COCKPIT AVIONICS INTEGRATION AND AUTOMATION

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Integration
What is it Really?

- The act of forming, coordinating, or blending into a functioning or unified whole.
  
  Merriam-Webster

How does integration apply to Cockpit Avionics? ....
Benefits of Cockpit Integration

• Reduced pilot work load
• Increased system redundancy
• Increased maintainability
• Greater design flexibility for aircraft manufacturer
• Greater design flexibility for equipment manufacturer
MD-11 Flight Guidance/Flight Deck System
Honeywell System Summary

• 44 Line replaceable units (LRUs) per shipset
• 28 Different LRU types
• 48 Microprocessors per shipset
• 8 Different types of processors
• 1.5 Million total words of software
• 175 ARINC 429 type buses
• 8 Different ARINC data protocols
• 14 Other signal types

Honeywell Approach to Avionics Systems Integration

• Goals

• Tools and techniques
Honeywell Approach

Goals

- Develop systems that are safe and meet regulatory agency requirements
- Develop systems that optimize the operation of the aircraft
  - For the pilots
  - Passengers
  - Operators
  - Mechanics
- Develop, test, and certify systems on schedule at a reasonable cost
  - Minimize interface problems
  - Reduce on-aircraft development, test, and demonstration time
  - Identify and correct system problems early

Tools and Techniques

- Team approach with airframe manufacturer
  - Joint development of system architecture and system analyses
  - Use of combined systems experience—airframe/avionics
- Systems integration organization
  - Coordinate top level system design
  - Enhance communication internal/external
  - Coordinate solutions to common design problems
  - Coordinate solutions to problems involving multiple systems
  - Perform top level system testing
  - Provide flight test and flight operations support
- System level test facilities
  - Subsystem test benches
  - Subsystem validation facilities (VALFAC)
  - Integration validation facility (VALFAC)
Cockpit Avionics Integration

Conclusions

- Level of integration in cockpit avionics has increased significantly in recent years
- Benefits of integration are readily apparent in modern aircraft cockpits
- Approach to avionics system design must change in order to take full advantage of system integration
- Different types of test facilities/test procedures are required for integrated systems
- Changes in aircraft manufacturer/avionics system supplier relationship likely
What are the effects on Cockpit Automation? . . . .

Automation
What is it Really?

- Automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human operators.

Merriam-Webster

- How does this apply to Cockpit Avionics? . . . .
## MD-11 Cockpit Automation

<table>
<thead>
<tr>
<th>Typical Aircraft System</th>
<th>MD-11 System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autopilot</td>
<td>Auto Flight System</td>
</tr>
<tr>
<td>Flight Director</td>
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<tr>
<td>Auto Throttle</td>
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<tr>
<td>Compass System (slaved)</td>
<td>Flight Management System</td>
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<tr>
<td>Auto Nav – Lateral</td>
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<tr>
<td>Auto Nav – Vertical</td>
<td></td>
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<tr>
<td>Performance (Auto Speed)</td>
<td></td>
</tr>
<tr>
<td>Attitude Director Indicator</td>
<td>Electronic Flight Instrument System</td>
</tr>
<tr>
<td>Horizontal Situation Indicator</td>
<td></td>
</tr>
<tr>
<td>Engine Instruments</td>
<td></td>
</tr>
<tr>
<td>Aircraft Alerts</td>
<td>Aircraft System Controllers</td>
</tr>
<tr>
<td>Fuel System</td>
<td></td>
</tr>
<tr>
<td>Hydraulic System</td>
<td></td>
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<tr>
<td>Environmental System</td>
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<tr>
<td>Electrical System</td>
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### MD-11 ASC Hydraulic System Functions

- **Pre-flight**
  - Pressure test (manually initiated)
  - Engine-driven pumps test
- **Normal**
  - System operation monitor
- **Abnormal**
  - Fault isolation and system reconfiguration
MD-11 ASC Fuel System Functions

• Pre-flight
  - Test

• Normal
  - Fuel schedule
  - Tail fuel management/CG control
  - Fuel circulation to prevent freezing
  - Wing fuel balance
  - Forward pump control
  - Ballast fuel management

• Abnormal
  - Fuel dump monitor
  - Manifold drain
  - Outboard tank monitoring (trapped/premature transfer)
  - Tank overfill
  - Component failure accommodation

MD-11 ASC Environmental System Functions

• Pre-flight
  - Test

• Normal
  - Engine start configuration
  - Bleed air limit
  - Manifold pressurization
  - Take-off mode control
  - Economy mode

• Abnormal
  - Failure reconfiguration
  - Manifold failure
MD-11 ASC
Miscellaneous System Functions

• Pre-flight
  - Cargo fire test
  - Cargo doors test
  - Air data heaters test
  - Emergency lights battery test

• Normal
  - Engine start control
  - Auto ignition
  - Cargo fire agent timing
  - APU/CFDS interface
  - APU shut down, on/off control

• Abnormal
  - Pilot heat fault recovery

Cockpit Automation Concerns

• Crew awareness – does pilot need to know
• Crew work load
• Fail safe design
• Compatibility with existing operational environment
• Certificability
Cockpit Automation Conclusions

- Automation is unavoidable
- Automation is beneficial
- Cockpit designs must address operational/human factors concerns
- Pilot is ultimately responsible for aircraft/passenger safety. He must be able to do his job.