The Glass Cockpit

OR

What Is Going On In Commercial Aircraft
Computing And Electronics

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Before The Glass Cockpit

- ☐ Mechanical instruments
- ☐ Expensive, unreliable
- ☐ Limited performance
- ☐ Poor accuracy

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The Glass Cockpit

- ☐ What are you seeing when you look through the cockpit door?
- ☐ **An elaborate and complex computer system**

Computers now ***dominate all*** aircraft systems:

- Displays, Control, Navigation, Safety

What and Why?

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Airbus A380
First Commercial Flight 10/25/2007

A Glass Cockpit—Boeing 777

Autopilot Interface

Lots of computers

Lots of software

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Pop Quiz!

- ☐ An autopilot is a machine that can fly an aircraft in some circumstances
- ☐ Developed to reduce pilot workload
- ☐ When was the first aircraft autopilot introduced?

1912
By Sperry Corp

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Primary Flight Display

- □ Artificial horizon
- □ Heading
- □ Altitude
- □ Pitch, yaw
- □ Etc.

Flight Management System

- □ Primary function is navigation
- □ Contains navigation database for reference
- □ Allows route planning, route change, time estimation

EICAS

- □ *Engine Indicating and Crew Alerting System*
- □ Flight engineer replaced by automation
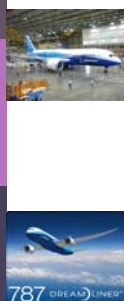- □ Provides general system monitoring capability

ACARS

- □ **Aircraft Communications Addressing and Reporting System**
- □ Transmission of messages between aircraft and ground via direct HF/VHF or satellite
- □ Low data rate data uplink and downlink
- □ Used to allow:
  - ■ Uplink of status updates, e.g., weather
  - ■ Downlink of flight status changes
  - ■ Downlink of engineering data—engine, avionics, etc.
- □ Presentation on multi-function display

Boeing 787 Dreamliner

Pilot Control Yoke

Airbus A380

No Pilot Control Yoke!
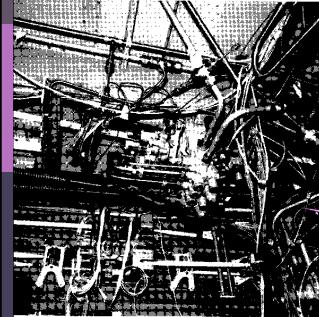
Department of

L1011 Hydraulic Load Center
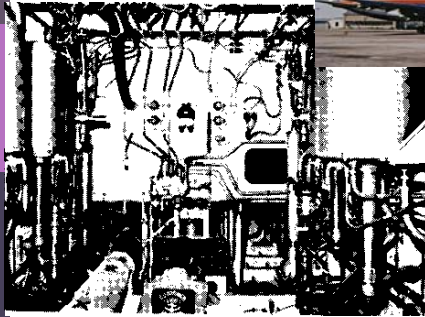
- Pilot/control surface connection originally wires and cranks
- Enhanced with hydraulics

L1011 Flap Servo Valve Control

Plumbing Nightmare

A320 Flight Control System

Digital Fly By Wire

777 Primary Flight Computers

Three Independent Lanes

Power Supply	Power Supply	Power Supply
AMD 29050	Motorola 68040	Intel 80486
Bus Interface	Bus Interface	Bus Interface

Three Independent Channels

Three Independent Buses
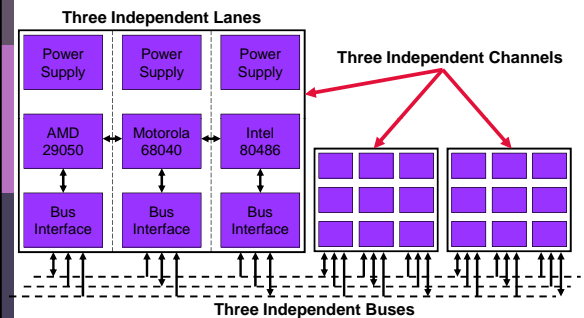
A380 Rolls Royce Trent 970s

Distributed Real-Time Computer Network

Broadband Network Connection

- **Typical aircraft gas turbine engines**
- **Incredibly reliable**
- **Incredibly efficient**

Aircraft Engine Communication

- Engines typically owned by third party, usually manufacturer
- Airlines contract for "thrust"
- Engine-to-ground, real-time data link
- Engine monitored by owner throughout flight
  - Temperatures, pressures, flow rates, vibration, settings
- Preventive maintenance schedule mostly abandoned

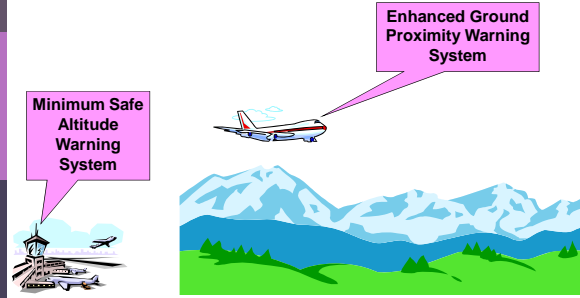## Korean Air Flight 801 (747-300)

Controlled flight into terrain

228 killed

Guam, August 6, 1997

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General Altitude Monitoring

Enhanced Ground Proximity Warning System

Minimum Safe Altitude Warning System

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Enhanced Ground Proximity Warning System

□ Prevent:

Controlled Flight Into Terrain

□ Approach:
- Terrain map of world
- Projects aircraft path for several minutes of flight
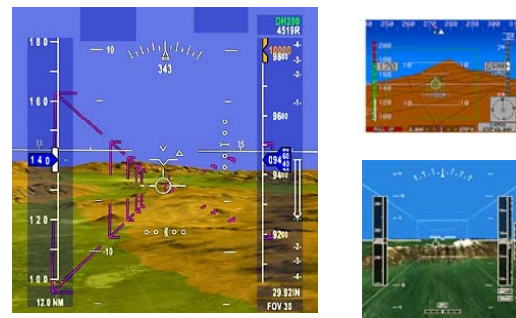- Warns pilot if any chance of ground impact

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Synthetic Vision

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Conclusion

Don't Worry, The Wings Won't Fall Off

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