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Examples of More Electric Aircraft Research in the Aerospace Research Centre

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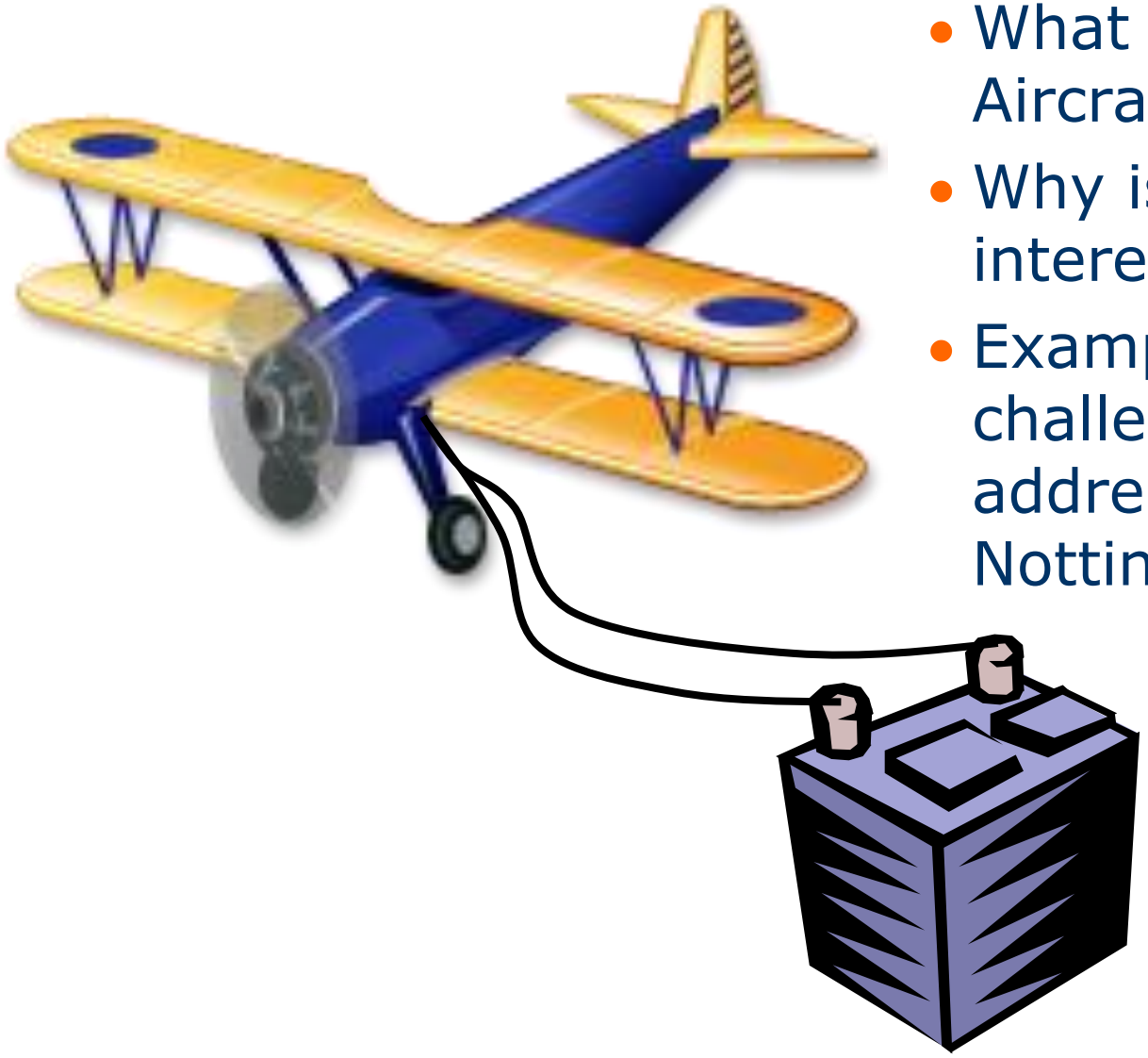
Introduction



- What is a More Electric Aircraft (MEA)?
- Why is there so much interest in MEA?
- Examples of the challenges we are addressing at Nottingham?

Power Networks – "Conventional" Aircraft

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Jet Fuel

Figures for A330/B777 size

Propulsion Thrust (≈ 40MW)

Gearbox driven generators

Electrical 200kW

High pressure air "bleed" from engine

Pneumatic 1.2MW

Gearbox driven hydraulic pump

Hydraulic 240kW

Fuel pumps and oil pumps on engine

Mechanical 100kW

Total "non-thrust" power ≈ 1.7MW

Equivalent to 5 Nottingham trams!

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"More Electric Aircraft" Concept

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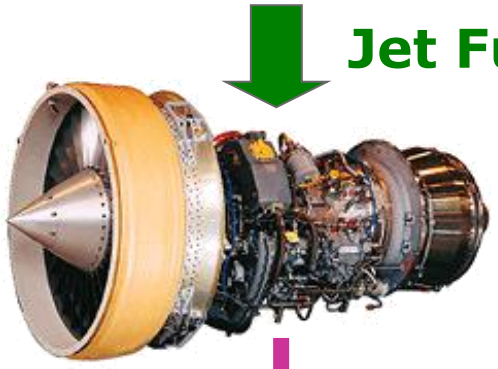
Rationalisation of power networks

Remove Pneumatic, Hydraulic and Mechanical networks

"Bleedless" engine



Electrical system power ≈ 1MW (3 trams!)

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"More Electric Aircraft" Some Motivations

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- Removal of hydraulic system
  - Potentially reduced system weight
  - Ease maintenance
- "Bleedless" engine
  - Improved efficiency
- Desirable characteristics of electrical systems
  - Controllability (turn-on-and-offable)
    - » power on demand
  - Re-configurability
    - » maintain functionality during faults
  - Advanced diagnostics and prognostics
    - » more intelligent maintenance
    - » increased aircraft availability
- **OVERALL**
  - **Reduced operating costs**
  - **Reduced fuel burn**
  - **Reduced environmental impact**

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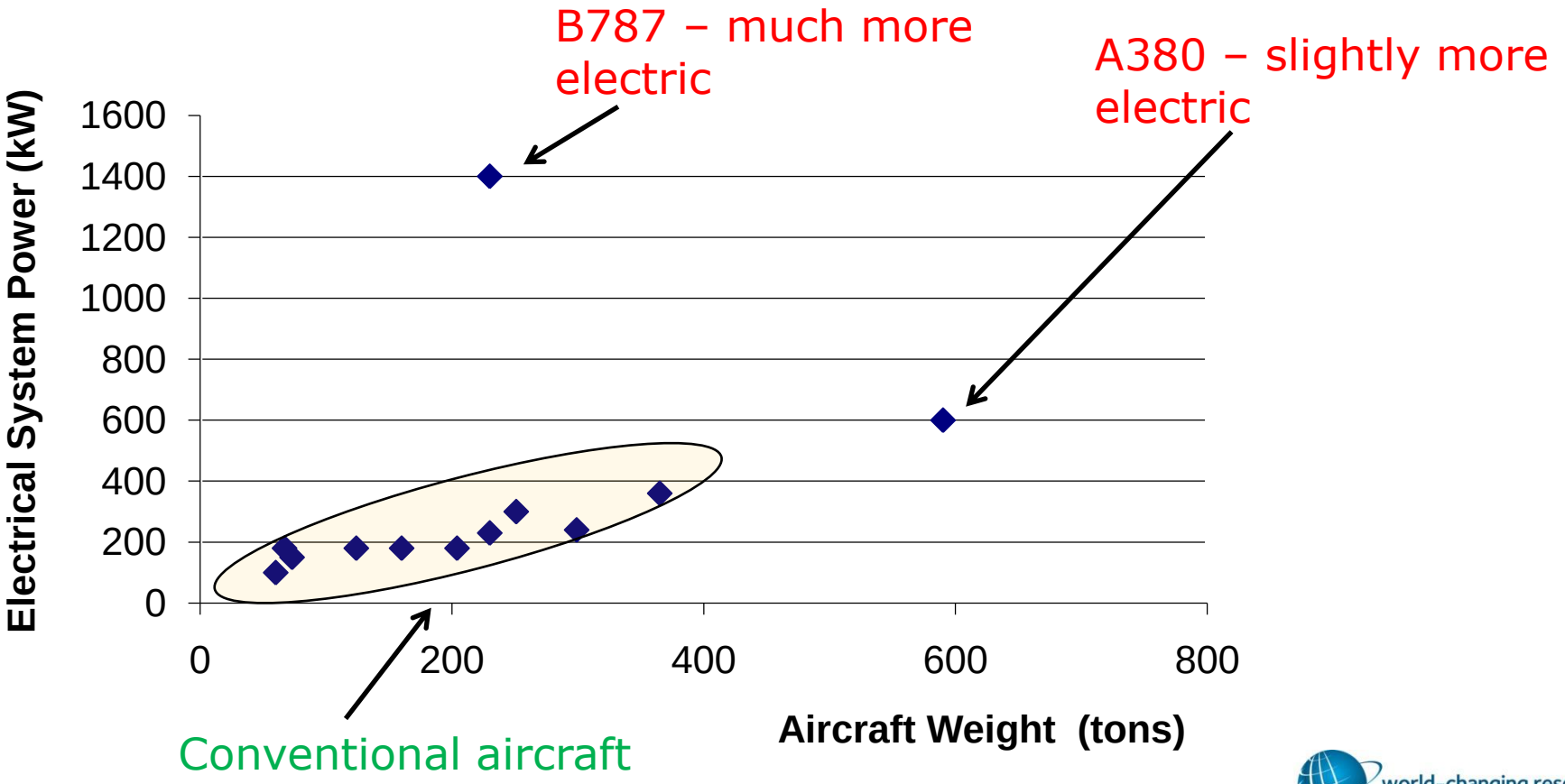
Some Challenges and Research

- Huge increase in the rating of the electrical power system
  - Up to 10 times more electrical power with MEA



Some Challenges and Research

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National electricity system

Lots of relatively small loads

Huge network

- "Easy" to control
- Individual loads have little influence on the system (usually – unless many act at the same time!)

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Some Challenges and Research

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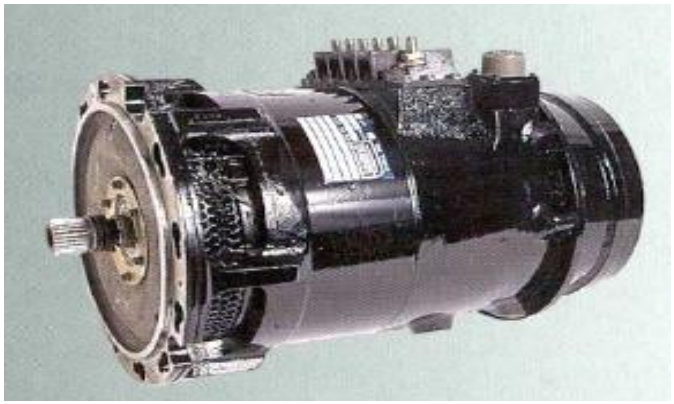
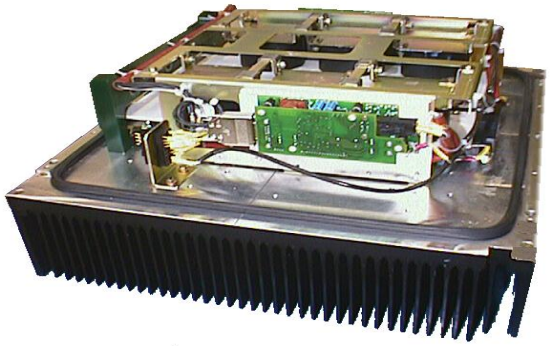
More Electric Aircraft Electrical System



≈ 220kW

Relatively small generators



Some important single large loads
eg Environmental control (>100kW)
Wing anti-ice (>100kW)

- Single loads can have significant influence on the generator (and the engine driving it)
- Some research topics for Nottingham
  - How to configure network?
  - How to model network?
  - How to ensure stable operation?
  - How to deal with faults?

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Some Challenges and Research

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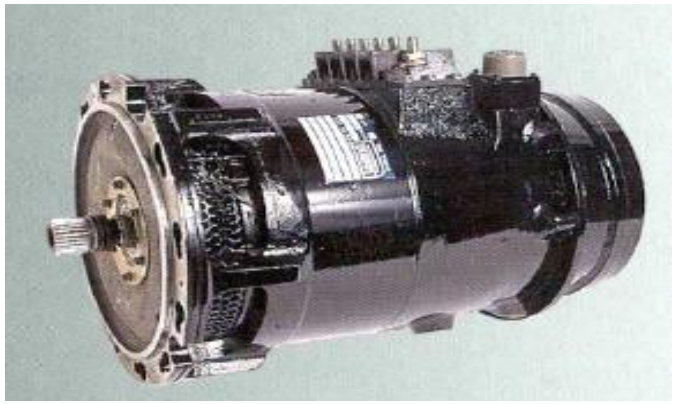
Generator characteristics do not match load requirements



Generator output

Frequency "wild" AC

(frequency varies with engine speed)

Constant voltage

Typical load requires

Controlled frequency AC

Controlled voltage

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Some Challenges and Research

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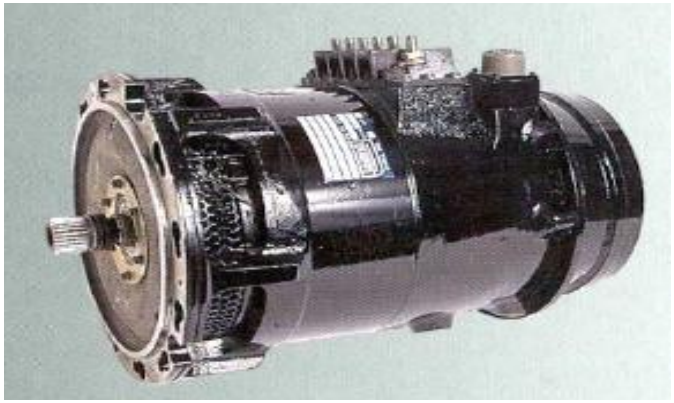
"Power converters" needed between generators and loads



Generator

Power Converter

Load

Matches load and generator and allows load to be controlled

Uses a technology called

"Power Electronics"

Nottingham is good at this!

– amongst the World leaders

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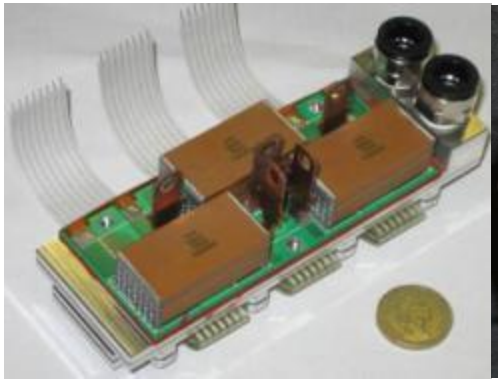
Some Challenges and Research

- Power Electronics has been the KEY enabling technology for MEA
  - Advances in power electronics have made it possible to power and control loads electrically that were impossible before
- BUT – the technology is still not good enough to capitalise fully on the potential benefits of MEA
- MEA advantages are marginal with current technology
- Advances in Power Conversion technology are essential to achieve the MEA goals and potential




Some Challenges and Research

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- Surprisingly – we have not yet developed the perfect power conversion system!
  - 100% efficient (no power loss – no waste heat)
  - Zero weight and volume
  - Infinite reliability (many loads are flight critical)
  - Zero cost
- But we are working on it!
- Multi-disciplinary Team includes
  - Electrical Engineers
  - Mechanical Engineers
  - Thermal Engineers
  - Semiconductor Physicists
  - Materials Scientists
  - Metallurgists
  - Mathematicians

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Summary

- More Electric Aircraft concept offers huge potential for future air transport
- Nottingham has one of the foremost research groups in the World in Aerospace Electrical Systems (≈ £10M funding)
- Research spans:
  - Basic technology research (e.g. physics of failure)
  - Applied research (e.g. advanced technology demonstrators)
- Expertise spans:
  - Device and component technology → Complete systems
  - Analysis → modelling → **practical validation**
- We are closely engaged with the key industrials in the European supply chain and with International airframers (Boeing, Airbus, Eurocopter for example)


Thank you