Orbiter Cockpit

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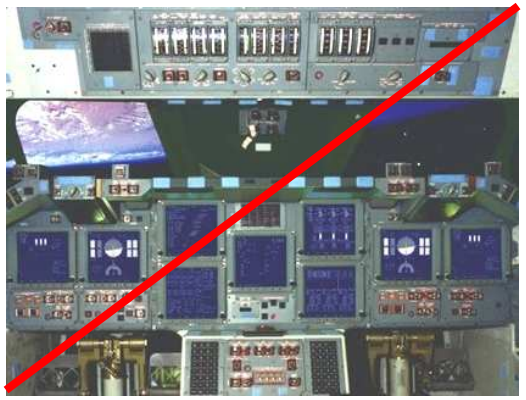
The Orbiter cockpit is less advanced than modern aircraft cockpits despite a substantial upgrade in 2000

Design Requirements

- **Normal operation with only two seated pilots (excluding payloads)**
- **Return capability with only one pilot**
- **Crew selection of manual or automated functions**
- **Exterior and interior lighting for visibility**

Original "CRT-Mechanical" Cockpit
Designed in 1970s

Multifunction Electronic Display System (MEDS)
First flown in 2000



Cockpit Avionics Upgrade Program (CAU)
Cancelled in 2004

The cockpit satisfies its original requirements but still has human factors problems

OBSTACLES TO DEVELOPMENT

- Budget cuts (1970s, 2004)
- Lack of computer power
- Difficulty in space-qualifying hardware and software
- Astronauts' reluctance to complain (for fear of losing flight assignments)
- Impending Shuttle retirement in 2010

CURRENT PROBLEMS

- High workload, especially during emergency situations
  - underutilized LCD displays
  - difficult fault diagnosis
- Cluttered cockpit layout
- Poor situational awareness
- Insufficient "human centered" automation?

Poor human factors design – by today's standards

The Cockpit Avionics Upgrade (CAU) is a first step in resolving these deficiencies

CURRENT PROBLEMS

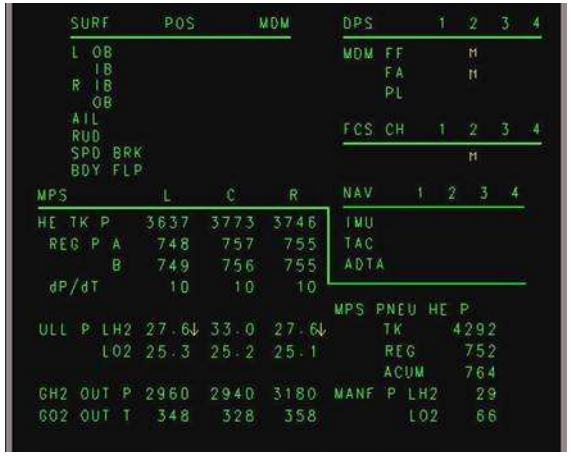
- High workload
  - under-utilized displays
  - difficult fault diagnosis
- Cluttered cockpit layout
- Poor situational awareness
- Insufficient “human-centered” automation?

Increased computational power

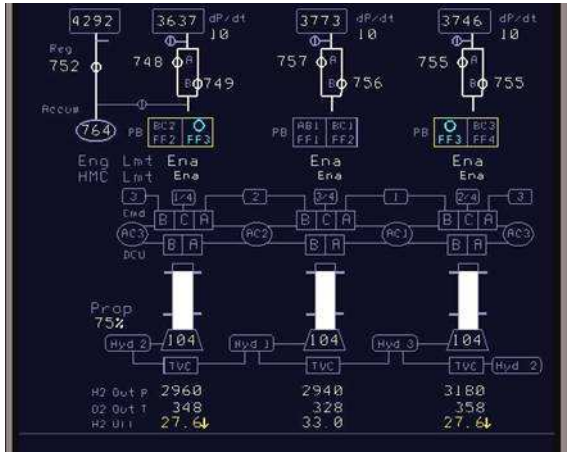
Improved display technology

COCKPIT AVIONICS UPGRADE

- Graphical displays
- Use of color displays
- Customizable screens
- Edge keys as adjunct to hardwired switches
- Improved fault diagnosis and analysis software



CAU



The automation should be more human-centered but still allow for full manual control

	Level of Automation	
Phase	**Current**	**Recommended**
Ascent	• Autopilot for nominal ascent • Cryptic Caution and Warning System • No automation during emergencies	• Improved fault diagnosis software and display techniques • Flight computers recommend and/or prioritize several possible actions
In Orbit	Depends on mission and payload	
Entry and Landing	• Autopilot entry • Manual, fly-by-wire final approach and landing; backup landing autopilot*	• No change to current system BUT landing autopilot should be flight-tested at least once

Pilots should ALWAYS have final control authority

Note: * Has never been flight tested

Other proven technologies could further improve situational awareness and reduce spatial disorientation

General Aviation Display Technology

Highway-in-the-Sky, Synthetic Vision

Haptic feedback garments

3D audio, voice recognition

The CEV will have a more advanced and less cluttered cockpit than the Orbiter

- **Ballistic, capsule-type spacecraft like the Apollo Command Module**
- **Ground and water landing capabilities**
- **Longer duration missions to the Moon and Mars**

DESIGN RECOMMENDATIONS

- **Implement CAU suggestions**
- **Simpler cockpit layout**
- **Increased computing capabilities**
- **Higher level of human-centered automation**
  - **autonomous docking**
  - **subsystem health monitoring**
  - **reduced dependence on Mission Control**

30-35 years more advanced than Orbiter

Summary and Conclusions

- **The current Orbiter cockpit meets the original design requirements; however, it is not optimal from a human factors perspective**
- **In our redesign, we suggest**
  - **implementing the Cockpit Avionics Upgrade program**
  - **increasing the human-centered automation to reduce workload but always allowing the pilot to have final authority**
  - **using proven cockpit technologies to improve situational awareness and reduce spatial disorientation**
    - **general aviation technologies, highway-in-the-sky, synthetic vision**
    - **haptic feedback, voice recognition, 3D audio**
- **These improvements can also be applied to the CEV cockpit**

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