Assessing the Economic Benefits of Engineering Research and Associated Training in the UK.

Stakeholder workshop 25 June 2014, RAEng, London 10.30hrs - 12.30hrs

Background

EPSRC and the Royal Academy of Engineering commissioned Technopolis to run a study to assess the economic returns to the UK of investment in engineering research and associated training.

The project, which is being overseen by a steering group chaired by Professor John Fisher CBE FREng, Deputy Vice-Chancellor at the University of Leeds, will provide:

i. Quantitative and qualitative estimates of the economic impact of the UK's investment in engineering research and associated training, highlighting the most significant sectors and areas of activity.

ii. Evidence of the different routes by which engineering research achieves economic and societal impact, for example:
   - Skilled people into society/industry
   - Inward investment
   - New businesses
   - Improvements to existing business
   - Policy and public services.

As part of this study, a stakeholder workshop was organised as an opportunity for academic and industrial representatives from the engineering community to engage and contribute to the project. Members of the project steering group also attended – a full list of attendees is at Annex A.

Main points of the meeting

Professor Fisher emphasised that the study will be for the benefit of the whole engineering community.

Technopolis presented an overview of their methodology for the study:

- The proposed definitions of engineering and training;
- The conceptual framework that will guide the study;
- The overall methodologies that will be employed, which include an analysis of investments in engineering, the outputs (people, research outputs), outcomes and the impact on GDP and productivity;
- Measuring the relationships between inputs and final impacts using econometric analyses; and

- The role of case studies in the study will be crucial to the success of the project. One important source of information will be access to case studies from universities submitted to the Research Excellent Framework. A request for this information has been sent to 60 universities with significant engineering research capability. *(Note: as of 8 July, more than 350 case studies from 27 universities have been received.)*

Discussion

- Overall the consensus was that the study was long overdue and attendees were generally very supportive of the study.
- There is a need for a clear engagement plan to be developed to help identify the target audience and the main mechanisms for dissemination.
- The challenge of using historical information to argue the case for future investment is challenging. Engineering is complex so the study will need to communicate a few simple messages very clearly.
- There needs to be some realism about the study and the development of robust evidence: the study timescale is tight and it will not be possible to have access to all relevant data.
- The study needs to make reference to evidence found in studies already available eg the Perkins Review of Engineering Skills, "The impact of universities on the UK economy" (UUK). This first review recognises the importance of a talent pipeline and the impact on industry strategic sectors.
- The benefits of engineering should be considered in more than just financial terms – for example some engineering benefits could be described using quality-adjusted life years (QALYs).
- There was some concern that there would be double counting of benefits with studies already done.
- Time lags between investment and impact/benefits vary considerably between industry sectors. In addition, investment is partly dependent on the level of confidence in the economy that companies have at that time.
- Case studies will opportunistic and not exhaustive. An overall quantitative value for all the case studies will not be calculated.
- It was noted that investments levels increase hugely as the TRL level increases and that there is a high attrition rate of projects.
- The Technology Strategy Board should be consulted about levels of investment.
- The UK HEIs sector is the 7th largest overseas earner in the UK. A significant proportion of that income comes from overseas students and a significant chunk of that total coming from postgraduate engineering students. It should be possible to separate out the contribution that these postgraduate engineering students provide to the UK. Universities UK have done some work on the impact of universities which include the overseas student issue, though this was not done at the subject level.
- EU funding will be considered by looking at the UK participation in FP7.
- The focus of industry discussions with ministers is usually international competitiveness, for example comparisons with Japan, Germany, China etc. Is there a way that international competitiveness can be included in the study?
- One challenge will be separating out UK investment from global investment by companies, as a significant number of companies are international.

- It is important that this exercise is recordable so that there can be a repeatable exercise in the future.
- Need to be aware of unintended consequences that the data and findings may uncover.
- There is a significant likelihood of duplication/overlap of the economic benefits with previous studies eg maths, chemistry.
- There is a major challenge for identifying the economic benefits of R&D in the MoD. For example, having an agile and flexible highly trained workforce has shown benefits for example by saving civilian lives in Afghanistan.
- The need to be aware that some small investments have led to very large impacts and benefits, so case studies should not be decided on by investment levels only.
- Industry can contribute to the study by championing the messages coming out of the study. It was noted that health/medical sciences have done well in recent previous spending reviews, partly because of the very coordinated and consistent way that the whole medical community has communicated the importance and benefits of medical research and training.
- Whilst the REF impact case studies are a very valuable source of evidence, their contents are based on specific rules and constraints and represent one university's perspective of a particular impact: they are unlikely to portray a sufficiently complete picture to be used as a stand-alone example for this study.

Conclusions and next steps

- The overall view of attendees is that the study will cover a very complex landscape, and as such it will be important that the study is approximately right rather than precisely wrong. The methodology will be crucial if it is to achieve this.
- Technopolis are keen to engage with some of the attendees of the workshop to discuss some of the points raised in more detail.
- The project steering group will meet after the workshop to consider the points raised in the discussion.
- A second stakeholder workshop will take place on the morning of the 22 October. Attendees from this first workshop will be invited to this second event, plus a wider representation from the engineering community.

Annex A Stakeholder workshop Attendees

Imperial College London	Prof Jeff Magee	Principal of Engineering
University of Birmingham	Prof Richard Williams	Pro Vice Chancellor
University of Surrey	Prof Jonathan Seville	Executive Dean Faculty of Engineering and Physical Sciences
University of Bristol	Prof Paul Weaver	Research Director
Aston University	Prof Alison Hodge	Associate Dean
University of Oxford	Prof Dominic O'Brien	Deputy Head of Engineering
University of Cambridge	Prof David Cardwell	Head of Engineering (from Sept 2014)
University of Manchester	Prof Tony Brown	Head of Electrical and Electronic Engineering
Loughborough University	Prof Chris Hewitt	Head, Centre for Biological Engineering
University of Southampton	Prof Tim Leighton	Professor of Acoustic Engineering
University of Nottingham	Prof Seamus Garvey	Professor of Dynamics
E.On Technologies Ltd	Mr John Bateman	Leader in Technology & Process Management
Shotttrinova	Ian Shott	Managing Partner, RAEng Enterprise Committee
Energy Technologies Institute	Andrew Haslett	Director of Strategy
Surrey Satellites	Matt Perkins	CEO
BAE Systems	Prof Andy Wright	Director - Technology Acquisition Advanced Technology Centre
Jaguar Land Rover (JLR)	Mr Tony Harper	Head of Research and Advanced Systems Engineering
BT	Dr John Seton	Head of University and Regional Partnerships
NPL	Glenis Tellett	Enterprise Manager
IP Group	Dr Achim Hoffmann	Physical Sciences
DSTL	Roland Knott	Head of Science and Technology Strategy
Engineering Professors' Council	Susan Kay	Executive Director
IMEchE	Prof Clive Neal-Sturgess	Emeritus Professor of Mechanical Engineering
Thales	Richard Egan	Technical Manager, Thales Research and Technology
University of Leeds	Prof John Fisher	Deputy Vice-Chancellor
Rolls Royce	Dr Jackie Wildhaber	Assistant Chief Engineer
Independent	Prof Steve Williamson	
BIS	Dominic Rice	Economic Advisor
EPSRC	Dr Sue Smart	Head of Performance and Evaluation
EPSRC	Dr Kedar Pandya	Head of Engineering
EPSRC	Stephen Loader	Senior Manager, Evidence and Impact
RAEng	Dr Hayaatun Sillem	Director of Programmes and Fellowship
Technopolis	Paul Simmonds	
Technopolis	Cristina Rosemberg	
Technopolis	Tammy Sharp	
Technopolis	Xavi Potau	

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Assessing the economic benefits of engineering research and associated training in the UK

Stakeholder Workshop
25 June 2014

Professor John Fisher, Deputy Vice Chancellor, University of Leeds
Chair of Steering Group

Dr Kedar Pandya, Head of Engineering, EPSRC

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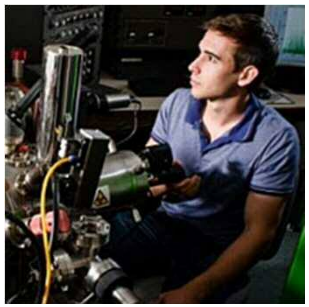
Overall Project aims and objectives

Provide quantitative and qualitative estimates of the economic impact of the UK's investment in engineering research and training, highlighting the most significant sectors and areas of activity.

Demonstrate the different routes by which engineering research achieves economic impact, for example:

- Skilled people into society/industry
- Inward Investment
- New businesses
- Improvements to existing business
- Policy and Public Services



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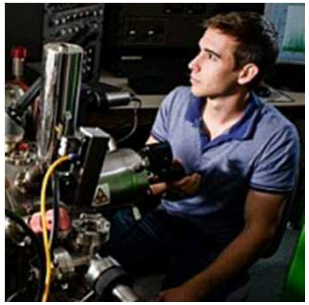
Workshop Objectives

- To inform the engineering community of this study and to encourage participation in it.
- To enable Technopolis to share their planned methodology for the study.
- To improve the study by enabling the engineering community to contribute to it.
- To build a shared understanding of the importance of running this study.



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Workshop Structure

- Welcome and introductions
- Workshop purpose
- Project methodology – Paul Simmonds and Dr Cristina Rosemberg, Technopolis.
- Plenary discussion of methodology
- Identifying case studies
- Summing up/conclusions

- Lunch at 12.30hrs

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Background

- Joint project by EPSRC and RAEng
- Rationale – SR2015 and beyond
- Main audience for the study: HM Treasury, BIS
- Builds on previous initiatives: EPSRC economic benefit studies of Maths; RAEng Engineering for Growth

ENGINEERING FOR GROWTH

Jobs and growth:
the importance of engineering skills to the UK economy

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Project Rationale

- The study will form part of the evidence base for the next Spending Review.
- Evidence collected and presented must be robust and defensible.
- Case studies to show the breadth and complexity of engineering research and associated training.
- Key messages need to be enduring and not linked to political stances.
- Training focus will be postgraduate (MSc, PhD, EngD etc), including masters-level CPD modular training.

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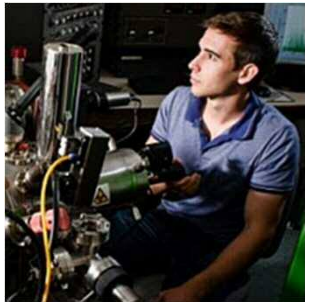

Project Steering Group

Professor John Fisher FREng	Deputy Vice Chancellor, University of Leeds (Chair)
Dr Norman Apsley FREng	Chief Executive, Northern Ireland Science Park
Mr Warren East FREng	Former Chief Executive, ARM Holdings
Professor Robert Mair FREng	Department of Engineering, University of Cambridge
Professor Elaine Martin FREng	School of Chemical Engineering and Advanced Materials, Newcastle University
Dominic Rice	Economic Advisor, Department for Business, Innovation and Skills
Dr Jackie Wildhaber	Assistant Chief Engineer, Rolls Royce
Professor Steve Williamson FREng	Former Deputy Vice Chancellor, Research and Innovation, University of Surrey

EPSRC/RAEng representation

Dr Kedar Pandya	Head of Engineering, EPSRC, & Senior Policy Advisor, RAEng (part-time secondment)
Dr Hayaatun Sillem	Director of Programmes and Fellowship, RAEng
Dr Sue Smart	Head of Performance and Evaluation, EPSRC
Stephen Loader	Senior Manager, Evidence and Impact, EPSRC (Project Manager)

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Previous economic benefit studies…making the case for investment in EPS research

Physics research
4 million jobs, £77bn of economic output, £100bn exports

Mathematical sciences research
2.8 million jobs, 16% of UK Gross Value Added

Chemistry research
6 million jobs, 21% of GDP, 15% of UK exports

Manufacturing research
10 years of EPSRC manufacturing centres generated an impact **16 times original investment**

Importance of Physics to the UK economy (IoP, 2012) http://www.iop.org/publications/iop/2012/file_58713.pdf
Mathematical sciences – leading the way to economic growth (EPSRC and CMS with Deloittes, 2014)
http://www.ima.org.uk/_db/_documents/4_page_economic_impact.pdf
The economic benefits of chemistry research to the UK (EPSRC, RSC, with Oxford Econmics 2010)
http://www.epsrc.ac.uk/newsevents/pubs/the-economic-benefits-of-chemistry/
The economic impact of the Innovative Manufacturing Research Centres (EPSRC with DTZ, 2011)

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Paul Simmonds and Cristina Rosemberg

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Discussion

- What are your immediate reactions?
- What could we do to strengthen the review?
- What specific issues or concerns do you have?
- How can the engineering community contribute in order to improve the study?
- How can EPSRC, RAEng and the engineering community maximise the benefits of the review findings?

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Case studies

- Report will highlight 10 case studies.
- Will show the breadth and complexity of engineering research and associated training.
- Need to go beyond obvious examples.
- Have contacted universities for engineering REF Impact case studies. Already received more than 200 from 13 universities. *(note: as of 8 July more than 350 case studies from 27 universities)*
- Initial suggestions include: Hitachi/Alstom re: high speed trains; Tata; Dyson R&D in the UK; metal sorting; the extensive use of technology by Supermarkets.

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Conclusions and Next Steps

- Steering Group meeting this afternoon to consider workshop outcomes.
- A second stakeholder workshop on 22 October 2014 to share draft findings.
- Technopolis study will report in late autumn 2014, final report published in December/January.
- Aim to have a launch event in early 2015
- Your contributions have been extremely valuable.

- Please send T&S claims to Helen Webb, EPSRC
- Lunch available

Thank you

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Assessing the economic returns of engineering research and training in the UK

Introduction to a study commissioned by the EPSRC and RAEng

Cristina Rosemberg
Kristine Farla
Tammy Sharp
Paul Simmonds

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Study objectives (1/2)

- Provide an overall estimate of the economic impact of the UK's investment in engineering research and training, highlighting the most significant sectors and areas of activity
- Demonstrate the different routes by which engineering research achieves economic impact, for example
  - *Skilled people into society/industry*
  - *Inward Investment*
  - *New businesses*
  - *Improvements to existing business*
  - *Policy and Public Services*

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Study objectives (2/2)

- The study will provide evidence to support the case for public investment in engineering research
- It intents to build upon and contribute to the existing body of knowledge regarding the contribution of engineering to the economy

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Main purpose of this presentation

- To present an overview of our methodology
- To test some working hypotheses with you
- To present and discuss potential case studies

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Defining engineering

- The first challenge - drawing the boundaries for the study
  - *Numerous 'engineering' definitions in use by various actors*
    - Research
      - *EPSRC engineering 'theme' research areas (94)*
      - *REF UoAs (3) Web of Science (38)*
      - ***HESA JACS subject classification (9)***
      - *IET / ABET engineering and technology fields (16)*
    - Skills / postgraduate research qualifications (PhDs, MPhils)
      - *EPSRC skills priorities*
      - ***HESA JACS subject classification (9)***
    - Economic activity
      - ***ONS SIC (classification)***
      - ***ONS Employment by Occupation (Standard Occupational Classification (7)***
      - ***ONS Labour Force Survey [LFS] (ISCED, SOC)***
- A need for pragmatism
  - *Use multiple classifications / accept they will not coincide fully*
  - *Use best available classifications / accept may both overstate and understate*

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HESA JAC subject classification

- (H1) General engineering
- (H2) Civil engineering
- (H3) Mechanical engineering
- (H4) Aerospace engineering
- (H5) Naval architecture
- (H6) Electronic & electrical engineering
- (H7) Production & manufacturing engineering
- (H8) Chemical, process & energy engineering
- (H9) Others in engineering

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ONS for industry classification

- Economic activities with high concentration of SET skills
  - *From report 'Jobs and Growth' commissioned by the RAEng*

Industry	SIC 2007 Definition	SET-Concentration (ONS LFS 2009)
Computing & Telecommunications	61,62	4.75
Electronic & Precision Engineering	26-28	4.51
Manufacturing	13-25, 29-33	3.04
Utilities	35-39	2.69
Construction	41-43	2.32
Business Services	68-75	1.27
Media & Publishing	58-60, 63	1.13
Food, Drink, & Tobacco	10-12	1.10
Other Services	94-97	0.94
Public Admin & Defence	84	0.83
Agriculture & Mining	01-09	0.76
Finance & Insurance	64-66	0.75
Transport & Storage	49-53	0.57
Retail & Wholesale	45-47	0.52
Education	85	0.41
Arts & Entertainment	90-93	0.31
Support Services	77-82	0.26
Health & Social Services	86-88	0.25
Accommodation & Food	55-56	-

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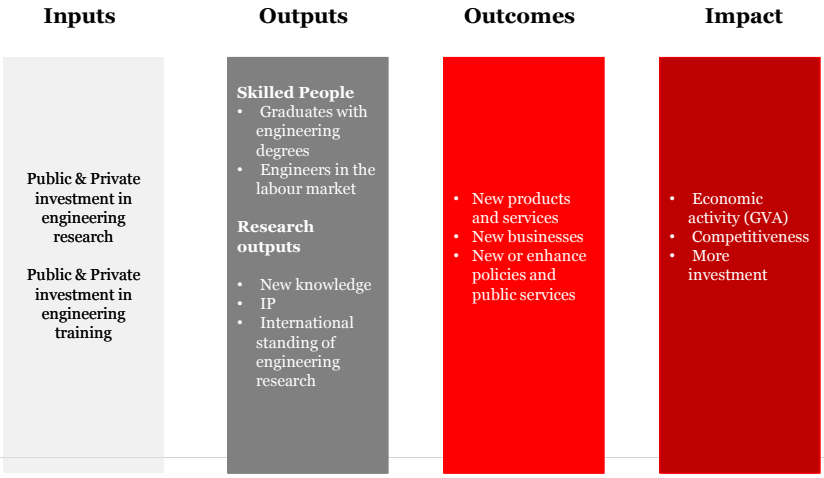
Pathways to impact (a simplified view of the elements in the analytical framework we plan to focus on …)



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Inputs

- Public & Private investment in engineering research
  - *Indicators*
    - Net Government expenditure on SET government departments and research councils *that relate to engineering*
    - Government expenditure on R&D (GvERD) (indicator is also available at sectoral level)
    - R&D from the UK Business Enterprise Research and Development (BERD) survey, contains R&D data for different sectors from the 1996-2012.
- Public & Private investment in engineering training
  - *Indicators*
    - EPSRC
    - John Perkins' review

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Engineering research training outputs

Area	Indicators	Sources
Doctorates	- Number of PhDs graduating annually - Number / share of all engineering PhDs with industrial support - Value of industrial support to PhDs	- EPSRC - HESA
Other postgraduate research degrees	- Number of Mphils graduating annually	- EPSRC - HESA

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Engineering research outputs

Area	Indicators	Sources
New knowledge	- Number of publications - Number / per unit R&D expenditure - Field weighted citation impact	- EPSRC - BIS / Elsevier annual review of international performance
Intellectual property	Number of patents filed by UK residents	- EPO PATSAT - HEBCI data do not link back to subjects or departments
Research collaborations	UK Participation in FP7 (ICT, NMP, Space, Transport)	- E-Corda

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Engineering research & training outcomes

Area	Indicators	Sources
Innovation in the private sector	- Enterprises engaging in innovation activities	- CIS
Innovation in the public sector	- Literature review	- Case studies

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Final impact – adding it all up (1/2)

- Many of the outcome metrics are qualitatively different
  - *One cannot simply add them together to arrive at an overall estimate of economic impact*
  - *Rather we will use the various factors as inputs to an economic model, which will allow us to test / estimate the impact*
- Econometric analysis
  - *Historical and sectoral analysis*
- Resulting in an estimate of the contribution to GVA per sector
  - *For a given year*

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Final impact – Econometric analysis(2/2)

- Exports
  - *link SET expenditure and exports, over time*
  - *link engineering skills and exports, for a given year, per sector*
- FDI
  - *link SET expenditure and FDI, over time*
  - *link engineering skills and FDI, for a given year, per sector*
- Productivity
  - *link SET expenditure and TFP, per sector*
- GDP/GVA
  - *link SET expenditure and GDP/GVA, over time*
  - *to link engineering skills and GDP/GVA, for a given year, per sector*

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Case studies to highlight significant areas of impact

- 10 case studies
  - *Private (8)*
  - *Public sector (2)*
- Sources of information
  - *Desk research (EPSRC / RAEng papers)*
  - *REF Impact Case Studies from HEI engineering departments*
    - Leads for possible cases to showcase / develop further
    - Analytical report profiling the types and locations of notable impacts realised as a result of public investments in engineering research
  - *This workshop …*
    - We would welcome any suggestions you may have

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Private sector case studies (8)

- Thematic case studies
  - *Attraction of multinational R&D investment (e.g. Bluestone Global Tech at Manchester, Red Hat at the University of Newcastle,)*
  - *Research-based university spinouts (e.g. Astex Pharmaceuticals or Apatech or Intelligent Energy or Xen)*
  - *Industrial support for engineering research and training (e.g. BAE Systems, Rolls Royce, Jaguar Landrover, P+G)*
  - *Engineers as a motor force driving innovation and creativity*
- Company / sectoral case studies
  - *Productivity gains*
  - *New products or services*

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Public sector case studies (2)

- Public policy
  - *National flood and coastal erosion risk management strategy*
- Public services
  - *National Measurement System*

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A second stakeholder workshop in autumn

- Present the key messages to a second workshop
  - *Validation*
  - *Prioritisation and points of emphasis*
  - *Evident gaps*
  - *Clarity of presentation of messages*
- A draft report in October
- A final report in November
- Summary published in December

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Structure of final report

1. Summary (separately publishable)
2. Inputs: Investment in engineering research and training
   - *Public and Private investment in engineering training*
   - *Public and Private investment in engineering research*
3. Outputs
   - *People*
     - Graduates
     - Engineers in the labour market
   - *Research and research outputs*
     - Publications
     - Patents
     - Research collaborations
4. Outcomes: Pathways to impact
   - *Engineers and engineering research as innovation agents*
     - Engineers and engineering research as innovation agents in the private sector
     - Engineers and engineering as inputs for the provision of high quality public services
   - *Engineers and engineering research as drivers of competitiveness*
5. Final impact
   - *Impact on GDP/GVA*
   - *Impact on Productivity*
6. Conclusions
7. Annexes

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Discussion …

- Questions or suggestions about …
  - *Scope of the study*
  - *Working definitions / classification systems*
  - *Official data sources*
  - *Other relevant studies*
  - *Possible case studies*
- What have the engineers ever done for us?

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Thank you

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EPSRC – engineering grants by industrial sector

- Aerospace, Defence and Marine
- Manufacturing
- Construction
- Energy
- Healthcare
- Environment
- Transport Systems and Vehicles
- Pharmaceuticals and Biotechnology
- Water
- Chemicals
- Electronics
- Information Technologies
- Food and Drink

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ONS for occupational and industrial categories

- ONS SOC
  - *2121 Civil engineers*
  - *2122 Mechanical engineers*
  - *2123 Electrical engineers*
  - *2124 Electronics engineers*
  - *2126 Design and development engineers*
  - *2127 Production and process engineers*
  - *2129 Engineering professionals n.e.c.*

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Pathways to impact (a simplified view of the elements in the analytical framework we plan to focus on …)

Inputs	Outputs	Impacts
Public investment in engineering research and training	New knowledge	New products and services
Private investment	IP	New businesses
Third sector investment	International standing of engineering research	Economic activity (jobs, GVA, exports)
International investment	Engineering PhDs	Productivity
		Competitiveness
		New policies and public services

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