



Examples of More Electric Aircraft Research in the Aerospace Research Centre

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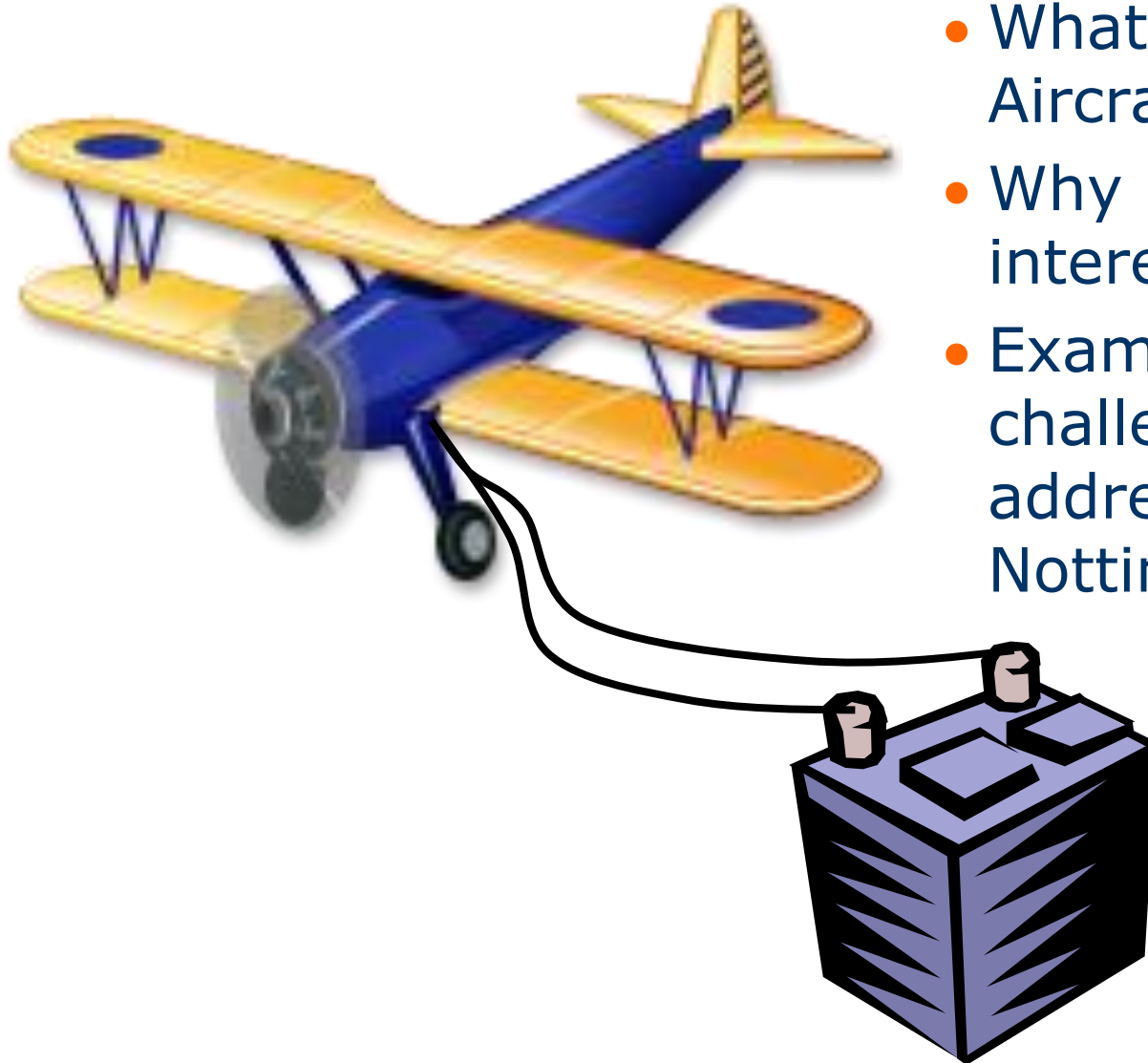
Electrical Systems and Optics Research Division

Introduction



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- 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
($\approx 40\text{MW}$)**

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 $\approx 1.7\text{MW}$

Equivalent to 5 Nottingham trams!

"More Electric Aircraft" Concept



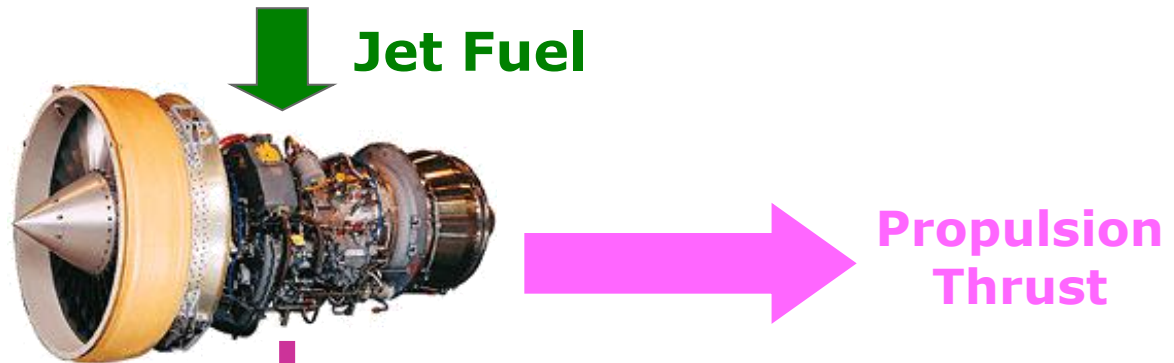
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Rationalisation of
power networks

Remove Pneumatic,
Hydraulic and
Mechanical networks

"Bleedless" engine



**Engine
driven
generators**

**Expanded electrical
network**

**Existing
electrical
loads**

ELECTRICAL
Cabin pressurisation
Air conditioning
Icing protection

ELECTRICAL
Surface actuation
Landing gear
Braking + Doors

ELECTRICAL
Fuel pumping
Engine Ancillaries

New electrical loads

Electrical system power \approx 1MW (3 trams!)

"More Electric Aircraft" Some Motivations



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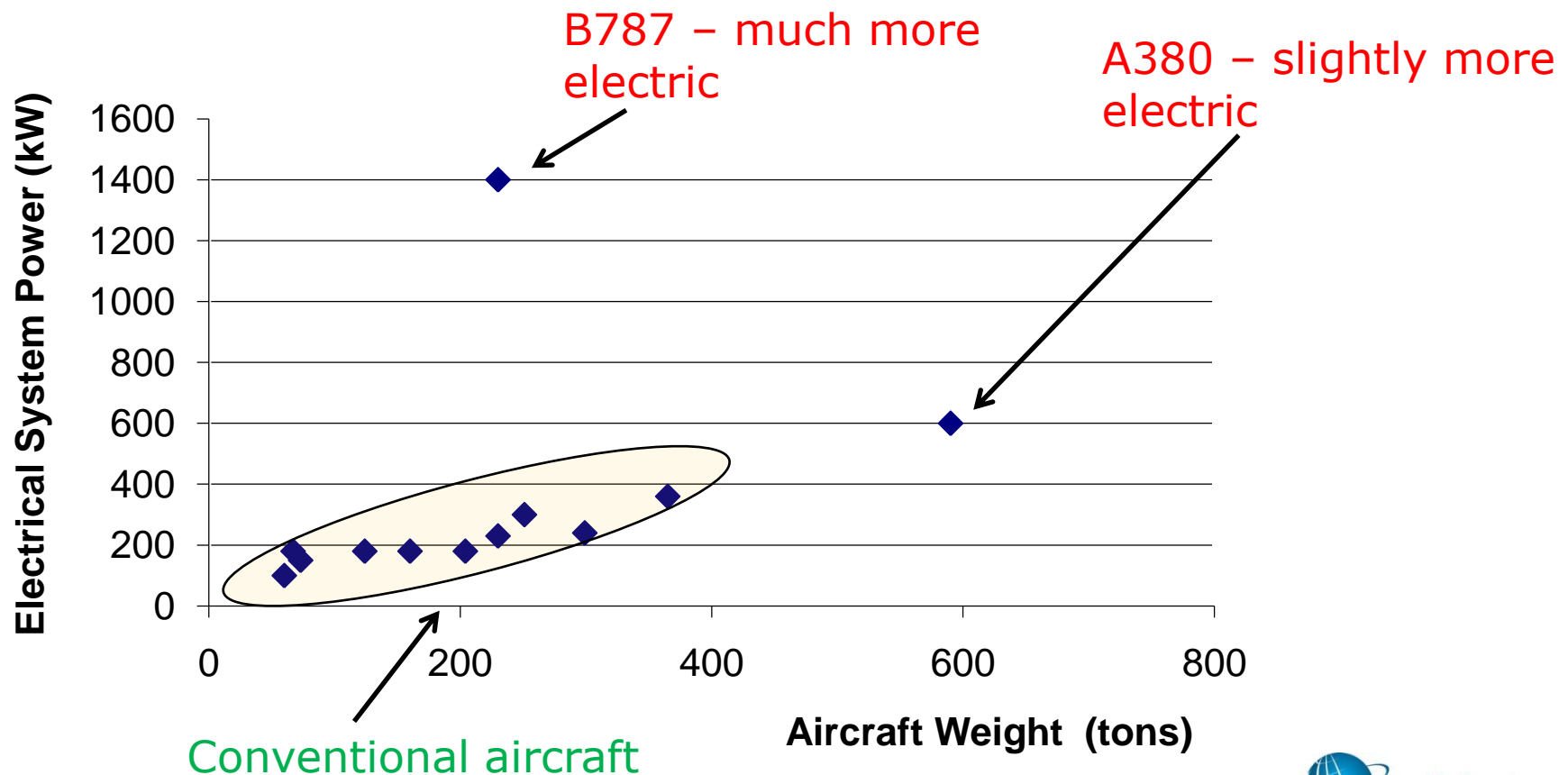
- Removal of hydraulic system
 - Potentially reduced system weight
 - Ease maintenance
- "Bleedless" engine
 - Improved efficiency
- Desirable characteristics of electrical systems
 - Controllability (turn-on-and-offable)
 - » power on demand
 - Re-configurability
 - » maintain functionality during faults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



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!)

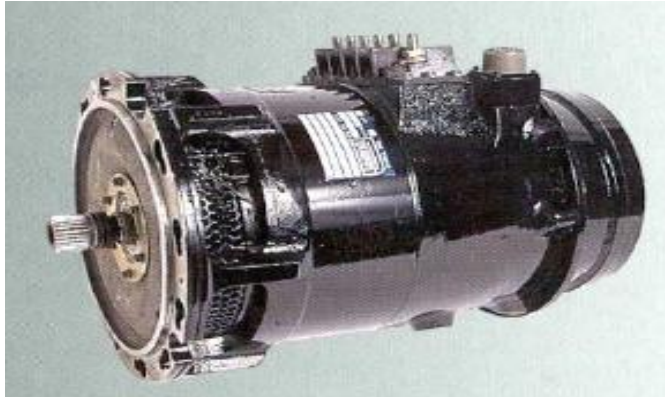
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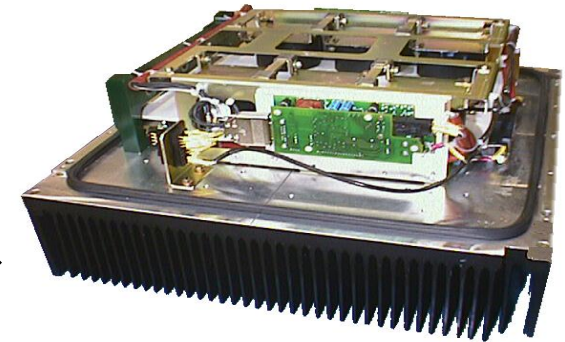
More Electric Aircraft Electrical System



≈ 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?

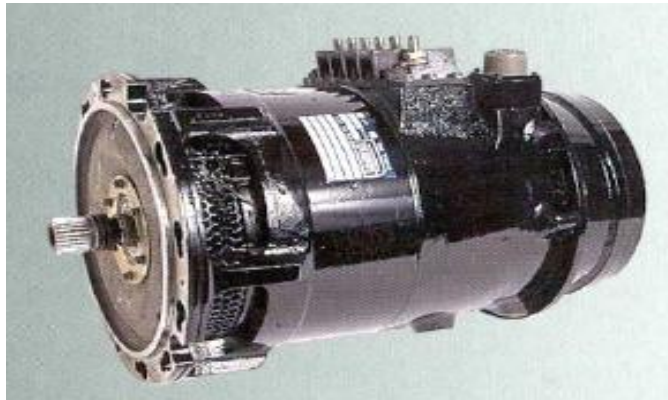
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Generator characteristics do not match load requirements



Generator output

Frequency "wild" AC
(frequency varies with engine speed)
Constant voltage

Typical load requires

Controlled frequency AC
Controlled voltage

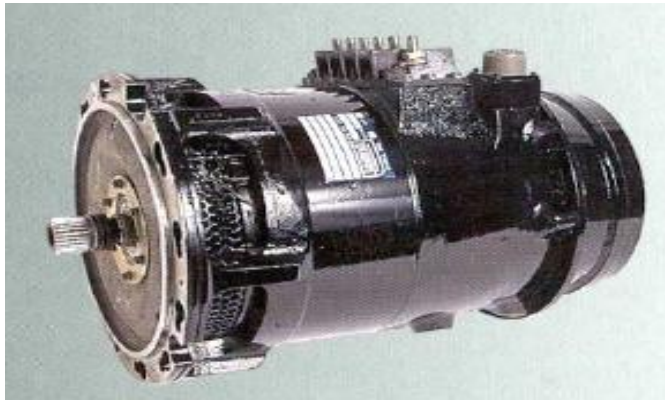
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“Power converters” needed between generators and loads



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



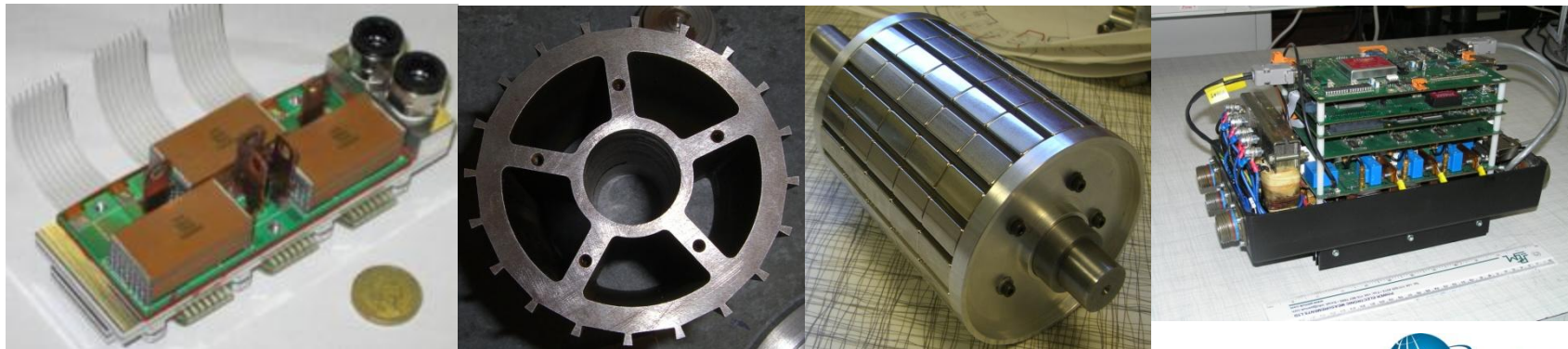
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- Power Electronics has been the KEY enabling technology for MEA
 - Advances in power electronics have made it possible to power and control loads electrically that were impossible before
- BUT – the technology is still not good enough to capitalise 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



Summary



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- 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 (\approx £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 \rightarrow Complete systems
 - Analysis \rightarrow modelling \rightarrow **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