



Rolls-Royce

Effective Industry-Academic Collaboration

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HEPI Autumn Conference, 5. December 2012, The Royal Society, London

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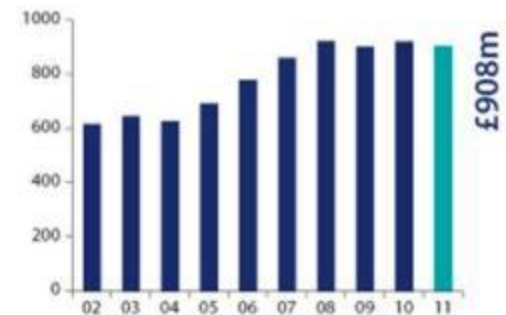
Research and development

We develop technologies and intellectual property that allow us to compete on a global basis in highly competitive markets.

- £908m invested in R&D in 2011
- £7.5bn invested in R&D over the past ten years
- 475 patent applications in 2011
- 28 University Technology Centres worldwide



Gross research and development expenditure (£m)



The Rolls-Royce Academic Network

- Rolls-Royce has established a strong network of successful academic collaborations
- Long term, strategic relationships
- Mutually beneficial, they take time to establish, but deliver significant and wide ranging benefits
 - Technology, Tools, Skills



http://www.rolls-royce.com/technology_innovation/index.jsp

Rolls-Royce University Technology Centres

Europe

19 University Technology Centres (UTCs) in the UK
1 UTC in Sweden
1 UTC in Norway
1 UTC in Italy
4 UTCs in Germany and strong links to DLR
Other links being developed

North America

1 UTC at Purdue in the USA

Partnerships with Virginia Tech and the University of Virginia, USA
Links to Georgia Tech, Illinois, MIT
Developing relationships in Canada

Asia

1 UTC at Pusan in Korea

Research centres in Singapore and Japan
Developing relationships in India and China

28 Rolls-Royce University Technology Centres worldwide

University Technology Centres



- Long-term strategic view
- 5 year rolling contracts
- Owned by an internal Rolls-Royce business unit
- Distinct technical discipline
e.g. noise, aerodynamics, combustion, performance
- Technology maturity monitored
- Technology transfer
- Funding support includes public sources

Partnerships that Work...

...over 700 people are working in the UTC network of world-class research teams...

- Multiplication of effort
- Recruitment pipeline for Rolls-Royce
- Secondment opportunities for Rolls-Royce employees
- Access to government funding
- Confidence to invest for the future
- UTC contribution to & benefit from IP
- Global network, wider collaboration
- Extensive research facilities/labs
- Effective allocation of risk

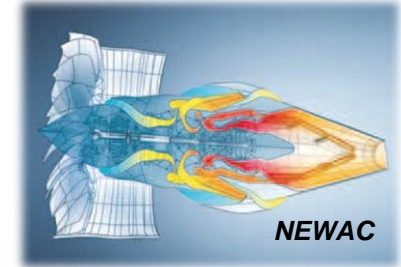
...over 400 doctorates are being supported by Rolls-Royce at any one time...



EPSRC

Engineering and Physical Sciences
Research Council

Technology Strategy Board
Driving Innovation



The expertise of seven University Technology Centres in the UK contributed to the development of the hollow titanium fan blade:

University of Birmingham:
titanium material

Cambridge University:
modelling of fan efficiency

Imperial College:
aero-mechanics

Nottingham University:
manufacturing technologies

Oxford University:
bird impact analysis

Southampton University:
flow effects on fan noise

Swansea University:
material mechanical behaviour

Advanced Manufacturing network – Bridging the Technology Readiness gap

The Model

- Strong Industry pull
- Industrial 'Sand Pit'
- Technology transfer culture
- Collaborative environment
- Research with scale and pace

The Value

- High calibre teams
- Industry scale equipment
- Full scale components
- Sharing of knowledge and resources
- Exemplary public / private partnership
- Delivers real benefits
- Co-location of engineers



A Global Network of Manufacturing Research Centres⁸



A Global Network of
Advanced Manufacturing
Research Centres



But it is a *Balance*

- You cannot easily “stop and start”
- It costs money, time and effort
- Publication & IP
- Avoid complacency

**Need to keep the overall picture of the relationship;
it is not just as a collection of projects**

Making collaboration effective

- Avoid the EFFICIENCY trap
- Define what makes it successful to you
- Keep it simple, but take more than one view
- Rolls-Royce focuses its measures around
 - Strategy
 - Leadership
 - Resources
 - Output



An International Perspective

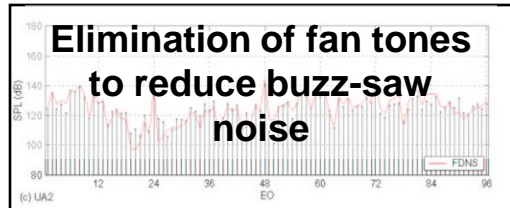
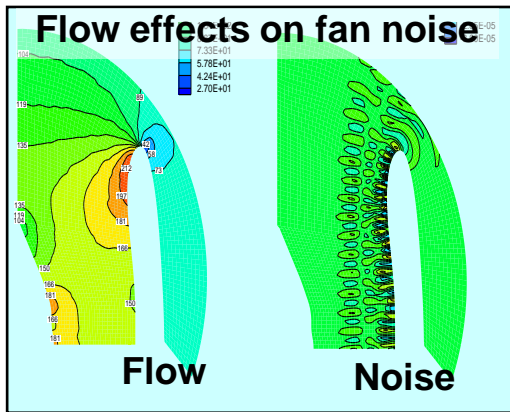
- UK
 - Excellent research & fundamental science
 - No national research centres.
- Germany
 - Excellent science, strong engineering skills,
 - National research centres (eg Fraunhofer, DLR).
- Asia
 - Generally still see PhD as training,
 - Very strong support for applied research
- US
 - Legislature influences IP ownership, but can be worked
 - Good economic development mechanisms

And yes, it works



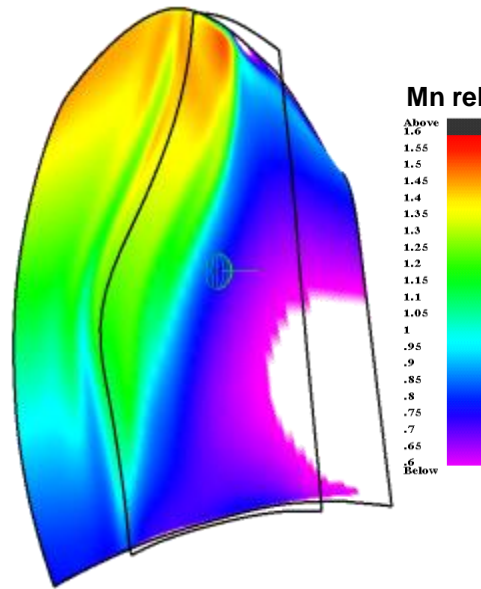
Significant technology delivery - single component example (Trent 900 swept wide-chord fan blade)

University of Southampton



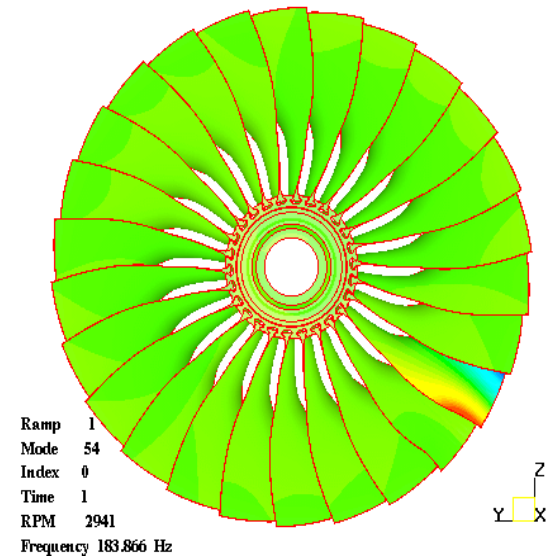
University of Cambridge

High efficiency swept fan



Imperial College London

'Aero-Mechanics of Bird Damaged Fan'



University of Birmingham

Titanium materials understanding

University of Nottingham

Manufacturing technology

University of Oxford

Understanding of bird-impact response





Rolls-Royce Group



Reliability, integrity, innovation