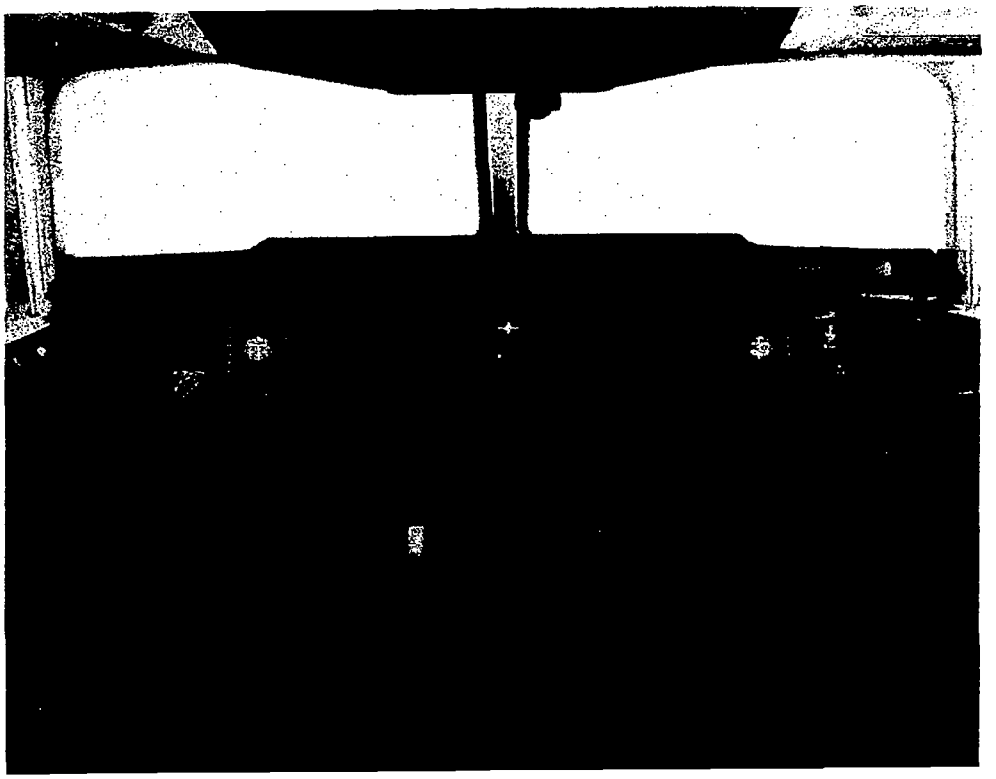
RESEARCH OPPORTUNITIES FOR FUTURE COMMERCIAL TRANSPORTS

J. F. Longshore
Douglas Aircraft Company
Long Beach, California

First Annual NASA Aircraft Controls Workshop
NASA Langley Research Center
Hampton, Virginia
October 25-27, 1983

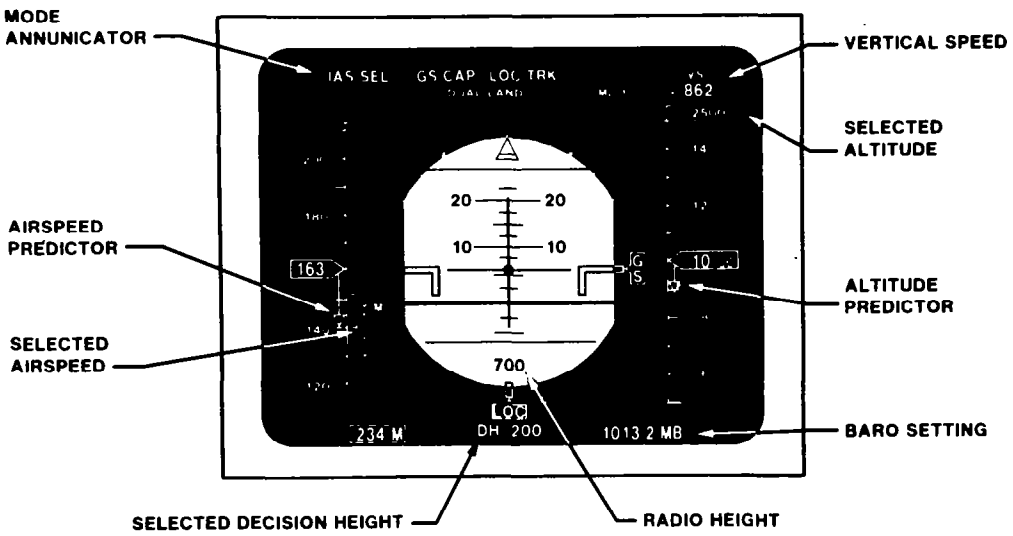
MD-100 COCKPIT

This photo of one of the MD-100 flight deck configurations being discussed with the airlines illustrates the flexibility in display formats afforded by today's CRT technology. All of the formats shown can be extensively tailored to phase of flight and aircraft configuration and can be configured to provide unique data to the flight crews for special situations.



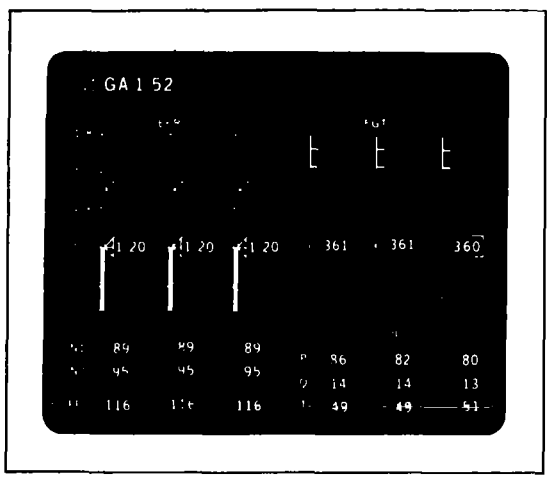
MD-100 PRIMARY FLIGHT DISPLAY

This photo illustrates the typical primary flight display format. Note that this display includes all air data, flight control system mode annunciation, radio altitude and decision height, as well as the traditional attitude director functions. The navigation display on an adjacent CRT is typical of those found in recently certified flight management systems.

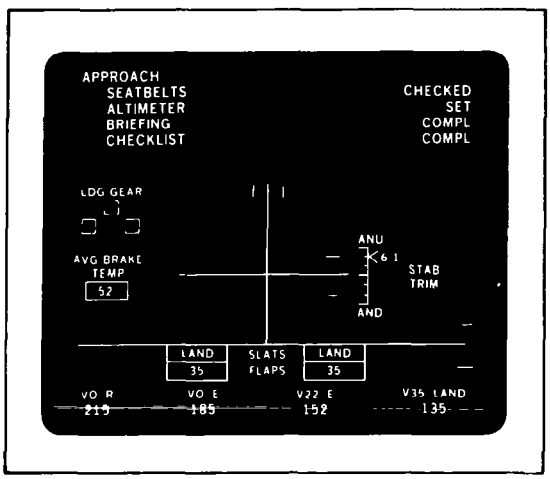


MD-100 MULTIFUNCTION DISPLAYS

These display formats are typical of the MD-100 subsystem displays. A synoptic system display is used for the fuel, pneumatic, electrical, and hydraulic systems. These can be called up by the crew. Color and symbology changes are used in the synoptics to identify system configuration and annunciate system failures.



ENGINE PARAMETERS IN MFD 1



PHASE-OF-FLIGHT DISPLAY IN MFD 2

FLIGHT DECK/FLIGHT CONTROL SYSTEM CONCEPTS

- The objective of the ongoing NASA fault-tolerant architectural studies is to identify architectural concepts that have sufficient reliability for full-time fly-by-wire applications. Additional effort will be required to develop the methodology and criteria to be used in certifying such systems. NASA would function as the facilitating agency working with the air transport community and the FAA to define these methods and criteria.

- The impact of failures and the appropriate corrective action in future highly integrated fault-tolerant aircraft systems will be difficult to determine. Artificial intelligence (expert systems) concepts may be applicable to the aircraft system management computers required to manage such systems. Expert systems require extensive data bases to be effective. NASA research would focus on building failure mode and effects and degraded mode data bases and on defining and validating expert system concepts for aircraft system management.

FAULT-TOLERANT CONTROL SYSTEM
CERTIFICATION CRITERIA AND METHODOLOGY

ARTIFICIAL INTELLIGENCE/EXPERT SYSTEM
CONCEPTS FOR AIRCRAFT SYSTEM
CONTROL AND DISPLAY SYSTEMS

AIRCRAFT/NATIONAL AIR SPACE SYSTEM COMPATIBILITY

- The air transport industry has invested considerable effort in the design and development of fuel-saving flight management systems. To be effective, these systems must be allowed to control the climb, cruise, and descent flight profiles without undue air traffic control interference. The FAA is in the beginning phases of defining a national air space system aimed at increasing air space and airport capacity through the use of increased automation. This system could potentially increase air traffic control constraints to the detriment of efficient aircraft operation. NASA research would be directed at achieving maximum synergy between the desires of air transport operators to minimize costs and the desires of the FAA to increase air space and airport capacity.

- The FAA national air space system plan makes increased use of automation and assumes increased aircraft densities in airport approach and departure areas. NASA research would be directed at investigating approach and departure route saturation sensitivities to abnormal conditions such as weather, in-flight emergencies, etc.

AIRCRAFT TRAFFIC CONTROL FLIGHT PROFILE AND PROCEDURE CONSTRAINTS

AIRPORT/AIR TRAFFIC CONTROL APPROACH AND DEPARTURE SATURATION SENSITIVITIES

DISPLAY RESEARCH

- The objective of the generic non-airframe peculiar display research activities would be to develop standard display formats that would be accepted and used by the air transport community.
- The objective of the display format human factors studies would be to develop standards pertaining to the use of colors, synoptics, etc., for communicating aircraft status and situation to the flight crew.

GENERIC NON-AIRFRAME PECULIAR DISPLAY FORMATS

- **PRIMARY FLIGHT INSTRUMENTS**
- **APPROACH,ROLLOUT,TAXI,TAKEOFF,AND DEPARTURE AIDS**
- **AIR TRAFFIC CONTROL RELATED DISPLAYS**

HUMAN FACTOR DISPLAY FORMAT STUDIES

- **FORMAT INFORMATION TRANSFER EFFICIENCY**
- **WORK LOAD ANALYSIS**
- **DATA REQUIREMENTS**
- **COLOR STANDARDS**