The EngD and its importance to UK plc

April 2014

This briefing document was produced to support representations made by the Association of Engineering Doctorates (AEngD) to the Minister for Universities and Science, the Rt Hon Mr David Willetts MP, at the Department for Business, Innovation and Skills, on 8 April 2014 (s*ee news release on AEngD website dated 2 May 2014*).

http://www.aengd.org.uk

Executive summary

Now almost 22 years old, the UK's Engineering Doctorate (EngD) scheme "was ahead of its time". Since 1992, the programme has delivered numerous innovations and has helped 100s of researchers achieve leadership roles in many UK engineering and technology businesses. The rigorous approach to partnerships between academia and industry exemplified by the EngD is being emulated by other EU states and in the USA, and is strongly supported by industry. Comments from over 30 industry sponsors attest to the EngD's value to 'UK plc'.

The Coalition's industrial strategy is increasing investment in centres for doctoral training (CDTs). However, due to what the AEngD believes was a flawed 'one size fits all' process, the EPSRC has cut the number of pure EngD centres from 28 to 16. Prior to these decisions, EngD centres comprised around 40 per cent of the total number of CDTs. They now comprise 14 per cent, despite the demonstrable benefits of EngD programmes to date.

The AEngD feels these reductions may compromise the Coalition's industrial strategy. It believes, first, that there is a **numerically far greater need for EngDs in industry than the need for PhDs** to support academia, and, second, that **EngDs deliver value to industry more quickly** – vital if the UK is achieve its competitive aims.

This document underlines the differences between the EngD and PhD research programmes.

- EngD research is driven by industry need
- EngD research is co-supervised by industry
- EngD research leverages high additional industry investment
- EngD researchers work mainly in industry
- EngD adds immediate value to industry
- EngD reduces 'time to market' for innovations
- EngD aid industry collaboration
- EngD experience counts towards CEng
- EngD graduates command higher salaries
- EngD graduates more likely to be employed in industry
- EngD graduates become industry leaders sooner

In short, the AEngD believes **EngD programmes**, while challenging to maintain, **deliver innovations and the engineering leaders of tomorrow more efficiently than PhD programmes**, while remaining as rigorous as PhDs.

The AEngD would like to see funding for doctoral training increased, perhaps by greater use of non-EPSRC funding (reflecting the cross-cutting nature of much EngD research), to encourage further investment, particularly as a recent AEngD/EPSRC-funded study shows EngD research:

- adds direct and early value for UK industry from the research undertaken,
- accelerates the 'time to market' of UK research,
- delivers UK engineering leaders more rapidly, and
- enables EngD graduates to become Chartered Engineers four years ahead of PhDs.

The AEngD believe all of these benefits, particularly when many EngD programmes are already closely aligned with identified industry research needs, will help deliver the national industrial growth strategy (and its constituent vertical industry strategies), and have a substantial national payback.

The AEngD further suggests that selection of EngD centres could be based on evaluation of their competence, and that research topics be determined by industry need under-pinned by their 50 per cent match funding.

Contents

Introduction

The Engineering Doctorate (EngD) scheme was established by the Engineering and Physical Sciences Research Council (EPSRC) in 1992 (following recommendations of the 1990 Engineering Doctorate Report, produced by a working group chaired by Professor John Parnaby).[1] The first EngD programmes began in 1992, and by the 20th anniversary of the qualification's launch in 2012, 29 schemes were offered by UK universities - either singly or as multi-institution academic partnerships (appendix.

"The EngD was ahead of its time," said Minister for Universities and Science The Rt Hon Mr David Willetts MP, when he spoke at the launch conference of the Association of Engineering Doctorates in London on 1 November 2012. Speaking at the Royal Academy of Engineering, Mr Willetts saluted the UK research community for creating a qualification that broadened understanding of engineering disciplines and applied intellectual advances to the world of industry, business and commerce. He said:

> "I think that engineering, not for the first time, was ahead of the field in the development of this qualification. … We can look around and see many other disciplines that are trying to learn from this as they broaden their doctorates so that they have the same kind of range of skills that the EngD represents."[2]

As a believer in evidence-based policy and evaluation, he went on to challenge the sector to track the career outcomes of people who have completed the qualification, before reiterating the Coalition's belief in "the importance of the engineer and the importance of the EngD within the STEM pipeline".

His support was echoed by Dr Paul Golby, chairman of the EPSRC, in his keynote address at the conference.[3]

Recent changes

However, this support is inconsistent with recent EPSRC announcements.

The EPSRC announced, on 22 November 2013,[4] 9 January[5] and 28 March 2014,[6] decisions about funding for Centres for Doctoral Training (CDTs). The announcements barely mentioned the EngD qualification, and analysis of the details (along with information usefully provided by the EPSRC's Neil Viner, at the AEngD's 2013 conference on 26 November 2013, and Jim Fleming, email dated 1 April 2014), reveals that, **of the 113 funded centres, just 16 are dedicated EngD centres** (at least three other centres offer a mixture of PhD and EngD). **Previously, EngD centres made up around 40 per cent of the total. They now comprise 14 per cent** (or 17 per cent including the mixed centres), despite the demonstrable benefits of EngD programmes to date.

There is, therefore, a deep sense of confusion and dismay among many stakeholders in the EngD qualification. This extends beyond the university-based industrial doctorate centres (IDCs) to include scores of industry sponsors, and 100s of both current and past EngD research engineers – who are concerned about future recognition of their qualification.

---

1 Parnaby J, (June 1990) The Engineering Doctorate. A SERC Working Party report to the Engineering Board of the Science and Engineering Research Council

2 Transcript, video recording and news release of speech on AEngD website - link

3 Video recording of Dr Golby's keynote on AEngD website, with presentation - link

4 "Willetts announces £350 million for PhD training in over 70 new centres" EPSRC news release (22 November 2013)

5 "Willetts to announce 19 new Centres for Doctoral Training" EPSRC news release (9 January 2014)

6 "Osborne announces 22 new Centres for Doctoral Training" EPSRC news release (28 March 2014)

Following a 9 January 2014 emergency meeting of the AEngD steering committee, chairman and EPSRC EngD Advocate Professor Patrick Godfrey, said:

> "The UK broke new ground when it followed the recommendations of the Parnaby Report and launched the EngD in 1992. The rigorous approach to partnerships between academia and industry exemplified by the EngD is now being emulated by other EU states and in the USA, and is strongly supported by industry. To date, over 600 UK and international sponsor companies have supported EngD research in the UK.[7] Moreover, **firms such as Airbus UK, BAE Systems, GSK, Jaguar Land Rover, Procter & Gamble, Renishaw,**[8] **Rolls-Royce and Tata Steel, have invested repeatedly in EngD research**. Thousands of EngD research engineers have been based in industry and co-supervised by their sponsors, delivering innovations, new products and services, and adding value to UK plc.
>
> "According to findings in a recent Manchester Business School study,[9] EngD research:
> - adds direct and early value for UK industry from the research undertaken,
> - accelerates the 'time to market' of UK research,
> - delivers UK engineering leaders more rapidly, and
> - enables EngD graduates to become Chartered Engineers a full four years ahead of their PhD counterparts.
>
> We believe all of these benefits will help deliver the national industrial growth strategy and have a substantial national payback."

This document outlines the AEngD's main concerns. It underlines the differences between the EngD and PhD research programmes. It highlights the special challenges of effectively harnessing the inputs of academia and industrial partners to deliver EngD research. It relates these to the needs of UK industry and the delivery of sustained national growth in the intellectual base of 'UK plc'. The following six sections (with associated appendices) detail:

1. the differences between EngD and PhD programmes
2. the industry impacts of EngD research
3. the support of industrial sponsors of EngD researchers
4. the UK's world leadership in creating the EngD over 20 years ago
5. concerns that the recent funding process altered the balance of doctoral funding, reducing support for demanding, industry-driven EngD programmes, and opportunities for EngD research to be funded to support the UK Government's industry strategy

7 Figure quoted by Dr Golby in his keynote presentation to AEngD conference, 1 November 2012.

8 Prof Nick Weston, Renishaw plc, told the 2012 AEngD conference his company had two completed EngDs, three writing up and six more "still at their studies"

9 Kitagawa, Fumi (2014) "Understanding the EngD Impact – A Pilot study" Draft report (1 April 2014). The research, undertaken by a team led by Dr Fumi Kitagawa, lecturer in enterprise studies at Manchester Business School, was co-funded by the EPSRC and AEngD.

1. Differences between EngD and PhD programmes

While it may have been the result of a drive for drafting brevity (and the AEngD understands from a meeting with EPSRC on 16 January, that EPSRC's view may also have been coloured by the low profile of EngD among CDT bids), neither of the first two EPSRC announcements mentioned the EngD qualification, tending to focus on PhD research – which is distinctly different in character to the EngD. **The EngD constitutes a form of academia-industry collaboration, which not only generates new knowledge but also enhances knowledge exchange between industry/ business and academia. EngD programmes enhance human capital development by producing people with skills, including leadership, management, as well as technical skills - focused on the needs of industry**.

For an EngD, academia provides the teaching and the abstraction of substantial contributions to knowledge for a thesis to meet the same quality standard as a PhD – in short, **an EngD is as intellectually demanding and as rigorously tested as a PhD**. The process, however, is different and it takes commitment and investment for universities to become competent in EngD delivery.

1.1 EngD research is driven by industry need

EngD research projects are identified by sponsoring industry organisations (while this is also the case with some PhD programmes, EngD programmes provide a more formalised relationship between the parties and integrate industry-relevant training into the student experience).

Industry sponsors identify a requirement,[10] work with an industrial doctorate centre to define the research topic and objectives, and the research opportunity is then advertised. In a competitive process, shortlisted applicants are then interviewed by the IDC and sponsor to ascertain their qualifications and suitability for the research vacancy (with quality measured not just by first degree and academic background, but by personal attributes, relevant prior experience and suitability for the industry sponsor's organisation; **the calibre and industry suitability of EngD researchers, as a result, tends to be higher than for PhD candidates**). The process concludes with the appointment of a successful candidate to work as an employee of the industry sponsor to undertake the research project.

Also, **research engineers tend to choose EngDs because they want to be industry-focused in their research, and to work in industry in their future careers**.

By contrast, PhD research projects rarely start with an industry requirement, but can be identified by candidates or academic staff's own interests. The process of appointment is often arguably less rigorous, and the desire to undertake research will often be less focused on achieving a future career in industry.

1.2 EngD research is co-supervised by industry

Delivered within an industrial environment **EngD research is also co-supervised by industry, ensuring it remains focused on achieving the sponsor's objectives**. EngD researchers are also examined by panels including industry-based personnel. (Again, the AEngD accepts these characteristics are also shared by some PhD programmes, but believes EngD programmes involve a more formalised relationship and provide industry-relevant training alongside the research experience.)

1.3 EngD research leverages high additional industry investment

10 The EPSRC Industrial Doctorate Centre Scheme: Good Practice Guidance says research should focus on "a real and relevant industrial problem, or series of problems, of similar difficulty and intellectual challenge to a conventional PhD programme."

EngD research attracts significant additional investment from industry. For example, one IDC said:

> "EPSRC funding of £4.6M would be matched by around £1M university cash and £2.5M industry cash, not to mention significant industrial time and research-infrastructure. If the latter were to be quantified it would no doubt amount to over £10M. I would be really impressed by any PhD-led CDT that could credibly present similar leverage."

1.4 EngD researchers work mainly in industry

As briefly mentioned above, the **EngD research engineer is appointed to work with the industry sponsor and will spend the majority of his or her time (up to 75%)**[11] **located with the sponsor**. A PhD candidate, however, will tend to be based in an academic environment, and will spend much less time in the industrial environment.

1.5 EngD adds immediate value to industry

As EngD research engineers are usually working directly in their sponsor's organisation,[12] **the outputs of their research are delivered incrementally direct to the business throughout the research process**. Other research models see the research applied following completion, or more slowly, meaning a delay in delivering value to UK enterprises.

1.6 EngD reduces 'time to market' for innovations

Leading on from the previous point, **EngD research allows continuous research and development of new products and services, reducing the 'time to market' for innovations**.

Note, this does not mean the process is purely about delivering industry requirements. The EngD creates a symbiotic relationship, harnessing academic rigour and industrial innovation.

1.7 EngD aid industry collaboration

Some IDCs take a strong sector-based approach. **Sponsoring companies sometimes work together to solve the sector-wide problems by identifying common issues and co-sponsoring EngD projects. The immediate value and reduced 'time to market' benefits are therefore potentially delivered across a sector and not just to one sponsor** (*see also section 2: Industry impacts)*.

> "The Centre's scientists are able to "see synergies between different industries and fields and transfer expertise and lessons. It is this linkage across sectors that is especially valuable and which separates EngD and PhD cohorts." *(Formulation Engineering IDC, mid-term review)*

1.8 EngD experience counts towards CEng

The four years typically spent working within an industry sponsor organisation while undertaking an EngD will be counted as industrial experience relevant to the achievement of Chartered Engineer (CEng) status. This has already been recognised by the Engineering Council and by UK professional engineering institutions (PEIs); for example, the IDC in Systems at the universities of Bristol and Bath was CEng accredited by three PEIs in 2013.[13]

This recognition will not be the case for PhD experience and training, meaning **EngD graduates**

11 The EPSRC Industrial Doctorate Centre Scheme: Good Practice Guidance says "Research Engineers are expected to spend around 75% of their time working directly with the collaborating company on project work and 25% on taught courses".

12 Contractual arrangements vary, but in the majority of cases research engineers are regarded as direct employees of their industry sponsors.

13 "EngD in Systems now an Engineering Council accredited degree", AEngD news release (22 August 2013)

can become Chartered Engineers a full four years ahead of their PhD counterparts.

1.9 EngD graduates command higher salaries

If value-added is calculated in terms of the salaries that individuals command upon graduation, it is significant that **EngD graduates tend to earn substantially higher salaries than their PhD counterparts** (*see also section 2: Industry impacts*).

1.10 EngD graduates more likely to be employed in industry

Analysis of the employment destinations of graduating researchers shows that **EngDs are more likely to**:

1. **be employed**
2. **be employed in industry**
3. **be employed in specific industry disciplines** (for example, 85% of Formulation Engineering IDC graduates were appointed to jobs in formulation engineering), and
4. **be appointed to more senior roles within their organisations** (for example, moving from R&D roles into management assisted by their EngD business training).

> In the 1990s, Zoe McMahon did an EngD on Integrating environmental management into mainstream business processes, through the Sustainability for Engineering and Energy Systems IDC at University of Surrey. She is now Director of Social and Environmental Sustainability and Compliance at HP.[14]
>
> Gareth Rice undertook EngD research with RTZ Borax and the British Oxygen Group in the 1990s, equipping him with knowledge and skills that saw him move to senior roles in Panasonic and then 02 Telefonica where he became Head of Environment.[15]

This is not to say that all EngD researchers will become employees of their sponsors upon graduation; the Manchester Business School study identified that some sponsors clearly use **EngD research to resolve specific and immediate business problems** they are facing, not just for recruitment purposes. **EngD programmes can also be used to release a sponsor's other R&D staff to address more pressing and short-term issues and challenges in their business**.[16]

The indirect impacts of the EngD on the career paths include broader commercial and **entrepreneurial opportunities** created by the former REs themselves.

> A former RE received additional investment to create a new venture related to his EngD project outcomes within the sponsoring company, which subsequently led to significant financial benefits.[17]

1.11 EngD graduates become industry leaders sooner

In short, **EngD programmes deliver the engineering leaders of tomorrow more efficiently than PhD programmes**.

---

14 Case study from Dr Paul Golby's presentation at AEngD launch conference, 1 November 2013

15 Presentation by EngD alumni, Dr Gareth Rice, at AEngD launch conference, 1 November 2013 - link

16 View expressed by Anglian Water's innovation programme manager in testimonial to STREAM IDC.

17 Cited in Manchester Business School pilot study, pp.27-28.

2. Industry impacts

The positive industry impact of EngD programmes is well understood by EPSRC. Its 2007 review[18] evaluated the impact of the EngD programmes positively, saying they were meeting real business needs, and many of the REs were having "**a major impact on business performance**", and the scheme was making a **valuable contribution to UK knowledge generation and transfer into industry**, while satisfying its goals in terms of scholarship and publication.

A 2007 study by PA Consulting/SQW Consulting[19] on the impact of the Research Councils highlighted the economic impacts of the EngD scheme:

> EngD graduates, relative to other PhD graduates in similar disciplines, enjoyed significantly higher salaries (between £100,000 and £300,000 over their careers) as a result of their training. The aggregate salary benefit resulting from EngD over the case study period, therefore, could be as much as £80 million, if all achieve the highest salary benefit, for an EPSRC investment of around £12 million. (p.43)

This compared to PhDs where the enhanced earnings averaged £70,000.[20] The same study also identified examples of financial benefits gained by industry sponsors thanks to EngD innovations:

- a new test method estimated to have **saved £ millions** by reducing warranty returns;
- a premium product with lower manufacturing overheads, realising **a total margin of £ tens of millions annually**;
- a new lower environmental impact product that has become the world leader; novel engine management techniques yielding significant fuel and cost savings, and
- lower volumes of persistent pollutants with implications for climate change

The 2013 Manchester Business School study summarised the impacts from EngD programmes and usefully identified five main areas of impact:

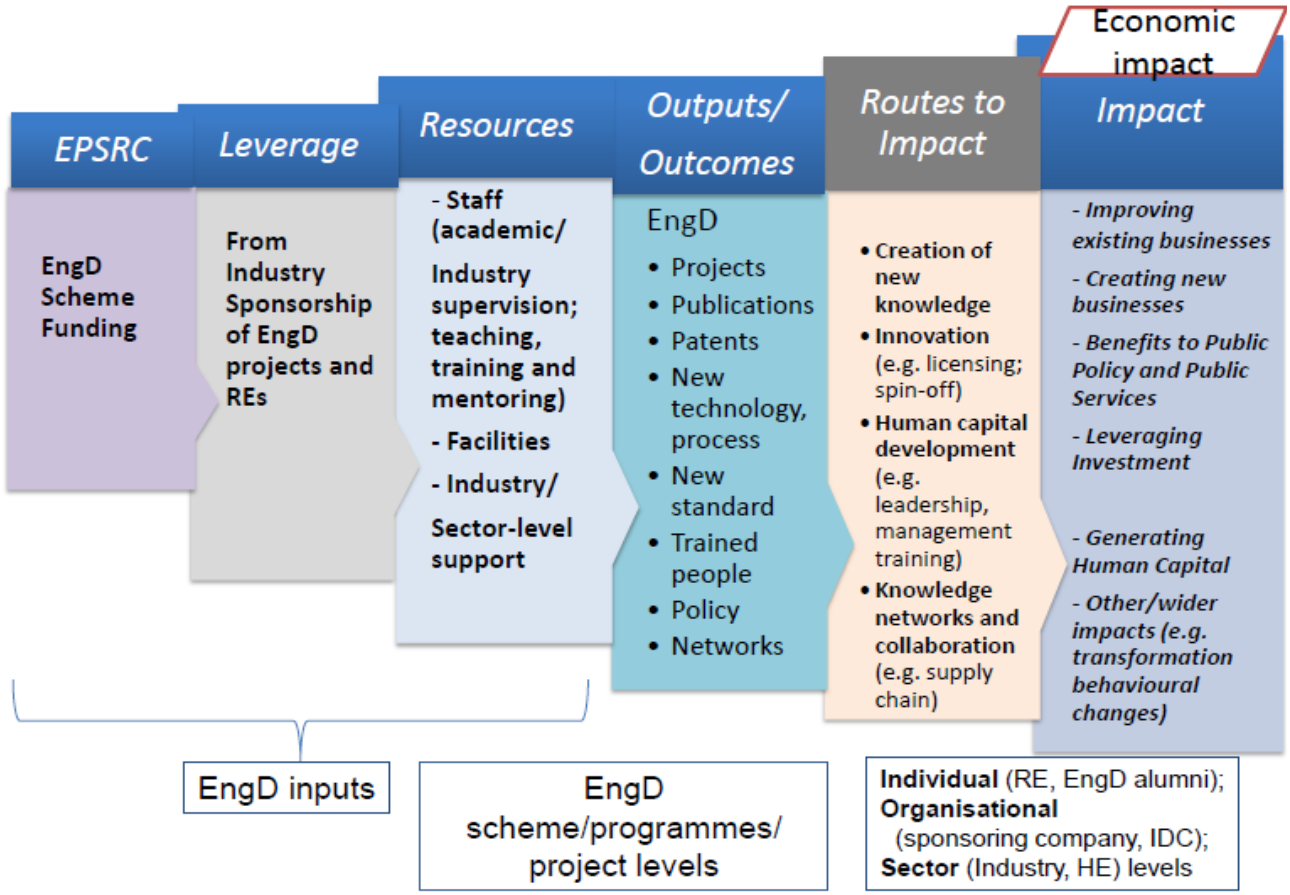
- **generation of new knowledge** - "increased in-house knowledge and research outcomes in the short/mid-term, as well as a long-term approach to technology problem solution and business change."
- **innovation-related outputs and outcomes** - these included licensing of patents, formation of spin-out companies, new product/service development, new market entry, business process improvements and faster time to market.
- **pan-industry knowledge networks and collaboration** - "Knowledge generated by one firm often diffuses into the industry as a whole through collaborative relationships, through supply chains or through movement of human capital."
- **human capital and skills development** - EngD research enhanced REs career paths, industrial partners' skills and the pool of talented future leaders across a sector
- **economic benefits** - Examples include EngD researchers identifying annual cost savings for sponsors of £2.4m and £3.0m, and a patented therapy eventually valued at £20 billion; for every pound invested by EPSRC, one centre identified a further £1.77 of industry investment in EngD research.

Figure 1 illustrates the routes from EngD inputs, outputs, outcomes and routes to impacts at the EngD scheme level.

18 EPSRC (2007) Report of a Review of the EPSRC Engineering Doctorate Centres. EPSRC, Swindon.

19 PA Consulting Group/SQW Consulting (2007) Study on the economic impact of the Research Councils – link

20 Detail included in Hughes, A and Martin, B (2012) Enhancing Impact: The value of public sector R&D – link.



The 2013 Manchester Business School pilot study also usefully summarised the impacts of EngD research as perceived by the research engineers:

Routes to impacts	Short term Impacts (during the programme)	OUTPUTS/ OUTCOMES *Forms of evidence*	Mid/Long term Impacts	OUTCOMES *Forms of evidence*
Generation of new knowledge	**Increased in-house knowledge and research outcomes**	*Published papers* *Conference papers*	**Long-term approach to technology problem solution and business change** **Policy change**	*Change in regulation, Codes of practices*
Innovation	**New technology, new instruments, new measures, processing**	*Patents* *Cost-savings* *Accelerated time to market*	**New Business Processes** **Future Strategic Changes** **New products, new services** **Creation of new business** **Sector-wide problem solving**	*Business development* *Leveraged Investment* *Revenue generation* *Spin-out companies*
Knowledge networks and collaboration	**Sector-wide problem identification** **Networks created by IDCs**	*Co-funding of EngD projects* *Event participation*	**Technology supply chain** **Further collaboration with academic and/or with other firms**	*Sharing of facilities, Collaboration across the sector/ Academia*
Human capital and skills development	**RE's academic and technological advancement** **Skills Development and Organisational Learning** **New employment**	*REs' research progress; training* *Employees' CPD opportunities* *Recruitment of the RE*	**EngD alumni promotion and progression** **Future management and leadership roles** **Pool of skills and human capital in the sector; Inter-sectoral labour mobility**	*Chartered status* *Salary benefits* *EngD alumni networks*

2.1 Generation of new knowledge

Numerous journal articles have been published based on the conduct of and results of EngD research. A complete listing would run to many pages.

Appendix B lists a small selection, showing 18 examples of contributions to professional learning generated from just three IDCs since 2011.

2.2 Innovation

- The 2009 IDC mid-term reviews highlighted **patents** awarded or applied for at six IDCs (Formulation engineering, CICE, Molecular Modelling and Materials Science; Digital Media, Systems, Optics and Photonics).[21] At the 2012 AEngD Renishaw plc's Nick Weston described one EngD project (developing an optical surface measuring system) which alone had generated five patent applications.
- The 2009 mid-term reviews also identified several **spin-out businesses** (for example, two from CICE, three from Optics and Photonics, three from VEIV, and one each from Molecular Modelling and Materials Science, and SEES; the STREAM IDC's first cohort included Asher Hoskins, who in 2013 founded Infrasense).

2.3 Knowledge networks and collaboration

- EngD research has promoted **strategic collaborations** which have sometimes led to more formal alliances, for example: between an IDC and an industry partner (VEIV and Arup; Molecular Modelling and Materials Science, and AWE) or joint projects between industry partners facilitated by an IDC (eg: by Transport and the Environment IDC)
- As hubs for collaboration, Formulation Engineering IDC and Biopharmaceutical Processing IDC **share resources** such as training courses. Sharing of specialist equipment – by industry with universities and vice versa, as at the Optics and Photonics IDC – also fosters collaboration.
- Some IDCs act as part of the **Knowledge Transfer Networks** (KTNs) in their respective research areas – for example: STREAM, Optics and Photonics, Biopharmaceutical Processing.
- IDCs such as STREAM have also provided **wider engagement across an industrial sector**, with research projects driven by water sector priorities, rather than the interests of a single industry partner (for example, four research projects that form part of the Energy DTC at Sheffield are being supervised by partners from the STREAM IDC, and the collaborations are highly valued by project sponsors as they provide 'cross fertilisation of ideas and increases innovation potential, maximising potential benefits'.)[22]
- Some collaborative relationships are **international**, building long-term links with universities and businesses overseas (eg: Molecular Modelling and Materials Science, CICE Biopharmaceutical Process Development, EFET, SEES). Another international example is STREAM's link with the ReNUWiT programme in the USA, which allows students and staff exchanges to collaborate on scientific advances which respond to pressing urban water management challenges.
- Some **knowledge networks are centred upon industry sponsors**. The Manchester Business School research, for example, included some preliminary analysis (see figure 2) of network patterns between IDCs (red) and industry partners (green). Several industry sponsors act as nodal points, linking different IDCs (eg: Rolls Royce, Thales, TWI, Buro Happold, National Physical Laboratory, BAE Systems, Airbus, Johnson Matthey).

21 These mid-term reviews were a snapshot of achievements, and further patent applications have been made. For instance, the Optics and Photonics IDC Annual Report 2012 – link – lists two examples.

22 From STREAM sponsor survey 2011

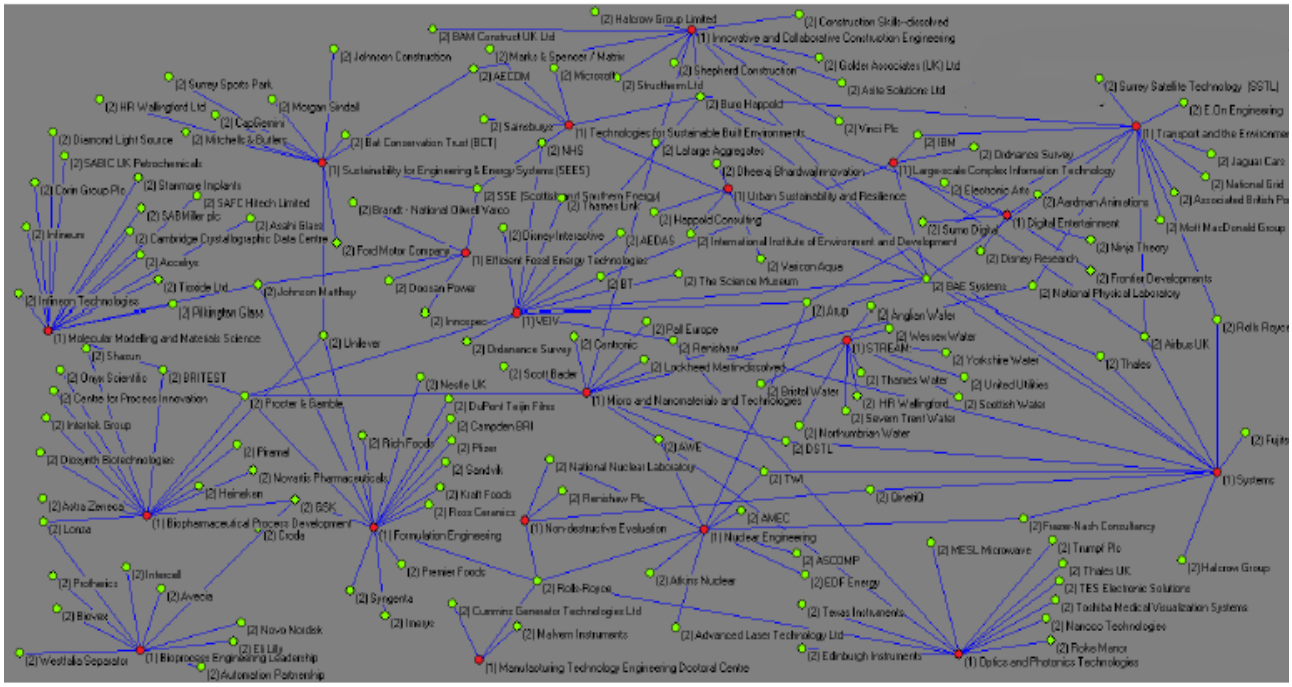


Illustration 1: Preliminary analysis of network patterns between IDCs (red) and industry partners (green)

- Alumnus Dr Gareth Rice, speaking at the 2012 AEngD annual conference, also stressed the value of **personal networks** grown through his ongoing involvement with the EngD programme at Surrey University SEES.

2.4 Human capital and skills development

- EngD research engineers can be '**agents of change**'. For example, a MiNMaT EngD, given the freedom to work on mid- to long-term problems, could seek more innovative solutions, which would not have been possible if they were subject to the normal company project management processes.
- As previously mentioned, EngD research can **enhance career paths**, accelerating graduates from technical or R&D roles into management, or opening up new opportunities in government, business and finance. A CICE RE, for example, having demonstrated high quality work and the ability to think rationally, was quickly promoted to Head of Sustainability “something that would not have happened so quickly without the EngD.”
- Enhanced opportunities for **Continuing Professional Development** (CPD) - Some industry sponsors send their employees to the training courses provided by the IDCs. This could have a broader impact on the organisational capability of the sponsoring companies, through improved skills and knowledge.Research engineers engaged in EngD programmes win industry fellowships and innovation awards, testifying to their **knowledge leadership**
- EngD programmes can facilitate **mobility of people and knowledge exchange** between industry and academia. For example:
    - A Royal Society Industry Fellowship (with Johnson Matthey and AstraZeneca), allowed two industry professionals to have a base at the Molecular Modelling and Materials Science IDC to participate in the EngD programme as employees of the firms
    - Another Royal Society Industry Fellowship (with Johnson Matthey) allowed a young academic from Formulation Engineering IDC to work part-time for four years at the company to enhance industry experiences. Dr Darren Cosker, a lecturer at the Centre for Digital Entertrainment is a Royal Academy of Engineering Research Fellow, and is spending half his time in Double Negative Visual Effects, enhancing the IDC’s link with that company, which also has two of its EngDs with Imaginarium,

a company founded by Andy Serkis.

It was clear from the AEngD's meeting with EPSRC on 16 January 2014 that the importance of investing in the industrial intellectual capital of UK plc is recognised across the research councils. As a cross-cutting theme, the AEngD feels that the UK government might usefully look at a broader, more collaborative approach to funding EngD research that takes into consideration the impact of that research on wider growth issues (see sections 5.5 to 5.7)

2.5 Economic benefits

Examples of **direct economic impacts** delivered by EngD research (identified in the Manchester Business School study; see also Appendix E) include outputs that have:

- cut costs
- brought new commercial products or services to market
- created intellectual property (IP), or
- attracted further investment

EngD research programmes can also act as **catalysts to generate further income**. The Manchester Business School analysis of the 2009 mid-term reviews (see also Appendix F) found examples including:

- spin-off research projects
- TSB grants
- RDA funding, and
- government contracts

Analysing EngD **employment outcomes** and Industrial CASE PhDs (the most industrially oriented PhD scheme for which there was data), the Manchester Business School study found:

- 33% of EngD graduates earn more than £35K per year, as opposed to 12.6% of the CASE PhD graduates
- 24% of EngD graduates found a job at their sponsoring firm, more than double the rate (9.9%) for CASE PhD graduates
- 85% of the EngD graduates work in non-academic sector compared to 66% of CASE PhD graduates
- 32 % of EngD graduates work in manufacturing and 27 % in professional, scientific and technical activities; for CASE PhD graduates, the figures are 14% and 19% respectively

3. Industry EngD support

There is substantial support for the EngD qualification from over 400 industry sponsors, including key EPSRC strategic partners, who have participated in past programmes and who continue to support current programmes.

Appendix B includes over 30 quotes from UK-based industry sponsors, many of which are international leaders in their fields (in **bold** are EPSRC strategic partners):

- **Arup**
- **Rolls-Royce**
- Renishaw plc
- Sony Computer Entertainment Europe
- Electronic Arts
- Double Negative Visual Effects
- Think Research
- The National Trust
- Wonky Films
- **Procter and Gamble**
- Imerys
- Unilever
- Pepsico
- United Utilities
- Anglian Water
- WRc plc
- **Airbus**
- Parsons Brinkerhoff
- Frazer-Nash
- CH2M HILL
- Buro Happold
- Thales UK
- Aedas
- BBC
- Disney Research
- Microsoft
- CIBSE
- **E.ON**
- Framestore
- National Nuclear Laboratory
- **EDF**

Appendix G lists over 400 UK EngD sponsor organisations associated with current EngD centres.

4. UK leads world in EngD development

The EngD scheme was established following the 1990 Parnaby report (1990) which saw the need for a major new scheme to provide Engineering Doctorate programmes in the processes and practices of engineering, required by industry. It concluded that such a Doctorate would be distinct from, and complementary to, the traditional existing PhD, which had been criticised for its lack of industrial relevance.[23]

While the EngD is now well recognised within the UK, it is also increasingly recognised internationally as a strong model for industry-based research. Countries in the EU, plus Australia and the USA, are striving to deliver similar EngD-like schemes supported by government funding schemes.[24] Having created and then spent over 20 years building the EngD brand, the UK is uniquely placed to help develop similar programmes in other geographies. However, the reputation of the EngD and UK leadership in delivering EngD programmes would be seriously compromised if central funding was seriously reduced in proportion to PhD centres.

The UK has an excellent record of world-class innovation over many years. It is widely recognised that we have been less successful than major competitors in turning that ingenuity into products and services which are economically world-class. The AEngD and its member Centres represent the clearest example of sustained academic-university research leading to exploitable products. We believe this model deserves expansion and sustained support as a means to reshape our ability to exploit research.

The AEngD would like to see funding for doctoral training increased, perhaps by greater use of non-EPSRC funding (reflecting the cross-cutting nature of much EngD research), to encourage further investment in EngD programmes (see also sections 5.5 to 5.7).

23 Godfrey, P (2012) The Engineering Doctorate (EngD) Developing Leaders for Tomorrow with Industry, CLAIU – EU Conference 2012 - link

24 For example, *Water*, the journal of the Australian Water Association in April 2014 features an article, "Leadership in Learning: Collaborative Approaches to Building the Water Sector of the Future," which looks at EngD experience in the UK and concludes: "Looking ahead for the Australian water sector, there are opportunities to develop models of research education similar to the EngD programs run by IDCs." (p.7)

5. 'UK plc' needs a different approach to EngD funding

The AEngD remains supportive of the CDT-based approach to doctoral training in general, with its emphasis on strong industrial support for all doctoral programmes, a requirement for the Masters-level taught programme and transferable skills training programmes. This has helped the UK move away from the traditional model of PhD training which was commonly and internationally accepted as insufficient to deliver economic growth and industrial leadership (Parnaby Report, 1990). Changes in the last decade are supported unreservedly and viewed as necessary and highly important steps forward for postgraduate training in the UK.

The AEngD also welcomes the views (identified in the Manchester Business School pilot study) of some sponsors that it is important to have a "balanced portfolio of R&D activities and skills." Different centre types – CDTs and IDCs – complement the R&D activities across the industry sectors covering different scopes of technology and different types of skills needed for the future leadership and technical research in industry.

However, the AEngD is concerned that the process used to arrive at the CDT funding decisions did not adequately attract universities to apply as EngD Centres or evaluate EngD programmes in comparison to PhDs, resulting in disproportionate damage to the future of EngD programmes (this critique is covered in sections 5.1 to 5.4 below).

More importantly, in light of the development of clear industrial strategies by the Coalition, the AEngD also believes the UK should be increasing the number of EngD Centres so that key industry sectors can deliver the innovations and personnel needed to compete in the global economy (see sections 5.5 and 5.6).

5.1 EngD overlooked in 2013 EPSRC guidance

The AEngD believes the EngD was given a lower profile in recent EPSRC communications relating to the CDTs funding call. Following the 2008-2009 funding round, for example, EPSRC published a useful document 'Industrial Doctorate Centre Scheme: Good Practice Guidance',[25] and this helped guide decision-making then with respect to EngD programmes. The 2013 CDT funding round, by contrast, made no specific mention of EngD requirements in its selection criteria.

EPSRC suggested (at the AEngD conference IDC Directors meeting on 26 November 2013) that they could not tell universities which degree to award. However, this 'passed the buck'. The EngD was set up specifically to address economic and industrial problems in the UK identified 20 years ago, and has been largely successful. It certainly has strong support from industry. By omitting EngD in its guidance, the EPSRC effectively delegated to universities a decision about the future of the EngD qualification that they individually were not in a position to make. Given a free choice, many universities will self-interestedly opt for PhDs.

5.2 EngD distinction omitted

The EPSRC guidance also omitted an important and fundamental distinction between PhD and EngD: the latter requires **real world industrial and professional experience and practice, while pursuing EngD research 'with' industry** (see EPSRC Good Practice Guide for IDCs, 2010).

This requirement is a key distinction between EngD and PhD. Industrial experience as a substantial part of the EngD experience and training:

- enables strong alignment of the EngD with the competencies of professional engineers required for CEng registration (this is recognised by the Engineering Council UK and Professional Engineering Institutions,PEIs, and is manifested in the recent accreditation of several current EngD programmes in the UK)

25 EPSRC (2011) *The EPSRC Industrial Doctorate Centre Scheme: Good Practice Guidance* - link

- adds value for industry because the RE can be trained to take professional engineering responsibility as well as to deliver research and innovation.

5.3 EngD and PhD impacts blurred

Centres were rightly engaged in a highly competitive process demanding strong proposals, presentations and interviews. However, the AEngD understands that EPSRC requirements to show evidence of strong industrial support and impact for both PhD and EngD programmes meant there was sometimes little distinction between the impacts of the two approaches, and panels were not adequately briefed about the nature of EngD programmes.

5.4 EngD experience and honesty 'counter-productive'

Experienced IDCs were knowledgeable and honest about the challenges (completion rates, tensions between academic/industrial interests in the EngD framework, challenges in supervision etc) of delivering EngD programmes. Possibly, new applications came across as more enthusiastic at the interviews, but their naivety may not have been recognised by the panels. The AEngD believes that experience of running EngD programmers was not valued by interviewing panels and reviewers.

With panels often making judgments based on narrow distinctions between high quality proposals and interviews, it is easy to see why 'realistic' EngD presentations may have suffered by comparison.

A desire for 'new' and more tightly-focused approaches to delivering CDT programmes will also have put cross-cutting centres at a disadvantage. Yet the abilities to synthesise across disciplines and to abstract knowledge from what is done is a core strength of the EngD. It enhances learning by industry and so confers competitive advantage.

5.5 EngD funding needs different treatment to support 'UK plc'

The delivery of an enhanced EngD programme should also be seen as a key component of the Coalition's Industrial Strategy, set out by Business Secretary Vince Cable in September 2012.

- **developing strategic partnerships with industry**
- **supporting emerging technologies**
- improving access to finance for businesses
- **working with business to help develop skills that businesses will need**
- publishing government contracts to provide confidence to business investment[26]

The AEngD strongly believes EngD research enables and supports at least three of the above areas (1, 2 and 4), and that EngD centres' specialisms are closely aligned with:

- emerging areas where the UK has particular strengths
- cross-cutting requirements identified in UK vertical industry strategies (section 5.6)

It is aware that UK government has engaged with the research community to develop a clearer understanding of future technologies, recalling the Technology Innovation Futures report overseen by the Government Office of the Chief Scientist,[27] the Technology Strategy Board's foresight report on Emerging Technologies and Industries Strategy,[28] and the UK research councils' advice on long-term investment in science infrastructure.[29] Such analyses have been refined to highlight "eight great technologies" which the Government should promote with further capital investment and technology support, and are areas in which the UK has distinctive capabilities which it should commercially exploit:[30]

---

26 Industrial strategy: government and industry in partnership – link

27 Technology and Innovation Futures: UK Growth Opportunities for the 2020s

28 Emerging Technologies and Industries Strategy 2010-2013

29 RCUK Strategic Framework for Capital Investment (November 2012) - link

30 The Minister for Universities and Science, is deeply familiar with this work, having authored the Policy Exchange's

- The big data revolution and energy-efficient computing
- Satellites and commercial applications of space
- Robotics and autonomous systems
- Life sciences, genomics and synthetic biology
- Regenerative medicine
- Agri-science
- Advanced materials and nano-technology
- Energy and its storage

In the AEngD's view, there are existing EngD programmes that have, could and will directly impact on almost every one of these eight areas. For example:

- in its successful research centre bid, the Non-Destructive Evaluation IDC felt its work related to four of the eight areas - especially advanced materials and robotic and autonomous systems.
- in April 2014, Northern Ireland power generator AES announced new energy storage plans, building on research undertaken by 2013 TSBE graduate Marek Kubik looking at managed ramping and relaxing constraints that keep conventional generation on and curtail wind-generated energy use.

5.6 The EngD should be aligned with UK vertical industry strategies

Building on the Coalition's overall industry strategy, several sector-based strategies have been developed. Delivery of key competitive advantages in these industries often requires a cross-cutting approach reflecting the inter-dependent infrastructures involved. The AEngD believes many existing EngD centres are well placed to deliver the necessary systems integration skills and research. Current sectoral strategies include:

- Life sciences
- Aerospace
- Nuclear – *see case study 1 below*
- Oil and gas
- Information economy
- Construction – *see case study 2 below*
- Professional and business services
- Automotive
- Offshore wind
- Agricultural technology
- International education

(Other case studies can be provided relating EngD to relevant vertical industry strategies.)

Case study one: Nuclear

The Government's Nuclear Industrial Strategy[31] sets out a vision for nuclear technology to be a major contributor to the UK's low carbon future and 'Green Growth' agenda by increasing the UK business contribution to the domestic nuclear programmes, regaining the UK's credibility as a 'top table' nuclear nation and thereby increasing export and inward investment.

2013 pamphlet, "Eight Great Technologies" - Willetts, David (2013) Eight Great Technologies, London, Policy Exchange - link

31 HM Government (2013) Nuclear Industrial Strategy: The UK's Nuclear Future.

Fundamental to delivering this ambitious strategy is an increase in nuclear skills and R&D, both of which form central themes within the Strategy. Building the next generation of industrial leaders as well as subject matter experts across all stages of the nuclear lifecycle is central to nuclear achieving a safe and growing contribution to the UK's energy mix. The decline of the sector during the 1990s and early 2000s has led to an ageing workforce and a high rate of retirement, so that the nuclear sector faces a major skills challenge both in terms of scale **and timing**. Add to this the skills associated with new build, and the scale of the nuclear skills challenge is significant.

To address this challenge, the Department for Energy and Climate Change has established the Nuclear Energy Skills Alliance (NESA) with a workstream on higher-level skills[32]. This is developing a skills strategy that aims to: develop industrial technical leadership, accelerate SQEP[33] status, and transfer knowledge to the younger generation.

The proposal to EPSRC for a Nuclear Energy IDC[34] (not funded) reflected this approach by targeting the supply of the next generation of **industrial technical leaders** for the nuclear sector through effective partnerships of academic centres of excellence and leading nuclear companies. Its aim was to address **near-term applied research** challenges across the full nuclear life cycle of both civil and defence plant including current operations, new nuclear build, waste management and decommissioning, and fuel cycle services. It would have built on the current successful IDC in Nuclear Engineering (2007 to present) which is on target to deliver over 70 EngD graduates into the nuclear sector, suitably equipped with industrially relevant skills acquired through the integrated technical/management and research skills training provided by the programme. A distinguishing feature, and a mark of the quality of the current IDC, is its accreditation by IET and IMechE as providing an approved professional development programme, producing highly skilled "industry ready" individuals who can progress rapidly to CEng – an important measure of professionalism, very relevant for those operating in such a highly regulated sector.

Case study two: Construction

The global construction market is expected to grow to $12tn by 2020, up 67 per cent from 2010 and forming 13.2 per cent of world GDP. A forecast $97tn will be spent in this decade. The major opportunity for UK-based construction businesses in the current decade is to win work in the expanding markets of the developing world. Currently around £7.6bn p.a. is earned by export. "Construction 2025"[35] highlights the need to invest in smart construction and digital design, with the global market for integrated city systems alone forecast to be worth £200bn p.a. by 2030. The strategy stresses research and innovation to meet both local and global opportunities presented by green construction, smart construction and digital design, citing building information modelling (BIM) as one area where the UK has world-leading skills.[36] To realise its 2025 vision, the government has committed to:

- building the UK's competitive advantage in smart construction and digital design through the Digital Built Britain agenda
- **working with academic and research communities to bring forward more research, development and demonstration to the wider industry** and work to remove barriers to innovation *[emphasis added]*

Some centres, currently no longer to be funded, are engaged in industry-focused research helping fulfill these commitments. For example, BIM-related research is being conducted through the CICE centre at University of Loughborough, TSBE at University of Reading, and the IDC in Systems at Bristol and Bath, among others.

---

32 Led by Prof Andrew Sherry (Dalton Institute, University of Manchester)

33 Suitably Qualified and Experienced Personnel

34 led by Manchester's Dalton Nuclear Institute and Imperial College London, with Birmingham, Lancaster, Sheffield, Strathclyde and Surrey Universities

35 Construction 2025 (July 2013) - link

36 In April 2013, the UK's Construction Industry Council published a report, "Growth through BIM" by Richard Saxon, highlighting the UK's leadership on BIM and the opportunities to export its expertise.

5.7 EngD funding based on centre competence and match funding

As a cross-cutting theme, the AEngD feels that the UK government might usefully look at a broader, more collaborative approach to funding EngD research that takes into consideration the impact of that research on wider, more cross-cutting growth issues. For example, the potential environmental and sustainability, employment, economic productivity and other impacts of EngD research might be usefully considered by other government funding sources.

The AEngD also suggests that selection of EngD centres could be based on evaluation of their competence, and that research topics be determined by industry need under-pinned by their 50 per cent match funding.

Appendix A

The Association of Engineering Doctorates - background

The Association of Engineering Doctorates established its steering group in 2010 and now encompasses almost all of the 28 current EPSRC-designated industrial doctorate centres delivering EngD qualifications at UK universities, with industry sponsors, existing EngD research engineers and alumni as associate members.

A community engaged in research in engineering and related disciplines, it aims to:

- promote acceptance and recognition of Engineering Doctorate (EngD) degrees within host institutions and industry
- promote excellence and maintain the quality of EngD degrees
- develop wider and more strategic industrial research collaboration
- identify and promote the benefits and impacts from EngD research
- recruit sufficient and suitable top quality research projects
- attract and recruit high calibre Research Engineers (REs)
- develop and promote taught programmes tailored to REs and industry needs
- encourage strong academic engagement and feed back into the host institutions' research base

Appendix B

From STREAM IDC

Ometto, F., Pozza, C., Whitton, R., Smyth, B., Torres, A.G., Henderson, R.K, Jarvis, P., Jefferson, B., Villa, R.,(2014) The impacts of replacing air bubbles with microspheres for the clarification of algae from low cell-density culture. Water Research. Volume 53, Pages 168–179.

Turner, S.W.D., Jeffrey, P., Marlow, D., Ekström, M., Rhodes, B.G. and Kularathna, U. (in press) Linking climate projections to performance: an application of the decision scaling approach on a large urban water resources system. Water Resources Research.

Ward,B and Savic, D. A (2012) A Multi-objective Optimisation Model for Sewer Rehabilitation considering critical risk of failure. Water Science & Technology, 66(11), 2410-2417."

From Optics & Photonics IDC

“Characterisation of Terahertz Beam Profile and Propagation,” IEEE J Sel Top Quant Electron 10.1109/JSTQE.2012.2205668

Jim Piper, Yoshihiro Ikeda, Yasuko Fujiawa, Yoshiharu Ohno, Takeshi Yoshikawa, Alison O’Neil and Ian Poole, “Objective evaluation of the correction by non-rigid registration of abdominal organ motion in low-dose 4D dynamic contrast-enhanced CT,” Phys. Med. Biol. 57 1701 (2012)

M. Perry, P. Niewczas and M. Johnston, “Effects of neutron-gamma radiation on fiber bragg grating sensors: a review”, IEEE Sensors Journal, vol 12, no 11, pp 3248-3257, 2012. DOI: 10.1109/JSEN.2012.2214030

M. Perry, P. Orr, P. Niewczas and M. Johnston, “Nanoscale resolution interrogation scheme for simultaneous static and dynamic fiber bragg grating strain sensing”, Journal of Lightwave Technology, vol 30, no 20, pp 3252-3258, 2012. DOI: 10.1109/JLT.2012.2213891

M. Perry, P. Niewczas, M. Johnston, K. Cook and J. Canning, “Induction Brazing of Type-I FBGs into Kovar Ferrules Exploiting Curie Transition”, IEEE Sensors Journal, vol PP (pre-publishing), 2012. DOI: 10.1109/JSEN.2012.2227705

Downing, J., Findlay, E., Mayo, G. and Harvey, A.R., “Multichannel finite conjugate imaging”, JOSA A, Optical Society of America, 29, 921-927, 2012

McKenzie, G., Record, P., “Non-Contact Measurement of DC Voltages using Nonlinear Elements”, Measurement Science and Technology 23(4) p045001, IOP, Feb. 2012

From TSBE (examples from 2012 and 2013 only)

Kubik, M. L., Brayshaw, D. J., Coker, P. J. and Barlow, J. F. (2013) Exploring the role of reanalysis data in simulating regional wind generation variability over Northern Ireland. Renewable Energy, 57. pp. 558-561. ISSN 0960-1481 doi: 10.1016/j.renene.2013.02.012

Kubik, M. L., Coker, P. J., Barlow, J. F. and Hunt, C. (2013) A study into the accuracy of using meteorological wind data to estimate turbine generation output. Renewable Energy, 51. pp. 153-158. ISSN 0960-1481 doi: 10.1016/j.renene.2012.08.084

Mudie, S. A., Essah, E., Grandison, A. and Felgate, R. (2013) Benchmarking energy use in licensed restaurants and pubs. In: CIBSE Technical Symposium, 11-12 April 2013, Liverpool John Moores University, Liverpool, UK. (In Press)

Mudie, S. A., Essah, E., Grandison, A. and Felgate, R. (2013) Energy benchmarking in commercial kitchens. In: 11th REHVA World Congress & 8th International Conference on IAQVEC (CLIMA 2013), 16-19 June 2013, Prague, Czech Republic. (In Press)

Rawlings, J., Coker, P., Doak, J. and Burfoot, B. (2013) Do smart grids offer a new incentive for SME

carbon reduction? Sustainable Cities and Society. ISSN 2210-6707 doi: 10.1016/j.scs.2013.04.003 (In Press)

Darby, H. J., Kelly, F. and Elmualim, A. A. (2012) Whole life carbon – a building case study. Structural Engineer, 90 (12). pp. 38-44. ISSN 1466-5123

Waring, S. D. , Essah, E. E., Gunnell, K. and Bonser, R. H. C. (2012) Breathable roofing membranes and bats: interactions, outcomes and predictions. In: BSA 2012 – Proceedings of the 1st International Conference on Building Sustainability Assessment, 23-25, May 2012, Porto-Portugal.

Williams, D. R. and Tang, Y. (2012) “Methodology To model the energy and greenhouse gas emissions of electronic software distributions”, Environment Science & Technology 46 (2). pp. 1087-1095. ISSN 0013-936X doi: 10.1021/es202125j

Appendix C

Support for EngD programmes – quotes from UK businesses

"Without the work done by EPSRC-funded students, the Trent 900 would not have flown."
Colin Small (Rolls-Royce)[37]

"The EngD is by far our most preferred vehicle for collaborative research with universities. It is the most successful method of technology transfer we have yet discovered. It allows us to train, recruit, and retain the very best research and development talent. It helps us work effectively with some first class academics. The EngD produces commercially aware scientists and engineers."
Prof Nick Weston (Renishaw plc)[38]

"The CDE programme is an exciting research opportunity for innovation partnerships between academia and industry."
Maria Stukoff (Sony Computer Entertainment Europe)[39]

"The EngD programme gives Electronic Arts a great opportunity to collaboratively pursue research topics with academia that can bring competitive advantage to our games. We are very happy to be part of this scheme to develop high calibre candidates for the future of the industry. [The impact the]… guys have had is in bringing energy and a broader interest in research and pulling in ideas from outside the team to impact our work… this is a great motivational benefit for our team."
Dr. Mike Bassett, (Electronic Arts)

"We have been delighted with our work as part of the CDE Programme. …the team at CDE have been realistic and pragmatic in recognising the flexibility we require as a company to make this working relationship a success and thus far it has proved a positive experience for all those involved."
(Jeff Clifford, Double Negative Visual Effects)

"[Working with a] Doctoral student offered us the opportunity to address the technology lag in our sector using a skilled resource, while at the same time not requiring a significant financial investment. Wayne's background is very different to the rest of our staff who are mainly statisticians and aerospace engineers. His academic experience is a huge benefit to us as it allows us to tap into an area we know very little about. It has also allowed Wayne to achieve much more in a short space of time than we could. Having Wayne and the support of the University in a diverse program like this has finally given us something to really demonstrate our research capability and make us stand out from the crowd."
(Conor Mullan, MD, Think Research)

"…although [The National Trust] is, in origin, a Victorian institution, we have about 4 million members today, so we have a currency and validity. We need to be forward-looking as well. The Trust is well-known for its conservation skills but we also need to engage with and communicate with a worldwide audience and it's quite clear we need to be able to harness the latest technological advances in order to be able to do that."
(David Adshead, Head Curator, The National Trust)

"Jake [Doctoral student] has already proven a great addition to the Wonky team. He has helped us plan a new online approach to pitching which has helped us win new business with new clients including the British Heart Foundation and CBBC. He has also contributed to the development of our digital strategy for a multi-platform childrens series. The contributions

37 Quoted by Dr Paul Golby in presentation at AEngD launch conference, 1 November 2013

38 From presentation delivered by Prof Nick Weston, AEngD launch conference, 1 November 2013 - link

39 This and the following six testimonials provided by industry sponsors at Centre for Digital Entertainment.

and advice from Jake's supervisor Mike Molesworth has been beneficial. His experience of working with broadcasters and insights into the industry, particularly in terms of understanding the audience, has proven useful to us from a business point of view as we develop our strategy for exploiting our existing IP and content.
(Vicky Brophy, Head of Production, Wonky Films)

"ongoing participation in the Centre will allow access to a range of key skills and academic expertise' … this will be a vital resource and 'sandpit' for future EngD projects…. We would look to fund between one and two students per year, to a level of funding commensurate with our existing programmes"
(Rolls-Royce)[40]

"The collaboration with the Formulation Engineering Centre at the UoB [University of Birmingham], has greatly magnified P&G business impact."
(Procter and Gamble)

"If IMERYS did not have access to the EngD programme, it would limit our involvement with UK Universities."
(Imerys)

"Formulation Engineering is at the heart of most of Unilever's products… we will support with appropriate funding and in-kind effort over the next 5 years."
(Unilever)

"Participation in the Birmingham EngD programme today and in the future offers an opportunity to enhance our contribution to technology leadership in Pepsico."
(Pepsico)

"I would confirm United Utilities continued support of the STREAM EngD programme to provide advanced engineering training in the sector and to meet the demand for research engineers who can provide leadership to meet future challenges. We would see the STREAM EngD programme as supporting UU's research, operations and strategic ambitions in meeting the challenges we face such as in meeting increasingly stringent standards, achieving efficiencies and facing issues such as climate change."
(Stephen Whipp, head of innovation, United Utilities)[41]

"The programme enables Anglian Water to carrying out focused research for the business where in the past it has been an area difficult to resource and progress medium to long term projects in a cost effectively manner.
"The students once obtaining their doctorate will provide a source of highly qualified and competent resource to fill an ever increasing gap due to the current ageing and therefore time limited experienced technical staff. Stream enables the identification of potential future employees and managers to address the envisaged shortfall."
(Barrie Holden, innovation programme manager, Anglian Water)

"It allows us and our research partners to tackle research topics which are difficult to engage with within the strictures of the regulatory 5 year AMP cycle but which are crucial to the long-term sustainability of water services in the UK."
"It provides opportunities through the project development process to discuss and debate current and future problems across the sector and prioritise/coordinate research investment to meet these challenges.
"It offers WRc opportunities to play a meaningful role in Research Engineer recruitment and training, with the potential to recruit direct from the cohorts to strengthen our skills base with researchers who are familiar with, and to, the sector."
(Ian Walker, WRc plc)

40 This and following four quotes from letters supporting Formulation Engineering IDC.

41 This and following two quotes from testimonials supporting STREAM IDC.

"Under the EngD research programme … [and] thanks to Yifan's research work, the time that Airbus UK repair engineers spend in searching for information is reduced by more than 50%, and our capability for handling customer enquiries (on time and on quality) is greatly increased without the need for additional personnel. This search tool is now deployed in Germany, UK and US for use in the daily repair engineering task, and is in the process of being rolled out to other locations in Airbus."
(Andrew Dunn, Head of Engineering, Customer Services, Wing at Airbus)[42]

"Christian's research within the tools and simulations team for Flight Engineering Sciences department focused on rapid methods for aerodynamic wing design. … The methods and processes aim to save between 20-80% of the time on tasks performed during a standard design process"
(Abdul Rampurawala, Flight Physics Engineer, Airbus)

"The EngD [Smart Cities – governance and implications for city councils] has already tangibly improved our consulting capability and has directly influenced policy decisions for smart cities in the UK and internationally"
(Volker Buscher - Director of Technology Innovation, Arup)

"For us one of the most exciting features of the EngD in Systems is the way in which your approach can be brought to new and challenging issues for the infrastructure sector."
(Steve Denton - Engineering Director, Parsons Brinkerhoff)

"Our investment to date in the Systems Centre has made a positive impact on our business in terms of supporting the development of new services, enabling the recruitment of leading systems thinkers, providing network opportunity across the international systems community, and contributing to the decision to form a new technical area within our business."
(Edward Goddard, Consultant, Frazer-Nash)

"We have sponsored four EngD Projects and the current EngD research is addressing very challenging socio-technical problems: 'Sustainability of large scale infrastructure projects' and 'Benefits of non-structural flood risk management responses'. These directly benefit our business and the businesses of our clients and have led to EngD graduates joining our company."
(Jon Wicks - Regional Technology Manager, CH2M HILL)

"Buro Happold is an integrated engineering consultancy working on leading built environment projects around the world. One of our defining features is a commitment to research and development and we are proud to have a long association with Bristol Systems Centre where we have sponsored EngD students from the Centre's early days. We currently have four research engineers (REs) with the centre and at least as many that are alumni. Given the nature of our business the research topics are varied and range from decentralised water systems through post-occupancy analysis of buildings to computational optimisation and crowd flow software development.
"All our REs engage in real life projects whilst working in Buro Happold and this gives them a deep understanding of how we work and the network on which to transfer their knowledge within the company. Almost all are employed at the end of their research and are soon in positions where they are given early responsibility and the opportunity to develop their core technical skills within a specialist group".
(Colin McCinnon, Innovation Director, Buro Happold)

"As industrial sponsors, we find the Engineering Doctorate the most cost-effective model for achieving our combined research and specialist postgraduate recruitment requirements. In addition, in our work with the Bristol Systems Centre we have got particular value from aligning the work of several of our sponsored EngDs under an umbrella project which is part

42 This and following five quotes from IDC in Systems.

of our strategic process improvement activity. In this way the EngDs are able to provide considerable value to Thales during the period of their studies, meet a wide spectrum of people at all levels in the company, and they and their supervisors get access to real world data (both quantitative and qualitative) across a portfolio of several hundred projects."
(Prof Hillary Sillitto, Systems Engineering Director, Thales UK)

"In 2010, AEDAS R&D Group invested £160,000 in AEDAS UCL Building Design and Performance Research Programme (2010-2014) led by Dr Dejan Mumovic, Co-director of the EngD Centre in Virtual Environments, Imaging and visualisation. This programme focuses on Architecture addressing key industry challenges with design, computational and statistical tools. … AEDAS R&D is committed to supporting the EPSRC Centre for Doctoral Training in VEIE in providing an outstanding research and educational experience for all its engineering doctorate students, and inspiring them to achieve their full potential. We will look at opportunities to support to work of the VEIE in kind, via research studentships and other research collaboration."
(Dr Judit Kimpian, Director of Sustainable Architecture and Research, Aedas)[43]

"We recognize that University College London's EngD VEIV Centre (now VEIE) is at the forefront of training people in the technology areas that are core to the BBC. … We value the research that is being conducted at UCL and the high quality of the training at the centre. One of the main modes of interaction [for the BBC and UCL strategic partnership] will be through studentships at the IDTC VEIE. … Given our strong partnership, we anticipate supporting further students over the lifetime of the IDTC VEIE."
(Stephen Baily, General Manager, BBC R&D)

"The [VEIV] Centre is unique in providing and developing the highest quality of young researchers with skills advantageous to advancing creative industries, the particular focus of Disney Research in the UK.… Our present EngD portfolio engages in technologies that reduce the costs of visual media production.… We look forward to playing an active role in the future of a renewed DTC, which is a technologically accomplished and much-needed initiative and highly recommend that the [VEIV] Centre is renewed to continue its current ground breaking and impactful work."
(Kenny Mitchell, Head of Research, Disney Research)

"Microsoft values UCL's world-class research in computing and in particular in virtual environments and interaction technologies.... We anticipate the VEIE area will be an important growth area for us as well as the UK economy."
(Shahram Izadi, Senior Researcher, Microsoft Research Cambridge)

"[The] VEIE EngD programme is an essential degree for those interested in applied science and the pathways to impact of research which are critical for successful skilled entrepreneurs."
(Paul Francis, Managing Director, Modus Services)

"Foresight and our clients benefited greatly from our continuing relationship with the EngD Centre in VEIV. The Centre's collaborative organisation means that Research Engineers are able to train in a multi-disciplinary environment, to bring diverse skills and perspectives to engineering problems. VEIV offers a unique programme of training and research, as well as access UCL's advanced expertise in computing, design and engineering disciplines."
(Alvise Simondetti, Global Leader Digital Environments, Arup Foresight)

"... there is fantastic potential for collaboration between Buro Happold and your proposed VEIE EngD Centre to further improve technologies for the design process in building services industry as well as developing interaction design and technology to encourage behavioural change and deliver sustainable built environment. Collaboration of computer and built environment scientists is the key strength of your outstanding proposal."

43 This and following eight quotes from VEIV IDC.

(Alasdair Young, Head of Sustainability, Buro Happold)

"CIBSE is aware that there is a need to stay at the forefront of developments in the computational building science and engineering to ensure that we keep abreast of the latest academic and applied research. EPSRC Doctoral Training Centre in Virtual Environment and Interaction Engineering (VEIE) has a great potential to further improve technologies for the design and engineering of the sustainable built environments.
(Dr Hywel Davies, CIBSE Technical Director)

"Digital post-production is a multi-billion-pound industry sector to in the UK. Advances in R&D, of which [EngD VEIV project] is a strong example, are essential innovations that keep the UK industry competitive in a highly competitive, global market. The EngD VEIV programme has played an important role in driving scientific advances into marketable innovations."
(Dr Stuart Penn, CG Supervisor, Framestore CFC)

“The need for skilled and industrially focused students will become increasingly important in future years as the national needs to replace or update much of its existing infrastructure…. The EngD scheme offers a route whereby highly skilled personnel can be developed to match industrial needs in a short period of time.”
(E.ON)

“The scheme provides a key link in ensuring successful technology transfer of research from the academic to the industrial environment. Embedding high quality individuals within industry ensures that the research performed is highly relevant to the industrial need.”
(Rolls-Royce Marine)

“I think the EngD programme is an excellent way to progress research to a physical conclusion. Previous experience with a PhD programme has not progressed the technology as quickly as the results of the [Manchester] EngD students that we have supported over a number of years.”
(Rolls-Royce)

“The EngD programme is of significant benefit to industry for ... [its] increased industrial bias compared to a traditional PhD – this allows greater alignment of the work with live research contracts. …[It is] an excellent recruitment pipeline – the EngD provides an ideal opportunity to assess not only the technical capabilities of the student, but also their behaviours in an industrial setting. Much of the data can be generated to appropriate quality standards using industrial facilities, processes and procedures such that there is a better opportunity to use the data/outcomes in anger to support customers.
(Richard Howell, AMEC)

“I am a fan of the EngD scheme. ... The EngD scheme provides an attractive route to securing industrial research in the nuclear sector and is also an effective training ground for new nuclear scientists and engineers to join the nuclear industry, which is essential at a time when we are looking to rejuvenate the nuclear industry in the UK.”
(Prof Paul Smith, AMEC)

“... we have found the Eng Doc system to have been very useful over the past few years, in terms of both getting worthwhile R&D work undertaken on behalf of our clients and also on being able to have a good look at them in terms of possible future recruits.”
(John Sharples, AMEC)

“... The EngD scheme … allows a bit more flexibility than the more specific customer funded work that NNL undertakes. This is crucial in enabling people to broaden their horizons without becoming too blue-sky. This is something we fully agree with, because the

commercial drive that determines the way the industry operates now would not allow students to develop the breadth of understanding in ceramic wasteform matters that was possible previously during the BNFL era."
(Dr Mike Angus, Corporate Chief Technologist, National Nuclear Laboratory)

"The nuclear sector has positively engaged with the innovative EngD (doctoral) training programme for many years. Generators, their supply chain and University partners have all benefited form this distinctive style of education; with elements of taught programmes, an excellent cohort community of practice experience and close collaborative working with private sector sponsors. These three unique elements combine to accelerate the development of the high end technical skills needed to sustain the civil nuclear sector in the UK, both now and in the future"
(Dr Manus O'Donnell, R&D Manager, EDF Generation).

Appendix D

Examples of industry fellowships and innovation awards won by research engineers engaged in EngD programmes

- EngD candidates have been successful in securing Industry Fellowships from the Royal Commission for the Exhibition of 1851 (IDCs to benefit include VEIV, MiNMaT, Transport and Environment, and Non-Destructive Evaluation). In 2013 three of the eight Industrial Fellowships awarded went to EngD students.
- Two MiNMaT REs were part of a BAE Systems team that won a Chairman's Award for Innovation in 2010.
- EFET REs were awarded "Prize for Best Team Work" under Engineering Young Entrepreneurs Scheme (YES) in 2011.
- An EngD spin-out company from the Molecular Modelling and Materials Science IDC won the 2011 Shell Springboard competition.
- The Digital Media IDC had nominations for two BAFTA Awards for EngD technology which was integral to the game's product.
- Southampton EngD research engineer Frederick Levy won the British Geotechnical Association's Cooling Prize 2013.
- Growing People, a Community Interest Company established by Systems Centre EngD graduate Matt Montgomery, won an £8,000 runner-up prize in the University of Bristol's 2013 business challenge competition, the New Enterprise Competition
- A Transport and Environment RE, Peter Halswell, was runner-up in the 2013 National Instruments' Graphical Systems Design Achievement Awards, commended for his research with the Royal National Lifeboat Institution (RNLI).
- Systems IDC RE Tom Bartley was runner-up in the 2013 NCE Graduate of the Year competition.
- Dr Christopher Lane was awarded the Rolls-Royce John Bush award for his EngD project. The award is: "*to recognise and encourage engineers in the early part of their career who have made an outstanding technical contribution of value to Rolls-Royce".* He also won the Young Achiever Award at the 2012 World NDT conference.

Appendix E

Example **direct economic impacts** delivered by EngD research (identified in the Manchester Business School study) include outputs that have cut costs, brought new commercial products or services to market, created intellectual property (IP), or attracted further investment:

- An environmental technology developed for an industry partner [Retail] through an EngD project has led to £5 million cost saving. The project outcome had been immediately rolled out within the organisation both nationally and internationally.
- Bioprocess Engineering Leadership IDC's 2009 mid-term review report highlighted an EngD project outcome delivering a therapy with an estimated value of $20 billion.
- IP generated from an EngD project led to the assets in the trade sale of a company (VEIV IDC).
- “saved the sponsoring firm £0.9 million in 2009 and £2.4 million in 2010” [SEES].
- “the work showed saving of £1M pounds over 5 years for an up-front investment of £50K” [SEES IDC]
- “due to the acceleration in time to market, estimated labour savings of 80% in a market sector worth $1.5 billion” [Bioprocess Engineering Leadership IDC].
- “a sponsoring company investing in £500K on a new delivery system based on the EngD research” [Molecular Modelling and Materials Science IDC]
- “a patent application for a new underwater turbine design – will save potentially £300K a year” [Systems IDC]
- “A new approach to project-based support service delivery helped an IT systems implementation of a multi-million pound improvement for the business [CICE IDC].
- “The resultant throughput saves us £1 million per annum” [Formulation Engineering IDC, testimonial letter]

Appendix F

EngD research programmes can also act as **catalysts to generate further income**. The Manchester Business School analysis of the 2009 mid-term reviews found examples including spin-off research projects, TSB grants, RDA funding, and government contracts

- a spin-off research project (with a value of £591,600) 50% funded by TSB [TSBE]
- TSB grant for the UK post-production/special effect communities (value £500,090) [Digital technology]
- inward investment in London [VEIV]
- a provision of £1.148 million from One North East (Regional Development Agency) was discussed [Biopharmaceutical Processing IDC]
- RE able to use his research outputs to secure £0.5 million worth of funding from his sponsoring organisation to set up and develop a new business venture [CICE]
- EPSRC grant India Bridging the Urban Divide £2.6 million [Fossil Energy and Carbon Capture IDC]
- EPSRC Nanotechnology Grand Challenge £3.1 million [MiNMat]
- EPSRC Centre for Emergent Macromolecular Therapies £5.2 million [Bioprocess Engineering Leadership IDC]
- Sustain won a contract with the Department for Environment, Food and Rural Affairs (Defra) to lead a consortium of waste management experts, including researchers at the IDC in Systems to develop better in-house for Waste Prevention Programmes. The consortium's work is part of the UK Government's long term plans to work towards a zero waste economy - a key part of the Coalition Agreement.

Appendix G

EngD sponsors – an 'Aardman to ZedFactory' list of EngD industry sponsors

Engineering doctorate (EngD) research is directly related to the needs of UK business through the detailed involvement of, to date, over 400 industry sponsors, including almost all EPSRC strategic partners (in **bold**). EngD sponsors range from specialist small- to medium-sized businesses (SMEs) through to the UK offices of multi-national firms.

3i Technology Ltd
4T2
Aardman Animations
ABB
Accelrys
Action Sustainability
Advanced Laser Technology Ltd
AECOM
Aedas
Aero Engines Controls
AES
Aggregate Industries
Air Products
Airbus
AkzoNobel
Albion Water
Alcyomics
Alstom Power
Altair
AMEC
Ametek Taylor Hobson
Amey Highways
Anglian Water
Apical Ltd
Applied Scintillation Technologies
Argonne National Laboratory (USA)
Art Access & Research
Arts Catalyst
Arup
Arvia Technology Ltd
Asahi Glass
ASCOMP
Asite Solutions Ltd
ASL Vision
AstraZeneca
Atkins Nuclear
Automation Partnership
Avecia
AWE
Babcock & Wilcox
BAE Systems
Balfour Beatty
BAM Construct UK Ltd
BASF
Bat Conservation Trust (BCT)
BBC
BCF Designs
Beckers Paints
Belson UV Technik
Bentley / Crossrail
BF2RA (Biomass Fossil Fuel Research Alliance)
Biopharm Services
Biovex
BOC Edwards
Boeing
Boots
Bosch Thermotechnology
Bovis Lend Lease
BP
BPL
Brandt - National Oilwell Varco
BRE
BRE/Hereford Futures
Bristol Myers Squibb
Bristol Water
BRITEST
British Energy
British Precast Concrete Federation
British Research Establishment
Broadcom
BT
Buro Happold
Cambridge Crystallographic Data Centre
Campden BRI
CapGemini
Carbon Disclosure Project
Cargill
Carpenter Technology
Cascade Technologies
Caterpillar
Cella Energy
Centre for Process Innovation
Centronic
Ceram
CFMS
Charnwood Molecular
CheckRisk
CIBSE
CIOB
CITB
Civil Engineering Monitoring Ltd
Clean Coal Ltd
Clean Energy Europe
Clifton Suspension Bridge Trust
Cobham Advanced Composites
Codeplay
Computational Dynamics Ltd
Concrete Preservation Technologies
Construction Skills
Corewire
Corin Group Plc
Corporate Risk Associates
Corus
Costain
Costain + COMIT Projects
CPL Industries
Createc Ltd
CRESS
Croda
Crytek
CSIR
Culham Centre for Fusion Energy
Cummins Generator Technologies Ltd
Cybula
DAQS Limited
Demuris
DHL Neutral Services
Diamond Light Source
Digital Lightspeed Solutions
Diosynth Biotechnologies
Disney Research
DNV GL
Doosan Power
Double Negative Visual Effects
Dstl
DuPont Teijin Films
Dynamic Flow Technologies
E.ON
EADS
EDF Energy
Edinburgh Instruments
Electronic Arts
Eli Lilly
Energy Technologies Institute
ESI
Essex & Suffolk Water
ETAS
European Office of Aerospace Research & Development
European Synchrotron Radiation Facility (ESRF)
Evotec
Excitech / Capita Symonds
Exxon Mobil
Faithful + Gould
Fat Pebble
Fire Protection Association
FNC
Ford Motor Company
Forest Research
Framestore
Frazer-Nash Consultancy
Frontier Developments
FujiFilm
Fujitsu
Fujitsu Microelectronics
Gatwick Airport
GCHQ
GE Healthcare
GE Aviation
GKN
Gloucestershire Hospitals NHS Foundation Trust
Golder Associates (UK) Ltd
Gooch and Housego plc
GSK
Guardian News & Media
Halcrow Group Limited
Halcrow Yolles
Hanovia
Heidelberg Cement
Heineken
HEL
Hexcel
Holoxica
HPA
HR Wallingford
HSE
Hueskar Ltd
Hydro International
i-dmsolutions

IBM
Imerys
Imetrum
Independent Stabilising Company
Indestructible
Industry sponsors
Infineon Technologies
Infineum
Informa plc
Ingenza
Innospec
Inside Secure
Institut Straumann AG
Intercell
InterfaceFLOR
International Geosynthetics Society
Intertek Group
IT Power
J P Kenny
Jacobs
Jaguar Land Rover
JCB
JCK Joinery
Johnson Construction
Johnson Matthey
Kerry Group
Kraft Foods
Labosport
Lafarge Aggregates
LB Foster Rail Technologies
Leicestershire County Council
LGC Limited
Liverpool Conservation Technologies
Lockheed Martin
London Borough of Brent
Lonza
M-Solv
Mallinson Architects & Engineers
Malvern Instruments
Manufacturing Technology Centre (MTC)
Marks & Spencer / Matrix
Mast Carbon
Matilda's Planet
MCS Ltd
Memsstar
Merlin Circuit Technologies
MESL Microwave
Messier-Bugatti-Dowty
Met Office
Micro Drainage
Microsoft
Ministry of Defence
Mitchells & Butlers
Mode7
Mood International Software
Morgan Sindall
Motor Design
Mott MacDonald
Mouchel
Musion
MustRD
Nanoco Technologies
National Composites Centre
National Grid
National Industrial Symbiosis Programme
National Nuclear Laboratory
National Physical Laboratory
National Trust
Natural Motion
NDA
NEC
Nestle UK
NetComposites
Neural Insights
NHS Greater Glasgow and Clyde
NHS Lothian
NHS Moorfields Eye Hospital
Ninja Theory
Northumbrian Water
Novartis Pharmaceuticals
Novo Nordisk
NSG Group
Ondine Biopharma
Onyvax
Onyx Scientific
Optos
Orb Electrical Steels
Ordnance Survey
Pacific Northwest National Laboratory
Pall Europe
Pall Filtration
Pall Life Sciences
Parker Hannifin
Parsons Brinckerhoff
PCIP
Pepsico
Perceptive Engineering
Perkin Elmer
Peter Brett Associates
Pfizer
Pilkington Glass
Piramal
Plasma Quest
Plasticell
Plymouth Marine Lab
Powerlase Ltd
Powerlase Photonics
PowerPhotonic
Premier Foods
Procter & Gamble
Protherics
Provision
QinetiQ
Raith GmbH
Ramboll
Rapita
RDC Aviation
Renishaw Plc
Responsible Solutions
Rich Foods
Rock and Alluvium
RockTron
Rofin
Rogers Leask Group Ltd
Roke Manor
Rolls-Royce
Ross Ceramics
Rutherford Appleton Lab
RWEnpower
SABIC UK Petrochemicals
SABMiller plc
SAFC Hitech Limited
Safeeng
Sainsburys
Sandvik
Sandvik Coromant
SCA Industries
Schneider Electric UK
Science Warehouse
Sciencescope
Scott Bader
Scott Wilson
Scottish Bioenergy
Scottish Water
SeeByte
Selex Galileo
Sellafield Sites
Sematech
Serco
Severn Trent Water
Shasun
Shell
Shepherd Construction
SIFAM Fibre Optics
Silicon Laboratories Inc
Silverstone Circuits
Skanska
Smoke & Mirrors
Somethin' Else
Sony
Southern Water
SSE (Scottish and Southern Energy)
ST Microelectronics
STFC, RAL
Structherm Ltd
STS-Sumitomo
Sumo Digital
Surrey County Council
Surrey Sports Park
Sustain
Swansea Printing Technology ltd
Syngenta
Tangentix
Tata Colors / Specific
Tata Steel
Technical Surfaces Limited
Technicut Ltd
TES Electronic Solutions
TESBV
Tesco
Texas Instruments
Thales Optronics
Thales UK
Thames Water
The Converging World
Thermo Fisher Scientific
Think Research
Thomas Swan
Thyssen Krupp Tallent
Tidal Generation
Tioxide Ltd
TiSICS
Toshiba
Toshiba Medical Visualization Systems
Tower Cold Chain Solutions
Triumph Design
Trojan Technologies
Trojan UV
Trumpf
TWI
Uformia
UK Astronomy Technology Centre
UKAEA Culham
Unilever
United Utilities
URS
Useful Simple Projects
Vale
Valero Energy
Venatrack
Vestas Wind Systems
Vinci Plc
Virtual Interconnect

Wates
Wessex Water
West Highland Animation
Westfalia Separator
Westland Helicopters
Willmott Dixon
WIP-AIMR (Japan)
Wonky Films
WRc
YorkMetrics
Yorkshire Water
ZedFactory

Appendix H

Number of EngD centres - reflecting the changes over recent time.

Early chronology

Nineteen IDCs were identified by EPSRC in 2009, with a further seven subsquently added (see the EPSRC Industrial Doctorate Good Practice Guidance note),[44] giving a **total of 26** (one - Systems Approaches to Biomedical Science, University of Oxford – does not award EngD).

In August 2011, an IDC in offshore renewable energy, offering EngDs, was announced, at Edinburgh, Strathclyde, Exeter.[45]

In September 2012, five CDTs were announced,[46] including two centres offering EngDs, bringing **total** to 29 (**28** of which offered EngD):

- Composites Manufacture
- COATED

W**inter 2013-2014 EPSRC announcements**

From November 2013 announcement[47] – **eight** EngD centres (plus one DPhil):

- University of Bath Professor Phil Willis EPSRC Centre for Doctoral Training in Digital Entertainment
- University of Bristol Professor Ivana Partridge EPSRC Centre for Doctoral Training in Composites Manufacture
- University of Sheffield Professor Keith Ridgway EPSRC Centre for Doctoral Training in Machining Science
- Heriot-Watt University Professor Derryck Reid The EPSRC Centre for Doctoral Training in Applied Photonics *(formerly Optics & Photonics)*
- University of Oxford Professor Charlotte Deane EPSRC Centre for Doctoral Training in Systems Approaches to Biomedical Science **(NB: does not award EngD)**
- University of Nottingham Dr Christopher Tuck EPSRC Centre for Doctoral Training in Additive Manufacturing and 3D Printing *(formerly Manufacturing Technology Engineering DC?)*
- University College London (UCL) Professor Gary Lye EPSRC Centre for Doctoral Training in Bioprocess Engineering Leadership
- University College London (UCL) Professor Nora De Leeuw EPSRC Centre for Doctoral Training in Molecular Modelling and Materials Science
- University of Strathclyde Professor William Leithead EPSRC Centre for Doctoral Training in Wind and Marine Energy Systems *(formerly IDCORE?)*

from January 2014 announcement[48] – **four** centres

- Cranfield University Professor Paul Jeffrey EPSRC Centre for Doctoral Training in Engineering for the Water Sector (STREAM IDC)
- Swansea University Dr James Sullivan EPSRC Centre for Doctoral Training in Industrial Functional Coatings: COATED2
- University of Nottingham Professor Colin Snape EPSRC Centre for Doctoral Training in Carbon Capture and Storage and Cleaner Fossil Energy *(formerly Efficient Fossil Energy Technologies)*

44 http://www.epsrc.ac.uk/SiteCollectionDocuments/other/IDCGoodPracticeGuidelines.pdf

45 http://www.epsrc.ac.uk/newsevents/news/2011/Pages/boostforrenewableenergy.aspx

46 http://www.epsrc.ac.uk/newsevents/news/2012/Pages/futuremanufacturing.aspx

47 http://www.epsrc.ac.uk/newsevents/news/2013/Pages/phdnewcentres.aspx

48 http://www.epsrc.ac.uk/newsevents/news/2014/Pages/19newcdts.aspx

- University of Surrey Professor Julie Yeomans EPSRC Centre for Doctoral Training in Micro-and NanoMaterials and Technologies

from March 2014 announcement[49] – **four** centres

- Professor Peter Fryer University of Birmingham EPSRC Centre for Doctoral Training in Formulation Engineering
- Professor Peter Cawley Imperial College London EPSRC Centre for Doctoral Training in Quantitative NDE *(formerly Non-destructive Evaluation?)*
- Professor William Powrie University of Southampton EPSRC Centre for Doctoral Training in Sustainable Infrastructure Systems *(formerly Transport & the Environment*
- Dr Kerry Kirwan University of Warwick EPSRC Centre for Doctoral Training in Sustainable Materials and Manufacturing (EngD) *(formerly High Value, Low environmental impact manufacturing)*

An email on 1 April 2014 from EPSRC's Jim Fleming said the March announcement included:

"... further CDTs that will be offering EngDs (4 EngD only, 2 mixed PhD & EngD). … at least one other CDT will be offering the EngD despite this not being part of their bid! So establishing final numbers of CDTs that offer EngDs may take some time ...."

Update
At the time of the meeting with the Minister (8 April 2014), and also at the time a press release was approved (2 May 2014), no further information had been provided by EPSRC on the 'mixed model' centres. The above summary reflecting the AEngD's current view was shared with the EPSRC prior to the news release. As some centres also changed names, the AEngD list may not be 100% accurate.

A note re AEngD membership

AEngD represents 25 IDCs. Three EngD-awarding centres were not members of the AEngD:

- IDCORE – Edinburgh, Strathclyde, Exeter
- Industrial Doctorate Centre in Advanced Forming and Manufacture – University of Strathclyde
- Doctoral Training Partnership (DTP) in Structural Metallic Systems for Gas Turbine Applications - universities of Cambridge, Swansea and Birmingham

Systems Approaches to Biomedical Science, University of Oxford, does not award EngD, and so is not a member (though SABS staff have participated in EngD administrator meetings)

49 http://www.epsrc.ac.uk/newsevents/news/2014/Pages/newcdts.aspx