

Innovation by design

How design enables science and technology
research to achieve greater impact



“The Valley of Death – everyone talks about conquering it, but if you visualise commercially-minded people on one side and scientists on the other, we need a bridge in the middle to meet halfway. Where scientists need an appreciation of market orientations, the commercially-minded have to have an appreciation of the science and its development. The UK has been inventing for years but has not been very good at commercialisation – now we’re trying to do that, and design is a huge part of that.”

Keith Dobson, Head of Business Development, NPL



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Introduction

The UK has a phenomenal scientific research base. Its universities are amongst the most successful in the world for scientific discovery, coming second only to the USA for research citations. This cutting-edge science and innovation base is at the heart of plans for long-term economic growth and is crucial to our ability to cope with urgent and complex societal and health challenges such as obesity and dementia.

But the UK is lagging behind other countries in making the most of these kinds of opportunities. We invest less in research and development and our innovation system often presents formidable obstacles in getting scientific ideas and discoveries to market.

Creating the right environment for science innovation requires a strong pipeline of talent and skills from schools to universities and professional research. Also vital is a place-based approach to strategic planning: science facilities must have the right transport infrastructure and proximity to businesses and housing. The right tools and methods to catalyse innovation are also key.

Design is one of the most powerful tools we have for this and for smoothing the journey from research insight to practical, marketable applications. It provides structure and focus to the innovation journey by helping to find practical applications for research insights and mapping the route from idea to market proposition.

To provide an evidence base on the role of design to aid research commercialisation, in 2014 Design Council commissioned an evaluation report from Technopolis Group on the role of design in the commercialisation of science and technology. The research was conducted between April and October 2014, and consisted of a focused literature review, two surveys, respectively of programme beneficiaries and non-beneficiaries, a set of 20 stakeholder interviews, and ten case studies of commercialisation projects supported by Design Council.

This report is particularly timely, as it coincides with several key developments in innovation policy both in the UK and beyond. In particular, the Department of Business, Innovation and Skills' (BIS) Science and Innovation Strategy (2014) aims to further focus efforts to support business investment in R&D, as well as to increase use of the UK's science and innovation systems to support Small and Medium-Sized Enterprises (SMEs). The strategy includes strong references to the importance of design:

“The UK is world-renowned for its design capability – capability that is championed nationally by Design Council as a means to create better places to live, better products to use and healthier living.”

Commercialising science research is also a central pillar of the UK's Industrial Strategy (2012), which coincides with wider developments at the EU level. The importance of design as a key discipline and activity to bring ideas to market has been recognised in commitment 19 of Innovation Union, a flagship initiative in the Europe 2020 Growth Strategy.

This consensus has most recently resulted in the European Commission's Action Plan for Design-Driven Innovation, which, over the next two years, aims to spread awareness about design for growth and consult on ways to build greater design capacity into businesses across all member states.¹



Key findings

The research demonstrates that design accelerates commercialisation and increases value. Specifically, the evidence highlights the following main benefits to commercialisation projects:

- 1 Greater ability to secure further development funding
- 2 Clearer communication of new technology to potential investors
- 3 Improved prototyping, fundraising pitches and market entry strategies.

Based on this evidence, design has the potential to improve the productivity of UK technology transfer and increase both the proportion of university Intellectual Property (IP) that finds application in society and the absolute number of high-growth, star performers.

Beyond these direct effects on specific commercialisation projects, we also find that design support has considerable spillover effects on other projects, as well as on the Technology Transfer (TT) organisations as a whole. Moreover, we find that several instances of design support – be that in the form of project mentoring or training days for TT staff – have a cumulative effect.

As a result of multiple instances of support, design capacity is built up, resulting in overall benefits to the Technology Transfer Office's (TTO) operations:

- 4 Increased ability to identify commercial viability of new technologies
- 5 Better portfolio management and risk reduction
- 6 Increased links between TTOs and the design industry.



University commercialisation in the UK

TTOs are no longer viewed purely as a vehicle for one-way linear transfer of technology from laboratory to market. They are instead understood as key linkage and communication points between research, industry and government, where technologies themselves, as well as expertise from within the research community, are shared with the outside world, but where expertise, demand and opportunity are also brought into the research institution from elsewhere.

They are vital in helping technologists navigate the legal and regulatory hurdles they face from early-stage development through to commercialisation and identifying opportunities such as funding. What they tend to lack, however, is the expertise needed to help turn innovative science and technology research into viable, profitable products and/or services.

Following the recent recession, there was a refocus of government policy to better target public investments for stimulation of private-sector growth. This was especially the case for higher education institutions. While, for the most part, higher education and research funding is distributed via HEFCE through the Research Councils on the basis of peer review and academic merit (known as the Haldane principle), the new impact agenda has led to a greater need to ensure research is used beyond the academic sphere. There is additional incentive directly through BIS and Innovate UK to focus research specifically on areas of high potential growth.²

“The impact agenda is absolutely imperative to the prosperity of the UK.”

Dr Malcolm Skingle, Director of Academic Liaison, GlaxoSmithKline⁶

TTOs cannot therefore simply be understood as standalone organisations aiming to generate revenue through assisting academics with the commercialisation of their research. Instead, they play an increasingly significant part in aiding the impact agenda, as well as the changed focus of government policy to stimulate private-sector growth through higher education institutions.

As such, the importance of technology transfer facilities at universities has increased significantly, and more training and resources have been diverted to these endeavours in recent years. The role of design support needs to be understood in the context of this changing mission and funding landscape.

“‘Design’ is what links creativity and innovation. It shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end.”

The Cox Review, 2005

The benefits of design

Interest in the topic of design and its importance to innovation and economic growth received a major boost through the Cox Review in 2005.³ Highlighting the strongly increased competitiveness of emerging economies such as China and India, it concluded that the UK needed to better draw on the strength of its creative industries, especially design, to remain a strong global economic player.

It also highlighted the fact that while the use of design has demonstrably positive impacts on economic performance, businesses – especially SMEs – are unable to draw on the UK’s existing design expertise. Key reasons cited were prohibitive cost and lack of knowledge and understanding of both design’s benefits and where to find appropriate design support.

The review recommended that Design Council’s Design for Business programme be significantly expanded to raise the profile of design in UK SMEs and build a greater overall design capability. Since then, Design Council has had an increasingly important role in providing

design support and raising the profile of design. In the Innovation and Research Strategy (2011), BIS acknowledged the strategic importance of design for innovation, noting:

“Most successful high-tech businesses are design and technology-driven. However, there are parts of the economy where design awareness remains low, including amongst SMEs, scientists seeking to commercialise new ideas and the public sector.”

BIS Innovation and Research Strategy 2011

Most recently, the Witty Review noted Design Council as one of ten key government-supported innovation support organisations, alongside actors such as Innovate UK, UKTI, and HEFCE.⁴

The Design Leadership Programme⁵ provides design support to businesses, particularly SMEs, public-sector organisations, start-ups, and the university research base.



“Growth is dependent on innovation – it’s a key determinant of our economic success. Innovation is more than just technological innovation. It includes a wealth of creative endeavours and, of course, the design of new processes and changing the way people interact with the world.”

Rosa Wilkinson, Innovation Director, IPO

Adding value and raising investment

The capacity for design to add value to commercial endeavours is well known. A 2009 report calculated design expenditure in the UK at around £50bn annually,⁶ highlighting the importance businesses more broadly attach to design. A 2012 study showed that, on average, for every £1 businesses invested in design, they gain over £4 net operating profit, over £20 net turnover and over £5 net exports.⁷ More broadly, businesses that invest in design have approximately 50% better long-term financial performance than businesses that do not.⁸

In the institutions and institutional links that comprise a national innovation system, TTOs are a prime example of intermediaries between research and business. Less well-explored are the skills, processes and tasks needed for institutional linkages to function properly and result in a climate of widespread innovation. Lack of expertise rather than economic or infrastructural factors is increasingly seen as a major barrier, categorised as “capability failure”, “soft institutional failure” or “soft network failure.”⁹ Design is evidently a prime candidate to fill the gap.¹⁰

Working with universities

Design Council support for universities has run since 2010, first as a free programme under the banner Innovate for Universities, and, since 2012, as part of the wider Design Leadership Programme, with 50% match-funding contributions from BIS. Much of the programme is led by Design Council Design Associates (DAs), who are independent design professionals. One element of the support programme is delivered in cooperation with PraxisUnico, a commercialisation network that provides training for TT professionals across the UK.

The support programme comprises three distinct parts:

- A 90-minute module delivered as part of PraxisUnico’s twice annual Fundamentals of Technology Transfer training course
- Design for Technology Transfer (D4TT): a one-day interactive training course delivered to as many as 15 technology transfer professionals, twice a year, co-developed and co-delivered by Design Council and The University of Nottingham
- Opportunities, offered annually by Design Council, for mentoring by a Design Associate, of specific commercialisation projects. Universities with a commercialisation function are encouraged to apply, submitting a minimum of four science and technology research projects for support. Support covers two full days of mentoring per project, typically over a period of six months.

The evaluation findings in detail

Technopolis drew ten case studies from universities that had participated in the mentoring programme and surveyed people who had participated in the one-day programme, alongside people who had not. They also conducted depth interviews with senior stakeholders from organisations engaged in the support of science and innovation in UK universities.

The impact of design on the commercialisation of scientific research?

The study found that Design Council trained and coached approximately 30% of the UK's technology transfer offices (TTOs) and 5-10% of its TT practitioners. This is a deeply impressive result for a small programme, but a substantial portion of the total UK TT community has yet to receive design training or mentoring.

Assessment of Design Council's design training or mentoring programmes demonstrates that design impacts commercialisation in several different ways.

Training

Design for Technology Transfer (D4TT) is a one-day training programme developed specifically for professionals. Developed by Design Council and University of Nottingham, it aims to build an understanding of key design principles and how they can be taken away and immediately applied to relevant research projects.

Past participants were surveyed on the benefits their projects had accrued as a result of their participation in the programme. There was a clear indication

that the objective of raising awareness and building an understanding of key design principles and how they can be taken away and immediately applied to relevant projects was being met.

A cumulative capacity building effect also was noted in those who progressed from the training to the mentoring programme.

This wider cumulative capacity-building is a further effect of design on commercialisation, but also indicates how design can figure in a national innovation landscape. The data suggests that a support programme of this kind can strengthen the overall capacity of research to commercialise via design, with design capability understood as a key wider framework condition for successful innovation.

Technopolis also interviewed recipients of design coaching to understand in more depth how design had helped them address key tasks and challenges in the exploitation of research.

Greater ability to secure further development funding

The case studies show commercialisation teams consistently stating that design support helped in securing development funding or raising investment from commercial partners.

For basic research (broadly, TRLs 1 and 2), funding is generally secured from the UK's main research funding councils (eg EPSRC, BBSRC, etc).

“If you take research concepts at low TRLs, one thing design can do quickly is move that forward and that’s when companies get interested. Design can help to accelerate it and start to encourage more discussions.”

Stuart Brown, Business Development Manager, Staffordshire University

In 2009, however, all UK Research Councils introduced compulsory impact statements and impact plans for every application, including those for fundamental and blue-sky research. Though these statements may be quite brief, they must plausibly show who might benefit and how, and what plans they have for using the new knowledge.

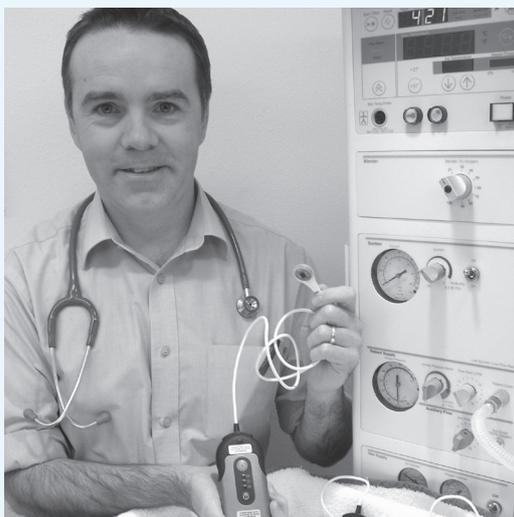
Programmes offering support for experimental development and demonstration (higher TRLs) also demand what amount to commercialisation and business development plans. Researchers often lack the training or experience for this, so many call on external support.

Case study: University of Nottingham

Following development of a prototype, Design Council worked with the University of Nottingham's TTO to deliver a workshop involving designers, technical and technology transfer staff, clinicians and market researchers. This identified 45 ways of commercialising the technology, greatly accelerating the process of identification of routes to market. A total of £375,000 of investment has since been raised from various sources, and £1.6m recently awarded from the Biomedical Catalyst Fund (Innovate UK).

“As a result of Design Council, you can come and see our latest 30 inventions coming out of the University in early prototype form; you can tell us what you think of them and we’ll build that into our development process.”

Dr George Rice, Technology Demonstration Centre Manager
Nottingham University



Clearer communication of new technology to potential investors and end users

Some new technologies, though close to a final product (TRL 5 and onwards), need to be accompanied by service offerings such as usage or training manuals. Researchers rarely have experience of working with services. The study shows that Design Associates both highlight this need (which may not have been considered), and assist with the service design itself.

Improved prototyping, fund raising pitches and market entry strategies

Many projects had functional prototypes at the outset, but these were rarely user-friendly. Shortcomings such as loose wires and cables were typical.

Design Associates pointed out the need to take into account not just narrowly technical considerations but user requirements (appearance, interface, etc). They were also able to advise entrepreneurs on developing and presenting prototypes better suited to prospective funders.

Case study: University of Hertfordshire



A Design Associate helped Researchers at the University of Hertfordshire formulate and then commission design of a service package for a robot - 'Kaspar' - they had created to help children with autism.

The Design Associate highlighted the need for this product to be accompanied by a service package addressing:

- what teachers or parents could expect from the product and supplier
- how to train teachers and parents in the use of Kaspar
- how they could find additional information and how to collect feedback.

Development and field trials of Kaspar continue and the service package in the form of an itemised list is integrated into the trials.

"I knew nothing about these issues but I could see it is important. I found the whole process interesting; it made us think about things we normally wouldn't. We were all very pleased with how the workshops were organised and the outcomes are now very useful for us in order to progress this project further."

Dr. Kerstin Dautenhahn, Professor of Artificial Intelligence, University of Hertfordshire

Case study evidence: Sheffield Hallam University

State-of-the-art radiotherapy approaches for breast cancer require increasing levels of precision accuracy to avoid long-term side effects. However, current methods for positioning and immobilising the breast are inadequate. Researchers at Sheffield Hallam University had developed a support bra for use in radiotherapy to increase breast placement precision and enhance patient comfort and dignity. This project required significant funding for further development. To obtain it, the team needed to understand and clearly articulate the route to market in the NHS context.

“The Design Associate gave a different design perspective and provided confidence in the process.”

Georgia Hatzigiannidou, Technology Transfer Officer, Sheffield Hallam University

Some aspects needed reviewing from the point of view of end users. The bra was originally planned to have individual components that could be removed and replaced. The DA’s work with the team showed that this was an unrealistic approach from end-users’ perspectives and had to be revised. Contingency plans were also created to cover the risk of other technical aspects proving problematic later.

The DA also assisted in developing visual materials to ensure clearer communication of the product’s strengths.

To help bring the project to fruition, the team applied for an i4i award to obtain further development funding from the National Institute for Health Research. This required provision of information on planned routes to market, an area where the team had little prior expertise. Collaboration with the Design Associate addressed this. The application was successful and an estimated £560,000 is due to be awarded for further development and testing.

The user-centred approach and communication materials also helped the team to scope commercial interest. Panache Lingerie Ltd. has been identified as a potential commercial partner.



“As we seek to promote and enable the effective use of design amongst the business community, we must strive for a more intelligent approach to the signposting of design services and to ‘matchmaking’ between designers and businesses. It’s not sufficient simply to advise businesses to use ‘design’ because, as we know, the design community consists of a broad spectrum of specialist fields.”

Ben Griffin, Lead Specialist, Design Innovate UK

Connecting to the wider design industry

The UK has an especially large and diverse design industry with numerous practitioners and specialisms.

Most TTOs featured in the case studies were unaware of this, so the Design Associates’ role in connecting them to appropriate designers was critical. Making these connections was the most frequently observed Design Associate action. Most of this extra design capacity was for prototyping or service design.

As well as helping commission designers, Design Associates explained to each team what to expect and sometimes sat in on initial meetings. In some cases, Design Associates not only suggested design companies to teams but played a part in making the case to the universities for funding these further design activities.

Case study: University of Leicester

Researchers at the University of Leicester made the discovery that exposure to very specific, individually tailored coloured light led to alleviated symptoms of tinnitus in up to 40% of tested subjects. Further research was carried out to confirm these findings and this produced impressive data on the efficacy of tint therapy in treating tinnitus.

The Design Associate worked with the project team on developing the device, providing insight into consumer use patterns. The team was thereby able to explore options for the project’s design direction, including power supply, plastic material selection and relevant optical properties, each of which are particularly important in domestic settings. The team went on to employ the design agency Smallfry to create a prototype that now has MHRA approval for clinical trials.



“Design Council gave us the resources to access professional design help. The design that was reached then actually led to us developing the technical side of the device to work with the new design. Currently the project is about to begin the second stage of clinical trials.”

**Dr Mike Mulheran, Lead researcher,
University of Leicester**

The role played by design in accelerating routes to market and/or onward commercial success

Design Council's Double Diamond is a framework for the design process. It starts with divergent thinking – consideration of numerous ideas – then moves to convergent thinking – the refining and selection of ideas.

In the first diamond many ideas are generated and considered before they are narrowed down. In the second diamond key ideas are selected, developed and tested before being refined again.

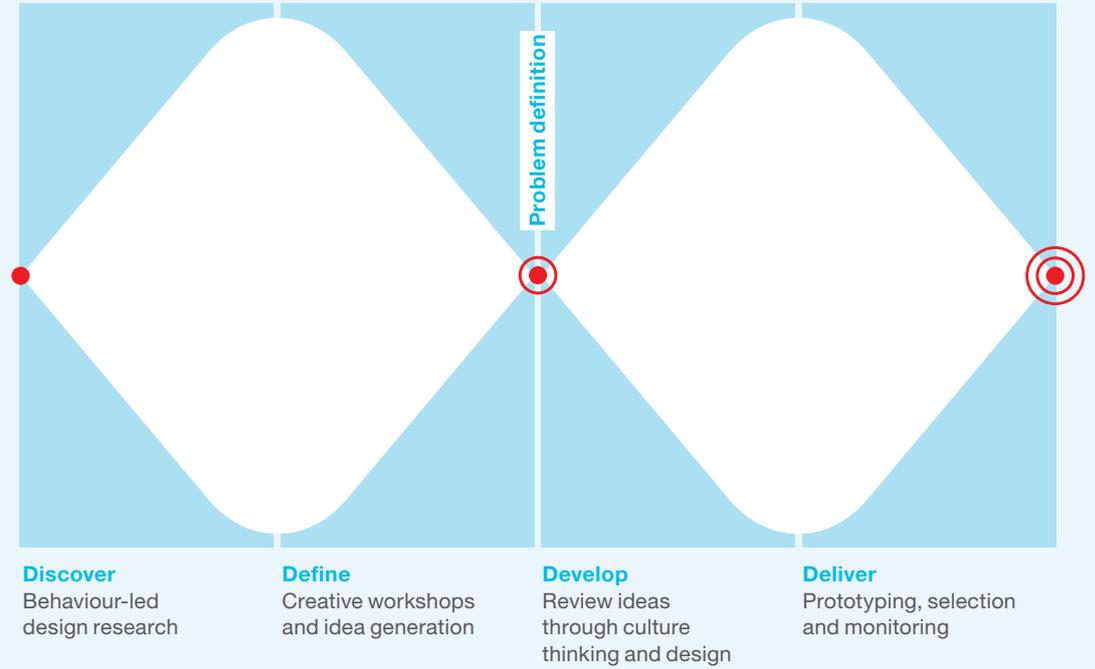
In the context of science and technology research, a given technology's potential applications might be considered and whittled down in the first diamond, then ways of turning this into a marketable product or service would be sifted and refined in the second.

“Design is the best tool we have for bringing that human perspective into the innovation process and so plays a vital role in delivering outcomes that are more viable, desirable and usable.”

Ben Griffin, Innovate UK

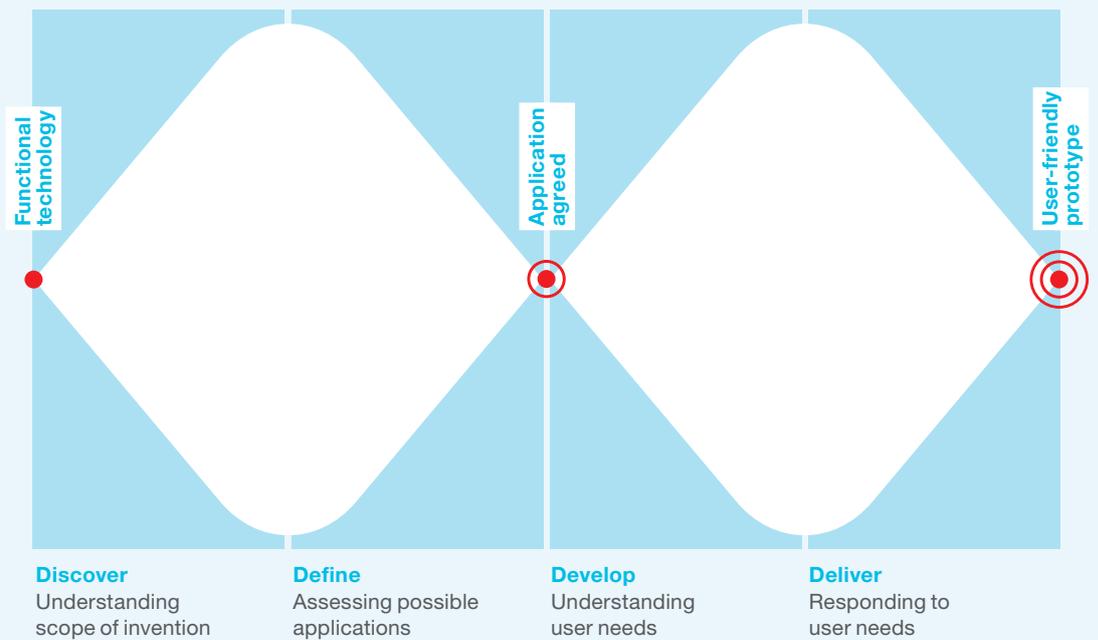


Figure 2
The Design Council Double Diamond



Source: Design Council

Figure 3
The Double Diamond adapted to the commercialisation of science and technology



Source: Technopolis, based on Design Council's original Double Diamond

Figure 4
Typology of design activities

| Stage | Activities |
|--|---|
| Discovery phase User research Managing information Design research groups | Market research |
| Definition stage Project management Project sign-off | Project development |
| Development Visual management Development methods Testing | Multidisciplinary working |
| Delivery stage | Final testing, approval and launch targets, evaluation and feedback loops |

Source: Design Council, Eleven Lessons: managing design in eleven global brands

Design in the innovation system

In line with Design Council's Typology of Design Activities, and with other studies,¹¹ the research shows that design brings a broad range of different benefits to commercialisation. There is, however, a potential problem here in that design risks being perceived as spreading itself too thin and insufficiently deep. How can design perform all the tasks it does better than the individuals specifically trained for them?

The answer is, it cannot and does not pretend to. The research shows that design serves an integrating function, bringing together more closely and coherently all the various skills, steps and stakeholders involved in commercialisation.

Designers help integrate an understanding of user needs at stages in the development including prototyping, development funding applications and concept generation. They facilitate clearer and easier communication between the differentiators throughout the Commercialisation process.

Creating these closer connections is a strongly acknowledged function of design in the interview data, across a broad range of different stakeholders.

In the study of innovation systems, the importance and effects of governance, agencies and institutions, as well as of the linkages between them are well understood. Less well-explored in the literature are the skills, processes and tasks that need to exist for institutional linkages to function properly.

There has been growing recognition that there are barriers to innovation caused by lack of expertise, capabilities and networks rather than by economic or hard institutional or infrastructural factors. These factors are increasingly considered important in the study of innovation systems. However, there is limited literature assessing specific skills and forms of expertise and their role and contribution to well-functioning innovation systems.

“Design forms part of the innovation infrastructure and it is important that all organisations involved work in a joined up way as much as possible, have a good understanding of what each other do and good communication between agencies.”

Paul Mason, Innovate UK

Design is a prime candidate in this respect: a process comprising skill sets that are essential for institutional linkages of a national innovation system to function properly and achieve the desired results.

Both as a wider framework condition and in terms of the programme’s specific activities, design can connect demand and user needs to the research base, train researchers and TT staff, help with pitching inventions to large companies and enable the creation of new firms.

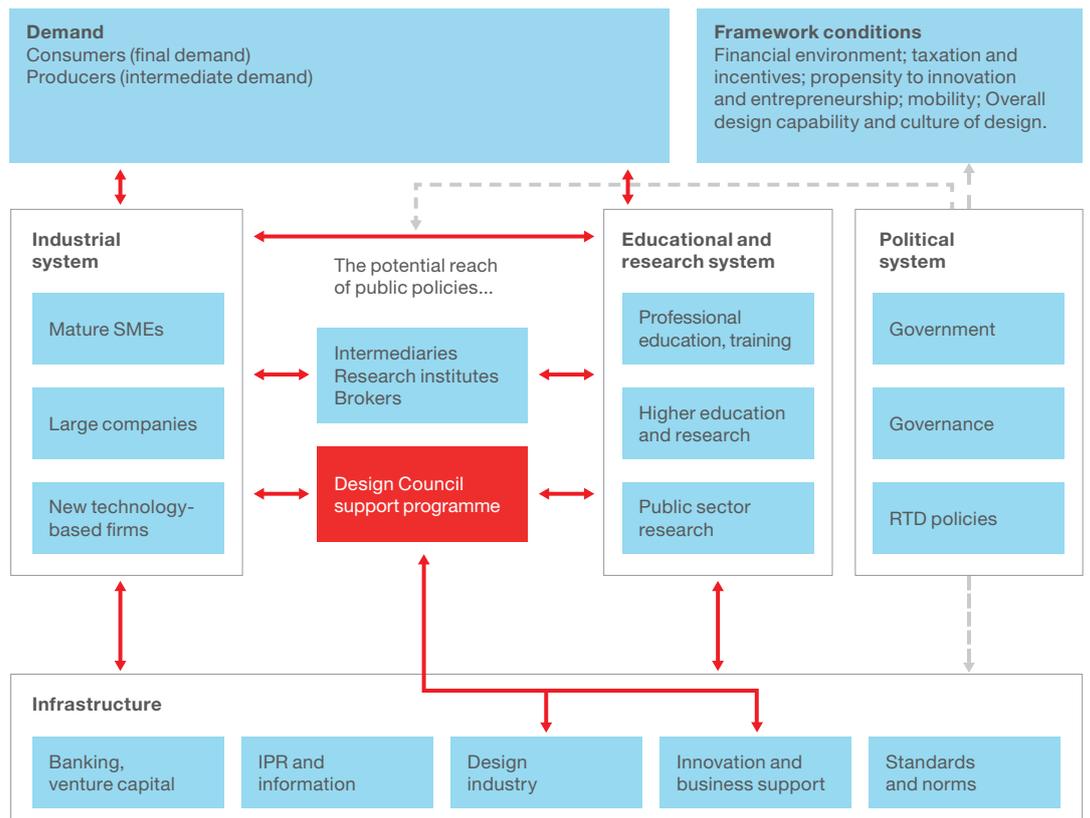
As such, rather than occupying a box within the institutional matrix of the national innovation system, innovation systems instead need to be complemented by a ‘design system’, aimed at strengthening linkages throughout the innovation system and establishing a culture of design as an overarching framework condition.

Design Council’s work can be identified as an important component of the UK’s innovation system, linking design to the research base and building up design capacity within it.

This study has highlighted the importance of employing strategic design throughout the innovation process. If creativity is the generation of new ideas, innovation is the successful exploitation of those ideas. Critically, it is design that binds the two together.

Design helps organisations to determine, develop and de-risk concepts. It shapes ideas to make practical, realistic and attractive propositions. In order for the UK to compete on a global, highly competitive innovation landscape, it must embrace the full potential of design.

Figure 5
Design Council support programme as part of a wider innovation infrastructure



Recommendations

Awareness

The aim of future signposting should be to ensure all technology transfer organisations at UK universities – and ideally all researchers involved in development of new science and technology beyond TRL 1 (i.e. applied rather than blue-sky research) – should:

- be aware of the programme
- have access to an evidence base highlighting the benefits of design for commercialisation projects.

To communicate directly to the wider research community, research councils providing funding for post-TRL 1 research should also signpost the programme, both in their general documentation and as part of their funding application systems.

These steps are especially important since awareness of design's benefits to the research and TT community is currently low.

Education

Given the growing recognition that barriers to innovation can be caused by lack of expertise, it is essential to support increased design capability and a culture of design at all levels of the UK innovation system, including research commercialisation in universities.

For early career researchers, there may be the possibility of integrating a short module into programmes at doctoral training schools. These are becoming increasingly prominent and already deliver some degree of entrepreneurial training.

Additionally, in application processes for development funding post-TRL 1, research councils could signpost Design Council's project mentoring as a source of support. This could help build a general awareness of design among researchers, especially if accompanied by case studies and a clear, succinct description of how design boosts commercialisation.

Further work exploring and assessing all these options needs to be done.

Engagement

It is critical that design is recognised by policymakers and funding bodies as a key framework condition of the UK's innovation system. The current lack of engagement and cooperation between the UK's impressive design industry and the university research sector needs to be understood as a failure in the innovation system and addressed head-on.

Beyond Design Council's role in supporting specific commercialisation projects, the wider organisational and strategic benefits of design support need also to be understood. With many TTOs still in their relative infancy, design support can provide a critical learning tool in these facilities' further strategic and organisational development. This is especially important in the context of seeking to increase the social and economic benefits of publicly funded research in the UK.

Scaling

In recognition of the importance of various pathways to impact other than IP, especially outside the more applied sciences, there is an acknowledged need for TTOs to broaden their offer to academics to include more entrepreneurship or commercial consultancy. Copyright and design rights are expected to be increasingly important going forward, with strong growth in high-value services in the wider economy.

This means it is important to assess options for expanding Design Council's support programme so as to expand, in turn, the remit of TTOs. With the programme delivering obvious benefits both short and long-term, for both individual projects and organisational factors, there is obviously huge potential in offering it to far more than the 30% of the UK's TTOs and the mere 5-10% of its TT practitioners the programme has worked with so far.

[For further information or to apply for the Design Leadership Programmes for Universities and research bodies, contact](#)

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Design Council champions great design. For us that means design which improves lives and makes things better. As an enterprising charity, our work places design at the heart of creating value by stimulating innovation in business and public services, improving our built environment and tackling complex social issues such as ageing and obesity. We inspire new design thinking, encourage public debate and inform government policy to improve everyday life and help meet tomorrow's challenges today.



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