



# Review of the Catapult network

Recommendations on the future shape,  
scope and ambition of the programme

*Dr Hermann Hauser*

For:

The Rt Hon Dr Vince Cable MP

Secretary of State, Department for Business,  
Innovation and Skills

The Rt Hon Greg Clark MP

Minister of State for Universities, Science and Cities



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# Foreword

by Hermann Hauser



In my report in 2010 I called for the UK to establish a network of technology and innovation centres. I am pleased that the Coalition Government responded to my call in September 2010 with an initial investment of over £200 million to create the first seven Catapult centres. Four years on, Vince Cable and David Willetts asked me to see how well the first centres are doing and consider what the future of the network should be and how we should, as a nation, seek to get there.

In 2010 I said:

*“.....we must continue to invest in, and support, research excellence; ensure we support areas of UK industry which have the ability and absorptive capacity to capture a share of high value activity; and close the gap between universities and industry through a ‘translational infrastructure’ to provide a business focused capacity and capability that bridges research and technology commercialisation.”*

During my review I visited all seven Catapults and have seen this vision becoming a reality. I have met their leadership teams, discussed their business plans and reviewed some impressive outcomes. I have met many of their customers and collaborators, and I have engaged with the broader innovation community to seek their views through an extensive consultation process.

I have been genuinely surprised at the degree of progress made and impressed by the quality of the people and facilities in the emerging network. The UK is playing catch up with the best innovation systems in the world in translational infrastructure, so I was very encouraged to see how rapidly we are closing the gap.

This excellent performance is in no small part due to the leadership of Innovate UK, the new name for the Technology Strategy Board, in guiding the network to this point and the role it continues to play as the principal funder of the network. The Government’s long term commitment to funding and building this network has also been critical to provide the confidence needed to attract the right talent and to ensure businesses invest themselves through their engagement in projects at the centres.

I have also confirmed that several of the under-pinning principles I set out in 2010 still hold true and have contributed strongly to this early success. These include the balanced funding model based on global best practice, the “national” status of the centres and the criteria for choosing the themes for centres, namely:

- A large global market to exploit
- A UK global lead in research capability, and
- The necessary absorptive capacity to commercially exploit in the UK

It was gratifying to find that the way in which we have started building this network was fundamentally right. However, lessons have been learnt in these first few years and the consultation process has made clear that some fine tuning of our approach is needed.

My recommendations, significantly influenced by this important feedback, are set out in full in this report. They respond to the questions set out by Vince Cable and David Willetts in their original commission to me and I extend my gratitude to those of you that either wrote in to the review or attended one of the events.

Based on the evidence so far I conclude that the UK needs a ‘translational infrastructure’ of the size and scale seen in competing nations and supported in the same way that successive Governments have invested in the UK science base, which has resulted in our academic research capability being the quality it is. Governments across the world have been boosting investments in research and development. By contrast, the current low levels of investment in R&D in the UK by both the public and private sector are, as indicated by Tera Allas in her excellent benchmarking report, perhaps due to research intensive sectors comprising a smaller part of the UK economy and the UK having lower levels of research conducted within these sectors. This in turn will compromise our ability to compete effectively in the knowledge economy.

To address this and rebalance our economy, we must not only continue to sustain and grow our investment in our world leading science base, but extend this to our support for innovation. Both these investments call for long term industrial strategies and funding which are common in other competing nations. The Government should acknowledge the importance of building this network for the future capability of the UK to compete in global markets, and in doing so the scale of investment required to enable it. This will be a long term endeavour requiring commitment by the current Government and successive Governments to come.

The existing Catapult centres are a great stride forward but they will need continued support to strengthen capability, remain world beating and to expand their capabilities. I urge the Government to maintain the current 1/3 funding model, and commit to expand the network in a measured way adding up to one or two centres a year. Innovate UK and our Research Councils should be asked to develop a

pipeline to incubate new centres in key future technologies that will help drive the UK economy into the global markets that will deliver vibrant economic growth for the UK.

This would set the UK on a trajectory of creating a network of around 30 centres by 2030. Doubling Innovate UK's budget to closer to £1 billion per annum by 2020, would fund a major expansion in innovation activities across the Innovate UK portfolio, including expansion of the Catapult network, which would stand at around 20 centres by 2020. At this point an evaluation should be able to provide insight on the emerging impacts of the earlier Catapults which would help to take a view on the future investment options.

A lasting impression from my visits and discussions has been the countless businesses and academics who have praised the Catapult centres as a “neutral” convenor, the place where collaboration across the technology readiness levels can take place effortlessly. This is truly heartening. It has also been very good to see that where good business cases have been presented Catapult facilities have been expanded.

I have made nine key recommendations in this report which, if acted upon, will strengthen the existing network. I look forward to seeing a flourishing Catapult network in the decades to come providing the UK with a similar structure in depth as other competitor nations and a long lasting impact to the UK's economic performance.

Hermann Hauser CBE FRS FREng FInstP

Cambridge UK

November 2014

## Recommendations

1.	The UK must maintain its focus and commitment to investing in the existing Catapults, subject to effective performance and relevance, over the long term.
2.	In keeping with international best practice, public sector funding must be prioritised to maintain the current 1/3, 1/3, 1/3 funding model for existing, successful Catapults.
3.	Innovate UK should grow the network of Catapults through a clear and transparent process, based on the current criteria, at no more than 1-2 centres per year, with a view to having 30 Catapults by 2030 with total core funding for the network of £400 million per annum.
4.	Growth of the Catapult budget requires increased funding for Innovate UK in line with recent calls to double UK innovation spend, bringing the Innovate UK budget closer to £1 billion per annum by 2020, such that it can explore and invest in a wider portfolio of emerging opportunities and support the most promising areas at scale.
5.	Each Catapult should work with Innovate UK to develop more effective SME engagement strategies. Approaches should include working with local authorities and business groups to reach potential high growth SMEs and important clusters of activity in regions across the UK.
6.	Catapults should develop a stronger more coherent engagement model for working with Universities (national and international), building on best practice, with a view to drawing on and commercialising knowledge to help UK industry gain competitive advantage.
7.	Innovate UK and the Catapults should work together to develop more sophisticated Key Performance Indicators (KPIs) that sit within Catapults' Grant Funding Agreements, that incentivise impact and engagement with industry whilst still ensuring that Catapults work ahead of the market. These should reflect the difference in the sectors and the maturity of the relevant centre.
8.	Once established, Catapults should take advantage of their role as a neutral convenor to identify and help address wider barriers to innovation and commercialisation, and work with relevant parties to inform and deliver solutions. These could include regulatory and non-technological barriers such as business models and skills requirements.
9.	Government should ensure that the 'Catapult process' developed by Innovate UK is used when deciding whether a business-led, physical infrastructure based initiative should be supported.

# Background and context

## Chapter One

The March 2010 report, *The Current and Future Role of Technology & Innovation Centres in the UK*,<sup>1</sup> highlighted the need for the UK to close the critical gap between research findings and their subsequent development into commercial propositions. It made a case for long-term UK investment in a network of technology and innovation centres, based on best practice in other countries, such as the Fraunhofer Institutes in Germany and TNO in the Netherlands, to ‘deliver a step change in the UK’s ability to commercialise its research’. The rationale and arguments for such an infrastructure were reinforced by Sir James Dyson in his 2010 report *Ingenious Britain*.<sup>2</sup>

The two reports argued that such centres were required to provide business with access to the best technical expertise, infrastructure, skills and equipment. They would create a new framework for long-term investment and joint working between business and the UK research base, complementing the other programmes and resources available to stimulate innovation, harness the UK’s strengths, build capacity and generate the critical mass needed to compete effectively in global value chains and high growth markets.

In Autumn 2010, the UK Coalition Government provided additional funding worth over £200 million to Innovate UK to establish seven Catapults over the four-year spending review period from 2011 to 2015. The role of the centres would be to:

- enhance business access to leading-edge technology and expertise
- reach into the research base for world-leading science and engineering
- undertake collaborative applied research projects with business
- undertake contract research for business
- be strongly business-focused with a highly professional delivery ethos
- create a critical mass of activity between business and research institutions
- provide skills development at all levels.

Based on the recommendations in the March 2010 report, Innovate UK published a prospectus<sup>3</sup> in January 2011, which proposed key principles for the new network – what the centres should do; the criteria for choosing their areas of work; how they should be run; and the process for their development. The prospectus also invited

<sup>1</sup> Department for Business, Innovation and Skills, *The Current and Future Role of Technology and Innovation Centres in the UK: A report by Dr Hermann Hauser*, March 2010

<sup>2</sup> James Dyson, *Ingenious Britain: Making the UK the leading high tech exporter in Europe*, March 2010

<sup>3</sup> <https://www.catapult.org.uk/documents/2155693/2268412/Tech+and+Innovation+centres-a+prospectus.pdf/996a46c3-5fb6-47d1-9a04-d27fb67921ad?version=1.2>

views on the areas for future technology and innovation centres, and on the proposed management and governance arrangements.

Over 500 overwhelmingly positive responses were received, welcoming the proposals and suggesting a wide range of areas for future investment. This input from the research and business community complemented work undertaken by Innovate UK itself to define the strategy for developing the centres' programme.

In early 2011 the House of Commons Science and Technology Committee conducted an enquiry into the prospects for technology and innovation centres, seeking its evidence from many quarters. The resulting report<sup>4</sup> also strongly supported the initiative and the thrust of the proposals in Innovate UK's prospectus, and made some practical recommendations about how the programme should be taken forward.

Innovate UK subsequently established seven Catapults guided by five criteria:

- The existence of potential global markets which could be accessed through the centre that are predicted to be worth billions of pounds per annum.
- World-leading research capability in the area in the UK.
- UK business ability to exploit the technology and make use of increased investment to capture a significant share of the value chain and embed the activity in the UK.
- Potential for the centre to enable the UK to attract and anchor the knowledge-intensive activities of globally mobile companies and secure sustainable wealth creation for the UK.
- Close alignment with national strategic priorities.

#### Catapult Centres established to date

Cell Therapy  
Digital  
Future Cities  
High Value Manufacturing  
Offshore Renewable Energy  
Satellite Applications  
Transport Systems

In cases such as High Value Manufacturing and Satellite Applications, existing investments and capabilities were leveraged to form what are now Catapults. Others such as Cell Therapy and Future Cities were established from scratch.

<sup>4</sup> <http://www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/619/61902.htm>

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The Government has also provided additional funding worth £239 million since the 2010 Spending Review settlement, both to grow the capabilities of the first seven Catapults and to establish two more Catapults, now identified as Precision Medicine and Energy Systems, which will be operational next year.

In 2014 the Business Secretary, Dr Vince Cable and the Minister for Universities and Science, David Willetts commissioned this review of the progress made by the Catapult network since the 2010 report and the potential scope and scale of the network in the future. An online consultation resulted in 65 written responses, and stakeholders were consulted at events across the UK. Visits also took place to many of the Catapult locations to meet with all the senior management teams and several independent Board members.

These events and meetings highlighted that whilst many Catapults are at an early stage of their development there is good progress and engagement by both academic partners and business into the work of the Catapults. Throughout this report there are case studies from each of the centres.

The results of that consultation are reflected in the recommendations made in this report.

# Rationale, impact and additionality

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## Chapter Two

### The need for a translational infrastructure

Public investment to generate economic growth is driven by a need to demonstrate ‘additionality’.<sup>5</sup> Not only do interventions need to be commercially successful, they also need to demonstrate that they add value over and above what private sector would have done without support. Therefore public interventions need to target areas where barriers to private sector activity create gaps which inhibit economic growth.

The gap between early stage publicly funded basic research and privately funded research at the latter end of commercialisation, is commonly referred to as the ‘Valley of Death’. Firms struggle to bridge this void, where innovation is stifled due to a lack of applied translational research corresponding to the middle part of the technological readiness scale.

This is caused by a combination of market and system failures.<sup>6</sup> Government looks to overcome these barriers to foster innovation and unlock potential. Public support which is of sufficient scale committed over sufficiently long time periods is needed to address the following failures:

- **Uncertainty** (as opposed to risk which can be priced into markets) around the returns to innovation and the **long timescales** it takes to realise profits generally means that businesses are unwilling to invest in, and financial institutions are unwilling to lend to pay for, research and development despite the potentially large returns on offer.
- **Positive externalities** (productivity spill-overs across UK firms who do not pay for the R&D), are not factored into firms’ R&D investment decisions, meaning that investment is lower without public support, and generally happens in a more closed manner.
- **Natural monopoly** effects mean that facilities that a range of technical innovation relies on can be too large and expensive for firms to access. This particularly affects SMEs, but when combined with other market failures (like uncertainty) it can also affect larger firms. Procuring the capital to pay for these facilities requires large scale, patient investors.
- **Coordination failures** mean effective links are not made between firms, academia and/or government without a neutral convenor and/or a hub to connect and coordinate activity.

<sup>5</sup> HM Treasury’s Green Book uses following definition of Additionality: “An impact arising from an intervention is additional if it would not have occurred in the absence of the intervention.” See [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/220541/green\\_book\\_complete.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf)

<sup>6</sup> A more detailed discussion of these, and how the Catapult network creates additionality by addressing these is included in Annex A.

- **Incomplete markets** where an initial lack of demand (due to a lack of knowledge of the benefits) can inhibit potentially profitable R&D. This is particularly an issue in new technology areas where applications lack markets initially and/or can have a disruptive effect on current business models. Firms need the capacity to take new opportunities quickly and effectively in a globally competitive economy.

A Catapult by Catapult examination of how these failures are being addressed is included in Annex A.

## The role of Innovate UK

In terms of policy interventions there is no silver bullet. Science and innovation function as a complex system that is highly interdependent, multi-faceted and non-linear. Policy must be interconnected and coherent to maximise impact and address the priorities of the economy as a whole – this requires a range of policy tools which address this broader context, including and supporting the Catapult network in its specific task.

A benchmarking review<sup>7</sup> of the UK innovation system earlier this year identified the main aspects that matter for economic and societal outcomes. They are: money, talent, knowledge assets, structures and incentives, and the broader environment.

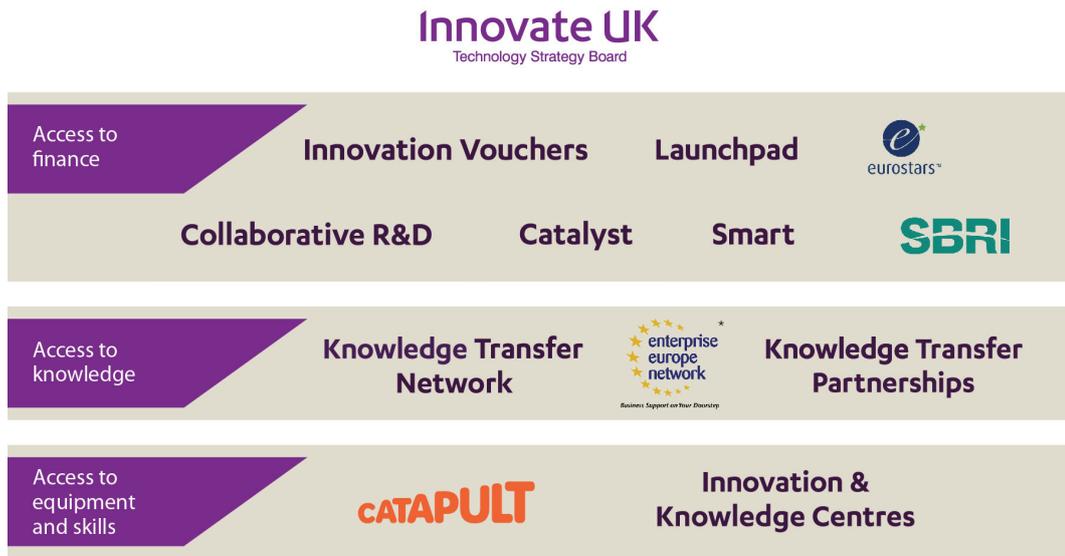
This report noted that whilst the UK has many strengths, such as open competitive markets, a world class science base and a modern intellectual property regime we lag behind leading nations in terms of public and private investment in R&D, in having capital markets with a short-term focus and with deficiencies in certain areas of skills.

Innovate UK, the UK's innovation agency, funds, supports and connects UK innovative businesses through a unique mix of people and programmes to accelerate economic growth. It works with business, academia and government to identify and prioritise support for areas where the UK has business strengths and academic capability that can address global challenges and create opportunities for UK economic growth. It then works with the relevant stakeholder community in each of these areas to identify barriers to innovation and to address these through the appropriate use of tools within its portfolio (see figure overleaf). More often than not, these programmes are taken forward in partnership with organisations like the Research Councils, which support excellent basic scientific research, and the British Business Bank which will seek to increase the supply of finance available to smaller businesses.

Catapults are an important part of Innovate UK's 'toolkit', and while not relevant or appropriate for all priorities, are established with core funding from Innovate UK to address specific market failures, with clear expectations of their role within a wider programme of work (see case study on Regenerative Medicine programme in Chapter

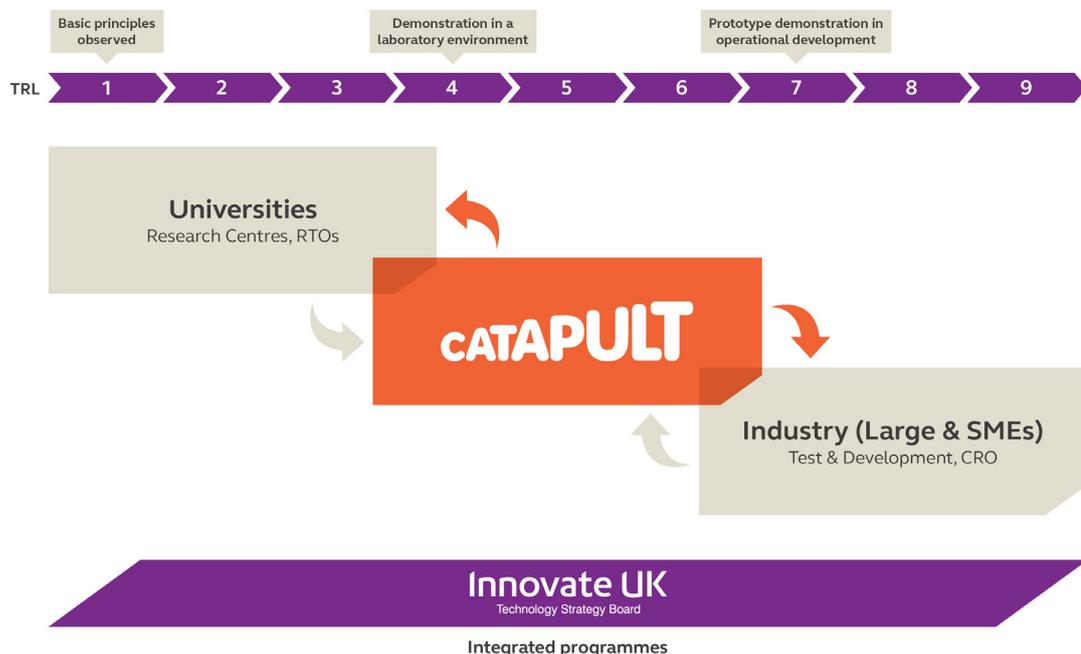
<sup>7</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf)

3). This addresses a critical weakness in the UK approach prior to the Catapults' formation, which saw a range of centres established by the Regional Development Agencies and Devolved Administrations with no clear role within Innovate UK's priority programmes, but with expectations nonetheless of competitively tendered project-based funding.



### Catapults and the intermediate infrastructure

The core rationale for establishing Catapults was that physical centres with associated technical know-how generally operate in the middle levels of technology readiness and provide services that address market failures, which in particular impact heavily on capital investment by firms, and tend to pay off over longer timescales.



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In the UK there is already an intermediate sector making a valuable contribution to innovation. Not-for-profit intermediate research bodies do not necessarily exhibit the same market characteristics as normal profit-seeking organisations. By forgoing the need to create an economic profit they can provide some services which would not be viable or a priority for a profit making venture. These organisations solve market failures that firms encounter by creating information networks and adapting scientific knowledge to more practical uses.

However, these organisations only offer a partial solution to the market and systems failures. Evidence has shown they are capital constrained and without public support activity becomes focused on less risky activities closer to market in established sectors rather than on emerging technologies and innovation areas which are riskier, but present larger potential social and economic returns.<sup>8</sup> Without intervention the sector operates at a sub-optimal level in terms of its contribution to UK economic growth. Innovate UK has established Catapults in key strategic areas of importance to the UK where market and systems failures limit the performance of the sector.

It is vital that Catapults interact with each other, the broader intermediate sector and the wider innovation system. Collaborating to combine creative abilities more effectively is a key element of the value a 'network' of centres provides.

Catapults build on the competencies of the sector and fill gaps where areas are under-funded, or provide capabilities where these do not yet exist. They conduct activity where market failures restrict the ability of existing centres of excellence in the Research and Technology Organisation (RTO) landscape to act. They do so for example by facilitating increased levels of R&D investment by business, reducing company costs and removing the uncertainties around financing. This in turn allows longer term investments in the development of new products, services and processes. They add further value to the R&D process through the wider networks of knowledge and partners they can access.

*“The clear benefit to GSK of working with CPI<sup>9</sup> is that we are able to concentrate on our strengths and have a partner explore areas where we are more limited... we want to use biotechnology to manufacture medicines and we are now using CPI to develop concepts that are either outside our expertise or have a more challenging risk profile.”*

Ted Chapman, Biotechnology Development Manager, GlaxoSmithKline

<sup>8</sup> See Study of the Impact of the Intermediate Research and Technology Sector on the UK Economy, Oxford Economics, May 2008 and [http://www.earto.eu/fileadmin/content/03\\_Publications/TechnopolisReportFinalANDCorrected.pdf](http://www.earto.eu/fileadmin/content/03_Publications/TechnopolisReportFinalANDCorrected.pdf)

<sup>9</sup> The Centre for Process Innovation (CPI) is part of the High Value Manufacturing Catapult

## Addressing natural monopoly issues

Successful international models, such as in Germany, demonstrate the effectiveness of leading edge, open access facilities in driving innovation. No single company or supply chain has the necessary capital to create and maintain such centres at the leading edge. While the wider intermediate sector addresses some of these issues, there is still a shortfall of capital.

The Catapults provide open facilities aimed at increasing the speed and scope of technology diffusion between different sectors. The facilities provided by the Catapults are often one-of-a-kind in the UK.



### Offshore Renewable Energy

The Offshore Renewable Energy Catapult (ORE Catapult) offers world-class testing facilities that private sector firms – both large and small – struggle to provide themselves. Wind turbine testing is crucial to improved reliability and cost reductions. By accepting the commercial risk and offering asset testing services, ORE Catapult is addressing a market failure and demonstrating real added value.

Issues of affordability and know-how are particularly acute for SMEs, who lack the scale to make investments like these. Catapults can help by engaging directly or by supporting the broader supply chain.

## PolyPhotonix

PolyPhotonix, an SME, has developed a therapeutic device for diabetes induced blindness with the help of the Centre for Process Innovation (CPI), part of the High Value Manufacturing Catapult. Using the CPI's facilities meant that PolyPhotonix did not need to invest in equipment which would prove prohibitively expensive to a start-up. They have also benefited from Innovate UK help through the Knowledge Transfer Partnerships (KTP) programme, Small Business Research Initiative (SBRI) healthcare funding and grants for feasibility studies.

*“Remaining lean and responsive – with short chains of communication between us and CPI – has given us the freedom and flexibility to react to new opportunities. We are able to book time and space in the clean room and to use the equipment we need when we need it. Although we operate as a private company, CPI's extensive resources and support have enabled us to grow at a realistic pace. Quite honestly, without CPI we wouldn't be here – that's the bottom line.”*

Richard Kirk, CEO PolyPhotonix



PolyPhotonix has been advised by the NHS that its two optical applications will save them £1 billion per annum. This device is currently in Phase 3 clinical trials.

## **Increasing the scale, speed and scope of commercialisation**

In a globally competitive environment, commercialising swiftly and effectively can make the difference between being a market leader or a market follower. Catapults increase the scale, speed and scope of commercialisation and focus their activities on riskier investments.

### **Increasing the scale and speed of commercialisation**

Cutting tool developer Technicut and toolholding specialist Nikken Kosakusho worked with the Advanced Manufacturing Research Centre (AMRC, part of the High Value Manufacturing Catapult) to prove that a new tooling system can achieve record-breaking rates of metal removal. Technicut has won new business and grown its workforce as a result of the collaborative research and networking opportunities. The patented system is now in production, and being deployed around the world. Consequently, Nikken is also investing in a new European research and development centre on the R-evolution development at the Advanced Manufacturing Park, next to the AMRC.

## **Enhancing value through collaboration**

Catapults need to draw on cutting edge knowledge generated by the research base. They add value through collaborative projects working across institutional boundaries, bringing together people with complementary skills sets. Their role as an intermediary leaves them well placed to identify and help fill the ever changing skills requirements of the knowledge economy and benefit the wider economy through dissemination of research.

### **Tackling one of the cell therapy industry's major challenges**

The Cell Therapy Catapult (CTC) and Loughborough University are collaborating to develop robust processes and new cell therapy manufacturing and delivery techniques.

The CTC is able to work with Loughborough's recognised experts in the manufacture and quality control of cells and tissues used in cell therapy, as well as linking with the University's Engineering and Physical Sciences Research Council (EPSRC) Centre for Innovative Manufacturing and its Doctoral Training Centre in Regenerative Medicine.

## Anchoring investment in the UK

Advanced economies seeking to retain high wage levels need to concentrate on activities high up the value chain. Global organisations that invest in R&D are entirely mobile and will seek to invest their R&D resources in the localities where the environment is most suitable, and in particular where there is a strong level of Government support and investment in key research infrastructure.<sup>10</sup> Facilities and capabilities available in centres like Catapults can help attract and anchor investment in the UK.

### Supporting growth sectors of the future in the UK

The Cell Therapy Catapult (CTC) worked with ReNeuron, a leading cell therapy company, on making the manufacturing processes for the CTX stem cell line commercially ready. Following the initiation of the collaboration ReNeuron received a £33 million financing package from a group of funders and institutional investors, enabling it to position itself as a global leader in stem cell development. Without CTC's validation ReNeuron would have lacked important support for the financing. This also helped cement ReNeuron's position in the UK as it was contemplating relocating its operations outside of the UK prior to this.

## Convening and collaborating

Catapults play a coordinating role, bringing together different parts of the innovation system – universities, research organisations and industry – to work in collaboration and help manage complex supply chains. This role as a 'neutral convener' is vital in attracting funding, identifying more beneficial investment opportunities and making the innovation process more efficient.

### The Digital Catapult's role as a neutral convener

The Copyright Hub is an excellent example of the Digital Catapult acting as a neutral convener. The Catapult and the Copyright Hub Company have partnered to convene a wide range of industry competitors and are building a pilot platform that will, over a series of use cases involving creative SMEs, lead to easier licensing of creative content. This will enable individuals to get the permissions they need to use copyright material with a single click and lead to the creation of a new copyright marketplace that the Hargreaves Review in 2011 identified could deliver benefits of up to £2 billion to the UK economy by 2020.

<sup>10</sup> See IFS (2006) University Research And The Location Of Business R&D <http://www.ifs.org.uk/wps/wp0702.pdf>

### **Satellite Applications Catapult international collaboration**

The Satellite Applications Catapult has developed a prototype for a global fishing monitoring tool. This was match-funded by The Pew Charitable Trusts, a US philanthropic organisation with an ambition of eliminating illegal fishing in 10 years. The prototype captures and analyses satellite shipping data, and combines it with specific vessel information to detect, track and prosecute illegal fishers.

Illegal fishing is a global threat to our oceans. It is estimated that one-in-five fish caught are done so illegally and accounts for up to 26 million metric tons of fish annually, worth up to \$23.5 billion. The neutral and non-profit making status of the Catapult enabled this collaboration which has brought together exactEarth Europe, a satellite data services company (now hosted in Harwell) and a Norwegian foundation working on sustainable fisheries to work together in the UK. The demonstrator is currently being developed with additional private sector funding from Pew.

## The impact of public spending on innovation

Direct public investment in R&D to support innovation leverages extra investment from the private sector.<sup>11</sup> Each £1 of public investment in collaborative R&D is estimated to offer a GVA return of £6.71<sup>12</sup> before taking spillover effects into account. Direct public investment in R&D also leads to a long run increase in firms' absorptive capacity.<sup>13,14</sup>

### Future Cities Catapult role in enhancing the absorptive capacity of firms

The core government funding for the Future Cities Catapult (FCC) helps to develop private sector capabilities by stimulating the innovation, the testing at scale, and the commercialisation, of new urban solutions. Lack of facilities for demonstration and validation at scale and in use are a significant barrier for both companies and for cities themselves. FCC's 'Sensing London' project is deploying multiple sensor networks across various locations in the Capital, allowing companies to test new technologies and trial new approaches. This and other major test sites across the country will allow firms to test complex solutions, as well as build confidence amongst clients to purchase them. Even at this early stage, all FCC's pilot projects with business, academia and cities throughout the UK have secured match-share funding and in-kind support.

<sup>11</sup> See for example, Guellec and De La Potterie (2003) The impact of public R&D expenditure on business R&D

<sup>12</sup> Technology Strategy Board: Evaluation of the Collaborative Research and Development Programmes (2011) <https://www.innovateuk.org/documents/1524978/1814792/Evaluation+of+the+Collaborative+Research+and+Development+Programmes+Final+Report/e09dbba0-1cfb-4607-973f-ae9caa73f66d>

<sup>13</sup> Absorptive capacity is the ability of a firm – underpinned by tacit knowledge embodied in people as human capital (skills, experience, etc.) – to recognise the value of new, external information, assimilate it and apply it to commercial ends.

<sup>14</sup> Research by Roper and Hewitt-Dundas found for manufacturing firms innovation support directed at new product development leads to an additional, persistent increase in firms' broad capability through both better technical skills and through the creation and more effective use of networks.

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## Addressing societal challenges

Catapults can play a critical role in addressing societal challenges and in helping the public sector achieve key policy objectives. Examples include helping to build our renewable energy sector,<sup>15</sup> design more efficient transport systems and harness satellite data to achieve a variety of outcomes such as prediction of climate events and enhanced national security.

### ORE Catapult – addressing UK energy needs

ORE Catapult serves a market that supports the Government's objectives of improving energy security and achieving greenhouse gas emission reductions.

Data-sharing is critical to lower cost of energy in offshore renewables, but commercial sensitivity often prevents competitors from sharing. SPARTA (System Performance, Availability and Reliability Trend Analysis) is a major new collaborative project between ORE Catapult, The Crown Estate and offshore wind farm owner/operators, which aims to overcome this barrier. The project will create a database for sharing anonymised offshore wind farm performance and maintenance data. Huge financial benefits can be derived from SPARTA for the industry through increased yield, better operations and management strategies and improved reliability: high level estimates put this at £200-300 million over the next five years, in a sector that could deliver potential economic benefits of £6.7 billion per year and 150,000 jobs by 2020 under a 15GW (accelerated growth) scenario. These benefits would not be possible without ORE Catapult operating in its role as a trusted and impartial organisation that can mediate between competitors and facilitate data-sharing.

<sup>15</sup> <https://ore.catapult.org.uk/documents/2157989/0/ORE+Catapult+UK+economic+impact+report/2c49a781-ff1e-462f-a0c7-b25eb9478b0f?version=1.0> ORE This report this year considers the likely economic and industrial growth opportunities of the sector, as well as estimating the potential benefits of the marine sector. It concluded that UK know-how will play a key role in realising substantial economic benefit from offshore renewables.

## LUTZ Pathfinder

The Transport Systems Catapult (TSC) has identified the huge potential of autonomous (self-driving) vehicles as a key growth area, and the LUTZ Pathfinder programme marks its first foray into this exciting sector. Working closely with Milton Keynes Council, where the Catapult is based, the programme will trial three autonomous pods in the town and assess their feasibility from both a technical and societal point of view.

Currently being built by Coventry-based firm RDM, the electric-powered two-seater pods will be equipped with sensor and navigation technology initially provided by the University of Oxford's Mobile Robotics Group, but with an open platform capability that will allow other Autonomous Control System suppliers to use the pods for test purposes.

Starting in early 2015, the Catapult will test the pods in an "urban laboratory" using a pavement route agreed with its partners at Milton Keynes Council. In so doing, it will seek to carry out test and development programmes in a legal, structured and appropriately controlled 'real world' environment and maximise benefits to the Council as well as the Catapult.



# Key findings and future network

## Chapter Three

The Catapults support and are part of Innovate UK's wider, prioritised programme of work. They provide "...a physical centre and its associated capabilities [that] address issues that cannot be tackled through a portfolio of projects, funded through established programmes, and distributed throughout existing research organisations alone."<sup>16</sup>

They have been established with a specific, complementary role in the UK's innovation landscape with clean interfaces between their suppliers and customers. They operate alongside other Research and Technology Organisations (RTOs), independent laboratories, innovation centres and some university enterprise units as part of the broader intermediate sector, building and augmenting existing competencies.

### **Regenerative Medicines and Cell Therapy**

The emerging field of regenerative medicine and the use of cells as therapeutic agents promises to revolutionise patient care, delivering benefits to patients and the UK economy. The number of UK companies working in regenerative medicine has been growing, and the basic underpinning research is progressing rapidly. But there are still significant barriers to be overcome to deliver successful clinical translation, benefits to patients and a commercially viable UK regenerative medicine industry.

Innovate UK has, along with its Research Council partners, invested around £28 million since 2009 in a series of R&D competitions focused on enabling companies to develop tools and therapies to commercialisation. It has established the Cell Therapy Catapult, to provide a critical mass of expertise and infrastructure to address the wider needs of the sector and enable the UK to better access a market estimated to exceed US\$5 billion between 2014 and 2020.

<sup>16</sup> CSTI POLICY BRIEFING NOTE: Characterising International Intermediate Technology & Innovation Centres

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## Activities and impact

The range of innovation activities individual centres engage in depends heavily on their 'local' innovation landscape and the organisational mission. However, the activities centres have engaged in to date mirror their international counterparts and are valued by customers:

- Technology services: providing cutting edge R&D services to industry through a combination of in-house specialist facilities and a highly skilled technical workforce many SMEs or mid-market companies could not afford;
- Technology development: undertaking precompetitive R&D and systems integration tasks; characterisation/measurement; translating knowledge and technology;
- Developing human capital: vocational training; advanced R&D competency training; technical and operational manufacturing advisory services; and
- Networking and sector development: dialogue with industry; developing standards and providing advice on the regulatory framework; advising on access to finance; coordinating R&D projects.

*“State of the art equipment and capabilities to help firms with a range of activities from proof-of concept to production validation; skills and expertise to make best use of the equipment and come up with innovative ideas; an innovation process covering key tasks from the initial generation and sifting of ideas through to production; a collaborative environment including mechanisms to bring together various elements of the supply chain.”*

Barnes Aerospace

**Informing future regulations:**

**Potential stem cell-based cure for airway diseases**

Severe Structural Airway Disease (SSAD) causes airway obstruction, leading to poor health and a 50% mortality rate if not treated successfully. Current surgical treatment has a high incidence of failure, and there is an urgent need for a more effective and long-lasting solution.

An Innovate UK funded consortium involving the Cell Therapy Catapult and led by Videregen Ltd, a UK SME, is developing a technique, which involves repopulating a decellularised trachea ‘scaffold’ with the patient’s own stem cells and epithelial cells. The other project partners are NHS Blood and Transplant, Royal Free Hospital and University College London.

As an alternative to conventional tracheal transplantation, this project represents a step change approach to the treatment of airway disease. Working towards and undertaking clinical trials requires an innovative approach to the regulatory and clinical hurdles. The Cell Therapy Catapult will be using its expertise in these areas.

The Catapults are one actor in a complex innovation system.<sup>17</sup> Knowledge is an intangible and mobile asset that can transfer (through people, products or publications) from Catapults to other projects, companies or industries, where it may be used for economic gain. This dissemination of knowledge is a key rationale for public support for business innovation, but it is almost impossible to track where knowledge flows and how it is applied. This makes the attribution of any impact on growth to the specific actions of the Catapults extremely difficult.<sup>18</sup>

This complexity has been accounted for in the evaluation approach to the Catapults. A logic model has been developed for each Catapult, clearly setting out the Catapult’s objectives and the logical framework for how they will achieve impact.<sup>19</sup> These help identify the key data that will be needed for an evaluation; how that data will be collected, and by whom, and sets out the observable outcomes that will emerge as Catapults progress along the logic model although it is difficult to be generic across a network with such diverse activities.

Benefits to R&D accrue over a number of years, with long lags to full impact.<sup>20</sup> This means it is too early to conduct a formal impact evaluation of the Catapult

<sup>17</sup> See Annex A of BIS (2014) Insights from international benchmarking of the UK science and innovation system

<sup>18</sup> This point is emphasised in European Commission guidance on the Evaluation of Innovation Activities. See [http://ec.europa.eu/regional\\_policy/sources/docgener/evaluation/pdf/eval2007/innovation\\_activities/inno\\_activities\\_guidance\\_en.pdf](http://ec.europa.eu/regional_policy/sources/docgener/evaluation/pdf/eval2007/innovation_activities/inno_activities_guidance_en.pdf)

<sup>19</sup> Each Catapult is unique; targeting particular problems in their relevant sectors. As such, there is not a single set of metrics which would suitably allow an evaluation of impact across all Catapults – each one needs to be considered in its own context.

<sup>20</sup> BIS (2014) Rates of return to investment in science and innovation

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network. However, in the interim other measures can give a strong indication of early performance. Innovate UK is regularly monitoring KPIs from each centre to assess intermediate measures of success – inputs and activities. In the medium term, data will be gathered from businesses to assess early outputs. In the long term, changes in a number of key indicators will be measured against sector level baselines.

Early evidence against this framework, as well as the responses to our consultation, show that the more established Catapults in particular have made significant investments; attracted and recruited high quality staff that provide in-house expertise to business; and engaged extensively in R&D activities with academia and business.

The combination of technological capability and associated know-how is critical to a productive relationship with business. This has resulted in collaborations that have delivered economic impacts like significant new investments by industry in new processes and the creation of new jobs.

### **Optimising production of turbine parts**

Turbine discs and blades are at the heart of every engine that Rolls-Royce make and the conditions in which they must operate are some of the most extreme to be found in modern-day power systems.

By coupling the Advanced Manufacturing Research Centre's (part of the High Value Manufacturing Catapult) state-of-the-art machining capability with Rolls-Royce's core expertise in machining dynamics, discs were machined using the most optimal surface speeds while avoiding any detrimental vibrational instabilities. The technical methods deployed through the project enabled a step-change improvement in cutting tool performance and processing times, enabling achievement of the ambitious five- to six-fold reduction target in machining operations posted at the start of the project.

The major efficiency savings developed were fully validated by the manufacture of full scale demonstrator components at the AMRC, which underpinned the commitment and launch of the new disc factory by Rolls-Royce in Washington, Tyne and Wear.

Impacts like these are not confined to interactions with large businesses.



### **WeatherSafe**

WeatherSafe Coffee was formed after the Satellite Applications Catapult's first Hackathon in December 2012. The start-up has developed software using satellite data to provide coffee farmers with an early-warning service, coupled with practical and targeted suggestions on the actions they should take to mitigate and prevent risks caused by the weather and climate change. WeatherSafe has gone from strength to strength, attracting interest from all areas of the coffee industry – from scientists and governments to major exporters. WeatherSafe's primary focus is Rwanda but will also begin trials in Central America later this year.

There are also tangible benefits emerging from the Catapults working together across their network and with outside partners.

### **Enabling the UK's first city-scale Internet of Things network**

The Future Cities and Digital Catapults are helping make new services for citizens become a reality by working with leading technology companies, Milton Keynes Council and The Open University to build the UK's first city-wide, open access demonstration network for Machine to Machine (M2M) communications and the Internet of Things (IoT), giving UK firms a strategic lead in unlocking a potential global 'IoT' market opportunity estimated to be worth £11.2 trillion by 2050.

The project will deploy a large number of low power, connected sensors around the city and a range of different business models in a real world environment. It will identify use cases for Milton Keynes Council to meet the needs of its citizens and provide infrastructure for companies and start-ups to use to test commercial applications, new products and services. This will provide a development environment and platform for IoT innovation, attracting global companies to Milton Keynes and in doing so, deliver proof of concept in a real city environment that can be scaled up in cities across the UK and internationally.

Catapults are also beginning to play a role in addressing societal challenges and in helping the public sector achieve key policy objectives.

### **Future Airspace Strategy**

The Transport Systems Catapult has been working with the Civil Aviation Authority (CAA) and air traffic service provider NATS, towards implementation of the air traffic industry's Future Airspace Strategy. This envisions a modernised UK airspace that will offer "safe, efficient airspace that has the capacity to meet reasonable demand, balances the needs of all users and mitigates the impact of aviation on the environment".

The Transport Systems Catapult acted as an honest broker in providing a Departure Planning Information (DPI) solution that is now being deployed across UK airports. The Catapult has enabled the implementation of real time departure information sharing at airports like Stansted and London City, and over 20 UK airports are expected to adopt the solution by the end of 2015.

A new arrival system was introduced in 2014 allowing airports to absorb arrival delays more efficiently and reduce airborne holding by approximately 20%. Preparations are also well advanced to implement time based separations from 2015 to increase resilience by allowing aircraft to fly closer in strong wind conditions.

The Catapults established to date have addressed a critical weakness identified in the UK approach to investment prior to this, which saw funding dispersed across the UK, the resulting centres lacking critical mass and with insufficient attention being paid to factors like their proximity to industry customers.

Innovate UK's impartial approach to identifying a suitable location balances a number of factors including:

- Access to relevant facilities (e.g. for Cell Therapy, links to a hospital and clinicians)
- Presence of a critical mass of industry customers
- Access to potential partners (e.g. leading researchers)
- Local workforce with relevant experience
- Connectivity (eg Transport links)

Whilst Catapults are intended to be single centres of national capability they will clearly have a positive local economic impact. In some cases this is a result of consolidating talent and creativity leading to local spill-over benefits and in others, the Catapult has formed the centre of gravity for the creation of a new industry cluster or supply chains.

Local decision makers recognise this and have taken the opportunity to use local funding streams to support Catapults. Catapults are already engaging locally, and will continue to do so in the future, including with Devolved Administrations and Local Enterprise Partnerships to develop projects of strategic importance to the regions.

### **Centre for Innovation in Formulations**

The North East Local Enterprise Partnership will invest £7.4 million into a formulated product centre at the Centre for Process Innovation (CPI) as part of the Local Growth Fund. The new centre will focus on the areas of radical product and process design.

The new centre will provide facilities and expertise to help companies to develop, prove, prototype and scale up new formulated products. The centre will build on CPI's existing expertise in both formulated product and process design, and will collaborate closely with universities and companies in the North East region and beyond.

*“This new Centre will provide a tremendous opportunity for the region to play a leading role in this broad technology-driven market. It will be a key asset for the UK as a whole, creating new high level innovation-centric jobs, acting as a catalyst for skills development and further establishing the North East as a dynamic, open innovation region intent on securing inward innovation engagement from around the world.”*

Roy Sandbach, Chair, Innovation Board, North East LEP

## Long term commitment

The UK has world-class strengths in research, higher education institutions and the business environment, but it suffers from “.... a sustained, long-term pattern of under-investment in public and private research and development (R&D) and publicly funded innovation.”<sup>21</sup>

*“Catapults are becoming an important part of the UK’s innovation ecosystem and help to fill the serious gap in support for innovation which puts UK businesses at a disadvantage internationally. Raising our performance on innovation must become a national priority on a par with deficit reduction and service reform, and is essential to rebuild our supply chains.”*

Katja Hall, CBI Deputy Director-General

The UK’s total investment in R&D has been relatively static at around 1.8% of GDP since the early 1990s. Whilst the optimal R&D level for countries is context specific, evidence looking at countries productivity levels suggests current UK investment is likely to be sub-optimal.<sup>22</sup> Most leading innovative countries invest more as proportion of their national income: the US at 2.8% of GDP, and with France and Germany consistently above 2% of their GDP invested in R&D, with aspirations to increase to 3% or more. China and South Korea have also significantly increased R&D expenditure.<sup>23</sup>

Before establishing the Catapults, the UK also lagged all EU Member States in the scale of its state funded RTO sector, with investments in France and Germany dominating the sector.<sup>24</sup> The UK does however have a very active and successful private RTO sector which is not core funded by the state – under this wider definition, it would be the third largest in the EU by turnover.<sup>25</sup>

<sup>21</sup> BIS Analysis Paper Number 3: Insights from international benchmarking of the UK science and innovation system

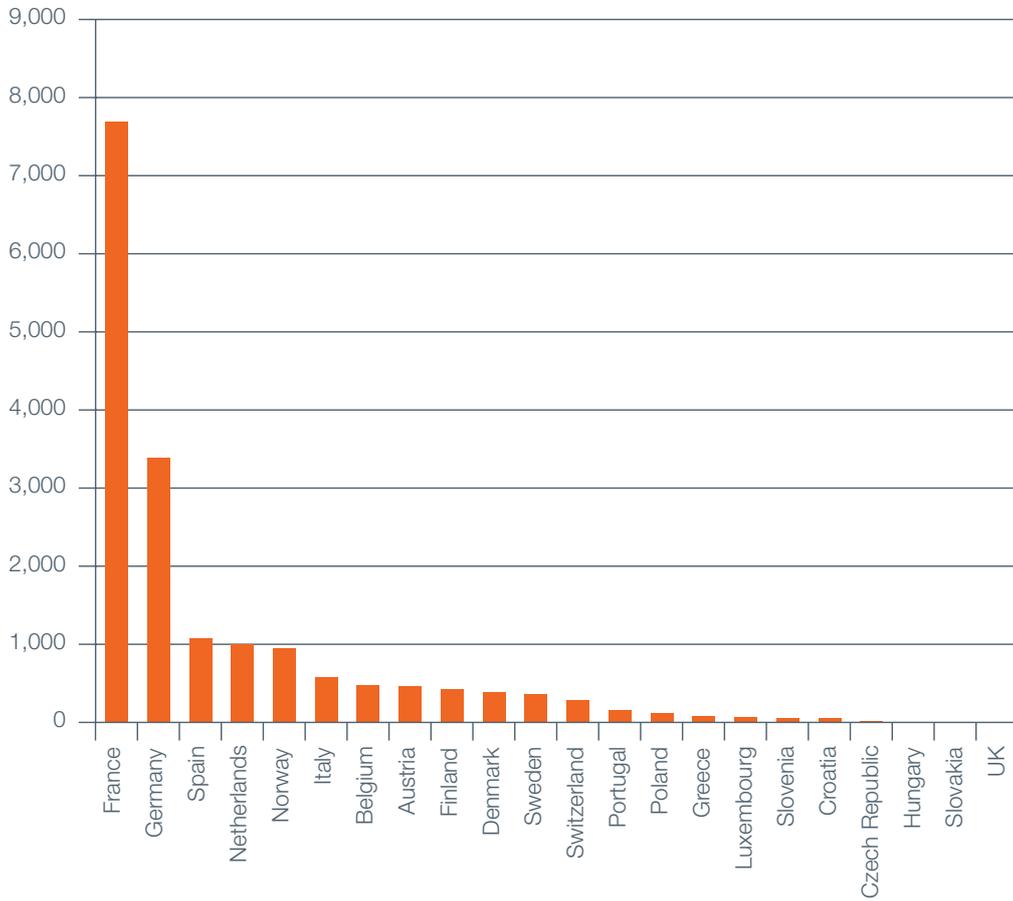
<sup>22</sup> What is the optimal rate of R&D investment to maximize productivity growth? Coccia.M, Technological Forecasting and Social Change 76, 2009.

<sup>23</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf)

<sup>24</sup> Technopolis: Impacts of European RTOs (A Study of Social and Economic Impacts of Research and Technology Organisations)

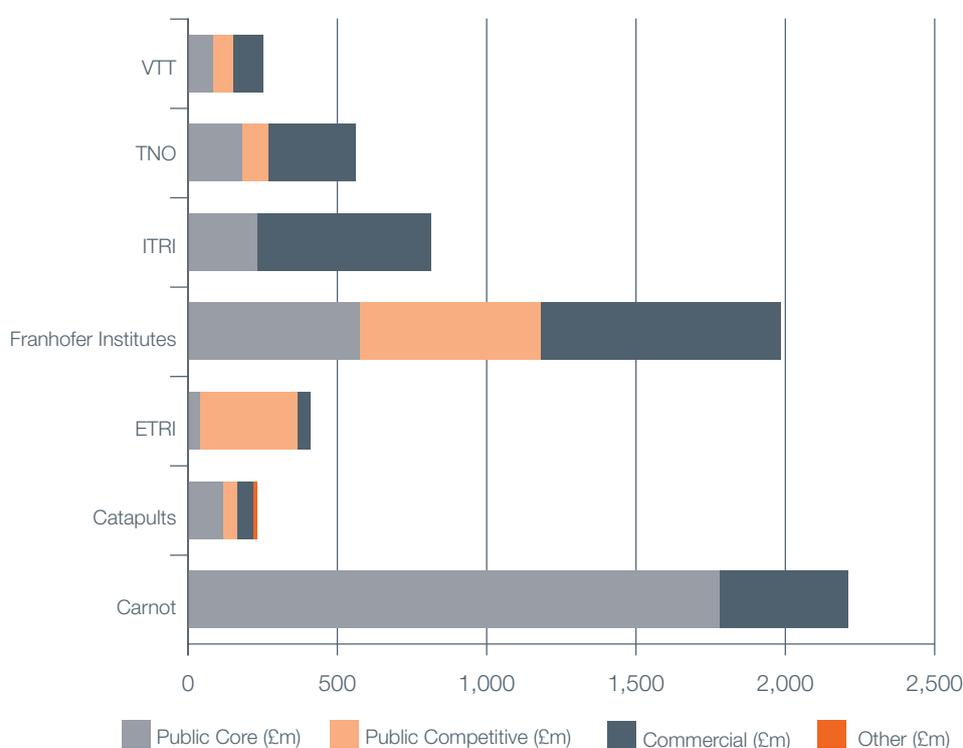
<sup>25</sup> These figures are dominated in terms of turnover by QinetiQ

Annual estimated size of country's state funded RTO sector (€m)



The scale of public investment in the Catapults also significantly lags behind some of our major competitors.

## Funding balance and comparison of the annual turnover of 'Catapult-like' centres worldwide<sup>26</sup>



<sup>26</sup> The figures are based on the following sources and an associated set of assumptions:

- The public contribution to the Carnot centres includes both core and competitive funding <http://www.instituts-carnot.eu/livres/our-network/FLASH/index.html?page=1>
- Catapult centre figures for FY 2013/14, based on an exchange rate of 1.25 and excluding one-off capital uplift, which would otherwise take the public core funding figure to €220 million
- Other figure for Catapults covers membership fees paid by industry to some of the centres comprising the High Value Manufacturing Catapult
- South Korea's Electronics and Telecommunications Research Institute (ETRI) figures are from a 2013 presentation (<http://www.might.org.my/en/MI%20Document/ETRI-%20Jai%20Ho%20Kim.pdf>)
- Figures for Fraunhofer Institutes are from the UK Science and Innovation Network
- ITRI (Taiwan's government-owned Industrial Technology Research Institute), 2012 figure based on an exchange rate of 0.026. No figures however exist for the exact funding 'Rising to the Challenge: U.S. Innovation Policy for the Global Economy' notes that half its operating budget is provided by the government and that the other half is derived from the private sector in the form of licensing fees and payments for contract R&D [https://www.itri.org.tw/eng/UpFile/\\_userfiles/file/ITRI\\_AnnualReport\\_2012.pdf](https://www.itri.org.tw/eng/UpFile/_userfiles/file/ITRI_AnnualReport_2012.pdf).
- TNO (Netherlands Organisation for Applied Scientific Research), 2012 figures – [https://www.tno.nl/downloads/tno\\_annual\\_report\\_2012.pdf](https://www.tno.nl/downloads/tno_annual_report_2012.pdf). The figures include €113m of revenue from ~45 companies in which TNO has holdings of more than 50%
- VTT (Technical Research Centre of Finland), 2013 figures – [http://www.vtt.fi/vtt/vtt\\_figures.jsp?lang=en](http://www.vtt.fi/vtt/vtt_figures.jsp?lang=en)

There is a global race to bring new technologies to market more quickly, to gain first mover advantage and establish a dominant market position. Investment in the Catapults needs to be sustained in the longer term to maintain and increase the impacts and levels of value that have already emerged. Without a long-term commitment from Government to the balanced funding model, Catapults risk becoming focused on established markets where returns are more certain, rather than emerging opportunities which are riskier, but present large potential social and economic returns. Financial constraints will also affect Catapults' broader functions like their ability to engage with and translate knowledge and technology from the research base in-house and make this knowledge applicable in a commercial environment.

*“The existing Catapult centres are still in their infancy and need time to demonstrate their benefit before substantial business income is forthcoming. Notably each Catapult will take a different amount of time to reach this stage... Government needs to provide financial stability for the centres and be patient to allow the model to prove itself.”*

British Private Equity & Venture Capital Association (BVCA)

### **Recommendation One**

- 1.** The UK must maintain its focus and commitment to investing in the existing Catapults, subject to effective performance and relevance, over the long term.

## Maintaining public funding

The principles of the funding model in the UK seek to balance funding between public and commercial sources. Following an early growth phase of typically 3-5 years, when public sector funding will dominate, established Catapults are expected to roughly balance their funding from three sources:

- core public funding for long-term investment in infrastructure, expertise and skills development and carry out applied R&D projects into the key challenges facing their sector
- business-funded R&D contracts, won competitively
- collaborative applied R&D projects, funded jointly by the public and private sectors, also won competitively.

The underlying principle of the funding model is that it provides the right conditions for UK businesses and researchers to collaborate by sharing risk and to focus on the most advanced and risky technologies with the greatest commercial potential. The model is based on international best practice: institutions such as Fraunhofer (Germany), TNO (Netherlands), and VTT (Finland) all lie in the 30-40% core funding range.<sup>27</sup> Secure, long-term core funding is essential to allow the Catapults to carry out applied R&D projects addressing the key challenges and opportunities facing their sectors; it allows them to take-on the new areas that are too large or too risky for individual companies to tackle. These can range from development of new technologies to breaking regulatory barriers. Sharing the development risk between Government and business is vital for preparing UK industry for the future.

The UK private sector does not invest sufficiently in innovation until it is close to market (typically around TRLs 7-9). Evidence shows that without public core funding Research and Technology Organisations move their activities upstream into consulting (rather than R&D/technology transfer) where there are fewer spill-overs and there is a private market already in place.<sup>28</sup> The same research also shows an element of private funding is needed to ensure activities remain market relevant. The third element of competitively won public funding through for example Innovate UK's priority programmes and the European Commission's Horizon 2020 programme allows RTOs and businesses to undertake applied research and technology development that marries knowledge from their own and other sources, which may have significant practical applications in the medium term. The Catapult network's balanced funding model is key to maximising their impact through a balanced portfolio of short to long term projects.

The High Value Manufacturing Catapult has already reached and exceeded the two non-core funding income targets. In 2013/14 the High Value Manufacturing Catapult

<sup>27</sup> <http://www.biginnovationcentre.com/Assets/Docs/Catapult%20to%20Success%20report%20final.pdf>

<sup>28</sup> [http://www.earto.eu/fileadmin/content/03\\_Publications/TechnopolisReportFinalANDCorrected.pdf](http://www.earto.eu/fileadmin/content/03_Publications/TechnopolisReportFinalANDCorrected.pdf)

had 1,515 private sector clients, generating a private sector income of £65 million,<sup>29</sup> in addition to £44 million of collaborative R&D. This put the collaborative R&D and commercial leverage per £1 of Catapult core expenditure at £2.98.

Industry appetite and engagement is welcome, but it reduces the impact of public funding and presents a risk that the Catapults will move their activities to focus on shorter term opportunities if public funding does not also increase. Fraunhofer centres attract 40 cents of additional state funding for every €1 of industry income they secure,<sup>30</sup> subject to this funding falling within the range of 20-50% of the overall turnover of a centre and incentives are also in place to encourage engagement in European Framework Programme projects. A 2009 study of the Danish GTS system,<sup>31</sup> which at the time attracted only 10% core funding, noted that “... *its comparatively low R&D-intensity and unusually strong focus on services means that Danish industry tends to get a lower amount of R&D-related, knowledge-intensive support from its institutes than does industry in other countries*”.<sup>32</sup>

*“It certainly should be the case that Catapults generate a significant amount of their revenue from business. The level of business revenue required by a Catapult must be set sufficiently high to ensure they remain focused on creating commercially exploitable IP through partnerships with business, whilst not forcing Catapults to become so short term in their outlook they cease to be able to fill the gap in the innovation landscape they were created to fill.”*

BCS, The Chartered Institute for IT

The current funding model is therefore key to maintaining a critical mass of activity and leading-edge capability at individual centres. For example, the forecast value add of the High Value Manufacturing Catapult was significant and could continue to grow, provided that additional core funding is secured to match this.

## Recommendation two

2. In keeping with international best practice, public sector funding must be prioritised to maintain the current 1/3, 1/3, 1/3 funding model for existing, successful Catapults.

<sup>29</sup> £21million of which was in kind contributions from industry

<sup>30</sup> See for example [http://www.earto.eu/fileadmin/content/05\\_Working\\_Groups/07\\_Working\\_with\\_SMEs/1.\\_Fraunhofer\\_SME\\_Program\\_Official.pdf](http://www.earto.eu/fileadmin/content/05_Working_Groups/07_Working_with_SMEs/1._Fraunhofer_SME_Program_Official.pdf)

<sup>31</sup> A Step Beyond: International Evaluation of the GTS Institute System in Denmark

<sup>32</sup> The report went on to note that “...the ‘performance’ required of the GTS institutes in the future is not only of services but to a greater extent of capability development, raising the question whether a more open form of core funding would be appropriate in line with international practice”.

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## Growing the network

Many stakeholders noted during the consultation that the UK should lock in funding for the current Catapults before expanding the network. Others were clear that new Catapults should be created where there is a compelling case, to ensure the UK is fully able to exploit global market opportunities in areas where it has natural advantages, like a clear research lead.

Innovate UK selected the established Catapults to complement the support provided to current priority programme areas. Creating the conditions to identify emerging opportunities which may also require Catapults, will become tougher in the future. A more bottom up process will be needed, informed by a detailed analysis of emerging or fast developing topics in the Research Councils' portfolio.

Stakeholders identified numerous areas which appear to fulfil the criteria for a Catapult. These included the green economy (or sustainable economy); climate change adaptation; robotics and autonomous systems; machine learning, translational genetics; next generation computing; internet of things; compound semi-conductors; photonics; water; smart and resilient infrastructure; food security; low carbon transport; non-animal technology; and synthetic biology.

In Germany, there are currently circa 50 Fraunhofer Project Groups and research units in other institutions eager to fall under the umbrella of the Fraunhofer brand and become fully-fledged institutes. These, often time-limited (2-5 years), initiatives are funded on the basis of the plausibility of the R&D market (industry need and interest); current cutting-edge research of the universities; and a unique selling point (i.e. that there is not already a host of other institutes devoted to the same topic/area).

There is currently no comparable process in the UK to seed and take forward future Catapults. However, Innovate UK, in partnership with the Research Councils, allocates a small budget to support early stage technologies or 'emerging technologies and industries'. These are areas that are at an early stage of technology advancement, but with highly disruptive potential. Following an assessment of around 140 different technologies, seven areas have so far been supported coordinated activities focused on knowledge exchange, R&D projects, and investments to build critical mass and nurture capability through the formation of Innovation and Knowledge Centres (IKCs).

Investments in emerging technologies and industries including the IKCs (and other comparable investments by the Research Councils in University based centres) could become the UK's approach to identifying future priority programme areas for Innovate UK, a vehicle for incubating new areas for Catapults, and an effective route by which topics are explored. This would provide the pipeline for generating Catapult prospects, but there would be no guarantee such activities would be future Catapults, as the Catapults must remain business led and oriented.

It will also be important to maintain some flexibility in budgets and approach to identifying potential new Catapults. Scientific breakthroughs and opportunities

may need a more immediate response than is feasible through a structured foresighting process.

Whilst there is scope for growing the size of the network in terms of both market opportunities and UK capability, impact will be limited by the amount of funding that the UK government is prepared to invest in innovation. Catapults must continue to be part of, and complement, a wide programme of innovation investment. Innovate UK's budget would need to grow at a rate that will allow it to provide that wider programme of support as the network grows, to realise the maximum potential of the network. At current levels of funding, Innovate UK will not be able to seed and grow the network of centres and under such a scenario, Innovate UK's portfolio will become unbalanced and the broader programmes within which the Catapults operate 'sub-critical'.

### Recommendations three and four

**3.** Innovate UK should grow the network of Catapults through a clear and transparent process, based on the current criteria, at no more than 1-2 centres per year, with a view to having 30 Catapults by 2030 with total core funding for the network of £400 million per annum.

**4.** Growth of the Catapult budget requires increased funding for Innovate UK<sup>33</sup> in line with recent calls to double UK innovation spend, bringing the Innovate UK budget closer to £1 billion per annum by 2020, such that it can explore and invest in a wider portfolio of emerging opportunities and support the most promising areas at scale.

### Interaction with SMEs

SMEs are important drivers of economic growth and innovation and often the creators of new and disruptive business models in fast moving emerging global markets. Large companies are well equipped to understand the value of, and engage with, Catapults. However, while there are some very good examples of successful interactions with SMEs, the consultation pointed to relatively limited SME awareness and interactions with the network of centres.

SMEs represent over 99% of all private sector businesses, nearly 60% of private sector employment and 48.1% of private sector turnover.<sup>34</sup> They are critical to job creation and play a key role in growth by driving competition and stimulating innovation. However, in 2011 only 37% of SMEs with more than 10 employees

<sup>33</sup> 'Innovate UK will need to run competitive collaborative research and development calls of £300 million per annum in 2030 in the technology areas that Catapults are established to achieve the equal balance between core funding, collaborative R&D and contract research.

<sup>34</sup> BIS Analysis Paper Number 2: *SMEs: The Key Enablers of Business Success and the Economic Rationale for Government Intervention*

reported undertaking innovation activity. Catapults can help address some of the barriers to undertaking innovative activities. *“As production processes become more complex there is an increasing need for firms to engage in Open Innovation; accessing services and working collaboratively to innovate. These issues are more acute for small businesses who lack the scale and scope to develop solutions in-house.”*<sup>35</sup>

The relative lack of SME engagement with Catapults could in part stem from physical distance from the centres. There may also be a lack of clarity among SMEs on the value of the ‘offer’ or how it complements the role of Public Sector Research Establishments (PSREs) and public RTOs.

*“...links between the Catapults and regional businesses and more local engagement activity to stimulate demand and interaction seem to be missing...”*

Heart of the South West LEP

Some respondents view the existence of membership fees in some of the centres within the High Value Manufacturing Catapult as a barrier to entry by SMEs in particular. However, there is no requirement to pay such fees to access Catapults, as this can be done on a (fee paying) project by project basis. None of the Catapults established since 2010 have, nor will they seek to have, a membership fee.

Some Catapults are now exploring ways to improve SME reach including by appointing regional centres of excellence; developing regionally led projects; and trialling processes like incubation deals or hackathons that incentivise SMEs and micro businesses to participate.

### Regional Nodes

The Digital Catapult will appoint three new nodes across the UK, each sponsored by the local LEP, with capabilities to develop data innovation programs and establish links with the Digital Catapult Centre in London. Nodes were identified following an assessment against their:

- Engagement with a local SME population focused on data innovation
- Potential for partnership with local research centres of excellence in data innovation
- Alignment with LEP/DA plans and leverage of EU structural funds.

<sup>35</sup> IBID

### Centres of Excellence

The Satellite Applications Catapult has focussed on developing a deep understanding and strong relationships with the scientific research base and has bolstered regional engagement through co-investment in Centres of Excellence.

Early in 2014, the Catapult launched three Centres of Excellence as focal points for Catapult activity outside Harwell, consolidating the links between the science knowledge base and the business community.

The three centres are:

- The East Midlands – led by University of Leicester in partnership with University of Nottingham and the British Geological Survey; focussing on transport and sustainable living sectors.
- Scotland – led by University of Strathclyde, with partners at the University of Edinburgh. This Centre also links to the Offshore Energies Maritime Programme.
- The North East – led by Durham, addressing all market-led programmes, with a particular focus on maritime and transport sectors.

Catapults will only be relevant to a small proportion of high growth SMEs,<sup>36</sup> but it is clear that every Catapult needs a dedicated SME strategy. These strategies should complement the work of intermediary organisations such as PSREs and RTOs, where relevant, and add value to the wider programme of work supported by Innovate UK to engage with and support high growth potential SMEs – its Knowledge Transfer Network for example, works closely with stakeholders to inform programmes and priorities. Innovate UK has also recently bid to host the Enterprise Europe Network to help connect the innovation landscape; enable SMEs to access funding and finance, including from the EU; achieve greater local connectivity; and to increase synergies between local, national and EU offers, with the potential to create partnerships globally.

### Recommendation five

5. Each Catapult should work with Innovate UK to develop more effective SME engagement strategies. Approaches should include working with local authorities and business groups to reach potential high growth SMEs and important clusters of activity in regions across the UK.

<sup>36</sup> See for example NESTA's report '*The Vital 6 per cent*'

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## Engaging with the research base

Catapults need strong cooperation with Universities undertaking basic research both nationally and internationally to develop their own capabilities.

International Technology and Innovation Centres (TICs) have especially strong relationships and “fuzzy boundaries” with Universities.<sup>37</sup> Arrangements like joint appointments, joint labs, shared infrastructure, and industry projects for student researchers facilitate the flow of scientific knowledge, technical know-how, industry requirements/market insights and human capital. In 2008, Swedish institutes collectively spent 21% of their core funding on joint projects with universities.<sup>38</sup> Many TICs also have complementary collaborative relationships with other mission-oriented research organisations.

The Catapults are developing a range of approaches to engage with the research base including:

- Strategic Relationships – formal partnerships with research base stakeholders;
- Joint Programmes and Projects with the research base and business;
- People and Skills development including formal training provision (e.g. studentships); people exchange mechanisms (e.g. secondments); and Continual Professional Development (e.g. MSc training); and
- Shared equipment and facilities

<sup>37</sup> CSTI POLICY BRIEFING NOTE: Characterising International Intermediate Technology & Innovation Centres

<sup>38</sup> Technopolis (2010) Impacts of European RTOs. A Study of Social and Economic Impacts of Research and Technology Organisations

### Links to the Research Base

The Offshore Renewable Energy Catapult (OREC) has close links with the UK's world leading academic community. The relationship to its Research Advisory Group allows it to present demand-led innovation needs to the entire UK academic community and to engage with and prioritise academic-led solutions and opportunities that can in turn be brought to the Catapult for further development.

By way of example, ORE Catapult worked with Queen's University Belfast to research replacing freshwater with seawater as the hydraulic fluid in the power-take off system. Using freshwater means that if a leak occurs the system has to be flushed out and refilled. This can be expensive and time consuming. Using seawater would mean that the system can be refilled from surrounding seawater and leaks become less important. However, potential micro and macro biofouling by organisms from bacterial to invertebrate scale becomes an important consideration when utilising seawater.

The outcomes of this study are now feeding into ORE Catapult's evolving plans for a programme of environment-focused research, in which biofouling communities and anti-fouling measures are key work streams. Improvements could reduce operational and maintenance costs, making devices more cost effective, improving their availability and providing real benefits to industry.

Interactions like these need to be embedded more consistently across the Catapult network, and as with SME engagement, strategies put in place as new Catapults are established.

*“At present, there seems to be a certain lack of visibility of the Catapult Centres to university computing departments. It is also not entirely clear what routes are available for computing departments to engage with Catapult Centres.”*

BCS, The Chartered Institute for IT

Partnerships with the research base should not be confined to UK Universities. While the UK has a globally competitive science base and Europe produces more scientific publications than any other part of the world, it trails the US in a number of fast moving fields when it comes to the most cited publications. Catapults should explore opportunities to tap into the global knowledge base, including through Horizon 2020, the new Framework Programme for research and innovation. The approach to pursuing opportunities for collaboration through international programmes must be strategic and in line with the Catapults' objectives to deliver real value.<sup>39</sup>

<sup>39</sup> Big Innovation Centre: *RTOs Contributing to Europe 2020 (to be published)*

### International engagement of RTOs

*“The proportion of internationally co-authored papers in VTT’s output is significantly higher than that of Finnish universities, which is 29% (Treuthardt & Nuutinen, 2012). They achieve this partly because they are major participants in EU Framework Programmes and partly because a key part of their role is to interact with global science and technology and make the results and capabilities that are generated available to national industry”*

Roles, effectiveness, and impact of VTT (2013)

### Recommendation six

6. Catapults should develop a stronger more coherent engagement model for working with Universities (national and international), building on best practice, with a view to drawing on and commercialising knowledge to help UK industry gain competitive advantage.

### Measuring success

While the network expands it will be vital to ensure that the impact of individual centres is being understood and captured against the broad impact framework developed for the Catapults.

The metrics for measuring performance must go beyond indicators like turnover, size, volume of R&D or IP registered and licensed. *“These indicators fail to capture their full role in their innovation ecosystem and new metrics are needed for this – to measure, for example, the quality of their relationships with businesses, universities and markets, their convening power, how they leverage their resources and how they identify and manage risk... reflects their own strategic targets and the role they intend to play in the innovation environment for their sector.”*<sup>40</sup>

Maintaining the industrial revenue coming into the Catapults is important as it provides a tangible indicator of the relevance of the work that the Catapults are doing. It cannot however be taken on its own as a KPI. The KPIs must ensure that the Catapults are always working ahead of the market, addressing the challenges and opportunities that are too large or risky for individual companies to address; and that the Catapults continue to take a long-term view of their impact on the sector and look beyond the horizons of their grant funding agreements.

<sup>40</sup> Big Innovation Centre: Catapult to Success: *Be Ambitious, Bold and Enterprising*

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As the Catapults mature it will be necessary to develop more sophisticated KPIs and incentives that drive the optimum behaviours.

Clear definitions of success and a transparent performance framework will give Government and business the confidence to maintain investment. They will also help promote the quality of the UK's innovation infrastructure, which can in turn help build foreign direct investment in the UK. There will necessarily be some variation in impact KPIs for individual centres as they service a range of themes and sectors which differ in maturity, scale and other defining characteristics. However, if a Catapult fails to meet KPIs when these variations have been taken into account, and there are concerns about its future economic impact, Innovate UK should make a judgement about whether to continue to invest in it or to reallocate funding elsewhere.

### Recommendation seven

7. Innovate UK and the Catapults should work together to develop more sophisticated Key Performance Indicators (KPIs) that sit within Catapults' Grant Funding Agreements, that incentivise impact and engagement with industry whilst still ensuring that Catapults work ahead of the market. These should reflect the difference in the sectors and the maturity of the relevant centre.

### Wider roles

The Catapults are uniquely positioned to add value beyond their core roles of providing a business-focused capability and relevant expertise.

The flow of skilled personnel between Catapults, the research base and industry increases the transfer of knowledge and the development of skills. The most mature Catapult, High Value Manufacturing, has now begun to identify wider skills gaps in its sector and has developed a more active role in addressing these shortcomings.

*“The catapults have a role in defining the next generation skill requirements that are applicable to effective deployment and integration of new techniques and technologies into commercial organisation.”*

BAE Systems, Military Air & Information

### **Skills Development at the High Value Manufacturing Catapult**

New Training Centres have been established at the Advanced Manufacturing Research Centre and the Manufacturing Technology Centre, which form part of the High Value Manufacturing Catapult.

In doing so, HVM Catapult is developing a cadre of technologists and engineers with cross sector design and manufacturing skills focused on the management and delivery of innovation. Involving all centres, a single programme of work is in place to develop this further, enabling HVM Catapult to offer industry a comprehensive skills solution for High Value Manufacturing.

Entrepreneurial training could also increase the capability of the businesses working with Catapults to take full advantage of the opportunities available to them – raising their absorptive capacity and that of the sector.

Links have also been made to the finance and investor community. The Satellite Applications and Transport Systems Catapults have had exploratory discussions with the British Business Bank and the Offshore Renewable Energy Catapult with the Green Investment Bank.

### **Attracting start-up capital to the Space sector**

A lack of awareness and understanding of the space sector within the venture capital community has resulted in a lack of start-up capital available to small businesses. The Satellite Applications Catapult (SAC) has actively addressed this issue, by assisting in raising a space related fund, increasing the understanding and knowledge within the financing community, signposting and mentoring SMEs seeking to raise funding and playing an active part in the Satellite Finance Network (SFN).

For example, Oxford Space Systems recently secured £500k of funding from a VC investor with the help of SAC, including support through negotiations. SAC support for SFN enables the network to deliver annual conferences to attract and inform SMEs, as well as raise awareness within the finance community. This goes some way towards overcoming the market failure of information asymmetry in the sector.

The policy landscape within which individual Catapults operate can help or hinder the rate at which new technologies are commercialised. Given their convening power, Catapults could provide an informed view to policy-makers on the barriers to innovation, and the value of potential policy choices in their sectors.

Caution must be exercised when expanding the Catapults' remit. They can play an important role in the development of skills, regulations and policy. Where this comes naturally in the context of technology development (for example, regulations in Cell Therapies), it should be pursued. Elsewhere, the Catapults should, in the short term at least, concentrate on their core technology mission. In time, as has been the case with High Value Manufacturing, they can develop an understanding of wider requirements in their sectors and consider taking on a more formal role in developing these or in providing advice on framework conditions.

### **Recommendation eight**

- 8.** Once established, Catapults should take advantage of their role as a neutral convenor to identify and help address wider barriers to innovation and commercialisation, and work with relevant parties to inform and deliver solutions. These could include regulatory and non-technological barriers such as business models and skills requirements.

### **The Catapult brand**

A coherent and easily understood innovation landscape ensures business confidence and the most efficient and impactful application of funding. In many countries where structured networks of Catapult like centres exist, a common brand is used to identify organisations that are part of a wider network, and provide assurance to business and other potential partners. This also enables the network to promote itself and compete effectively both nationally and internationally.

The definition of what a Catapult is and what its role should be in the system is very clear. Government should ensure that where it seeks to create new institutions in this space and where the pipeline approach identifies new emerging areas of potential Catapult interest, that they are developed through the Catapult process and are able to derive the benefits of being inside the Catapult network. This will avoid the risk that the landscape lacks coordination or alignment with national priorities or strengths.

### **Recommendation nine**

- 9.** Government should ensure that the 'Catapult process' developed by Innovate UK is used when deciding whether a business-led, physical infrastructure based initiative should be supported.

# Annex A

## The Catapult Network – Demonstrating Additionality<sup>41</sup>

This annex covers two key areas:

- An outline of the overarching evidence on the additionality of the Catapult network
- A brief summary, *Catapult by Catapult*, of how additionality is already being demonstrated across the network. Given the nascent state of most centres at this point, the evidence presented here is generally of a qualitative nature – hard impact additionality evidence will be addressed as part of the long term evaluation of the Catapult network.

### Overarching Evidence

The UK Government has an **active role in fostering innovation**. Government action aims to overcome barriers to innovation and unlock the UK's full potential. To maximise impact, our innovation systems must be interconnected and coherent, reflecting the shape and priorities of the economy as a whole.

Evidenced **market and system failures** show why there is additionality to public spending on innovation in the UK.<sup>42</sup> Without Government intervention, these failures will naturally lead to sub-optimal investment in innovation, to the detriment of UK economic growth. The Catapult Network helps to overcome these barriers.

**Facilities** provided by the Catapults are often one-of-a-kind in the UK. The Catapults provide facilities which suffer from natural monopoly, or indivisibility issues, due to their high cost. The intermediate sector addresses some of these issues; however there is still a shortfall of capital. SMEs could not afford to invest in such facilities, and anecdotal evidence suggests that even large companies would not invest in such facilities due to the associated level of risk.

**Global organisations** who invest in R&D are entirely mobile and will seek to invest their R&D resources in the localities where the environment is most suitable and in particular where there is a strong level of Government support and investment.<sup>43</sup> Catapults act to anchor investment in the UK. Without the work of the Catapults these investments would not necessarily occur. There are a number of international businesses, currently working with different Catapults, who have made this quite clear.

<sup>41</sup> HM Treasury guidance on appraisal and evaluation defines additionality as the impact arising from a Government intervention that would not have occurred in the absence of the intervention. It is the net, rather than gross, impact after making allowances for what would have happened in the absence of the intervention.

<sup>42</sup> BIS (2014) The case for public support of innovation at the sector, technology and challenge area levels

<sup>43</sup> See IFS (2006) University Research And The Location Of Business R&D <http://www.ifs.org.uk/wps/wp0702.pdf>

Catapults also increase the **scale, speed and scope** of commercialisation.<sup>44</sup> Activities are more likely to focus on riskier investments, which have higher societal payoffs. Projects are undertaken more collaboratively, enhancing the dissemination of knowledge created (positive externalities) and increasing the involvement of SMEs. In a globally competitive environment, commercialising swiftly and effectively can make all the difference between being a market leader or a market follower. Recent analysis has demonstrated a relative weakness in UK firms **'capturing' the value of innovation** investment, leading to a long tail of relatively unproductive firms in the UK. General deficiencies in 'complementary assets and business support' are an issue.<sup>45</sup> Catapult centres provide direct access to these types of support.

There is strong evidence that direct public investment in R&D to support innovation, **leverages extra investment from the private sector**. Most studies find a positive effect of Government funding on privately financed R&D.<sup>46</sup> Moreover, a report produced by PACEC for Innovate UK in 2011, documented the findings from an evaluation conducted to assess the economic impact of collaborative R&D, which constitute a third of Catapults funding. The report finds that for each £1 of public investment in collaborative R&D there was a GVA return of £6.71, once allowances are made for deadweight and displacement. The report only considered the benefits gained as a direct result of the project, and did not include any calculation of spillover impacts.<sup>47</sup>

As a programme targeted at large global markets, through development of multi-application and disruptive technologies, based on an understanding of **open innovation**, Catapults would be expected to have large **positive spillover effects**.<sup>48</sup> A recent BIS literature review of innovation provides strong support for the contention that direct public investment in R&D leads to additional UK economic output for that firm and the wider economy.<sup>49</sup> Private returns from business R&D were found to be 30% per annum, with social returns recorded at 2-3 times this level.

Furthermore, evidence suggests that direct public investment in R&D leads to a **long run increase in firm's absorptive capacity**. For example, research by Roper and Hewitt-Dundas<sup>50</sup> found for manufacturing firms innovation support directed at

<sup>44</sup> Innovate UK evaluation of CR&D showed that of those that would have proceeded without support 83% would be delayed- by 1-2 years and 21% would be delayed by 3-5 years. Also 52% would have done so at a smaller scale and 35% with a different scope. See Technology Strategy Board (2011) Evaluation of the Collaborative Research and Development Programmes

<sup>45</sup> BIS (2014) UK Innovation Survey: Innovative Firms and Growth

<sup>46</sup> See for example, Guellec and De La Potterie (2003) The impact of public R&D expenditure on business R&D

<sup>47</sup> Technology Strategy Board (2011) Evaluation of the Collaborative Research and Development Programmes

<sup>48</sup> According to a recent BIS paper, Catapults would be expected to have the greatest potential for spillovers of all Innovate UK programmes. See BIS (2014) An Economic Analysis of Spillovers From Programmes of Technological Innovation Support

<sup>49</sup> BIS (2014) Rates of return to investment in science and innovation

<sup>50</sup> Roper S. & Hewitt-Dundas, N. (2014). The legacy of public subsidies for innovation: input, output and behavioural additionality effects. ERC Research Centre draft

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new product development leads to an additional, persistent increase in firms broad capability through both better technical skills and through the creation and more effective use of networks. Other evidence from a cross country study has shown the **value of innovation is often understated** in social rates of return, as the impacts on absorptive capacity are not measured fully.<sup>51</sup>

## Catapult Specific Information

A short summary is provided below for each Catapult, highlighting key areas where they are already demonstrating additionality, or putting in place the right conditions to achieve additionality. The activities described provide just a snapshot of the many important projects Catapults are currently engaged in.

### Cell Therapy Catapult (CTC)

CTC have developed a portfolio of projects ranging from tackling of immediate needs, to long-term issues for the industry. CTC's levels of industrial demand since inception in 2012, continue to grow and to date they have exceeded all CR&D grant and commercial income KPIs.

An early example of CTC's added value is its collaboration with ReNeuron, a leading UK cell therapy company, on its flagship product. CTC worked with the company on making the manufacturing processes for the CTX stem cell line commercially ready. Following the initiation of the collaboration ReNeuron received a £33 million financing package from a group of funders and institutional investors, enabling it to position itself as a global leader in stem cell development. Without CTC's validation ReNeuron would have lacked important support for the financing.

The benefits of this collaboration include the development of new expertise at the Cell Therapy Catapult that can be used to accelerate the growth of the industry. In addition, it has helped a leading cell therapy company cement its position in the UK, assisted in development of its new medicines, and enhanced its commercial and competitive edge. Prior to this project with the CTC, ReNeuron was contemplating relocating its operations outside of the UK. The company has now decided to remain in the UK following the results of this successful partnership.

### Digital Catapult

The Digital Catapult is working on a mix of projects all comprising of a number of iterative phases (feasibility, pilots, scale-up) so it is too early to identify significant economic outputs. However, measures of activity and trajectory associated with these project activities are encouraging.

<sup>51</sup> Griffith, R., Redding, S. & Van Reenan, J. (2003). R&D and Absorptive Capacity: Theory and Empirical Evidence. *Scandinavian Journal of Economics*, 105, 99-118.

The Digital Catapult is helping SMEs and the industry as a whole, to unlock specific challenges around data and creative content innovation, and using its neutral convenor role to develop projects to address these complex challenges, which often span public and private sector organisations and the fusion between Creative and ICT.

An early example of the Digital Catapult putting the right conditions in place to achieve additionality, is the Copyright Hub. The Catapult and the Copyright Hub Company have partnered to convene a wide range of industry competitors. They have agreed the specification of a pilot platform, which will in time, enable easier licensing of content, enabling individuals to get the permissions they need to use copyright material with a single click. This is an example of the Digital Catapult helping industry as a whole unlock specific data challenges, overcoming a network/coordination failure, and creating a wider benefit. The Copyright Hub will create the means for copyright to work better online, linking together existing content hubs so they can be accessed by a wider audience and providing much simpler licensing of content with lower transaction costs. The Hargreaves Review<sup>52</sup> in 2011 identified potential benefits of up to £2 billion to the UK economy by 2020 if this could be done effectively.

The Digital Catapult is also enabling SMEs to innovate, by using the platforms and capabilities they create. One of their key streams of activity involves integrating diverse data sets so they can be used to develop new products and services. The Digital Catapult adds value here in its role as a neutral convenor; a single innovator would not have the resources to pull together these potentially valuable multiple diverse data sets. An example of this is the Manchester Open Data Synchronisation project which addresses the issue of fragmentation of local council's data. The Digital Catapult's role has been to work with councils and local partners to release data in a unified format to enable innovators to develop new products and services. The first phase attracted 20 developers to a hackathon event, over 800 repeat development users and has so far led directly to two SMEs developing commercial products using the data.

### Future Cities Catapult (FCC)

With more and more of the world's people – and economic activity – concentrated in cities, the global market for integrated cities solutions will be worth around £200 billion by 2030.<sup>53</sup> The UK, with its related strength in business, academia and urban innovation, is well placed to service this market. The core government funding for Future Cities Catapult helps to further develop these capabilities by stimulating the innovation, the testing at scale, and the commercialisation, of new urban solutions.

<sup>52</sup> DigitalOpportunity: A Review of Intellectual Property and Growth <http://www.ipo.gov.uk/ipreview-finalreport.pdf>

<sup>53</sup> Future Cities (2014) UK capabilities for urban innovation. A report by Future Cities Catapult and Arup, with research from The Work Foundation and in association with UKTI

A significant barrier for both companies and city administrations is a lack of demonstration and validation at scale and in use.<sup>54</sup> 'Cities Unlocked' has brought together Microsoft, Guide Dogs for the Blind, Network Rail and Transport for London, along with SMEs MiBeacon and Mubaloo, to test new technologies that help blind and partially sighted people navigate cities. These kinds of partnerships are allowing firms to test complex solutions, as well as build confidence amongst clients to purchase them. Even at this early stage, all FCC's pilot projects with business, academia and cities throughout the UK have secured match-share funding and in-kind support.

No individual company has all the skills necessary to deliver the requirements of cities in the future. Even the largest ones find it difficult to build broad enough collaborations to meet the challenge. This is a particular problem for smaller innovative companies. FCC fulfils a vital role in addressing this capability failure in the sector.

### High Value Manufacturing Catapult (HVMC)

The HVMC has experienced significant levels of industrial demand since its inception in 2011. This industrial demand has, and will continue to leverage significant amounts of funding from the private sector (which currently accounts for 45% of HVMC's income). Industrial investment in HVMC is considerably beyond the levels forecast in the original plan.

Collaborative working between the centres ensures the impact made by HVM Catapult is 'greater than the sum of its parts.' There are a number of examples of collaborative working between all seven of HVMC's centres.

There are a diverse range of examples where both small and large companies have undertaken work with HVM, delivering a commercial benefit that could not have otherwise been achieved, because they do not have access to the equipment and expertise (and either cannot afford to acquire it, do not wish to take the risk to acquire it, or cannot justify acquiring it until it is proven as effective). Moreover, this is capital equipment the TIC centres which make up the Catapult struggled to finance before core funding was achieved.

PolyPhotonix, an SME, which has developed a therapeutic device for macular degeneration, has been advised by the NHS that its two optical applications will save them £1 billion per annum. This device, developed with the help of CPI, is currently in Phase 3 clinical trials. Using CPI's facilities means that PolyPhotonix did not need to invest in equipment which would prove prohibitively expensive to a start-up. PolyPhotonix CEO Richard Kirk spoke positively about the support offered by CPI.

<sup>54</sup> TSB (2013) Technology Strategy Board 2013-14 Delivery Plan <https://www.innovateuk.org/documents/1524978/2138994/Delivery+Plan+-+Financial+year+2013-14/c435471d-222c-4e63-8269-d0f4b2b61c2f>

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*“Remaining lean and responsive – with short chains of communication between us and CPI – has given us the freedom and flexibility to react to new opportunities. We are able to book time and space in the clean room and to use the equipment we need when we need it. Although we operate as a private company, CPI’s extensive resources and support have enabled us to grow at a realistic pace. Quite honestly, without CPI we wouldn’t be here – that’s the bottom line.”*

Richard Kirk, CEO Polyphotonix

Cutting tool developer Technicut and toolholding specialist Nikken Kosakusho worked with the AMRC to prove that a new tooling system can achieve record-breaking rates of metal removal. Technicut has won new business and grown its workforce as a result of the collaborative research and networking opportunities. The patented system is now in production, and being deployed around the world. Consequently, Nikken is also investing in a new European research and development centre on the R-evolution development at the Advanced Manufacturing Park, next to the AMRC.

Both the above examples highlight the ability of HVMC to increase the scale, speed and scope of commercialisation, and to anchor jobs and investment in the UK that would otherwise be lost overseas.

### Offshore Renewable Energy Catapult (ORE Catapult)

The ORE Catapult is adding value to the industry in its role as an impartial convener and trusted collaborator. Data-sharing is critical to lower cost of energy in offshore renewables, but commercial sensitivity often prevents competitors from sharing, this could be described as an information asymmetry or network failure.<sup>55</sup> SPARTA (System performance, Availability and Reliability Trend Analysis) is a major new collaborative project between ORE Catapult, The Crown Estate and offshore wind farm owner/operators, which aims to overcome this barrier. The project will create a database for sharing anonymised offshore wind farm performance and maintenance data. Huge financial benefits can be derived from SPARTA for the industry through increased yield, better operations and management strategies and improved reliability – high level estimates put this at £200-300 million over the next 5 years. These benefits would not be possible with ORE Catapult operating in its role as a trusted and impartial organisation that can mediate between competitors and facilitate data-sharing.

<sup>55</sup> TINA (2013) described this failure as ‘important’. See TINA (2013) Offshore Wind Power: Summary Report.

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ORE Catapult is also demonstrating additionality by serving technology testing markets with unique equipment. Testing leads to design improvements and ultimately reduces costs, and while there is a commercial demand for these assets from large and small companies, there is little private sector appetite to risk such a large capital outlay for uncertain returns. ORE Catapult provides facilities for testing blades 50m and 100m long, and for turbines of 3MW and 15MW rated capacity. Operation and management of the UK's fleet of 5500 turbines is estimated to cost almost £2 billion per annum by 2025: improved reliability is key to reducing this cost. By accepting the commercial risk and offering asset testing services, ORE Catapult is addressing a market failure and demonstrating additionality. The risk is considered worthwhile overall because it helps cultivate domestic expertise, delivers value to the British economy that outweighs the risk of commercial losses, and serves a market that supports the government's objectives of improving energy security and achieving greenhouse gas emission reductions.

### Satellite Applications Catapult (SAC)

Since its inception in April 2013, the Catapult has experienced growing demand for its services, such as access to facilities, expertise and jointly-funded collaborations. This demand is industrially driven and has leveraged significant additional funding to the Catapult, forecast to be approximately a quarter of total income in the current financial year.

A significant barrier in this sector is a lack of awareness of the potential benefits from satellite technology. The Catapult has established a number of important partnerships with organisations outside the space sector as part of its remit to inform and attract such users to satellite applications. A key collaboration has been with The Pew Charitable Trusts, a US philanthropic organisation with an ambition of eliminating illegal fishing in 10 years. The Catapult has been match-funded to build a prototype for a fishing monitoring tool which fuses satellite data and vessel information to detect and track illegal fishers.

Another 'blocker' in this sector is the lack of start-up capital available to small businesses. Again, this is largely due to a lack of awareness and understanding of the space sector within the venture capital community. The Catapult is addressing this issue by assisting in raising a space related fund, increasing the understanding and knowledge within the financing community, signposting and mentoring SMEs seeking to raise funding and playing an active part in the Satellite Finance Network. This goes some way towards overcoming the market failure of information asymmetry in the sector.

SAC's facilities, coupled with their on-site expertise, have enabled large and small companies to increase the speed and viability of their projects, and have also secured and encouraged overseas organisations to the UK. One example of this is the video wall, one of only a handful in the UK, providing the opportunity to see earth observation and science data in high definition. This facility has multiple private sector users, including Airbus who used the facility as a remote control centre for their simulate rover mission to Mars.

### Transport Systems Catapult (TSC)

The Transport Systems Catapult (TSC) has defined a market in Intelligent Mobility – worth over £900 billion a year by 2025 – and have been shaping the UK's long-term strategy to become a leading player in this market. With its neutral position in the market and world-leading industry-supporting capabilities, the TSC is best placed to focus on this emerging market, no individual private sector organisation has the knowledge, capability or financial motivation to do so.

The TSC has delivered a range of early impacts across a number of different mechanisms. The TSC is helping to catalyse industry-wide initiatives. For example, through the Departure Planning Information (DPI) programme the TSC is managing the upgrade of flight departure information at both major and regional airports, providing more accurate take-off data. Due to the range and diversity of the organisations involved, deployment had been at risk of stalling, but the TSC's intervention has enabled momentum to be maintained. TSC's role with the DPI programme demonstrates the importance of having a neutral player to facilitate investment that benefits a whole sector, but which could be hampered by disagreements between (often competing) organisations over who should pay for what, and when. The total direct benefit of the TSC intervention is estimated to be around £11.6 million over the next five years.

The TSC is leading on the coordination, exploration and physical demonstration of 'at scale demonstrators', such as the LUTZ Pathfinder autonomous vehicles programme. These demonstrators bring together a range of stakeholders to trial technology in a system context, thereby accelerating the maturity of the technology and generating increased confidence and demand from industry. The TSC is enabling demonstrations to take place on a larger scale and in more representative environments than would otherwise happen, primarily through collaborations between academia, industry and local and national government.

# Annex B

## Terms of Reference

Timescale – Delivery by Summer 2014 (feeding into the Science and Innovation Strategy by Autumn Statement 2014).

1. Is the policy as set out in 2010 working – review where the network has got to versus the original policy intent, this will be driven from network review, metrics review and interview-based research with business, academics and stakeholders.

2. What should the future direction for scope and scale for the network be?

Including consideration of:

2.1 Organic growth

2.2 Distinct Catapult models – challenge (e.g. Future Cities), technology (e.g. Offshore Wind), network (e.g. High Value Manufacturing)

2.3 Is there a role for adding other (Catapult-like) centres to the network, can the model be franchised in any way?

2.4 The role of the network in delivering the Government's Industrial Strategy

2.5 The role of the network in pulling through to commercial application, the Eight Great Technologies.

3. International strategy – linkages worldwide and particularly within Europe alongside other Centres (informed by work already underway with BIG Innovation Centre)

4. What would be the best funding model for a larger more ambitious network if that is the result of section 2?

5. How best does the Catapult Network sit within, and connect to, the rest of the Government's interventions such as British Business Bank, Green Investment Bank, Growth Accelerator, other Technology Strategy Board programmes, other innovation players.

# Annex C

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Hermann Hauser  
Partner  
Amadeus Capital Partners Ltd  
Mount Pleasant House  
2 Mount Pleasant  
Cambridge  
CB3 0RN

As you know, following your review of the future role of technology innovation centres in 2010, we committed to opening seven Catapult Centres in the Government's Plan for Growth. All Catapults are now open for business, are making very strong progress, and have become central to the delivery of the Government's Industrial Strategy.

Whilst it's still too early to judge the success of the still emerging Catapult network there are extremely encouraging signs that the more established centres are already pulling through new investments and all of them are actively shaping powerful new partnerships and strategies. But we must continue look to the future needs of the economy and consider what sort of network we need to aim for in the next 10-15 years.

I have therefore asked my officials and the Technology Strategy Board, to work closely together to review progress to date and to develop a proposal for the rate and nature of expansion of the network. Key questions this review will address include the right balance between a focus on increasing the scale of the existing centres and the scope of the network, to bring in other key sectors and markets. I attach a copy of the draft terms of reference.

I would like to invite you to lead this review provide expert and independent oversight. I am particularly keen to ensure that as we move forward we seek to stay true to your original concept. I understand you have been consulted on this and have indicated you are open to considering such a role.

The review will commence early in the New Year and will feed into the Science and Innovation Strategy due to report at Autumn Statement 2014.

I do hope you are willing to accept this role and I look forward to hearing from you.

DAVID WILLETTS

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Any enquiries regarding this publication should be sent to:

Department for Business, Innovation and Skills  
1 Victoria Street  
London SW1H 0ET  
Tel: 020 7215 5000

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BIS/14/1085