Can We Safely Keep it Simple?

First Flight of a Major Aircraft Upgrade

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Overview

- Basic aircraft
- The upgrade
- First flight issues and risks
- Risk mitigation
- First flight
- Lessons learned
Basic Aircraft

• US Navy C-2A (R) Greyhound
  (aka “COD”, carrier onboard delivery)
  – Dual piloted, medium range
  – Twin turboprop
  – Reconfigurable for cargo/passenger
• First delivered in 1965 (19)
• Re-procured C-2A delivered in 1985 (39)
• Carrier and shore-based (NOT a GA aircraft)
The Upgrade

C - communications
N – navigation
S – surveillance
/
A – air
T – traffic
M - management
Purpose of CNS/ATM

• CNS/ATM was to certify the aircraft in these areas:
  – RNP RNAV – Provides navigation accuracy, containment, integrity and appropriate alerts for operating in airspace where advanced civil navigation mandates are emerging.
  – Mode S – For operating in airspace where Mode S surveillance (ID) is being mandated (Europe). Includes both Elementary and Enhanced Surveillance requirements.
  – 8.33 kHz Channel Spacing – For operating in European airspace where 8.33 kHz is mandated at high altitudes.

• And not degrade any legacy capabilities
CNS/ATM Upgrade included

- New navigation suite
- New transponder
- Upgraded radio
- New Flight Management System (FMS)
- MAJOR cockpit upgrades
  - Glass displays
  - Lighting
  - New backup gyro
- Mod did NOT directly affect: engines, hydraulics, external aircraft mold-line, flight controls*

* Input to autopilot was modified
Legacy Cockpit
CNS/ATM
Cockpit
First Flight Issues

- Test asset had not flown in almost a year
- Required Functional Check Flight of basic aircraft systems
- First flight with new navigation, IFF, comm suite
- First flight with glass cockpit
First Flight Risks

- Failure of navigation sources
- Failure of FMS
- Failure of displays
- Basic aircraft post-maintenance failure
**Risk:** Failure of CNS/ATM component during first flight

**Description:** Components fail due to new component design or integration.

**Mitigation:**
1. COTS products
2. No mod to pitot static system
3. Legacy AOA system remains installed
4. Reuse baseline software
5. Extensive lab and ground test

Mitigations lower likelihood & consequence of new component failures.
- **Risk:** Potential for non-program-related aircraft system failure
- **Description:** Aircraft has not flown for almost 1 year, functional check flight requires new components
- **Mitigation:**
  1. Extensive FCF ground test
  2. Red-line FCF flight procedures approved
  3. Utilize two FCF qualified aircraft commanders w/ CNS/ATM training

Mitigations lower likelihood & consequence of non-CNS/ATM failures.
CNS/ATM Risk Mitigation

• Risk mitigation required reducing consequence to go from medium to low risk.

• What about instrumentation, monitoring or Safety Chase?
  – None reduce the consequence efficiently

• What do we need to fly an airplane day/VMC?
  – Airspeed, stall warning, energy state
Why AOA?

• For C-2 aircraft, in Day/VMC, reliable AOA gauge is all you really need to land
  – Provides precise airspeed/attitude
  – Provides stall warning
  – With known IHP can estimate ROD

• Legacy AOA system remained in cockpit
  – Not a part of the potentially compromised pitot/static system
  – Requires AOA probe and gauge only
Preparation for First flight

- Test planning including hazard analysis
- Extensive Lab test*
- On-aircraft ground test*
- Day/VMC weather restriction
- Familiar field
- Baseline software for nav and FMS already flying in another aircraft*
- New glass flight displays were modified COTS*
- No change to pitot static system*
- Legacy AOA intact*
- New COTS Emergency standby display
- CNS/ATM Procedures Trainer available for pilots

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First Flight

- 23 Oct 2007
- FCF required 3 separate flights
- Cockpit video recording of displays for post-flight review
- No safety-of-flight instrumentation
- No real-time monitoring
- Data bus recording for nav/IFF not working for 1st flight
Lessons Learned

- Instrumentation and monitoring can improve safety. However, keeping it simple and providing a safe viable alternative kept the test program on schedule and under budget.

- Early tester involvement in the design process led to the decision to keep the legacy AOA gauge and eventually simplified the requirements for mitigating first flight risks.

- Overcoming engineering’s resistance to keeping it simple can be challenging at best.
Questions?
New Primary Flight Display
New Emergency Standby