative business models and driving economic growth. Local policy conditions can have significant impact on entrepreneurs but have historically received rather less attention than national policy. Entrepreneurs are affected by their local environment. Sub-national bodies like chambers of commerce, cluster managers, councils and local regulators – as well as universities and big business – can all influence entrepreneurs' decisions and affect the framework within which startups thrive or die. Entrepreneurship policy should not be pigeon-holed as a subset of business policy, but seen as a cross-governmental issue which should also be the concern of science and technology policy, education policy, planning and multiple other areas.

10.3. Nesta has produced an ideas bank for digital entrepreneurship for local policymakers[40], starting with an evaluation of local digital entrepreneurship ecosystems in order to identify strengths and weaknesses. (Nesta's index of how supportive cities are for digital entrepreneurship can assist with this[41]). It recognises that start-ups are a special subset of SMEs, and that early stage start-ups have different priorities than later-stage scale-ups; each may require a different policy focus. Policymakers should aim to cultivate the ecosystem as a whole, which requires a holistic view. Relying on one or two mechanisms is unlikely to create a sustainable ecosystem.

Offices of Data Analytics

10.4. The most significant step government can take to improve the quality and level of innovation with the UK's open data is to encourage central government departments, local authorities and public sector bodies to be the primary consumers of their own data. They can use it to drive service improvements, identify inefficiencies and tackle issues like fraud and error. Doing so would not only help government and public sector bodies to save money (making open data more financially sustainable), but would also improve the quality and timeliness of the data they can publish as open data, making it easier and more reliable for those outside of government wishing to create useful tools and services with it.

10.5. The government's current strategy for 'dogfooding' data at a central government level is proving effective for achieving this. For local government and the wider public sector, government should encourage each city to create an office of data analytics (ODA) - a small team of data analysts that has the resources, technology and expertise to bring together, analyse and provide actionable insights from data sourced from all local authority and public sector organisations across the city. The model has proven itself in New York (as the Mayor's Office of Data Analytics) in reforming public services and driving local economic growth. UK versions are already being trialled in Manchester (GM-Connect) and by Nesta in London and the North East.

[40] Ideas bank for digital entrepreneurship [Available at http://www.nesta.org.uk/publications/digital-entrepreneurship-idea-bank-local-policymakers]
[41] Eurpean Digital City Index 2016 [Available at: https://digitalcityindex.eu/]