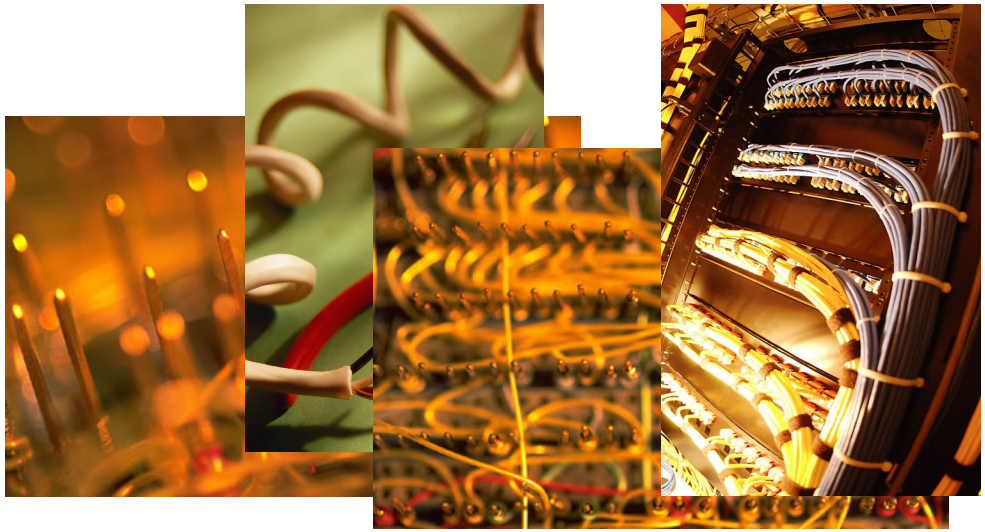
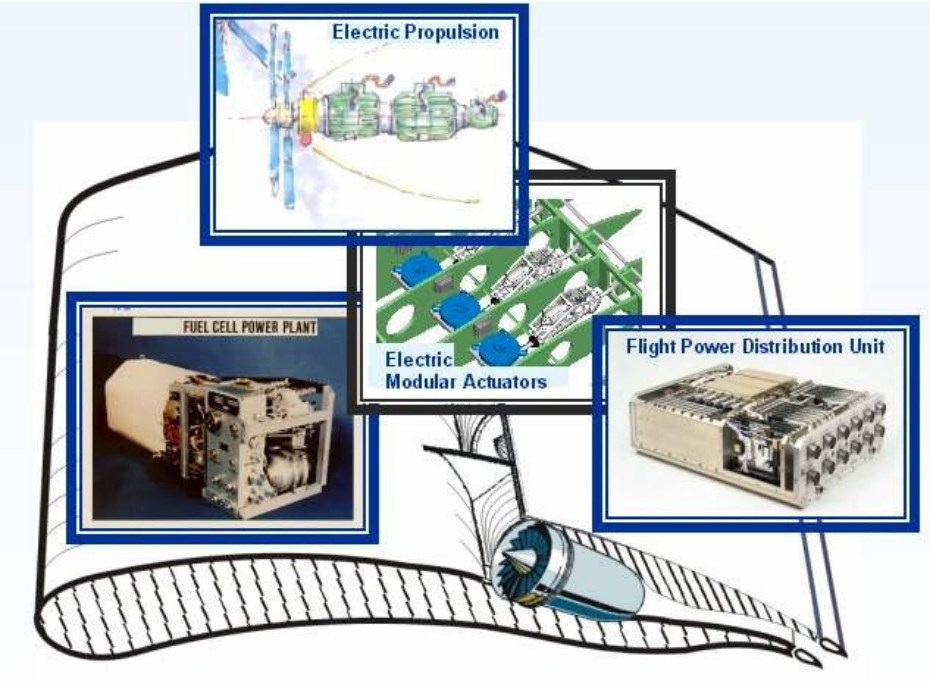
ELECTRICAL SYSTEMS

AIAA TEAM 1



Electrical Systems in Aircraft

- Avionics
- Hydraulics
- Environmental-control
- Lighting
- Subsystems



Electrical System Composition

- Batteries
- Alternators/Generators
- Transformer-rectifiers
- APU (Auxiliary Power Unit)
- Electrical Controls
- Circuit Breakers
- Wires
- Ram Air Turbines

GENERATORS

- Usually produces AC current
- 115/220 V
- Most aircraft have two generators
- Generally a 3 phase, 400 HZ generator
- Large aircraft may have back-up generators

TRANSFORMER-RECTIFIERS

- Used to convert to DC current
- Typically 28V

BATTERIES

- Power APUs
- Emergency locator transmitters
- Starting general aviation aircraft

APU

- The APU is used to start the engine and provide ground power
- Can provide in-flight emergency power
- Can be continuously operated if needed
- Most common is the jet-fuel APU
  - Small jet engine
  - Requires inlet and exhaust, both facing up to minimize noise
  - Inlet must be in high pressure, exhaust in low pressure area
  - Must be fire-walled
  - High maintenance, so easy access is essential
- Must be considered early in design because of these reasons
- Usually located near tail for transports and fuselage for fighters

RAM-AIR TURBINES

- Used in some cases to generate power
- Windmill is inserted in slipstream
- Can be used in emergencies

AVIONICS

- Powered by generators and transformer-rectifiers
- Include radios, instruments, navigational aids, flight control computers, radar, infrared, anti-icing, detectors, sensors, and other mission-specific equipment
- Integral part of design in terms of placing, weight, and costs

CATEGORIES OF AVIONICS

- Communication and Navigation
- Mission Equipment
- Vehicle Management

COMMUNICATION AND NAVIGATION

- Radios
- Weather
- Autopilot
- Radar, air-to-air and air-to-ground
- Infrared seekers and sensors
- Aircraft identification, friend and enemy
- GPS

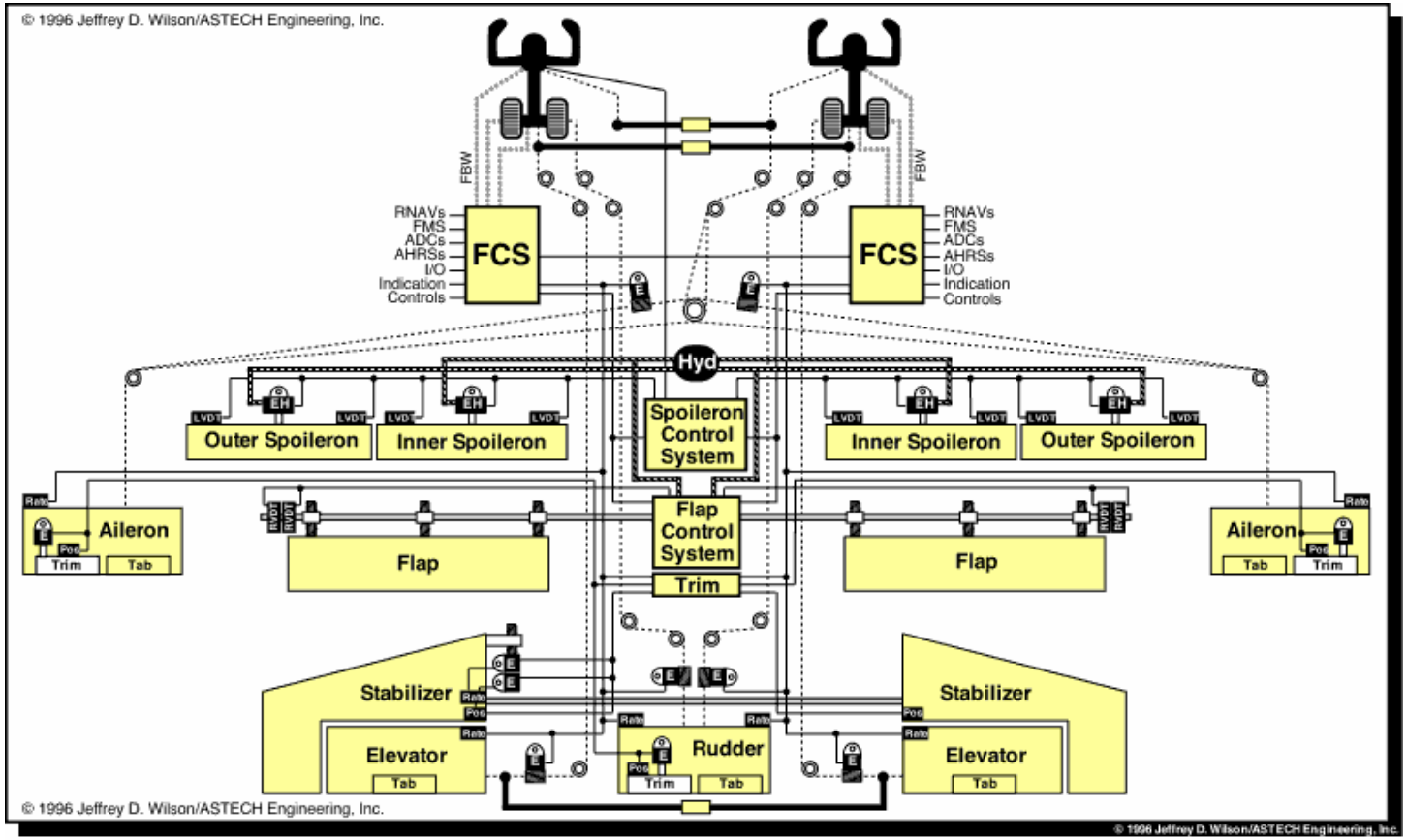
MISSION EQUIPMENT

- Gun/Missile aiming and control
- Electronic Stealth

VEHICLE MANAGEMENT

- Necessary for flight
- Fly-by-wire systems and flight control systems
  - Unstable aircraft stabilized by computers and actuators
  - Pilots give “suggestions” and computer allows them
- Fly-by-optics
  - Faster data transmission
  - Immunity from electromagnetic interference
- Systems to dampen flutter, suppress oscillations, re-distribute lift over the wing

VEHICLE MANAGEMENT con't.

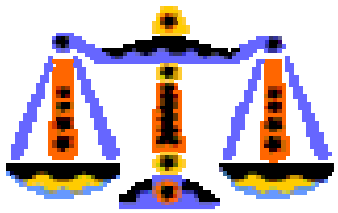


DETERMINING SIZE AND WEIGHT

- General aviation
  - FAA regulates what radios, navigational aids, and equipment that can be used for certain operations
  - Becomes a matter of picking from a catalog
- Industry/commercial aircraft
  - In-house expert can size avionics and electronics
  - This expert communicates with manufacturers
- Military
  - Usually state of the art systems, so little may be known
  - Drawings might not even exist
  - Estimates are required and usually made by in-house expert

A NOTE ON AVIONICS WEIGHT

- Devices are smaller, but quality and quantity are greater.
- Previous weight estimates are often used in design so when new advances are made, there is usually extra space/weight.
- This extra space/weight has been used for more advanced features and not just eliminated



NEW DEVELOPMENTS

- Electrical actuators
  - Replace hydraulics
  - Similar to RC models
  - Small electric motors drive control surfaces
  - Comparable in weight to hydraulics but faster and more reliable
- Electric brakes
  - Replace hydraulics
  - Like disc brakes on cars
  - Run by electric motor
  - Faster response
  - Can be used to prevent skids more reliably
  - Comparable in weight to hydraulics

NEW DEVELOPMENTS con't.

- Miniaturization of electronics
  - Smaller - More volume for payload
  - Lighter - More weight for payload
  - Allows for components to be embedded in aircraft skin
  - Allows for smaller aircraft ➔ UAVS
- Advances in computers
  - Advanced auto-pilots and flight controls
  - Can fly more unstable aircraft
  - Pilot may not be necessary
  - Bugs in computer code may lead to problems
- LEDs
  - Light emitting diodes
  - Brighter, easier to read, longer lasting displays and lights

NEW ADVANCES AT WORK

- Example: Honeywell “More Electric Architecture”, MEA
  - Basically a combination of the ideas above
  - Elimination of pneumatics and hydraulics
  - Lighter
  - Easier to maintain

ELECTRICAL DESIGN

- Size
- Weight
- Where will it go?
- Wiring – long wires will lead to signal loss and more weight
- Environmental effects – lighting and electromagnetic effects

AIAA Tactical STOL Transport

- Will require most of what was presented
  - APU
  - Batteries
  - Generators
  - Transformer-rectifiers
  - Avionics

Forestry UAV

- Require advanced electronics and avionics
- Could use electrical motors for propulsion
- Require batteries or some way to generate power in flight

Human Powered Aircraft

- None for final design
- For model:
  - Electric motor
  - Servos

Next 10 years…

- Fuel cells
  - Cleaner, quieter, more efficient
  - Won't replace engines anytime soon, but have applications in APU
- Electric propulsion
- Eventually…all electric aircraft?

QUESTIONS??

AIAA TEAM 1 MEMBERS

- Robert Adams
- Ryan Arnaudin
- LaMar Berry
- Shelley Biagi
- William Black
- Angela Brooks
- Stephen Bruso
- Nick Carlson