Industry-University Partnerships in Engineering Research and Development

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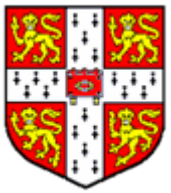

UNIVERSITY OF
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Industrial Collaboration is essential to Engineering Research

- Research is most exciting and challenging when it addresses issues of relevance to industry
- Such projects attract excellent students – it is thrilling for students to see their research results influencing products
- Important part of education of graduate students
  - understanding of where their work fits in
  - regular meetings/placements with industry
  - ability to communicate their research results to a wider audience
- Enhances job prospects of PhDs
- Influences funding, both direct from industry and through RCs and other government sources
- **In summary, it is what distinguishes 'Engineering' research from applied maths or physics**

Industrial Collaboration is essential to Engineering Research

- Mix of funding sources is required to balance mid- and long-term research
- Mix of industrial partners is best to maintain independence
- I am going to compare two very different industrial collaborations I am involved with and discuss the lessons learnt

University Gas Turbine Partnership (UGTP)

- One of Rolls-Royce's UTCs (University Technology Centres) which are widely seen to exemplars of good practice in industry/academia interactions
- The UGTP has a wide remit
- It involves 23 academic staff (PIs) in the Departments of Engineering, Chem Engineering and Applied Maths at Cambridge
- Typically

  70+ research projects
  ~ 25 PDRAs research associates
  50-60 research students
  12 support staff: technicians, computer officers, administrator

- Current projects of value £13.6M
- About £3.3M annual expenditure
- As well as research grants, RR funds

  2 professors, 4 X 0.5 lecturers and contributes to infrastructure costs through a 5-year rolling Agreement

University Gas Turbine Partnership (UGTP)

- Builds on a 25+ year collaboration
- Both University and Industry have a serious commitment to success of the collaboration
- Sustained commitment enables the University to build a world-class capability
  - **attractive for recruitment**
  - **justifies building of substantial experimental facilities, investment in instrumentation etc**
- Funding of key people (PIs) enables us to expand the research undertaken
- Can obtain gearing on RR funding, through EPSRC, DTI, EU etc
- Can provide specialised knowledge and training
- Source of interesting research topics/projects
- Funding is flexible and decisions can be made quickly
- Special IPR/funding arrangements

University Gas Turbine Partnership (UGTP)

Interactions between Rolls-Royce and the UGTP

- **Strong**
- **Sustained**
- **Many faceted**
- **Involve transfers of people, ideas, knowledge, funds**
- **Both parties put effort into making them effective**
- **Increasingly, projects involve other UTCs and RR suppliers**

Silent Aircraft Initiative (SAI)

- A collaborative, multi-disciplinary project between MIT, Cambridge University, and a diverse Community of Partners
- Three-year project funded
  - £2.4M by CMI (Cambridge-MIT-Institute)
  - with similar level of in-kind support from partners
- CMI's aim is
  - to fund bold experiments designed to understand and improve knowledge exchange
  - to set those experiments in the context of research programmes aimed at creating important new ideas, developed with a consideration for use
- SAI is one such research programme and is centered around a Knowledge Integration Community (KIC) addressing a 'grand' challenge
- Challenge: to design a mid-size passenger aircraft, with low fuel burn, whose noise would be inaudible outside a typical airport

The Knowledge Integration Community (KIC)

is a community of over 30 aerospace partners, industry, airline and airport operators, policy makers and academics

Partnership is inclusive, actively encouraging a wide range of partners with wide range of views

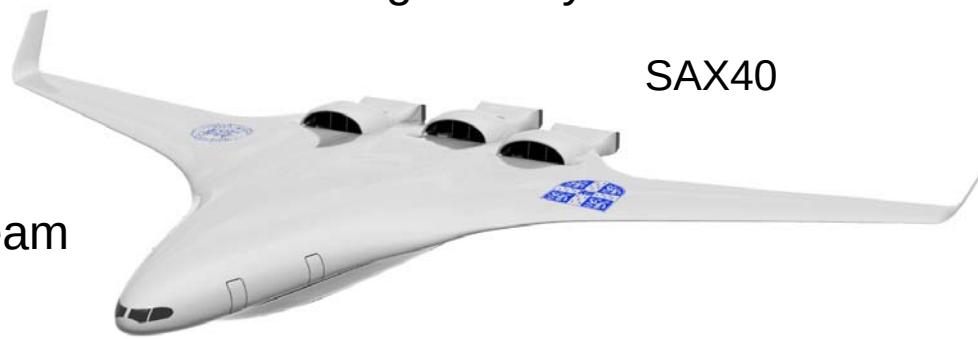
There has been continuous involvement of the KIC from first day of project at strategic and working levels helping to:

- prioritise research items and focus on key issues
- make decisions as a multi-disciplinary team
- provide continuous support with knowledge, review and feedback

Some of the members of the Knowledge Integration Community

Knowledge Exchange

- Examples of some of the interactions
  - University researchers using industry design codes
  - Industry participation at both a strategic and a working level
    - frequent interaction
    - two-way flow of information
  - Industry and government laboratory reviewing and providing feedback on the emerging design and supporting technologies
    - Boeing, Rolls-Royce, ITP, NASA
    - tangible SAI action in response to industry comments
- Boeing undertook full 3D viscous calculations of SAX geometry
- NASA undertook wind-tunnel tests
- RR trainees working with the SAI team
- Collaborative development and implementation of enhanced CDAs



SAX40

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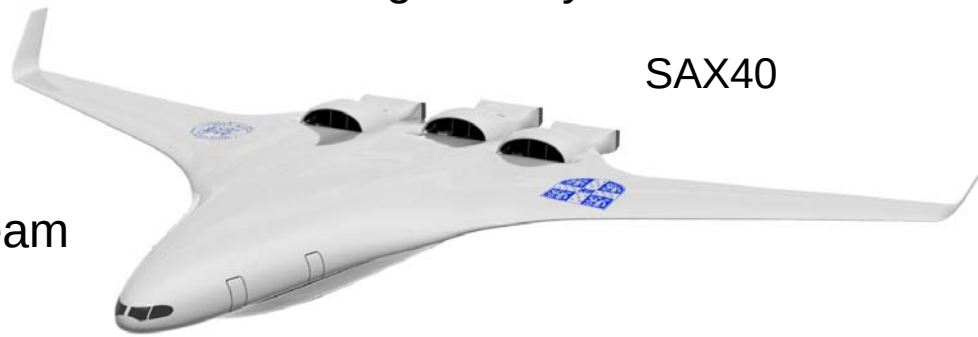


SAX40

- Collaborative development and implementation of enhanced CDAs

Development of Enhanced CDAs

- Continuous Descent Approaches

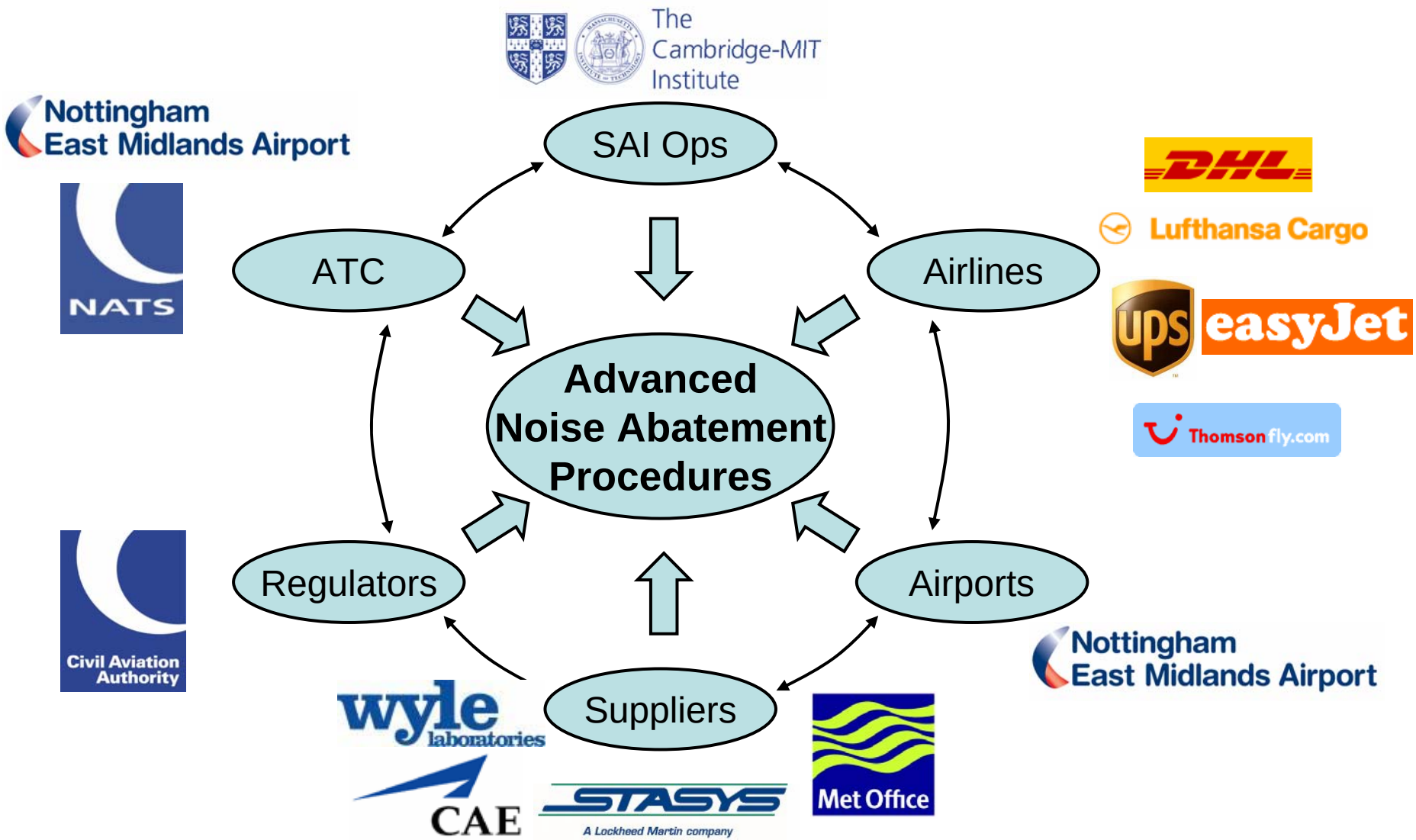
  a way of operating existing aircraft more quietly and with reduced fuel burn by removing level flight segments from approach trajectory and enabling the engines to remain at flight idle throughout approach

- As part of the SAI, enhanced CDAs were developed for Nottingham East Midlands Airport (NEMA) and are currently undergoing flight trials

- This was only made possible through a wide collaboration of the KIC with the Univeristy partners being the catalyst

Ops team in airline simulator

Strong Collaboration is Critical



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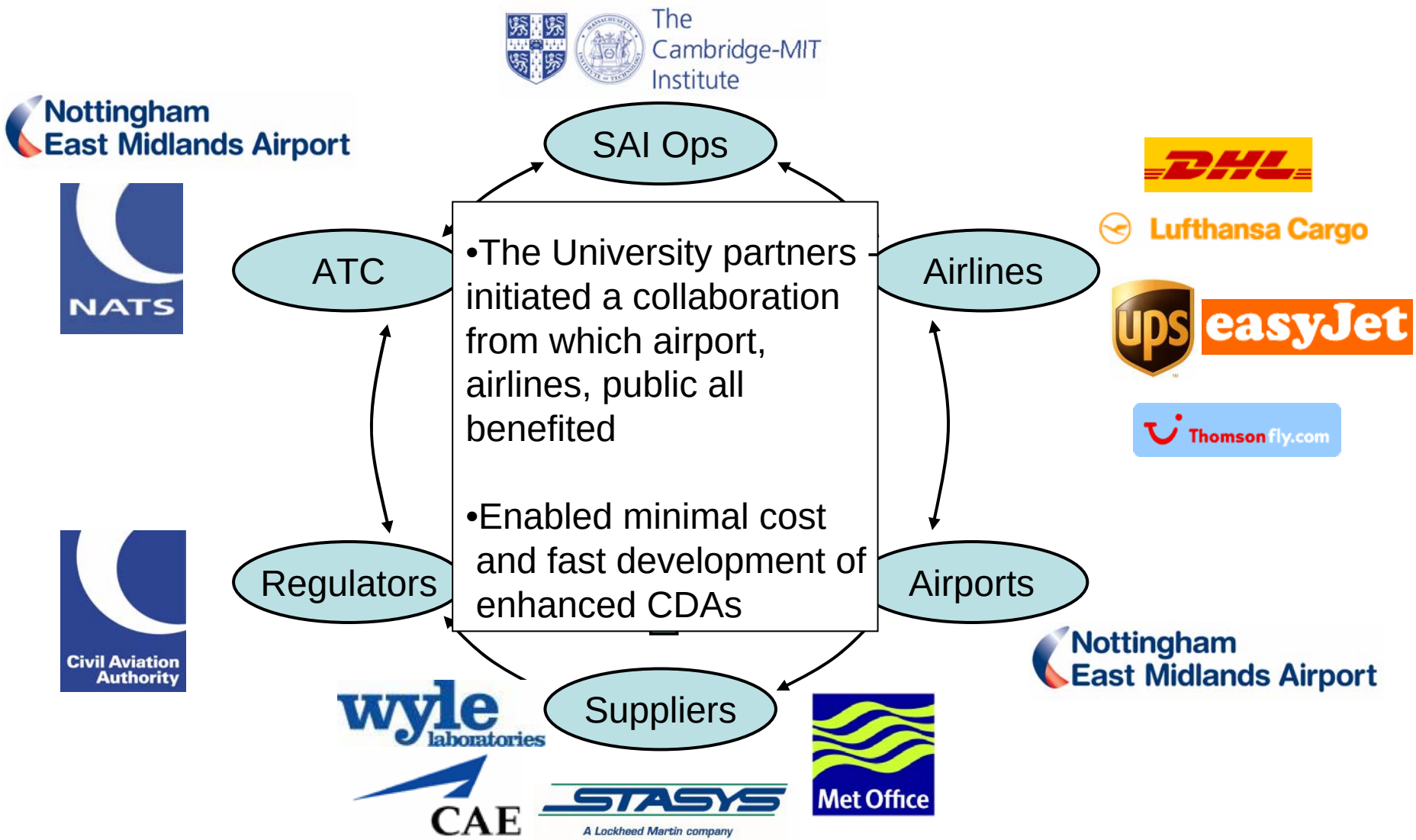

Link to Education and Outreach

- Master's students 1 (CU) 11 (MIT)
- PhDs 9 (CU) 2 (MIT) 2 (Cranfield)
- 17 MEng Final Year Project students
- 5 UROPS (Undergrad Researchers)
- New CU undergraduate course involving many Silent Aircraft team members
- New MIT aeroacoustics graduate course
- Outreach to school children via
  - Brunel Lecture, Farnborough Air Show Youth Day,
  - Science Week talk, Royal Society Summer Exhibition 2007
  - School design projects on undercarriage noise mitigation tested in Markham tunnel
  - Press coverage
- **Bottom line**: Trained people with the appropriate skills for effective integration of complex systems (e. g., an aircraft)

Threats – Lack of UK/National Labs

- In my area, the step between University research and application requires large-scale and expensive demonstration
- Typically, this would be done in National Laboratories
- These have largely been closed down or put on a commercial basis in the UK (eg Royal Aircraft Establishment; Pyestock) but remain a key part of Government strategy elsewhere (DLR, NASA etc)
- So, increasingly industry relies on test and development facilities overseas, which leads spins down into research and education with nearby Universities
- In UK, DTI and Industry has just invested in a demonstrator project – EFE - which will hopefully provide a UK-based route for technology demonstration

Threats – Uncompetitive costing, post fEC

	UK Pre fEC at 46% oh	UK cost at 100% fEC	Singapore	Germany
PhD	£30k	£30k	£15k	£30k
RA	£75k	£85k*	£35k	£50k

- FeC is a negotiated rate between RCs and Universities
- Also seen by Universities as the 'cost' of research and charges to be passed onto Industry
- UK 100% fEC RA level higher than full employment cost of a highly trained engineer in industry
- Singapore and German costs are typical levels quoted to industry for 100% funding of research ie gross costs

* UK 100% fEC RA figures often quoted at £100-125k, £85k may be an underestimate

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- Singapore and German costs are made possible by …
  - Strong additional government funding for world-class facilities and infrastructure
  - Recognition of the broader economic and long-term development benefits of sustaining strong linkages between Universities, Research Institutes and Industry
  - Favourable underpinning cost base
- **UK Universities have to operate and be competitive internationally**

Threats – IPR negotiations

- Universities have realised the value of their IPR
- This has led to Universities employing a large number of people associated with contract negotiation
- Can cause delayed starting times and sour academia/industry relations

Conclusions

- Industry-University collaborations are mutually beneficial
- There is not a single model for engagement but rather different models are appropriate under different circumstances
- The value of the collaborations cannot be priced in pure economic terms
- In particular, fEC is a crude costing model and if applied unthinkingly to industry contracts puts UK Universities at a disadvantage relative to the rest of the world