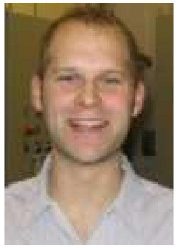
Introduction to AVDASI

Introduction

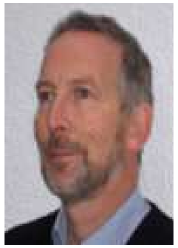


Dr. Steve Burrow, Unit director.

Teaching; Aircraft systems

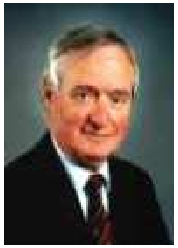
Prof. Fabrizio Scarpa.

Teaching; Fixed wing aircraft design; flight control



Mr. Pete Bunnis.

Teaching; Rotary wing aircraft; Gliders



Mr. Sandy Mitchell.

Teaching; Propulsion; Design history

What is AVDASI 1?

- AVDASI 1 introduces the design of, and components that make up, modern aerospace vehicles.

- It is ‘top down’ – we will start with aircraft and describe design and systems

- Knowledge based – we aim to broaden your knowledge of aircraft.

Air Transport Association (ATA) Chapters

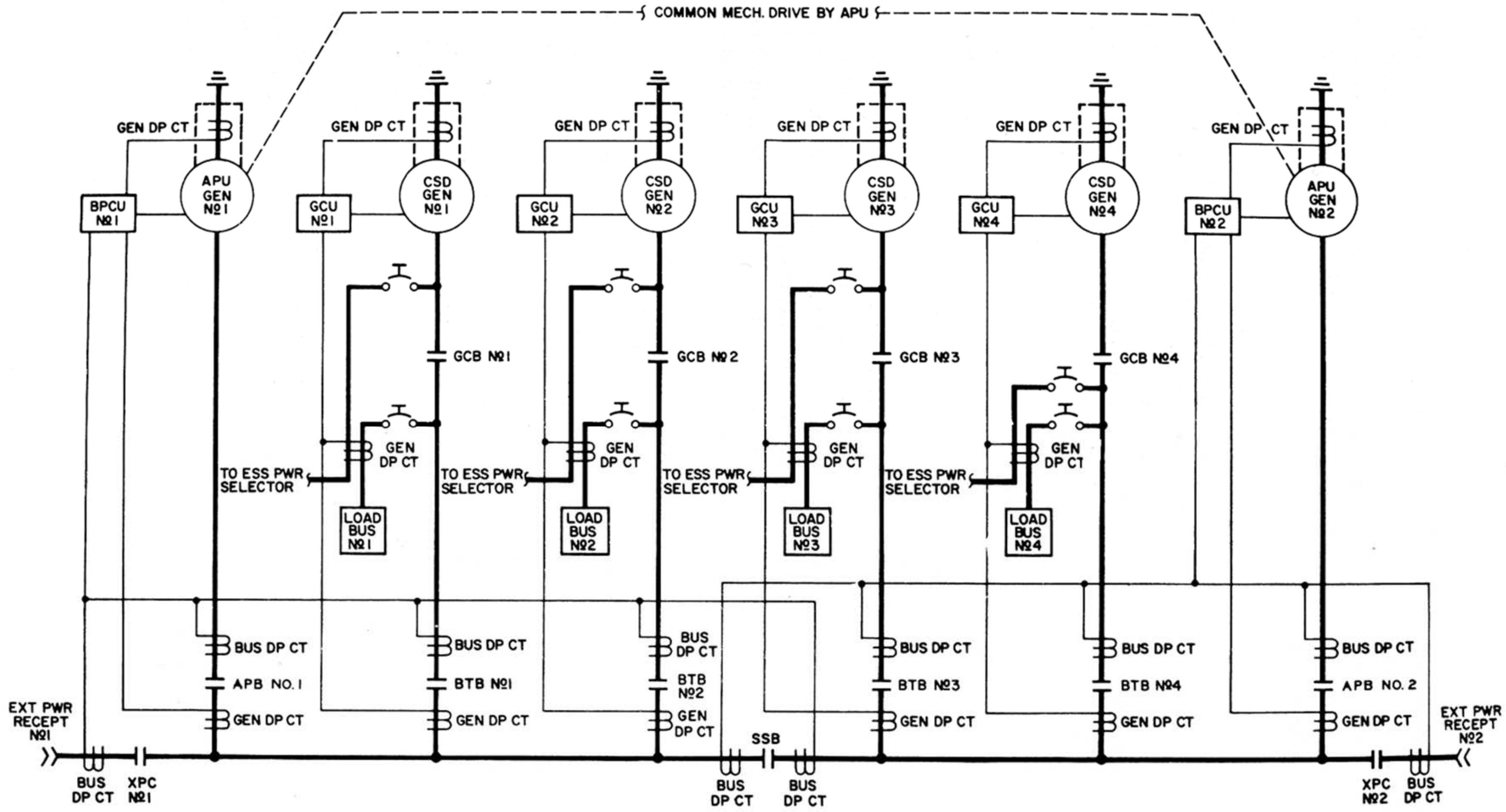
- Aircraft System
  - Aircraft
    - *9.1 Environmental Segment*
      - 21: Air Conditioning
      - 21: Cabin Pressure
      - 30: Ice & Rain Protection
      - 35: Oxygen
      - 36: Pneumatic
    - *9.2 Avionics Segment*
      - 22: Auto-flight
      - 23: Coms
      - 31: Recording & Indicating
      - 34: Navigation
    - *9.3 Electrical Segment*
      - 24: Electrical Power
      - 33-30,-40-50 Lighting
    - *9.4 Interiors Segment*
      - 25-10: Crew Accomod'n
      - 25-20: Pass'gr Accomod'n
      - 25-30: Water, Waste, Lavs & Galleys
      - 25-60: Emergency Provisions
      - 33-10: Signs & Lights
    - *9.5 Mechanical Segment*
      - 27: Flight Controls
      - 29: Hydraulic Power
      - 32: Landing Gear
    - *9.6 Propulsion Segment*
      - 28: Fuel
      - 54: Pylon
      - 71: Power Plant
      - 76: Power Control
    - *9.7 Auxiliary Segment*
      - 21: Air Conditioning
    - *9.8 Airframe Segment*
      - 53: Fuselage
      - 55: Empenage
      - 57: Wing
  - Training
  - Support
  - Facilities
  - Personnel

From the outside: Design Morphology

Under the skin: Components and Systems

Components and Systems

Electrical power



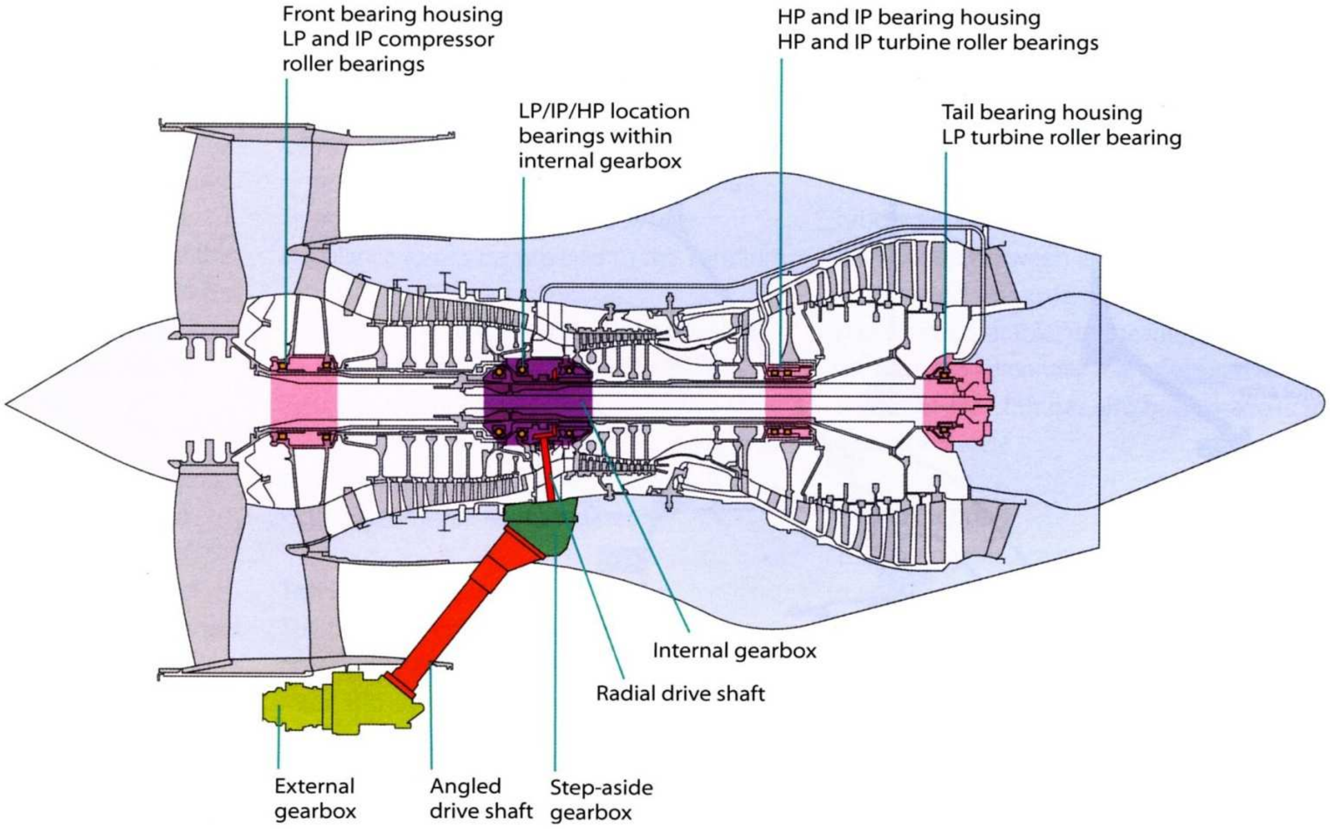
AC SYSTEM SINGLE-LINE DIAGRAM

University of BRISTOL

DEPARTMENT OF aerospace engineering

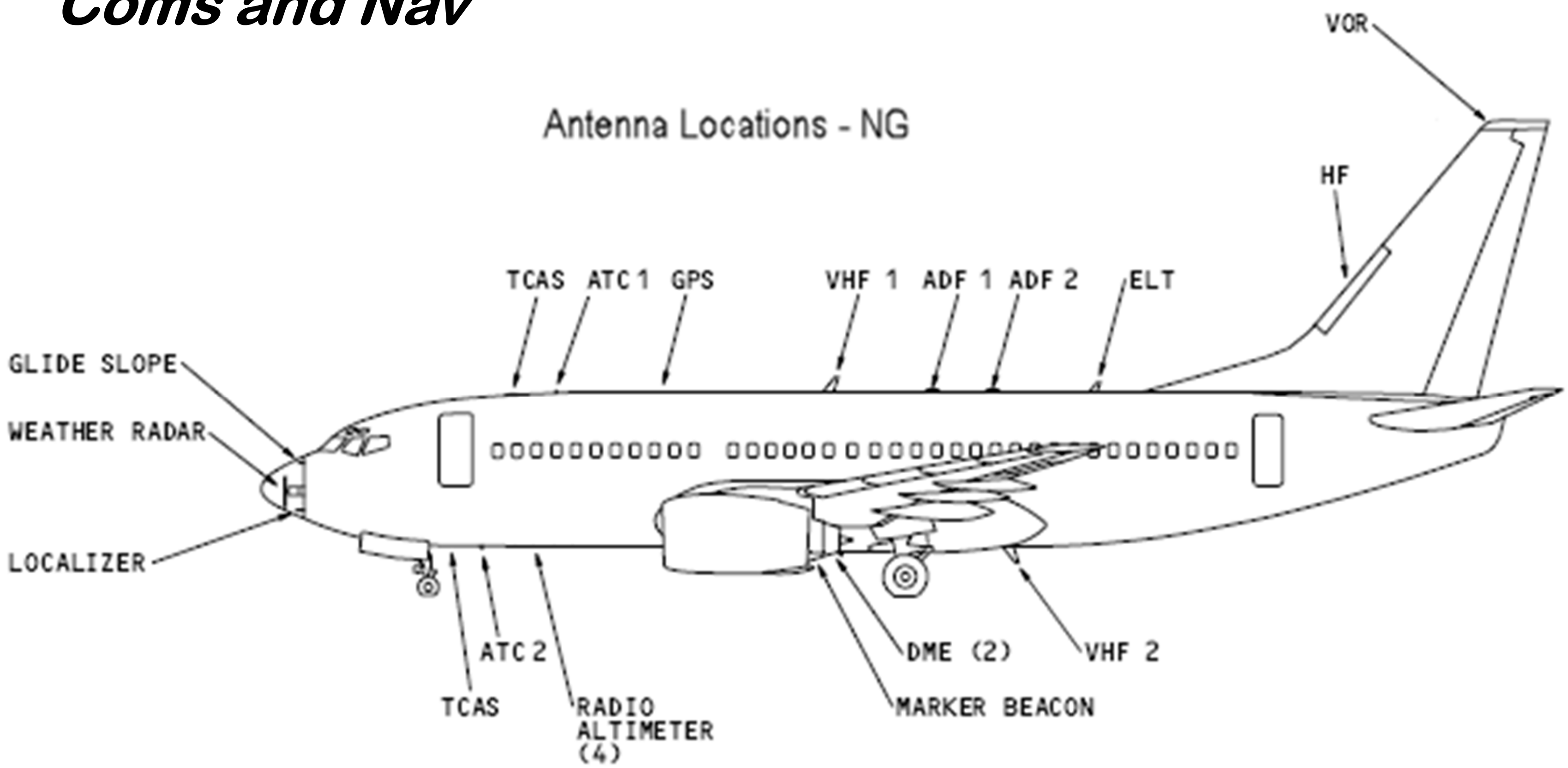
Components and Systems

Engines



Components and Systems

Coms and Nav



Lecture series content (by topic)

Date	Time/Location	Title	Lecturer
30-Sep	10-11am 1.4 QB Pugsley	Introduction to AVDASI	SGB
02-Oct	10-11am G44 Frank, Physics bld	History of aircraft design	NHM
07-Oct	10-11am 1.4 QB Pugsley	Gliders	PSB
09-Oct	10-11am G44 Frank, Physics bld	System Safety	SGB
14-Oct	10-11am 1.4 QB Pugsley	Fixed Wing Aircraft Design 1	FS
16-Oct	10-11am G44 Frank, Physics bld	Aerospace Radio and Communications	SGB
21-Oct	10-11am 1.4 QB Pugsley	On board navigation and Sensing	SGB
23-Oct	10-11am G44 Frank, Physics bld	Off-Board navigation systems	SGB
28-Oct	10-11am 1.4 QB Pugsley	Electrical power systems 1	SGB
30-Oct	10-11am G44 Frank, Physics bld	Fixed Wing Aircraft Design 2	FS
04-Nov	10-11am 1.4 QB Pugsley	Rotary Wing Aircraft 1	PSB
06-Nov	10-11am G44 Frank, Physics bld	Propulsion 1	NHM
11-Nov	10-11am 1.4 QB Pugsley	Propulsion 2	NHM
13-Nov	10-11am G44 Frank, Physics bld	Rotary Wing Aircraft 2	PSB
18-Nov			
20-Nov			
25-Nov	10-11am 1.4 QB Pugsley	Electrical power systems 2	SGB
27-Nov	10-11am G44 Frank, Physics bld	Hydraulic and pneumatic power systems	SGB
02-Dec	10-11am 1.4 QB Pugsley	HOD, FLIR and night vision	SGB
04-Dec	10-11am G44 Frank, Physics bld	Fuel Systems	SGB
09-Dec	10-11am 1.4 QB Pugsley	Flight Control	SGB
11-Dec	10-11am G44 Frank, Physics bld	Computing and Data Buses	SGB
16-Dec	10-11am 1.4 QB Pugsley	Environmental impact of aviation and future designs	JJ
18-Dec	10-11am G44 Frank, Physics bld	Biofuels	JJ

Assessment

- Occasional progress tests (no contribution to final mark)
- Summer Exam (100% of final mark)
  - Will be multiple choice and short answer format

Example questions

When did the first successful, manned, rotary-winged aircraft fly?

A) 1932

B) 1923

C) 1913

D) 1931

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Modern turbine blades are made from what metal?

A) titanium

B) unobtainium

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Example questions

The pressure in a typical aircraft hydraulic system:

A) is augmented using the low outside air pressure

B) can be increased to boost power at critical times

C) is around 200 times atmospheric pressure at sea level

D) causes the normally solid hydraulic fluid to melt

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Example questions

Which of these statements best defines 'integrity' in an aerospace context?

A) the attribute of a system or an item indicating that it can be relied upon to work correctly on demand

B) the probability that a system or an item is in a functioning state at a given point in time

C) the inability of an item to perform its intended function

D) freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment

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General info

- *10 credit points = 100 hours work*
    - Use the library and the internet to supplement lectures
- Lecture slides and support materials will be available on blackboard.
- It is intended that you attend lectures and supplement the power-point notes with your own.

General info

- Course is a framework for knowledge that is easily available to you.
- Use online resources to follow up aspects which spark and interest…..

A bit on Systems

Systems Engineering?

There are many different definitions of ‘Systems’ and ‘Systems Engineering’

“ **I.** An organized or connected group of objects.

1. A set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan; rarely applied to a simple or small assemblage of things…..” (OED)

Systems Engineering?

- During your degree you will hear Systems Engineering many times….

- It could be in reference to a technique or process used to design or manage or deliver a product or service. Sometimes called *‘soft-systems’*

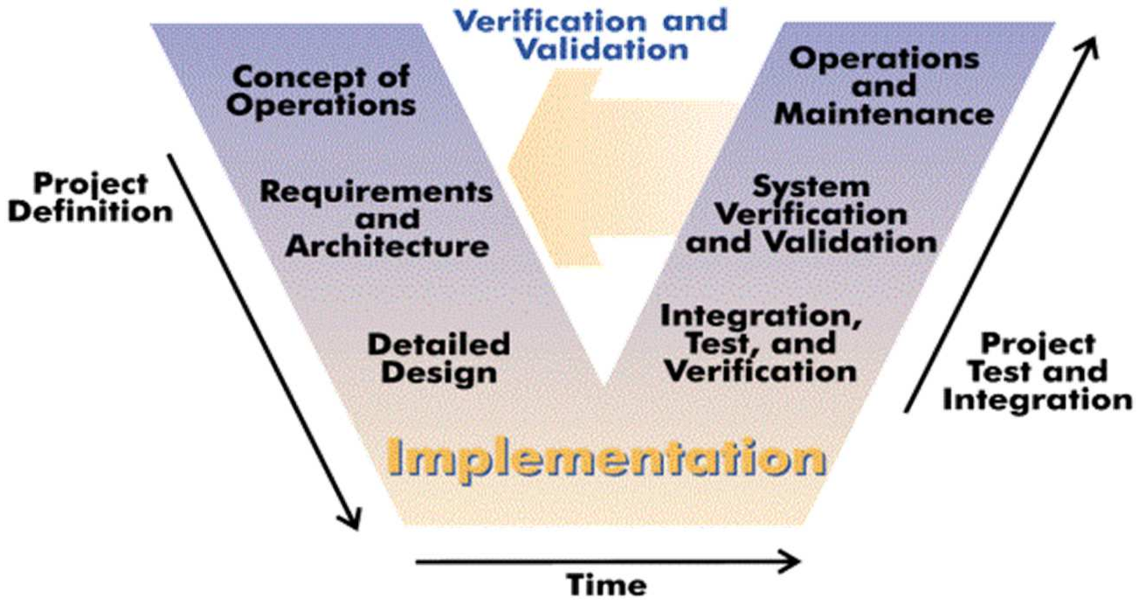
- Or it might refer to a connection of physical components. Sometimes called *‘hard-systems*’

compare – hardware/software

Systems Engineering?

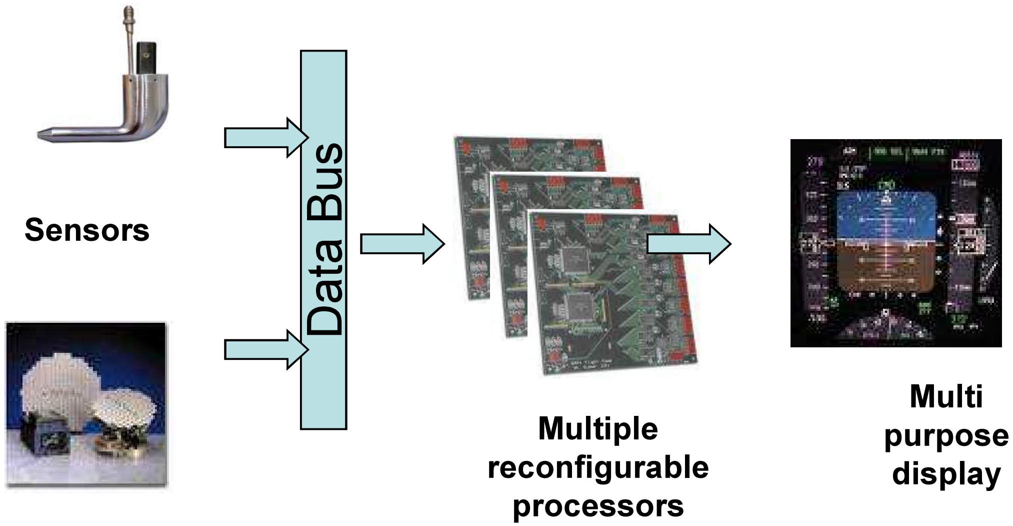
- This can be confusing – check the context

- In the aircraft design lectures of this series we will mention soft systems type processes……



Systems Engineering?

- This can be confusing – check the context
- ….but the majority of systems we will look at will be hard systems……



A bit on Safety

Aerospace System Safety

- Aircraft are complex machines but the consequences of failure are severe.
- Assessment of failures and safety is a well developed discipline…..

- ***Systematic*** failures occur every time a particular condition is encountered – exceeding a maximum rating, error in coding etc. They are repeatable and predictable.
  - The conditions that lead to the failure must be avoided

- ***Random*** failures could happen at any time – a bulb blowing, or oil seal failing under normal operating conditions.
  - These are dealt with using statistical techniques

Aerospace System Safety

- JAR (Joint Airworthiness Requirements) 25 defines failure conditions and likelihoods;

Severity	*Probability*	*Analysis*
Minor	Reasonably probable	1 $\times 10^{-3}$ per flight hour
Major	Remote	1 $\times 10^{-5}$ per flight hour
Hazardous	Extremely remote	1 $\times 10^{-7}$ per flight hour
Catastrophic	Extremely improbable	1 $\times 10^{-9}$ per flight hour

System Safety

Minor effect
Slight increase in crew workload.
Slight reduction in safety margins.
Physical effects, but no injury to occupants A reportable occurrence only.

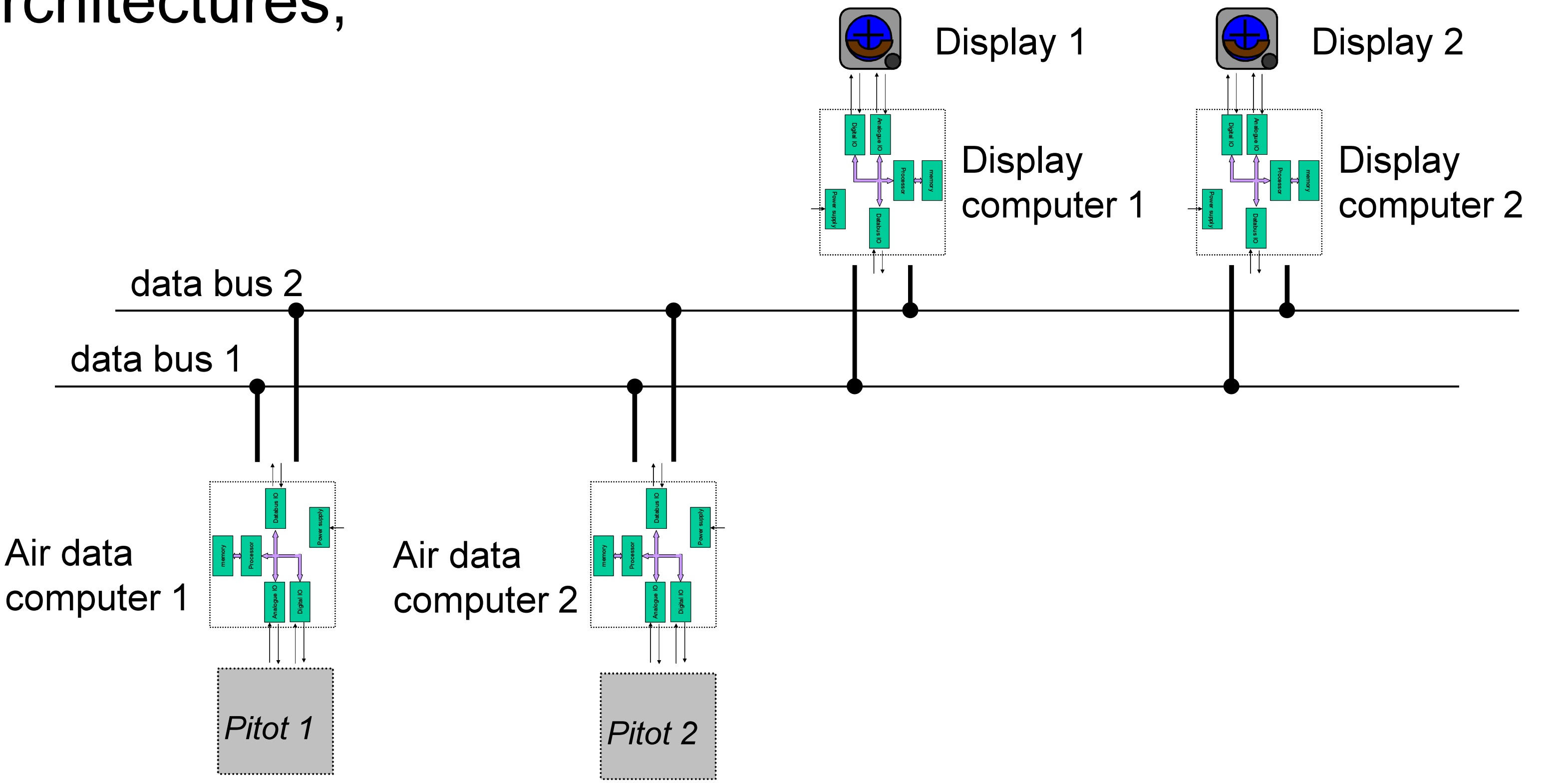
Major effect
Significant reduction in safety margins or functional capabilities.
Significant increase in crew workload or in conditions impairing crew efficiency.
Some injury to occupants.

Hazardous effect
Large reduction in safety margins or functional capabilities.
Higher workload or physical distress, such that the crew could not be relied upon to perform tasks accurately or completely.
Serious injury to, or death of, a relatively small proportion of the occupants.

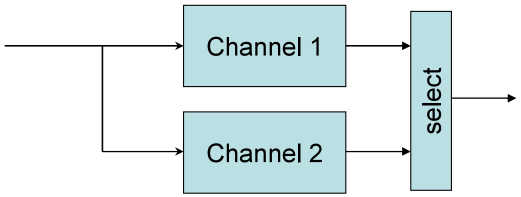
Catastrophic effect
All failure conditions which would prevent continued flight and landing.
Consequence is probably a multi-fatal accident and/or loss of the aircraft.

Redundancy

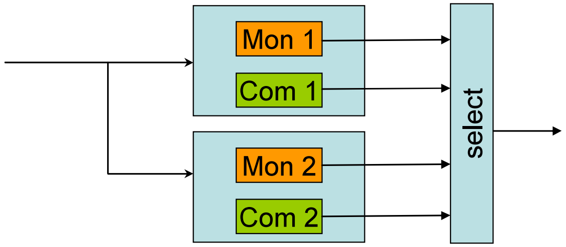
- Because most systems cannot meet the safety requirements on their own they are used in redundant architectures;



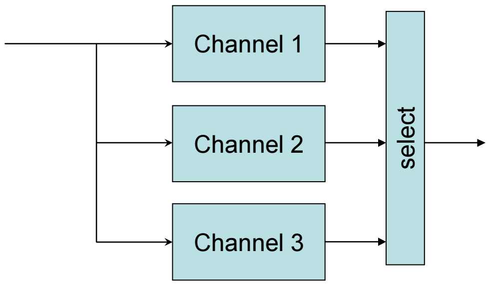
Redundancy



Duplex *- systems have two lanes. A duplex system can detect faults by cross-comparison between lanes. System operation can only continue after a single fault by pilot selection of the "good" remaining lane, assuming that this can be identified. This may be done by the pilot.*



Dual-duplex *- systems have two operating lanes, with two more lanes independently monitoring them. System operation can continue after a single fault, which can be detected and isolated by the monitoring lane. The system can do this automatically*



Triplex systems *- have three operating lanes. System operation can continue after a single fault by cross-comparison between all three lanes, and voting out a failed lane. Again this can be automatic*

Redundancy

- Systems from air data to the hydraulics feature redundancy – it is why we don't have just one big engine…
- Systems which might cause catastrophic effects – e.g. flight control, often have triplex redundancy.
- Often dissimilar hardware and/or software is used in redundant systems – this can help with systematic failures

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