Advanced Graphical User Interface for Next Generation Flight Management Systems

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Overview

- **Advanced FMS Research**
  - Background, Problem, & Objective
  - Approach
  - FY97-99 Progress & Results
    - Human Factors Evaluations
    - Results from pilot-in-the-loop simulation study
- **Recommendations**
- **Conclusion**

Background, Problem, & Objective

- **Background and Problem**
  - FMS scrutinized by leading aviation professionals
    - Opaque interface (mode confusion errors)
    - Knowledge gaps in understanding FMS's functional structure
    - Interface to complicated (especially during non-standard flight ops)
    - Lack of support to deal with increased cognitive demands
  - Alternative FMS interfaces have shown progress
    - Increase usability by focusing on underlying functionality and USER needs
    - Decreased reaction time, error rates, and workload
- **Objective**
  - Design and Advanced FMS Human Interface that will significantly reduce and/or eliminate human interface problems
  - Evaluate this Advanced FMS in a robust pilot-in-the-loop simulator

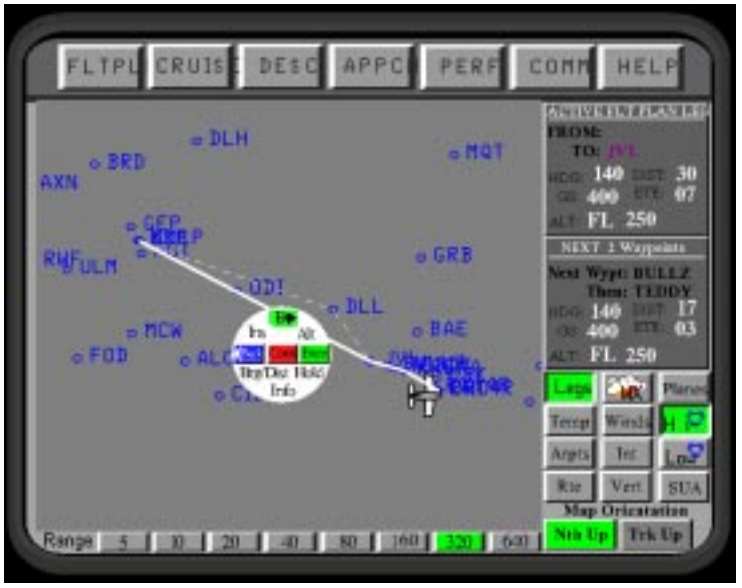
Approach

- **Extensive research literature review**
- **Cognitive Task Analysis of representative CDU type FMS**
  - Identified both physical and cognitive “bottlenecks”
- **Capture User (pilot) requirements**
  - Questionnaires, structured & unstructured interviews, SME’s, etc.
- **Design and prototype preliminary FMS candidates**
  - **Iterative evaluations “fine tune” prototypes = meet user’s needs**
    - Hueristic, Obtrusive/Unobstrusive user testing, walkthroughs,
    - In the Field (Contextual) studies, Repeated Measures design, etc.
- **Research & investigate alternative GUI display formats**
  - Paper Mockups, View Cells, PowerPoint, ToolBook, VAPS, etc.
- **Integrate the Advanced GUI FMS prototype with an existing FMS simulation tool (VISTA) for a more realistic evaluation of its alternative display concepts**
  - Real time pilot-in-the-loop simulation

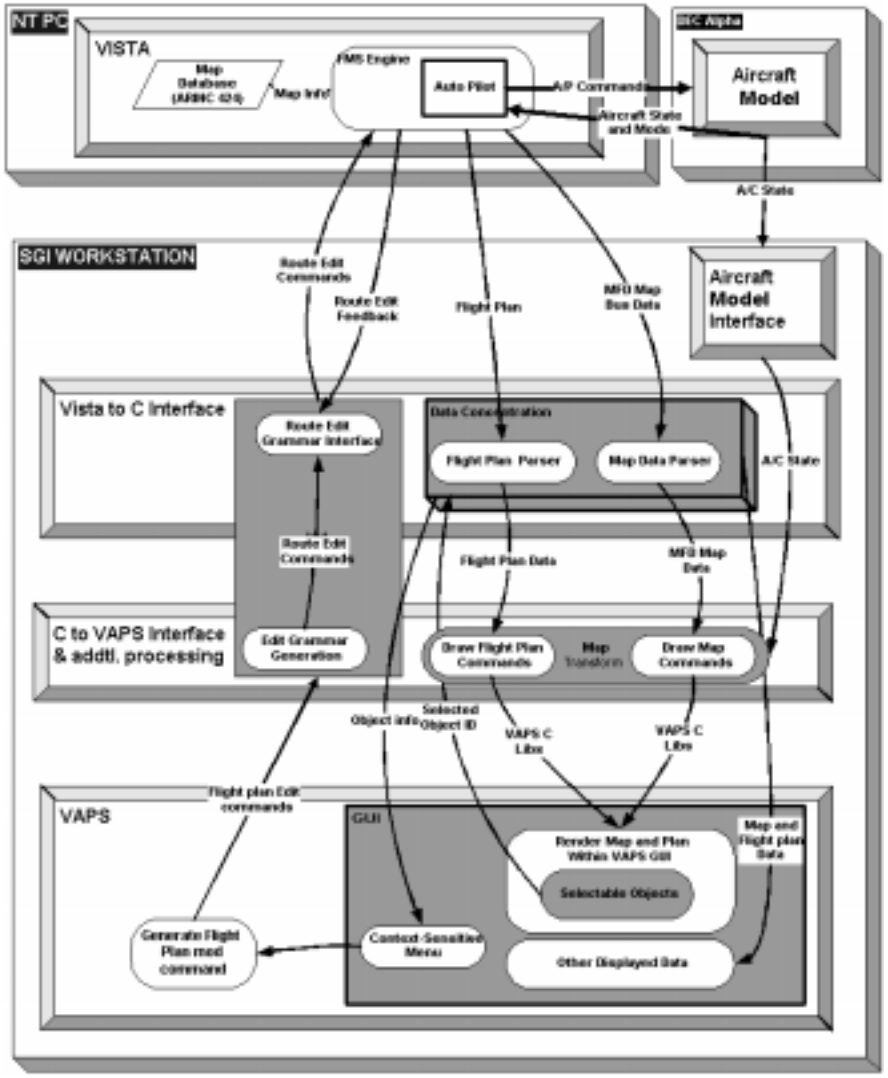
Examples of the Early Prototype (‘97)

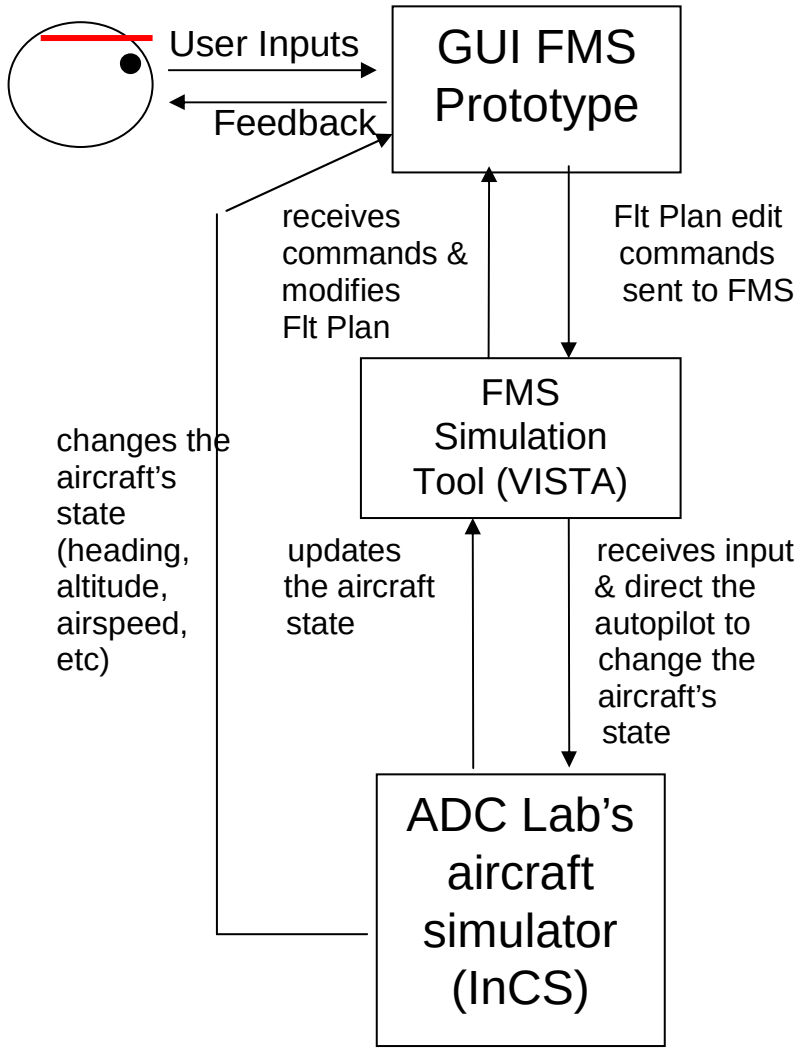
Examples of the Early Prototype (‘98)

The Final Prototype



FMS, VISTA, & InCS



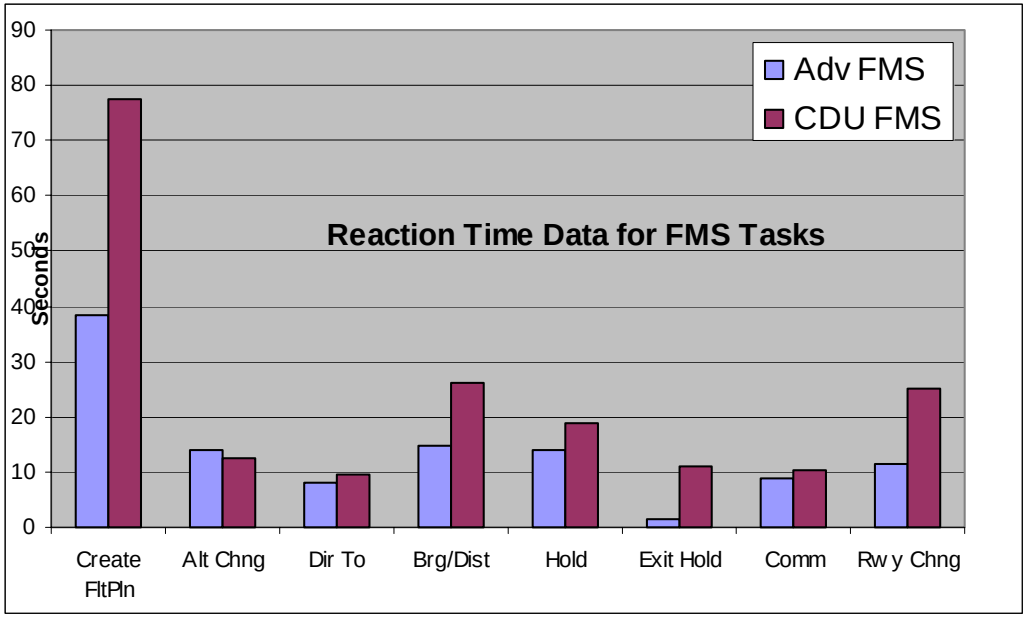


Human Factors Evaluations

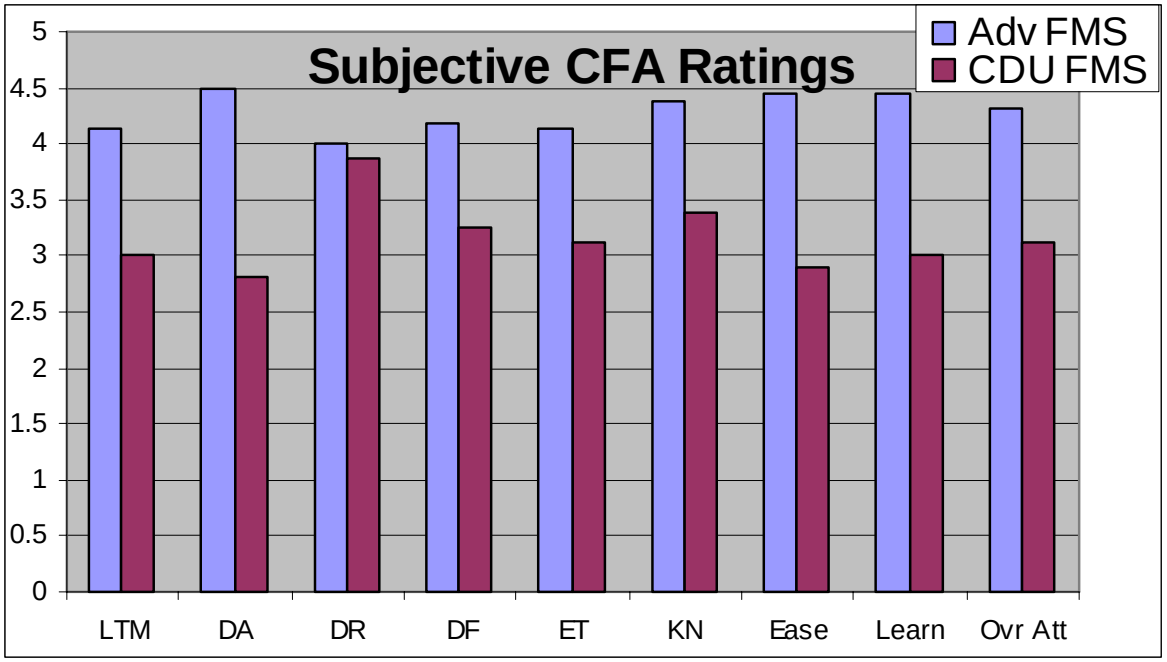
- **Methods Used**
  - Participants: 4 professional pilots participated (28 yrs & 10,400 hrs)
  - Data Recording: automatic and experimental observation.
  - Display Formats: Advanced FMS vs Conventional CDU
  - Scenario: Simulated flight from KMSP to KORD & KCID to KORD
  - Experimental Design: A repeated measures design
  - Independent Variable: Display formats were used as factors.
  - Dependent Variables: Reaction time, Operator Errors, Modified SWAT, and Subjective ratings (Cognitive Functional Analysis - CFA)
- **Procedures Used**
  - Briefing, practice trials, testing alternating formats
  - Create a flight plan, then actually fly that plan
  - Completed representative FMS tasks several times

Recent Results (‘99)

- **Statistically significant main effects for display format**
  - Advanced GUI FMS statistically:
    - had lower reaction times to complete tasks
    - fewer operator errors to complete tasks
    - lower levels of perceived mental workload
    - higher subjective ratings using the Cognitive Function Analysis



Recent Results (‘99)



- Long Term Memory - easy or difficult to recall from memory how to perform task
- Display Affordance - does the display present information to you to help your task?
- Error Tolerance - how easy or difficult is to recover from errors you make
- Keystroke number - is the # of keystrokes too much?
- Ease of use - overall how easy or difficult is it to use this display to complete tasks?
- Learnability - how easy or difficult is it to use the system?
- Overall attitude - what is your overall attitude?

Recommendations

- **FMS Human Interface Research for last 3 years reveals:**
  - Alternative GUI display formats do improve the human interface
  - Alternative GUI display formats reduce &/or eliminate problems between pilots and the FMS
  - Demonstrated it is ENTIRELY FEASIBLE to COMPLETELY CHANGE the human interface to the FMS WITHOUT change the underlying FMS code
  - Alternative input devices, CCD's and Voice Recognition, also help improve the overall human interface
    - Exhaustive evaluation of CCD's yielded most viable candidate(s) for context
    - ASR & TTS evaluations ongoing, preliminary results:
      - Dependent ASR superior to Independent ASR systems for accuracy in NOISE
      - TTS is promising as a redundant feedback display modality

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Questions?