

# Digital Economy:

Report of the 2012 RCUK Digital Economy Impact Review Panel



# Foreword

On behalf of the Programme Advisory Board (PAB) for the RCUK Digital Economy Theme (DET) I welcome this thorough and professional report and thank the reviewers for their diligence and attention to detail.

The DET has been and continues to be a major initiative in the RCUK strategy to cross- connect disciplines and have impact through large scale interdisciplinary research; for a review body, comprising independent UK and international users and academics, to commend it so highly is very rewarding. It will as a result inform not only the means of exploitation of the DET outcomes, but also help other RCUK Themes with similar activities realise their objectives.

The government in the UK is putting a considerable resource into digital activities and for this investment to be successful a high quality research base is essential; the DET has always aimed at fulfilling that role. The review corroborates the assertion that this aim is being achieved and will help others gain confidence in investing in digital industries in the UK. The review also compares the DET with others on the global stage and for it to be so highly thought of will also add to its investment potential, both commercially and as an attractor for the best DE talent in research worldwide.

The DET has evolved new ways of carrying out multidisciplinary research, innovative means of achieving impact, new research ecologies, supporting high quality research students from new sources, engagement with a wide spectrum of users, and has been an agent of transformational change. For this to be recognised in the review is praiseworthy and shows the recognition of the DET being dynamic and innovative in many different ways.

The report also makes some strong recommendations for impact to be better managed and coordinated. They will be acted on coherently and consistently for the duration of the current Theme and will be intrinsically placed in any future investments in the future programme of activities.

Whilst these impact and management factors are vital to the success of the DET in realising its potential, the fact that the programme of work is very highly praised from an academic point of view is very

rewarding. This shows that complex multidisciplinary programmes of research are viable given continuity of funding, pursuit of excellence in both researchers and research and that they can have Impact when innovative collaborative mechanisms are promoted managed and sustained.

The recommendation for continued funding is noted and the basis for that recommendation will be at the heart of propositions by both RCUK and the PAB to ensure that the past investment in DE justifies future DE investment.



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Chairman, DE Theme PAB  
Professor of Engineering Policy, UCL

August 2012

# 1. Executive Summary

This is the report of a Panel of twelve experts convened by the Research Councils UK (RCUK) Digital Economy Theme (DET), a programme of research funding that began in 2008.

The purpose of the review is to identify and benchmark the impact that the digital economy (DE) research has achieved to date and the potential for additional impact in the future.

DE research is defined by the Research Councils to be research that enables the UK to rapidly realise the transformational impact of digital technologies on aspects of community life, cultural experiences, future society, and the economy.

The Review Panel's terms of reference were to assess the extent to which the DET has:

- Delivered tangible benefits (impact) to the UK in areas identified to be of strategic importance to the UK economy, UK society and the UK research community
- Shown international excellence in respect of originality, significance, rigour and exploitation of research and training
- Added value and accelerated progress beyond what would have been achieved without the Theme.

The Panel was asked to deliver a report identifying further opportunities to maximize the impact of the Theme and making recommendations to the UK research community and Research Councils as to the means by which this may be accomplished.

The Panel found it appropriate to take a broad view of what constitutes impact, and adopted the Research Council's Impact Framework (see Annex B) as its basis for assessing impact throughout the review. In particular, looking beyond simple measures of knowledge and technology transfer to industry partners to include other forms of impact such as influence on government policy and creating new cultural and social experiences for society at large. Importantly the Panel also looked at scientific impact, that is, for research outcomes such as the development of new tools or collection of new data that would accelerate or otherwise benefit future research.

The Panel found the research supported by the DET to be of internationally excellent quality, and noted that the UK research community is in a leadership position compared to other countries. DET research was most effective where the researchers were able to draw on parallel fundamental research capabilities and there was evidence of DET research challenges generating new fundamental research questions. Concerns expressed at the outset of the review that the focus of the Theme on partnership with users and tangible impact might lead to short term goals and superficial tinkering proved to be unfounded.

From its analysis of the submitted evidence and arising from discussion during visits and presentations the Panel found good evidence of impact arising from the DET and were confident that further significant impact could be anticipated as the work funded by the theme matures. However the Panel strongly believed that there needs to be a much greater attention by the research community to managing impact strategically if this is to be fully achieved. In addition, the research community needs to learn how to better record, measure and communicate impact: there was a notable absence of such detail in much of the evidence submitted to the Panel in advance.

Societal and research community impact was generally stronger than economic impact. That said, the Panel found many strong engagements between researchers and users with significant potential for future economic impact, particularly in the financial services, health and well-being and creative media sectors.

There was much evidence of the DET having been an agent for positive change in the research community. Researchers were enthusiastically embracing new modes of multidisciplinary research jointly with users enabled by the DET, with a clear focus on tangible outcomes and the production of highly motivated and skilled postgraduates. In many, but not all, cases the Panel found strong institutional backing for new initiatives in support of the DET and this in turn is attracting further sources of funding and user participation. The DET is demonstrably providing new opportunities for career development and leadership in the academic research community.

Across the full range of investments reviewed in evidence, the Panel was able to identify common success factors amongst those investments that achieved results faster and the greatest return on the investment. Moreover investments that lacked these success factors, or managed them badly, were generally less impressive than those that had them. The list of identified success factors therefore provides a useful framework for guiding future investments.

In summary, the Panel found that the DET is well positioned for success, and is a template for how the Research Councils should go about directed strategic research with strong user engagement. There is however a pressing need for the DET investments to develop clearer impact goals, strategies for achieving them and the ability to manage research for impact as much as for academic success.

### Panel Recommendations

#### *Recommendation 1.*

The Research Councils should continue to support the Theme strongly. There is a strong enough demand and significant enough opportunity for the Research Councils to both extend the duration and the value of their investment in the Theme. In so doing it is critical that the Research Councils put in place a plan to sustain the strongest aspects and activities of the current Theme.

#### *Recommendation 2.*

The Research Councils should build on the success factors identified in this report, strengthen these in current investments and prioritise these in future investments:

- scale and focus
- clear governance
- well defined customer
- portfolio approach focussed on a coherent theme
- inclusion of integrating disciplines (such as industrial design and systems engineering)
- collection and stewardship of open data to support other researchers
- output of application programming interfaces (APIs) and platforms with appropriate open licenses.

#### *Recommendation 3.*

Given the clear evidence of key success factors for DET investments, set out in Recommendation 2 above, the Research Councils should extend their processes for reviewing DET proposals to include assessment of proposals against these factors and the impact management capability of the proposers.

#### *Recommendation 4.*

DE projects require much stronger project management of research, of impact outcomes and of external relationships than traditional research projects and this capability was found lacking. For the future success of the theme the Research Councils, universities and the research community need to work together to develop these capabilities. In particular universities should invest in giving research leaders appropriate project management training, mentoring and experience. For large-scale investments, researchers should include professional project and commercial managers in their project teams. The Research Councils should develop a means to benchmark and evaluate the project management capability of PIs and the support given to them by their institutions.

#### *Recommendation 5.*

Many larger DET investments have some form of user-led Steering Board, although there was no consistent approach as to whether these were executive in nature or merely advisory. From the evidence presented to the Panel, executive steering boards appeared to be more engaged and more effective. Therefore where a DET investment justifies a Steering Board it should have a formal role in the governance of the funded activity, including the ability to recommend changes to the organisational structures and staffing together with a formal relationship to the Research Councils in their role as sponsors of the research.

#### *Recommendation 6.*

The Research Councils need to be clearer on their goals and metrics for impact and communicate these more clearly to the DE stakeholders. The Research Councils should ensure that each investment has clear goals within this framework and is managed to maximise its impact. The impact framework goals and metrics should be co-developed with the research community to ensure ownership.

*Recommendation 7.*

The Research Councils need to develop lightweight monitoring processes throughout the lifecycle of each DET investment, appropriate to the level of investment being made. Where problems are identified, more significant management interventions should be put in place, and the cost of doing so be taken from the funding already allocated. (A similar scheme has been in place for some time within the National Digital Research Centre (NDRC) in Ireland and found to be effective).

*Recommendation 8.*

Universities need to improve their internal processes to remove barriers that might otherwise inhibit the success of DE investments. For example:

- The interdisciplinary nature of DE Hubs, Centres for Doctoral Training (CDTs) and projects requires financial and management structures that are independent of faculty boundaries.
- The deep engagement of a diverse range of users in DE Hubs, CDTs and projects necessitates a flexible and agile approach to Intellectual Property (IP) management, contract negotiation, procurement of services, payments to other institutions, payments to partner companies and external suppliers, etc. whilst being heedful of paths of greatest impact.
- Where Universities have secured multiple DE investments, these should be managed as a portfolio of mutually supportive projects rather than individually, to ensure maximum impact and minimum overhead.
- University administrators need to recognise that DE projects are shared business partnerships rather than one way technology transfer opportunities; therefore requiring streamlined commercial relationships based on mutual trust.
- Universities need to improve their ability to administer, supervise, examine and graduate multi-disciplinary PhD students whose research spans faculty boundaries. In addition to organisational issues, universities should ensure different approaches to research (e.g. experimental methods versus practice based methods), when appropriately used, are equally valid pathways to a postgraduate degree.

The Research Councils need to ensure their policies and administrations are responsive and

adaptable to these changing structures in the universities and research landscape.

*Recommendation 9.*

The Research Councils and the Technology Strategy Board (TSB) should work together strategically to transition DE investments from research through to development, for example, by exploiting Catapults and Knowledge Transfer Partnerships (KTPs).

*Recommendation 10.*

Across the DET there needs to be an appropriate level of engagement with small businesses that have a realistic plan to release products and/or services to exploit the research results. There needs to be an increased focus on the creative use of partnership funding, including TSB projects and KTPs, to facilitate this. The Research Councils should decide on the level of such engagement and manage their investments accordingly. The Research Councils should adjust their expectations and mechanisms for small and medium-sized enterprise (SME) engagement to reflect the short time horizons and limited resources of smaller businesses.

*Recommendation 11.*

The Research Councils should ensure greater communication and collaboration across the DET portfolio. DE Hubs and their leaders have a key role in this.

*Recommendation 12.*

Given the volume of research in the DET targeting social issues, communities, finance, healthcare and well-being, there is considerable scope for deeper investment by Economic and Social Research Council (ESRC) and Medical Research Council (MRC) to further increase the impact of the theme overall.

*Recommendation 13.*

The DET investments need to better engage with the economics community and with business leaders to develop better understanding of the economics of the DE, and of business and management models for digital enterprises. There is an opportunity for ESRC to deepen its engagement with the broad DE agenda by bringing economics expertise to the Hubs and projects and encouraging business schools to take a stronger

interest in the economics and management of digital economies.

*Recommendation 14.*

Across the Research Councils for the DET as a whole, there needs to be a stronger plan for exploitation of national initiatives for increasing UK's digital infrastructure and capabilities, such as future fibre broadband networks. An example might be the creation of 'living labs' (i.e. using public digital infrastructures to evaluate new technologies and applications, support field research and so forth).

*Recommendation 15.*

Especially in times of austerity, the research community needs to recognise the requirement to explain to the public the return on investment that comes from the use of public money in their research. The research community needs to be better able to communicate the actual and potential impact of its work as well as its scientific merit.

## Acknowledgements

In preparing this report, the Panel Chairman would like to acknowledge the contributions and commitment of all those who took part in the review, in particular:

- The Review Panel Members
- DE Hub, CDT and project leaders who were interviewed by the Panel, as well as those who responded to the portfolio survey
- All DET CDT students who presented their work to the Panel
- Those interested parties who responded to the public questionnaire
- The Engineering and Physical Sciences Research Council (EPSRC) staff that supported the Review Panel in carrying out its review.

# Contents

<b>1. Executive Summary</b>	1
Panel Recommendations	2
<b>2. Introduction and Background</b>	6
Purpose of the Review	6
Review Panel Terms of Reference	6
Structure of the Review	6
Review Panel Activities	7
Review Panel Membership	7
<b>3. Principal Findings</b>	9
<b>4. Significant Examples of Impact</b>	11
<b>5. Theme Strengths</b>	15
Success factors	16
<b>6. Theme Weaknesses</b>	19
<b>7. Concluding remarks</b>	21
<b>Annex A</b>	22
Table of Acronyms	22
<b>Annex B</b>	23
Review Evidence Framework	23
Evidence Framework	23
Impact Framework	23
<b>Annex C</b>	27
Biographies of Panel Members	27
<b>Annex D</b>	37
Review Week Itinerary	37
<b>Annex E</b>	32
Supporting Evidence provided to the Panel	33

## 2. Introduction and Background

### Purpose of the Review

This is the report of a Panel of twelve experts convened by the RCUK DET to review the impact of RCUK supported DE research.

The review covered all aspects of RCUK supported DE research, not just the research supported directly by the RCUK DET. The review process was supported and staffed by the EPSRC.

### Review Panel Terms of Reference

The Review Panel's terms of reference were to assess the extent to which the RCUK DET has:

- Delivered tangible benefits (impact) to the UK in areas identified to be of strategic importance to the UK economy, UK society and the UK research community
- Shown international excellence in respect of originality, significance, rigour and exploitation of research and training
- Added value and accelerated progress beyond what would have been achieved without the Theme.

The Panel was asked to deliver a report identifying further opportunities to maximize the impact of the Theme and making recommendations to the UK research community and Research Councils as to the means by which this may be accomplished.

The aim of the review was not to assess the quality of individual groups or institutions. They were asked to arrive at an informed view of the overall standing and impact of RCUK DE research in the UK as a whole from their impartial perspective. Panel members were chosen with this in mind and, as such, they brought a collective breadth and depth of expertise. In particular the Panel was asked to provide guidance on where action is required, and recommendations that aim to improve the UK's position over the coming decade.

### Structure of the Review

A small Review Advisory Group was formed, who advised on the scope and format of the review. This group consisted of Dr Dave Watson (IBM, the then Chair of the DET Programme Advisory Board (PAB)), Professor David Hogg (University of Leeds, member of the EPSRC Information Communications and

Technology (ICT) Theme Strategic Advisory Team) and Dr Andrew Herbert (Chair of the Review Panel).

The Panel membership was drawn from suggestions from a number of advisory streams. Suggestions were sought from the PAB, the DET Executive Committee, the Review Advisory Group, as well as suggestions from other RCUK colleagues. The full Panel membership is given below in Table 1.

### Evidence framework

An Evidence Framework, shown in Annex B, was provided to assist the Panel during the review week. This framework was provided to help ensure coverage of all relevant strategic issues and aid the identification of any areas that, in the opinion of the Panel, merited comment. The Framework was not intended to restrict the Panel; additional issues were addressed as they arose.

### Panel documentation

In advance of the review, the Panel was provided with documentation (detailed in Annex E) providing an overview of DE research in the UK in terms of its people, funding, organisation and policy. Evidence in this document was compiled from the Research Councils' management records and the UK DE research community. The documentation included:

1. an overview of UK Science and Innovation Policy and Research Funding
2. a description of the DET, its governance, funding and activities undertaken to date
3. a portfolio survey, compiled from investigator responses providing impact evidence against the DE Impact framework (see Annex B)
4. public comment, resulting from responses to an open questionnaire around the Evidence Framework.

The documentation was provided to the Panel as raw data without added comment or interpretation to avoid introducing any bias or preconceived outcome to the review.

The data provided for use by the Review Panel will be published on the RCUK website on completion of the Review. Any documentation provided in confidence will not be published.



## Review Panel Activities

The full Panel convened during the week starting Sunday, 13 May 2012 for the purpose of assessing the quality and impact of academic DE research in the UK.

The week started with briefing presentations for the Panel supporting the data provided in the Panel documentation, providing an overview of research in DE in the UK in terms of its people, funding, organisation and policy.

In a mixture of full and sub-Panel groups, the Panel interacted with researchers and students from 28 institutions who receive DE funding. This was achieved through Panel visits to the DE Hubs<sup>1</sup> in Aberdeen, Newcastle and Nottingham and interviews (face to face and by video conference), with selected representatives of the research and training portfolio. User partners were present in many of these

meetings, and there were a number of separate meetings with groups of users and with groups of students to learn more about their perspectives.

In closed meetings the Panel achieved collective understanding about the context, vision and opportunities afforded by the DET; made judgements on strengths and weaknesses of the DET to date with particular reference to impact, and developed recommendations about the opportunities for the future and how to proceed to pursue them. This report is the final product from the Panel developed from further analysis and refinement of its findings gathered during the review week.

<sup>1</sup> There are three RCUK Digital Economy 'Hubs' having funding of £12million each to carry out research and training from 2009 to 2014, building capacity and expertise in the skills needed to realise the Digital Economy. In general terms each hub is at the centre of a network of collaborative research relationships and user engagements and plays a leadership role with respect to its network.

## Review Panel Membership

The Panel members and their home institution or company are shown in Table 1. Brief biographies of the Panel members can be found in Annex C.

**Table 1: Impact Review Panel Membership**

Title	Organisation
Susan Aubrey-Cound	Marketing Consultant
Dr Sean Baker	Chairman, Incaplex Ltd Adjunct Professor at the University College of Dublin School of Computer Science
Professor Bruce Brown	Pro-Vice-Chancellor Research and Professor of Design at the University of Brighton
Professor Hazel Hall	Director of the Centre for Social Informatics, Edinburgh Napier University
Professor Chris Hankin	Professor of Computing Science, Director of the Institute for Security Science and Technology, Imperial College London
Dr Andrew Herbert OBE, FREng	Retired, formerly Chairman of Microsoft Research, for the Europe, Middle East and Africa region. Visiting Professor of University College London. Emeritus Fellow of Wolfson College, Cambridge
Professor Jim Hollan	Professor of Cognitive Science and Adjunct Professor of Computer Science and Engineering at University of California, San Diego
John Howkins	Consultant
Jonathan Legh-Smith	Head of Partnerships & Strategic Research and Head of Standards, BT Group
Dr Kenny Mitchell	Research Lead, Disney Research Edinburgh
Dr Paul Nightingale	Deputy Director of the Science Policy Research Unit (SPRU), at the University of Sussex.
Dr Adrian Woolard	Project Director, North Lab, BBC R&D

## DE Impact Review Panel and DET staff



From left to right

- Dr Hannah Collins, DET
- Dr Richard Bailey, DET
- Professor Chris Hankin
- John Howkins
- Dr Adrian Woolard
- Dr Paul Nightingale
- Dr Kenny Mitchell
- Professor Hazel Hall
- Jonathan Legh-Smith
- Professor Jim Hollan
- Dr Sean Baker
- Dr Andrew Herbert
- Susan Aubrey-Cound
- Professor Bruce Brown
- Dr John Baird, DET

### 3. Principal Findings

From its analysis of the submitted evidence and arising from discussion during visits and presentations the Panel found good evidence of impact arising from the DET and were confident that further significant impact could be anticipated as the work funded by the theme matures. However the Panel strongly believed that there needs to be a much greater attention by the research community to managing impact strategically if this is to be fully achieved. In addition, the research community needs to learn how to better record, measure and communicate impact: there was a notable absence of such detail in much the evidence submitted to the Panel in advance.

Societal and research community impact was generally stronger than economic impact. That said, the Panel found many strong engagements between researchers and users with significant potential for future economic impact, particularly in the financial services, health and well-being and creative media sectors.

Aligned with RCUK strategy, the DET is delivering against areas of strategic importance to the UK economy, UK society and the UK research community, and as such must be seen as a long-term investment. The DE will remain a challenge area of increasing scope over the coming decade. It has the potential to increase UK competitiveness, and to attract inward investment. In many respects the DET is fulfilling a UK need for strategic applied research, in part filling a gap left by the demise of industry and public funded laboratories that previously undertook such work.

The Panel found the research supported by the DET to be of internationally excellent quality, and noted that the UK research community is in a leadership position compared to other countries. DET research was most effective where the researchers were able to draw on parallel fundamental research capabilities and there was evidence of DET research challenges generating new fundamental research questions.

There was much evidence of the DET having been an agent for positive change in the research community. Researchers were enthusiastically embracing new modes of multidisciplinary research jointly with users enabled by the DET, with a clear focus on tangible



outcomes and the production of highly motivated and skilled postgraduates. In many, but not all, cases the Panel found strong institutional backing for new initiatives in support of the DET and this in turn attracting further sources of funding and user participation. The DET is demonstrably providing new opportunities for career development and leadership in the academic research community.

The DET is critically aligned with organizational innovation in universities. It models ways of working for the future in terms of multi-disciplinarity, increased impact, closer relationships with industry, and new routes to grant acquisition. Many DET projects provide an intellectual framework for integration of multiple disciplines such as design and computer science, giving greater impact in both the short and long term. In many, but not all, cases the Panel found strong institutional support for new initiatives in support of the DET and this in turn attracting further sources of funding and user participation.

The DET is demonstrably providing new opportunities for career development and leadership in the academic research community.

DET projects are multi-faceted, being multi-disciplinary, cross-Research Council, with many end users and many industry and academic partners, including local community members. This places new demands in terms of programme management skills and 'business management' on research leaders and the requirement for flexible and agile administration on the part of universities and the Research Councils.

Across the full range of investments reviewed in evidence, the Panel was able to identify common success factors for achieving greater value and faster results than might otherwise have been achieved. Moreover investments that lacked these success factors, or managed them badly, were generally less impressive than those that had them. The list of identified success factors therefore provides a useful framework for guiding future investments.

## 4. Significant Examples of Impact

'Impact' as defined by the Research Councils and as given in the evidence is a very broad notion ranging from, for example, the dot.rural hub introducing the Panel to a 77 year old 'community researcher' recruited into one of their projects, to the SiDE Hub reporting the creation of a new research centre with Red Hat, a major software vendor.

To bring structure to its analysis of impact, the Panel created a matrix based on the Research Council's DET Impact Framework (see Annex B). Each row of the matrix corresponded to an impact indicator from the framework. For each row in the matrix we looked in the evidence for significant exemplars of the referenced form of impact and qualified the exemplar in terms of how strong or weak the evidence was. Thus the dot.rural community researcher was classified as an exemplar 'user engagement' impact indicator and the Red Hat investment in SiDE as an exemplar 'portfolio' impact indicator.

The results of the analysis are shown in Table 2. The third column 'notes' contains general remarks about the corresponding impact indicator looking across the theme as a whole.

Originating as a working document, and given the volume of evidence to be summarized, the entries in Table 2 are necessarily highly abbreviated: moreover it must be emphasized that the table does not show all the impact achieved across the program as a whole and that many of the exemplars have impact (or the potential for impact) in other areas than those listed. However we feel it is important to baseline the impact recorded at the time of the review to enable the Research Councils to calibrate the further impact achieved as the Theme continues.

Importantly, as the Panel assembled Table 2 and discussed their findings, it found exemplars for all areas of impact and it found exemplars from across the breadth of the Theme investments.

From the table overall it can be seen that the impact strengths of the Theme to date lie in the areas of Knowledge and Capability:

- **Capability**  
3 of 6 elements rated as strong in the table below



- **Knowledge**  
2 of 3 elements rated as strong
- **Economy**  
1 of 6 elements rated as strong
- **Society**  
1 of 9 elements rated as strong.

This distribution is broadly as might be expected at this stage in the Theme's development, with impacts on policy and investment (Society and Economy impact areas) following successful growth of valuable knowledge, as well as sustainable research capability and capacity.

It should be recognised that much of the evidence reported in Table 2 draws from the observations of the Panel rather than directly from evidence presented by the researchers themselves. The Panel noted an apparent inability of a surprising number of researchers to articulate what "impact" means and explain the impact of their work. This may be accounted for by a number of possible reasons:

- A systemic failure of the community to think in impact terms at key stages of project development

- A narrow focus on impact as conceived for the upcoming Research Excellence Framework<sup>2</sup>, rather than the RCUK definition of impact<sup>3</sup>
- Not wishing to make premature claims for areas of impact with longer lead times, such as influencing government policy and securing future investment
- A lack of interest in reporting impact, regarding it as simply as bureaucratic reporting requirement rather than a strategic driver.

User engagement is particularly strong in two ways: working with industry partners and engaging with communities in society at large, i.e. the general public. The early establishment of strong partnerships between user groups and research communities creates the potential for future significant impact.

Pleasingly, all the major DET investments showed potential for significant impact. For example, in no particular order, and matched against DET challenge areas:

- The UCL Financial Computing CDT has strong user engagement with financial user groups and institutional support (New Economic Models),
- IU-ATC has had significant success in gaining further R&D investment, as well as generating international engagement and moving the UK higher up the preferred list of partner countries that India will work with (New Economic Models / IT as Utility).
- All three DE Hubs have made significant steps towards enhanced capabilities and are delivering impact in knowledge economy (Working across challenge areas, but each with a specialism).
- The Oxford Healthcare Innovation CDT shows good evidence of working with clinicians (Sustainable Society).
- Many of the smaller DET investments also exhibited potential for significant impact, for example:
  - Tales of Things and Electronic Memories (ToTEM) are working with a key user (Oxfam) and making large media impact (Sandpit, Sustainable Society).
  - 'How was school today?' – personal identity & social welfare, with a strong media representation (RiTW, Communities & Culture).
  - Faith – Transport road defect project (TSB, IT as a Utility).

The Panel found that some investments had an easier pathway to impact than others. For example, the CDTs that had established domain focus and a clear route to market appeared to be better positioned for success than those with rather more broad agendas and diffuse partnerships. This is to be expected and should be accepted as a valid risk.

The Panel's analysis has identified several areas that warrant further investment. For example, there is limited evidence to date of impact in 'cultural & quality of life enrichment', nor does there appear to be a set of projects in the pipeline that could deliver this at scale. This may indicate a need for investment in projects that could deliver desired impact in these two areas. Similarly work that addresses issues related to personal identity and well being in online environments could contribute to a stronger set of impacts related to the Sustainable Society Challenge area agenda in the DE Impact framework. The biggest gap in the portfolio is the lack of any research pertaining to digital economies as economic systems, new digital business models and the management of digital businesses. This is an important issue for ESRC to address.

<sup>2</sup> <http://www.ref.ac.uk/>

<sup>3</sup> <http://www.rcuk.ac.uk/kei/impacts/Pages/meanbyimpact.aspx>

The Panel also noted that the DET is rarely acknowledged as a source of funding when projects and programmes attract media attention

**Table 2: Major examples of impact across the RCUK DE portfolio**

Impact area	Element	Evidence status			Examples	Notes
		Strong evid. to date	Some evid. to date	Yet to be exploited		
Capability	Academia - Size and Shape	X			<ul style="list-style-type: none"> <li>dot.rural: 3+3 new posts</li> <li>Horizon: 6 new posts</li> <li>Media &amp; Arts Technology (MAT) CDT: new undergrad &amp; masters courses</li> <li>PI promotions</li> </ul>	
	Academic innovation		X		<ul style="list-style-type: none"> <li>Horizon: innovation training for PhDs</li> </ul>	Primarily occurring in CDT's
	Institutional investment		X		<ul style="list-style-type: none"> <li>Hubs &amp; CDTS: dedicated space</li> </ul>	Only in larger programmes
	Portfolio	X			<ul style="list-style-type: none"> <li>SiDE: additional portfolio income of £11M</li> <li>Horizon: additional portfolio income of £22M</li> </ul>	
	Training & skills		X		<ul style="list-style-type: none"> <li>CDTs joint supervision</li> </ul>	Activity across DE but variable
	User Engagement	X			<ul style="list-style-type: none"> <li>Hubs: steering boards + partners + co-production</li> <li>CDTs: internships</li> <li>ToTEM project</li> <li>UCLAN energy apps</li> </ul>	
Economy	Academic innovation			X	<ul style="list-style-type: none"> <li>Highwire patent</li> <li>SiDE spinout</li> </ul>	Few patents to date
	Attracting R&D investment			X	<ul style="list-style-type: none"> <li>Faith project</li> </ul>	Few to date, should be addressed
	Innovation in organisational culture & practices			X	<ul style="list-style-type: none"> <li>dot.rural as a centre</li> <li>Oxford CDT: impact on clinical practice</li> </ul>	Few current impact - number offering potential
	Innovation in Products & Services			X	<ul style="list-style-type: none"> <li>UCL Financial Computing CDT</li> <li>Horizon: computer operating systems</li> <li>Imperial: Healthcare Pathways and Procedures</li> </ul>	Few significant examples to date
	Training/skills			X	<ul style="list-style-type: none"> <li>None to date</li> </ul>	Student/industry confidence in future roles/opportunities
	User Engagement	X			<ul style="list-style-type: none"> <li>dot.rural: community researchers</li> <li>RiTW: How was school today?</li> <li>MAT CDT: BBC</li> <li>CDE (Bath/Bournemouth): Electronic Arts, Disney</li> <li>UCL Financial Computing: Banks, FSA, Bank of England</li> <li>ToTEM: Oxfam</li> <li>RiTW: Electronic cheques Banking for Older Old</li> <li>SiDE: Redhat</li> </ul>	

Impact area	Element	Evidence status			Examples	Notes
		Strong evid. to date	Some evid. to date	Yet to be exploited		
Knowledge	Academic innovation		X		<ul style="list-style-type: none"> <li>RiTW, clusters</li> </ul>	Where facilitated encouraged different universities to work together
	Academic leadership	X			<ul style="list-style-type: none"> <li>SiDE: 13 papers at CHI, including best paper award</li> </ul>	Lots of indicators found in evidence
	Knowledge economy	X			<ul style="list-style-type: none"> <li>Hubs events</li> <li>IU-ATC</li> <li>TEDDI &amp; BURD</li> </ul>	
Society	Cultural enrichment		X		<ul style="list-style-type: none"> <li>MAT CDT: V&amp;A exhibits</li> <li>FIRM: Salford communities</li> </ul>	Quite limited/area for future investment particularly given AHRC contribution
	Environmental sustainability		X		<ul style="list-style-type: none"> <li>dot.rural: Flexible Integrated Transport Services project (FITS)</li> <li>dot.rural: Mink app</li> <li>dot.rural: Bee app</li> <li>Horizon: smart meeting project</li> </ul>	Emphasis in dot.rural, opportunity for NERC co-investment?
Economy	Influencing policy			X	<ul style="list-style-type: none"> <li>Horizon: policy engagement</li> <li>IU-ATC: International engagement</li> </ul>	Initial contacts made but no long term impact as yet. Potential in dot.rural/horizon/UCL Financial Computing
	Innovation in public services			X	<ul style="list-style-type: none"> <li>dot.rural: FITS project/bus data</li> <li>SiDE: care home</li> </ul>	Primarily dot.rural & SiDE
	Media representation	X				Projects have had significant impact, but DE or RCUK not generally acknowledged
	Personal identity			X	<ul style="list-style-type: none"> <li>RiTW: How was school today?</li> </ul>	Should consider refocus/prioritisation of this area
	Public engagement			X	<ul style="list-style-type: none"> <li>Festivals</li> <li>Highwire</li> </ul>	As more outputs mature should be more engagement
	Quality of life enrichment			X	<ul style="list-style-type: none"> <li>SiDE: Portrait project</li> <li>dot.rural: MIME project</li> </ul>	Focus for dot.rural, Oxford
	Improving social welfare		X		<ul style="list-style-type: none"> <li>dot.rural: patient experience</li> <li>Sandpit: Bespoke, Preston housing estate/digital inclusion</li> </ul>	



## 5. Theme Strengths

The Panel found the DET overall was doing high quality application-inspired research, building on earlier investments in fundamental research. Concerns expressed at the outset of the review that the focus of the Theme on partnership with users and tangible impact might lead to short term goals and superficial tinkering proved to be unfounded.

Uniformly across the Theme, the Panel found outstanding examples of effective multi-disciplinary research (by which we mean researchers from different disciplines working together). In many cases this was being done successfully often despite significant impediments due to organizational issues within universities, as well as the widespread perception that multi-disciplinary research poses a high risk to an academic career. Pleasingly we found many universities were addressing these factors head on, for example by creating autonomous multi-disciplinary institutes.

The Panel found many projects being innovative in the means by which they achieved impact, developing new models for engagement with industry, government and social communities. The most successful welcomed the external groups as project partners and stakeholders (whether formally or informally) creating the potential for enduring relationships and enabling further routes to impact to be secured.

Especially around the larger investments in Hubs and CDTs, the DET has established new research ecologies between hitherto disconnected disciplines, institutions and user communities. This is of significant long-term benefit as it offers the means for previously unforeseen opportunities to be explored.

There is clear evidence already that DET funded work attracts further research investments from other sources, including European Union research funding, TSB funding for downstream development and from industry directly.

From its interactions with doctoral students, whether during visits to the Hubs or during the presentations given by the CDTs and projects, it was very clear to the Panel that the DET is attracting high quality research students from new sources. A surprising



number were graduates returning to research after gaining some industrial experience. These students were notable for their strong sense of purpose and maturity of outlook. Many had ambitions to take their research through to project, either within an existing company or through a start-up. These students saw their return to research as a means to advance their careers. None of those who wanted a more academic career saw their DE research as putting them at a disadvantage when competing for academic positions, although many expressed a concern that there were relatively few positions available to continue the kind of work they were doing.

The Panel also observed a much better gender balance in DET funded research than is the case with the basic research funded by the ICT Theme. It was apparent that the kinds of research funded by the DET theme were attractive to female researchers and that females were taking on leadership roles in DET funded research.

In several universities we saw strong evidence of the DET acting as an agent of transformational change to the research landscape. These universities were using the DET investments strategically to launch

new institutes, develop new academic leaders, foster multi-disciplinary teams and secure new pathways to impact. They were doing so with a clear objective of increasing their national and international competitiveness.

A novel aspect of DET funding was the provision of funding to the three Hubs for use in bringing other academic and user partners into their activities at the Hub's discretion (the Partnership Fund). This is a powerful tool enabling the Hub leaders to assemble strong teams to tackle their research challenges. Some Hubs had found ways to use this funding creatively to smooth the way to engagement from industry and community groups; although others reported that their university administrations struggled with handing on research income to other parties.

Across the Theme as a whole the Panel found a very wide spectrum of 'users' engaged with the funded projects: large corporates, small businesses, local government, charities, National Health Service, community groups and members of the general public. Many of these were newly established relationships, showing that the DET is reaching out to new audiences.

There was some evidence of the DET having a potential impact on government policy. A number of researchers funded by the Theme were engaged in policy discourse at both ministerial and official levels. It is too early to point to specific outcomes, but it is appropriate to give credit to the community for having started to engage at this level.

### Success Factors

There is a clear flow of factors leading to successful impact from the DET. Success starts with the identification of a focussed theme followed by the creation of a portfolio of related research with strong academic leadership and professional research management. This provides sufficient visibility and critical mass to gain significant industry, governmental and societal engagement with the theme and to attract the best researchers and students to work on it, and to accept the risks inherent in multi-disciplinary research. With the guidance and engagement of a coherent set of external partners the research is more likely to produce successful outcomes. With the scale effects of a portfolio approach to the research comes the ability to do larger scale projects spanning disciplines and to bring together individual strands of work

for greater impact. This becomes a virtuous circle as positive feedback from early work fuels further investment in both the basic research feeding the theme and in the application of that research to the theme itself.

From the evidence and visits a pattern of clear success factors emerged. The top factors were:

- Strong focus on research outcomes and follow through
- Professional impact management expertise and governance
- Significant portfolio style investment in large scale initiatives such as Hubs, CDTs
- Institutional and industrial commitment to large scale investment
- Inter-disciplinary capacity and its integration to address coherent user needs
- Collection and stewardship of open data to support other researchers.

### Strong focus on research outcomes and follow through

To achieve impact, a research activity must have a clearly defined and measurable target and a strategy for using research results to achieve the desired goal: the research cannot just be defined by a question to be answered, nor can knowledge and technology be simply 'thrown over the wall'. There has to be a plan of campaign for getting results into the hands of users in an accessible form and a process of handover as the users develop their understanding of the transformative nature of the results they have been given. But it is well known that research results cannot be predicted nor can breakthroughs be scheduled. It is therefore necessary for research leaders to continually update their impact strategies as the research develops and in the light of user feedback. It was evident to the Panel that the investments with the greatest potential for significant impact were those where the research leaders had a vision of what the likely opportunities for impact were for their research and built the structures needed to bring users into the research process and plan together for handover of knowledge and technology.

### Professional impact management

It was evident throughout the review process that the start up phase of the larger projects with significant investment required a shift in the scale of leadership and management needed, in order to bring a

collection of individual projects into a strategic programme that would achieve the aims of the Theme overall.

Given the scale of these operations, a commensurate scale of management expertise beyond that of regular grant programmes is required, such as the presence of a senior executive project manager alongside principal investigators. In particular, those instances where there was a clear and tightly knit partnership between the principal investigator(s) and the project manager, showed this to be an evident success factor in the work. The role of the steering groups and their terms of reference were also observed to be helpful in developing the work of each investment from start-up to completion with the intention of forming a sustainable activity lasting well beyond the initial funding. This was evident in a number of larger scale projects, such as FIRM and SiDE where interactions between steering group and project had been productive. Further, the brokering role of an impact fellow at dot.rural was seen to be particularly effective, in the context of the MIME and FITS projects.

### **Scale & investment**

It became evident that substantial portfolio style investments around research themes enabled these investments to be given clear focus and consistent management, thereby increasing the potential for substantial impact. Although it is too early to find precise indicators for these impacts, the thematic nature of the research made it easier to frame the types and range of impact that may be appropriate for the research. For example, it was evident that impacts were emerging across public policy, social inclusion, wealth creation, product innovation, and a broader cultural understanding of the DE. As the research matures it is also evident that greater awareness of the management of impact is emerging.

It became clear from the review process that the DET has stimulated significant benefits from the scale and focus of the investment and that the critical mass resulting from this enabled significant innovations in research methodology, for example open source initiatives to provide free access to APIs, data and platforms in order to enable knowledge exchange between researchers and the users of the research.

### **Institutional and industrial commitment**

The benefits of scale and focus also provide research institutes and their universities with the opportunity



to exert a greater purchase on the formation of potential partnerships within a global arena. In working with expanded user communities it was also evident that the scale of these projects necessitated clearer and more focused frameworks for the management of ethical issues and ethnographies, e.g. dot.rural.

Critical mass is generating a pipeline of external funding. SiDE received £800k per annum additional investment from their own institution, contributing to the further £11M funding gained from over 42 projects resulting from the DET £12M original Hub investment.

### **Inter-disciplinary capacity and its integration**

A significant benefit of the investment has been the creation of sustainable interdisciplinary research teams. These include the vertical skills of core research disciplines alongside the integrating potential of other disciplines such as design. In the majority of research seen, this range of interdisciplinary engagement was widely evident. For example, the HighWire CDT is specifically focused around user centred design problems leading to tangible solutions. In the SiDE Hub, a range of disciplines spanning sensor development to user engagement are all integrated through design skills, evident in the Driving Lab and Ambient Kitchen projects. Although design is a key example of such an integrating discipline, it is important to identify the

range of integrating disciplines that will work with core skills across such large-scale interdisciplinary projects.

Significant investment in the co-location of researchers from different disciplines at the Hubs and Centres had brought together interdisciplinary teams at a scale enabling innovation beyond traditional models of collaboration. For example, a broadening of communication skills among researchers needed to work productively with research users, building important outreach to public and user engagements were demonstrated in particular in the patient advocacy programme with dot.rural Hub.

### **Collection and stewardship of open data to support other researchers**

DE related research increasingly depends upon access to large-scale data resources that can be mined and interpreted in novel ways to enable intelligent applications and services. This is a trend being driven by industry through developments

such as web search engines, cloud computing infrastructures and as well as being driven by governments and other public bodies through open data initiatives. Therefore access to such data is a prerequisite for much DE research, and the production of further data is also often a result of DE research. This presents the research community with both funding and technical challenges in obtaining access to data in the first place and then curating that data for use by others. One advantage of the scale aspects of some of the DET investments such as Hubs and CDTs is that they are of sufficient size and importance to be able to negotiate to obtain data and curate it on behalf of the community: in particular they have the professional management skills to develop appropriate frameworks for acceptable use and privacy with the original data owners and the infrastructure resources to securely host data and make it more broadly accessible to the wider research community. For example, the SiDE project has constructed individual private data records in the cloud alongside community access to the aggregation of all data held.

## 6. Theme Weaknesses

### Managing for Impact – DE Hubs and CDTs

Given the scale of the individual investments, the Panel believed it is important that each of the Hubs and CDTs should be able to demonstrate professional project and business management aimed at ensuring maximum impact of their activities.

Principal investigators (PIs) and Directors of the Hubs and CDTs generally understand the importance of their activities having an ‘impact’ at the project level and were able to respond to the review in terms of specific examples at this level. This was evidenced in both the written submissions and the interviews. However it was also clear that the Directors had not fully grasped what impact might mean at the portfolio and programme level i.e. the overall impact of a Hub or CDT.

In written submissions and interviews, Directors and PIs struggled to articulate what strategic long term impact a Hub or CDT might have, and gave no evidence of having impact plans and metrics to assess their progress. Generally those Hubs and CDTs that had a clear customer (be it a single company or industry sector) had the most developed ‘pitch’, than those with a more diffuse set of customers. The Healthcare strategy at Imperial College London and the Financial Services strategy at University College London were notable examples of best practice.

Besides collecting examples of project level impact for the review submissions, PIs gave no evidence of continued monitoring and managing impact across their portfolios. Nor was there evidence of students being trained in ‘impact management’.

Finally, there was variable evidence of Hubs or CDTs reviewing the strategic direction of their programmes to ensure they were focusing on the areas of greatest potential and leveraging other significant initiatives in the UK. As an example, a core asset for the UK’s DE is the broadband infrastructure itself, which is currently undergoing a significant uplift. The UK Government and the EU is providing significant funding (e.g. through Broadband Delivery UK and the Research Development Fund) to cover those regions where commercial economics are insufficient to enable industry investment alone – roughly a third of the UK. Aside from the dot.rural Hub in Aberdeen which had engaged with Cornwall County Council’s broadband programme, there was no evidence of



Hubs or CDTs leveraging this investment despite the significant impact it will have on both consumers and businesses. It was unclear as to why this was so.

In summary, whilst the Hubs and CDTs were all demonstrating positive impact in terms of individual projects, they were lacking the strategic and programme management that the Panel believed was required to ensure that the overall investment achieves the maximum impact.

### Managing for Impact – Research in The Wild (RiTW), Sandpits etc.

In terms of the smaller projects initiated through RiTW etc., it was apparent that there was a lack of portfolio management from the Research Councils. In a scheme that involves about 300 individual projects (161 in the core programme), it is inevitable that there will be some overlapping of research topics. It is concerning that many of these activities are unconnected to and unaware of similar projects within the DET. Two examples are the projects concerning monitoring of energy consumption and those looking at various aspects of community reporting. This would be relatively easy to fix by using the Hubs as an information exchange for projects that fall within their area of focus.

However the Panel concluded this was in fact a symptom of the lack of programme management resources available within the Research Councils; at present there are three managers plus one member of staff for administrative support. Whilst there are two vacancies, the lack of current resource has resulted in mechanisms such as Stage Gating, KPI definition and reporting not being fully implemented. Instead the DET management team rely on individual universities to apply appropriate procedures to the individual projects they manage.

### **Financial issues**

Given the scale of the individual investments, the Panel believed it is important that each of the Hubs and CDTs should be able to demonstrate professional project and business management aimed at ensuring maximum impact of their activities.

Whilst all of the Hubs, CDTs and large projects (e.g. FIRM and DCE) completed the Research Project Survey it is disappointing that only 54% of the 270 PIs responded. This perhaps shows it is more challenging for those with smaller and more isolated investments to engage with an impact agenda than those with a bigger stake in it.

The DET is now experiencing a rapid growth in spend rate that is driven by the need to allocate (commit) funds within the relevant spending review period. There is a danger that lack of capability and capacity will jeopardise the quality of the DET because of inability to hire well-qualified people. Whilst we saw no definite evidence of this, there was anecdotal evidence that some of the PIs were concerned about this issue. However over time as the students currently being trained by DET CDTs graduate the required talent pool will become available and it is important there will be positions into which these graduates can be hired.

A number of investigators, particularly those involved in CDTs, sandpits and shorter projects (RiTW), expressed concerns about follow-on funding for DE work once the current budget for the DET is allocated and consumed. Some were concerned about pursuing their research agendas but there is also an issue about commercial exploitation which operates on a longer cycle than research funding. This could argue for better coordination between RCUK and the TSB to ensure that the many exploitable ideas that are being produced by the programme do find a downstream route to commercialisation.

The partnership funds allocated to the Hubs are an innovative initiative with the potential to significantly boost the outreach of the programme. Unfortunately, the Hubs have varied levels of understanding about the criteria governing the use of these funds and therefore the flexibility is not being used to its full potential. This problem could be easily fixed by ensuring closer collaboration between the Hub Directors to ensure promulgation of good practice.

From interviews, there is evidence that the innovative funding schemes employed in the programme are hitting bureaucratic barriers in universities. The Partnership Fund is a good example of this; it is a significant sum of money that appears as research income but is not available for spending in the university that holds the award. As stated in the previous paragraph, the investigators also see imagined barriers in the Research Council rules that restrict their flexibility and agility in using these funds.

### **Scope of Programme**

Although there was not too much concentration on the production of 'technology in search of an application' (a worry expressed to the Panel by some of those involved in the set up of the Theme) it does appear that most projects focus more on 'Digital' than 'Economy'. This is possibly a product of the fact that 66% by value and 72% by number of the grants are led by Engineering and Computer Science PIs. There is very little economics or business thinking contributing to the Theme. This reflects the disparity in levels of investment between the research councils, and perhaps a lack of interest in the topic at the business schools.

There is some evidence of risk of 'academic tourism' where projects were not optimally configured, in terms of investigator disciplines, to address the research question. For example, projects with an explicit social science component should include a social scientist as an investigator, rather than having, for example, a computer scientist becoming an amateur social scientist.

Many of the projects involve interaction with the public, either through direct contact or through the collection and use of personal data. This often raises ethical concerns and while investigators appear to be aware of these issues there was little evidence of advanced planning to deal with them and shortcomings in how some universities manage ethical review processes and training.

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# 7. Concluding Remarks

The Digital Economy Theme is an exciting initiative launched by the UK Research Councils which has been taken up enthusiastically by the research community. The Theme is already making 'impact' contributions and is likely to do so on a greater scale and more widely as the research matures. It is something of which the UK research community and the Research Councils can be proud, and is an example of UK leadership in research internationally.

The job of the Review Panel was made easy by the willingness of the research community and their user partners to engage with us, discuss issues freely and of course demonstrate their achievements to date and hopes for the future.

We hope our review will be seen by the research community, the universities and the Research Councils as a strong endorsement for the Theme and the innovations it has stimulated in research funding, institutional organization, research project management and attracting a new breed of research student. Many of these are aligned with other drivers for change in the research landscape such as a greater emphasis on multidisciplinary research and

user engagement. The investigators and students who have taken the risk to be pioneers and leaders in these transformations are to be congratulated for their courage and optimism.

Our biggest concern is the need for more economics and business understanding of digital economies to be put alongside the technological and user aspects. This is key to achieving the high ambitions set by the Research Councils in setting up the Digital Economy Theme.

With an increasing focus of the Research Councils as 'sponsors' of research we strongly encourage them to plan for success and ensure the sustainability of what they have created in planning future programmes and funding allocations. In that vein, we offer our recommendations with the aim of further enhancing the benefits of the Theme to the UK economy and the UK research community.

Andrew Herbert  
Cambridge

August 2012



# Annex A Table of Acronyms

<b>AHRC</b>	Arts and Humanities Research Council	
<b>API</b>	Application Programming Interface	
<b>BBSRC</b>	Biotechnology and Biological Sciences Research Council	
<b>BURD</b>	Bridging the Urban and Rural Divide	RCUK call for research projects
<b>CDTs</b>	Centres for Doctoral Training	RC funding mechanism for students
<b>DE</b>	digital economy	
<b>DET</b>	Digital Economy Theme	RCUK Cross Council Theme
<b>dot.rural</b>	dot.rural	DET Hub, University of Aberdeen
<b>EPSRC</b>	Engineering and Physical Sciences Research Council	
<b>ESRC</b>	Economic and Social Research Council	
<b>FIRM</b>	Framework for Innovation and Research in MediaCityUK	
<b>FITS</b>	Flexible Integrated Transport Services	dot.rural project
<b>Horizon</b>	Horizon Digital Economy Research, University of Nottingham	DET Hub
<b>Hub</b>	Critical mass investments by the DET	DET portfolio includes three Hubs at £12M each
<b>ICT</b>	Information Communications and Technology	EPSRC Theme
<b>IP</b>	Intellectual Property	
<b>IU-ATC</b>	India-UK Advanced Technology Centre	
<b>KTP</b>	Knowledge Transfer Partnership	
<b>MAT</b>	Media & Arts Technology	CDT, Queen Mary, University London
<b>MRC</b>	Medical Research Council	
<b>NDRC</b>	National Digital Research Centre (Ireland)	
<b>PAB</b>	Programme Advisory Board	DET advisory body
<b>PI</b>	Principle Investigator	
<b>RCUK</b>	Research Councils United Kingdom or Research Councils UK	
<b>RiTW</b>	Research in The Wild	DET call for research projects
<b>SiDE</b>	Social inclusion in the Digital Economy	DET Hub, Newcastle University
<b>SME</b>	Small and Medium-sized Enterprise	
<b>TEDDI</b>	Transforming Energy Demand through Digital Innovation	RCUK call for research projects
<b>ToTEM</b>	Tales of Things and Electronic Memory	Design in the Digital World sandpit project
<b>TSB</b>	Technology Strategy Board	
<b>UCLAN</b>	University of Central Lancashire	



# Annex B Review Evidence Framework

## Evidence Framework

An Evidence Framework, shown in Table 3, was provided to assist the Panel during the review week to help ensure coverage of all relevant strategic issues. The Framework was not intended to restrict the Panel; additional issues were addressed as they arose. The questions below were also used for the public consultation exercise which provided additional input to the Panel.

The questions were drawn from the EPSRC Evaluation Framework, and altered to reflect the cross-council nature of the DET.

## Impact Framework

To provide a guide to possible immediate, medium and long-term outputs and outcomes, an Impact

Framework has been developed by the DET in consultation with the community, based on the RCUK definition of impact<sup>4</sup>. An overview of the DE Impact Framework is given in Figure 1. This shows the four main headers and associated descriptors.

This framework is not meant to be an exhaustive list of all possible impacts of DE research, nor does the DET expect all grants and/or portfolios to deliver against all impacts. The framework gives a guide for the community on what the DET considers possible impacts, and on the evidence that the community should be collecting to show these impacts. Further details of the framework can be found in Table 4.

<sup>4</sup> <http://www.rcuk.ac.uk/kei/impacts/Pages/meanbyimpact.aspx>

**Table 3: Evidence Framework for DE Impact Review**

*Impact: The extent to which DET-funded research and training activities have delivered impact for the UK.*

1. The quality of relationships between UK academia and users both nationally and internationally, the degree of partnership leverage (in terms of both financial and influence), and how can these be improved.
2. The level of knowledge exchange (& researcher mobility) between the research base and users that drives cultural, commercial and technological advances, and how can these be improved.
3. The degree to which UK researchers have embraced and embedded thinking about how to follow up on potential opportunities, including public engagement opportunities, to maximise impact of their work.
4. The degree to which UK researchers are maximising impact from long-term research investments in line with national research challenges and future economic and social needs; including enabling the development of key emerging industries.
5. The extent to which research addresses key technological/ societal challenges facing the UK economy, how influence is being exerted on Government thinking and policy, and the global significance of the UK contribution in this area.

*Excellence: The extent to which the UK is maintaining international excellence in DE-related research areas identified as of strategic importance to the economy, to UK society and to other research disciplines.*

6. The extent to which UK DE-related research and training is internationally excellent in comparison with other leading nations.
7. The balance between research that is creative, adventurous and ambitious and research that is "safe", including the extent to which the free generation of ideas and curiosity based research is supported and the consequent emerging major and transformative innovations of benefit to the UK, demonstrated through examples of successes..
8. The extent to which UK researchers are proactively multidisciplinary in their approach and how well they are able to respond optimally to current and emerging technological/ societal challenges; includes the assessment of the added value of the multi-disciplinary DE approach (i.e. could this have happened without the DE investment), identification of specific barriers to such working and potential improvements which could address them, as well as being able to demonstrate successes achieved.
9. The degree to which research underpins and/or depends upon other research areas. What those areas are and how well the community engage with those areas nationally and internationally.
10. The degree to which DE research leaders are adopting a leadership stance as role models in terms of maximising the impact of their research, inspiring others and/or building cross-disciplinary teams to tackle global challenges.

Figure 1: DE Impact Framework



**Table 4: DE Impact descriptors**

	Indicator	Descriptor
Capability	Academia - Size and Shape	Academic promotions, new posts created ('upward' mobility) PI & staff institutional moves ('sideways', transdisciplinary mobility,) Group profiles: staff disciplines, age profile Undergraduate/masters degree core disciplines
	Academic Innovation	New methods developed for teaching and staff training
	Institutional investment	Institutional Investment in and changes to buildings/labs/location Institutional investment In staff, new posts
	Portfolio	Academic collaborations on grants, across Depts., across universities (Incl. international) Number of grant holders, PhDs New research grant income from DE funding, direct and influenced, follow on research activities (e.g. TSB, Wellcome, other RC progs)
	Training/Skills	Joint supervision of PhDs, details of supervisors from different disciplines (Transdisciplinary) Training modules/courses [academic content & transferable skills], including CPD
	User Engagement	Details of advisory input from user organisations (i.e. researchers benefit)
Economy	Academic Innovation	Details of patents, licences, spin-outs, consultancies
	Attracting R&D investment	Attracting 'translational' R&D investment (e.g. VCs, SMEs, global enterprises)
	Innovation in organisational culture and practices	innovation in organisational culture and practices (e.g. enhancing research capacity, knowledge & skills)
	Innovation in products & services	E.g. feedback into product/service design
	Training/Skills	First destinations of PhDs/CDTs
	User Engagement	Details of strategic partnerships with users User contribution to research activities £, time (secondments, placements) User participation in events (i.e. users benefit)

Continued overleaf

	Indicator	Descriptor
Knowledge	Academic Innovation	Innovations in dissemination e.g. open-sourcing materials New methods developed to: identify research challenges, engage others, stimulate creativity, innovate and work across boundaries Group profiles: staff disciplines, age profile
	Academic Leadership	Keynotes given, prizes and awards received (Esteem) Key publications/citations Details of participation in advisory bodies/Learned societies (incl, International] (e.g. boards, working groups, etc)
	Knowledge Economy	Key journal publications, co-authorship discipline profiles (Transdisciplinary) Participation in events, workshops, seminars, conferences (Transdisciplinary) Community led events and networking (across portfolio) Community led activities joint with other areas (academic outreach, beyond portfolio) New academic collaborations (across portfolio) Joint activities with other RC programmes
Society	Cultural Enrichment	Activities and impacts on cultural enrichment (creativity, curation, heritage)
	Environmental Sustainability	Activities and impacts on environmental sustainability (protection, impact)
	Influencing Policy	Attendance at Select Committees, input to consultations etc Details of relationships with Government departments/bodies and outcomes Innovation in evidence based policy-making and influencing public policies and legislation
	Innovation in public services	Innovation in the effectiveness of public services [e.g. transport, healthcare, etc)
	Media Representation	Brand establishment and recognition Key quotes, press interviews, YouTube videos, etc
	Personal Identity	Activities and impacts on individuals (e.g. maintenance of personhood, accessibility & Inclusion)
	Public Engagement	Evidence of engagement with schools and the wider public
	Quality of Life Enrichment	Activities and impacts on quality of life, health and well-being
	Improving Social Welfare	Activities and Impacts on social groups/communities (social welfare, cohesiveness}

## Annex C Biographies of Panel Members

### Susan Aubrey-Cound, Marketing Consultant



Susan has 26 years experience in retail and 15 years in ecommerce. Her appointment as director of M&S multichannel in July 2009 followed 18 months as Executive Assistant to Sir Stuart Rose (CEO/Chairman). Prior to this she held

positions at Marks and Spencer as Head of Marketing where her remit included campaigns for fashion, home, foods and CSR, having joined M&S in 2001 from Moss Bros where she had been Marketing and Ecommerce Director. A previous 9 years at BAA Airport Retail including Director of Ecommerce and CRM, following a number of group brand marketing roles, with P&L responsibility for BAA's ecommerce, credit card and loyalty card. Her retail career started as a merchandising and marketing in womenswear mail order after graduating in Psychology from Durham University

### Dr Sean Baker, Chairman, Incaplex Ltd



Sean Baker is an entrepreneur based in Dublin and co-founder of IONA Technologies plc, where he held many executive positions including CTO, SVP of Customer Services, Chief Scientist, VP Applied Research. His role in the start up

phase included funding the company through training and consultancy.

He is Chairman of Incaplex, a healthcare IT startup; and a member of the Boards of National Digital Research Centre, Calom Technologies and Gridstore. He is was Chairman of the Irish Software Association from 2009 to 2011, and is a member of the Advisory Council for Science, Technology and Innovation, the Irish government's high-level advisory body. He is a member of the governance boards of a number of Science Foundation Ireland funded projects including Lero, ICHEC and Clique.

Within the ISA, Sean is active in the Software Investor Forum, which mentors young companies on many areas including investment. He is also a mentor under Enterprise Ireland's iGAP programme.

He was a member of the board of Iona Technologies plc, Havok and the Object Management Group.

Sean is an Adjunct Professor at the UCD School of Computer Science and Informatics. He holds a Ph.D. in Computer Science from Trinity College Dublin, and held a tenured post in the Department of Computer Science at TCD, where he helped form the Distributed Systems Group in 1980.

Sean Baker is a NDRC Board member, and a member of the company's investment committee. The committee is responsible for NDRC's investment decisions, evaluating investment proposals against technical and business criteria, and reviewing the progress of projects within NDRC's portfolio.

### Professor Bruce Brown, Pro-Vice-Chancellor Research, University of Brighton



Bruce Brown is Pro-Vice-Chancellor Research (working across all the sciences and arts) and Professor of Design at the University of Brighton. For twenty years previously he was Dean of the university's Faculty of Arts & Architecture. Recently he was appointed by the Funding Councils for England, Northern Ireland, Scotland and Wales to lead the quality assessment of arts and humanities research produced by UK universities [Chair, Main Panel D REF2014]. He was a member of the Advisory Board of the UK Arts and Humanities Research Council and has advised international organizations including the Hong Kong Council for Academic Accreditation and the Qatar National Research Fund. He chairs the Portuguese Government's Fundação para a Ciência ea Tecnologia Research Grants Panel [Arts] and was one of four people invited by the Portuguese Government to conduct an international review entitled Reforming Arts and Culture Higher Education in Portugal. He has served as Trustee and Governor of organizations such as the Art's Council for England's South East Arts Board, the Ditchling Museum and Shenkar College of Design and Engineering, Tel Aviv. He is Editor of Design Issues Research Journal (MIT). Before joining higher education he worked as a designer being art director of CRAFTS magazine for the Crafts Council. He specializes in the social and

cultural effects of visual memory in the digital age giving keynote addresses at for example: Design and Ethics (Budapest), the Third International Conference of the Arts in Society (Birmingham), Graphic Memory (Ontario), The Design of Memory (Tel Aviv) and Memory is the Message (Chicago)]. He is an Honorary Fellow of the Royal College of Art and was elected FRSA in 1970.

**Professor Hazel Hall, Director of the Centre for Social Informatics, Edinburgh Napier University**



Professor Hazel Hall is Director of the Centre for Social Informatics in the Institute for Informatics and Digital Innovation at Edinburgh Napier University. She also leads the implementation of the UK Library and Information Science Research Coalition. In April 2011 she was named SLA Europe Information Professional 2011.

Hazel's main research expertise and teaching interests lie in information sharing in online environments within the context of knowledge management. Other themes in which she maintains an active interest include social computing/media, online communities and collaboration, the education and training of information professionals, and library and information science research. She has published and presented widely in these areas for international refereed journals and conferences (including as keynote presentations at international events), with further publication activity including professional press and monograph contributions. Her doctoral thesis considered the role of the intranet in knowledge sharing. As well as holding a doctorate awarded by the School of Computing at Edinburgh Napier and a Masters degree in Library and Information Studies, Hazel studied French and Italian language and literature as an undergraduate at the Universities of Birmingham, Nantes and Paris Sorbonne.

**Professor Chris Hankin, Professor of Computing Science, Imperial College London**



Chris Hankin is a Professor of Computing Science at Imperial College London and Director of the Institute for Security Science and Technology at Imperial. He has a PhD in Computer Science (University of London, 1979), joined

Imperial College in 1984 and was promoted to Professor in 1995. He has held various administrative roles at Imperial including Dean of Engineering (2000-2003), Pro Rector for Research (2004-2006) and Deputy Principal of Engineering (2006-2008). His research has focussed on mathematical approaches to the abstraction and analysis of large data sets. When the data set represents a program state space, this gives rise to static program analysis techniques that can be used to safely optimise program behaviour. More recently, he has been applying the same techniques to the analysis of large datasets that arise in criminal investigations; a recent contribution has been a new multi-scale algorithm for detecting sub-communities in networks. Whilst his early work concentrated on the use of discrete mathematics, his recent work has focussed on the analysis of probabilistic systems.

Hankin is a co-author of the seminal graduate text book on program analysis and has published about 90 journal and conference papers.

He has held several European and EPSRC grants. He is currently principal investigator on 1 EPSRC grant (EP/H023135/1 – Making Sense) and co-investigator on two other grants (EP/I038837/1 – Digital City Exchange – and EP/J020478/1 – DalSy Clouds).

He is Chair of the UK Computing Research Committee (UKCRC), President of the Scientific Council of INRIA and Editor-in-Chief of ACM Computing Surveys. He is a Chartered Engineer and Fellow of the IET (FIET), City and Guilds Institute (FCGI) and the Royal Society of Arts, Commerce and Manufactures (FRSA).

**Dr Andrew Herbert OBE, FREng**



Andrew Herbert is a British computer scientist, formerly Chairman of Microsoft Research, for the Europe, Middle East and Africa region. Herbert received a BSc in computational science from the Leeds University in 1975, and a Ph.D. in Computer Science from Cambridge University in 1978.

In 1978 he started working at the University of Cambridge Computer Laboratory as assistant lecturer in the Computer Laboratory working with others on the 'Cambridge Model Distributed System'. In 1985 he left Cambridge to found his own contract

research company (Architecture Projects Ltd - APM Ltd), which led projects to develop ANSA, the Advanced Network Systems Architecture. In 1996 he had founded another sister company called Digitivity to develop a product to enable the secure deployment of Java clients for business-to-business applications. Two years later he joined Citrix Systems Inc. following their acquisition of APM and Digitivity to become Director of Advanced Technology. In 2001 he joined Microsoft Research in Cambridge as an assistant director, and became managing director in April 2003. In 2010 he became chairman of Microsoft Research EMEA. He retired from Microsoft in September 2011.

Herbert is a Fellow of the Royal Academy of Engineering, a Fellow of the British Computer Society, a Liveryman of the City of London Worshipful Company of Information Technologists and a Fellow of the British Computer Society. He is a member of ACM and IEEE. He is a Visiting Professor at University College London, an Emeritus Fellow of Wolfson College, Cambridge and a member of St John's College, Cambridge. Herbert was appointed Officer of the Order of the British Empire (OBE) in the 2010 New Year Honours.

Outside of computing, Herbert's interests include flying and restoring vintage aircraft, computer conservation and building scale working models of steam railway locomotives.

Now in retirement, Herbert is the director of a project to construct a replica of the Cambridge EDSAC computer as it was in May 1947 when it ran its first program. The project is sponsored by Cambridge University and the Computer Conservation Society: The replica will be constructed at The National Museum of Computing.

### **Professor Jim Hollan, Professor of Cognitive Science, UCSD**



Dr. Hollan is Professor of Cognitive Science and Adjunct Professor of Computer Science and Engineering at University of California, San Diego (UCSD). He co-directs the Distributed Cognition and Human

Computer Interaction Lab and the Ubiquitous Computing and Social Dynamics Research Group. His research spans across distributed and embodied cognition, human-computer interaction, multiscale information visualization, computer-mediated communication, and software tools for

visualization. Dr. Hollan was elected to the ACM CHI Academy, an honorary group of leaders in the field of human-computer interaction, for multiple contributions that have shaped the field. His previous positions include Professor and Chair of the Computer Science Department at the University of New Mexico, Director of Computer Graphics and Interactive Media Research Group at Bellcore, and Director of Human Interface Laboratory at the Microelectronics and Computer Technology Corporation.

### **John Howkins, Consultant**



John Howkins is a specialist in the global development of creative economies. He is the author of 'The Creative Economy' (2001) and 'Creative Ecologies' (2009). John is Chairman of ITR in London and Howkins & Associates in China. In 2010-11 he advised the Prime Minister of Thailand on a five year plan for Thailand's creative economy.

He was Chairman of BOP Consulting, Britain's leading advisory company on culture, creativity and innovation, 2008-2011, and remains an associate. He was Chairman of Tornado Productions, one of Britain's first streaming companies, 2000-06. He was a director of HandMade plc 2000-09. He is a board director of HotBed Media.

Since 2006 he has visited China frequently and is well-known as an expert adviser on creativity and innovation. The Shanghai government set up the John Howkins Centre for the Creative Economy in 2006. Howkins & Associates is currently advising on new projects in Shanghai, Beijing and Wuxi.

He is the Founder and Director of the Adelphi Charter on Creativity, Innovation and Intellectual Property, and devised the London Intellectual Property Advisory Service ('Own It'). He was associated with HBO and Time Warner Inc from 1982 to 1996 with responsibilities for TV business development in UK and Europe.

He is Deputy Chairman of the British Screen Advisory Council (BSAC) and a Council Member of the Arts and Humanities Research Council (AHRC). He is a former Chairman of the London Film School. He was Executive Director and associated with the International Institute of Communications for many years.

He has a BA in International Relations and a MA and AA (Dip) in Urban Design. He is Visiting Professor at City University, London, and the Shanghai Theatre Academy.

### **Jonathan Legh-Smith, Head of Partnerships & Strategic Research and Head of Standards, BT Group**



Jonathan Legh-Smith directs BT's Strategic Research programme and manages BT's collaborative research partnerships with industry and academia. The Strategic Research programme addresses the longer-term opportunities

and technical challenges facing the BT Group. BT's research partnerships include strategic engagement with select industry partners and international universities, and participation in UK and EU collaborative research programmes.

From 2003 to 2008 Jonathan established and directed BT's Information and Communications Technologies (ICT) research programme which developed innovative ICT propositions and technologies to meet the needs of BT's large enterprise customers.

Jonathan is also BT's Head of Standards and is responsible for engagement in national and international standards development organisations. Jonathan has contributed to a number of organisations including ISO, ECMA, and The Object Management Group.

Jonathan's background is in technology strategy and research and was previously based in Silicon Valley, California as the VP, Technology for BT Technology & Innovation, working with early-stage technology companies and undertaking business development with BT's Business Units.

### **Dr Kenny Mitchell, Research Lead, Disney Research Edinburgh**



Kenny is an imaginer and research lead providing commercial technology solutions to the Walt Disney Company Ltd. He is located in the beautiful city of Edinburgh, Scotland at an outpost of the Disney Research's Zurich lab. Over the past 15 years he has shipped games using high-end graphics technologies including voxels, volumetric

light scattering, motion blur and curved surfaces. His PhD introduced the use of real-time 3D for information visualization on consumer hardware, including a novel recursive perspective projection technique. In between contributing to the technically acclaimed racing game Split Second, Spielberg's Boom Blox (BAFTA award winner), and the Harry Potter franchise games he is involved in developing new intellectual properties. His work includes collaboration with Disney Interactive Media Group, Disney Consumer Products, Marvel Enterprises, Pixar Research, Feature Animation and Walt Disney Imagineering, and many successful funded University collaborations. He is the most senior Disney research representative in the UK.

He is a work package lead for the EU FP7 PPP Future Internet: CONTENT project, an industrial supervisor for 3 EPSRC co-sponsored engineering doctorates and member of EPSRC Strategic Advisory Network, ACM SIGGRAPH Conference Guidance Group, Edinburgh University School of Design Informatics steering board and Edinburgh Napier University knowledge exchange network.

### **Dr Paul Nightingale, University of Sussex**



Paul Nightingale is Deputy Director of the Science Policy Research Unit (SPRU), at the University of Sussex. In 2012 SPRU was named the top think tank on innovation and technology policy in the UK. He was originally trained as a chemist, and after working in industry, got a DPhil from Sussex in Technology Policy in 1997.

He is a visiting Professor in Strategy at the Cass Business School (City University, London), where he teaches on the EMBA, is UK editor of Industrial and Corporate Change, and on the main editorial board of Research Policy the two top international innovation journals. From 2010-2011 he was a special advisor to the House of Lords Science and Technology Select Committee inquiry into public procurement and innovation.

He has published widely on innovation in financial services, instability in risk management systems, capital goods use in service firms, financing of biotechnology, bio-security, and the nature and use of knowledge. He has run a number of major research projects on bio security, biotechnology, finance and science policy. He lives in London.



**Dr Adrian Woolard, Project Director, BBC R&D**



Adrian is currently Project Director, North Lab, BBC R&D where he leads delivery of the creation of a new kind of world class R&D facility - an integral part of what BBC R&D will be in the 21st century. Previously he was

Head of Innovation Culture for BBC Research & Innovation - leading a small team focused on supporting open innovation programmes such as Backstage, BBC AHRC Knowledge Exchange, Innovation Labs and other strategic research collaborations/projects.

His research focus is exploring the changing relationships between content, audience and technology in the emerging multi-genre & multi-platform environment.

Adrian's recent research has been on areas related to new interfaces such as augmented reality, mobile, pervasive and embedded computing, the growth of participatory media and the potential value of play and application of game design to create new forms of education and entertainment.

His research background lies in the areas of animatronics, working with Jim Henson's Creature Shop, and virtual characters.

# Annex C Review Week Itinerary

Date	Activity
<b>Sunday</b> <b>13th May 2012</b>	Panel welcome & dinner, Sheraton Heathrow Hotel.
<b>Monday</b> <b>14th May 2012</b>	<b>Panel briefing session, Sheraton Heathrow Hotel:</b> Presentations covering the scope and governance of the DET and the context for the Impact Review Initial Panel discussion exploring the Terms of Reference and the Evidence Framework, and consequent avenues for questioning for the rest of the review week. Travel to DE Hubs (Aberdeen, Newcastle and Nottingham).
<b>Tuesday</b> <b>15th May 2012</b>	<b>DE Hub visits, which followed the same general format:</b> Welcome and Hub overview by Hub Director, followed by Q&A Demonstration of a range of projects and impacts Private Panel session Lunch, with students & poster session Discussion with project partners Open discussion and Q&A with Director + senior Hub members. Travel to Swindon.
<b>Wednesday</b> <b>16th May 2012</b>	<b>DET 'theme day', EPSRC.</b> Short interview sessions, physically and via Skype/videoconferencing. PIs sampled from across the DET portfolio, covering the various mechanisms used by the DET. Panel dinner with DE PAB.
<b>Thursday</b> <b>17th May 2012</b>	<b>CDT sessions, EPSRC.</b> Interview sessions with CDT Directors and other representatives from the Centres. Demonstration of research projects from the CDT students. Lunch with CDT Directors, students and other representatives from the Centres. Panel commenced drafting report.
<b>Friday</b> <b>18th May 2012</b>	<b>Drafting of report, De Vere Village Hotel, Swindon.</b> Presentation of main findings and recommendations to RCUK representatives. Panel departed.

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# Annex D Supporting Evidence provided to the Panel

The evidence document supplied to the Panel comprised four parts, detailed below. The evidence can be accessed on the RCUK DE website.

## **Part 1: UK Science and Innovation Policy and Research Funding**

Part 1 provided a high level overview of how the science budget was secured and distributed. It also contained broad descriptions of various Research Council mechanisms for supporting research and training.

## **Part 2: RCUK DET**

Part 2 provided RCUK-related grant and studentship data, information about relevant TSB activities and information on other potential funders and collaborators. It was prepared as a companion to 'Funding of Science and Innovation in the UK' to give more detailed contextual data relevant to Energy research in the UK.

## **Part 3: Evidence from the Portfolio Survey**

Part 3 provided evidence from the portfolio survey, a compilation of investigator responses providing impact evidence against the DE Impact framework

## **Part 4: Evidence from the Public Questionnaire**

As part of the preparation for the review a public consultation was held to gather evidence for the Panel. Responses were specifically invited from the Principle Investigators and project partners, and from any other interested person/organisation via a public call on the Research Council websites.

A standard template was used to ensure that submissions addressed the Evidence Framework agreed by the Steering Committee. The Panel was provided with the full text of all responses received.