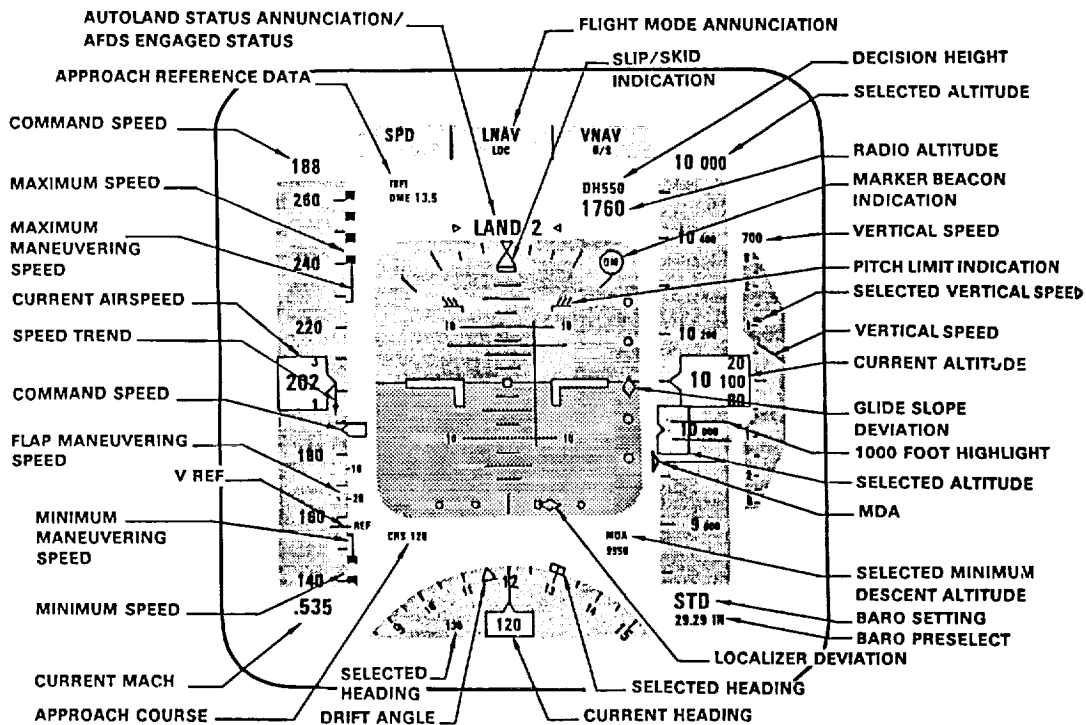# INFORMATION MANAGEMENT

Wendell Ricks
NASA Langley Research Center
and
Kevin Corker
BBN Systems and Technologies Corporation
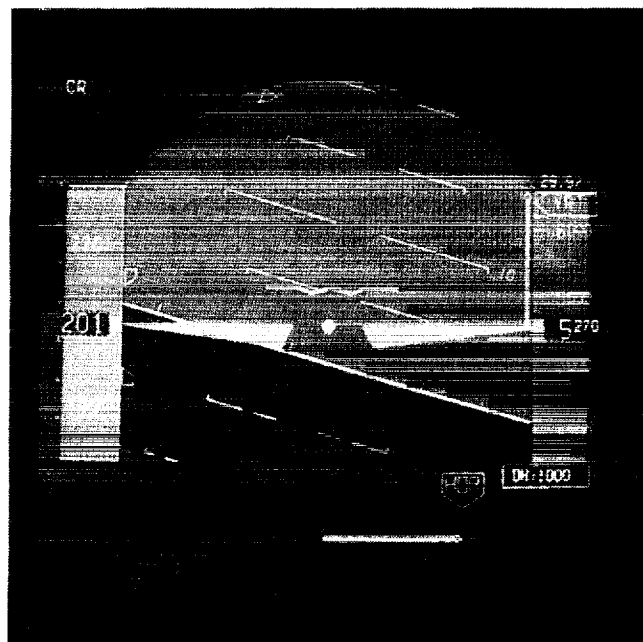
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Outline

- **PFD Information Management**
  - Problem
  - TTFIM Approach
  - Status
- **Cockpit Information Management**
  - Problem
  - Information Management Objective
  - System Characteristics
  - Issues
  - Approach

AUTOLAND STATUS ANNUNCIATION/
AFDS ENGAGED STATUS

FLIGHT MODE ANNUNCIATION

SLIP/SKID
INDICATION

DECISION HEIGHT

APPROACH REFERENCE DATA

SELECTED ALTITUDE

COMMAND SPEED

SPD LNAV VNAV

RADIO ALTITUDE

188

MAXIMUM SPEED

260

DME 13.5

DH550
1760

MARKER BEACON
INDICATION

MAXIMUM
MANEUVERING
SPEED

240

LAND/2

VERTICAL SPEED

PITCH LIMIT INDICATION

CURRENT AIRSPEED

SELECTED VERTICAL SPEED

SPEED TREND

220

VERTICAL SPEED

CURRENT ALTITUDE

COMMAND SPEED

202

10 100

GLIDE SLOPE
DEVIATION

FLAP MANEUVERING
SPEED

180

1000 FOOT HIGHLIGHT

SELECTED ALTITUDE

V REF

MINIMUM
MANEUVERING
SPEED

160

CRS 120

MDA

SELECTED MINIMUM
DESCENT ALTITUDE

MINIMUM SPEED

140
.535

STD
29.29 IN

BARO SETTING

BARO PRESELECT

LOCALIZER DEVIATION

CURRENT MACH

APPROACH COURSE

SELECTED
HEADING

DRIFT ANGLE

120

SELECTED HEADING

CURRENT HEADING

277

Information Management Problem with the PFD

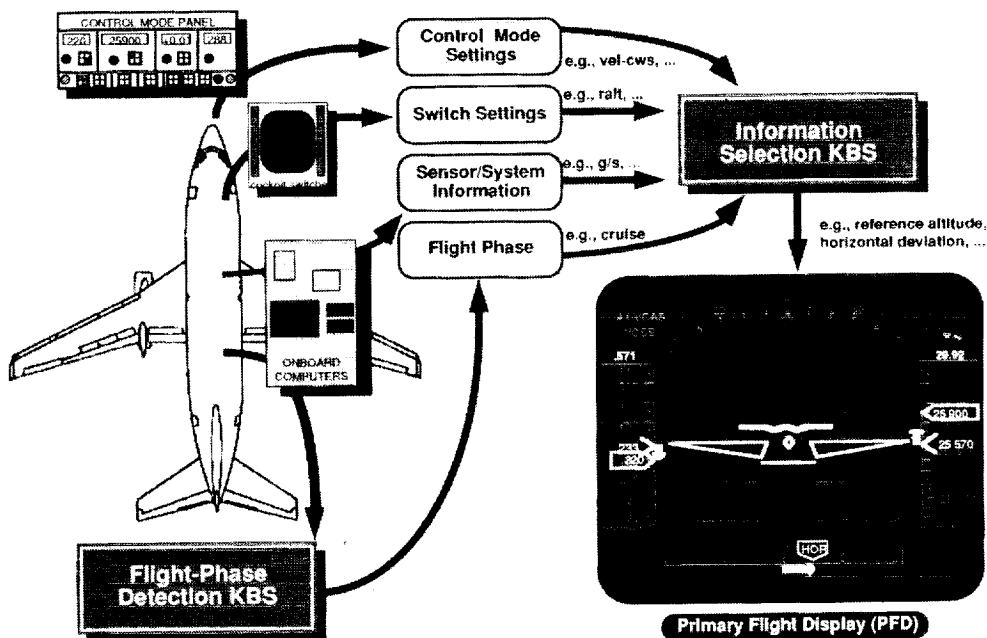## Increased amounts of information on the PFD increases the burden of interpretation

Target PFD Format

TTFIM Approach

Decrease the quantity of information on the PFD by presenting only the information pertinent to the current tasks

PFD Information Management

Status of the PFD
Information Management Work

- Validated the implementation and integration of TTFIM during June 1989 flight tests

- Completed implementation of automatic flight phase detection KBS and scheduled for validation during November 1989 flight tests

- Evaluation of the functional and operational utility of TTFIM will begin with the 1989 flight tests

Outline

- PFD Information Management
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    - System Characteristics
    - Issues
    - Approach

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Information Management Problem in the Cockpit

Large quantities of information currently compete for the attention of flight crews, and the amount of information is expected to increase

Information Management Burdens

Auditory
- ground control communications
- aircraft-to-aircraft communications
- intercrew dialogues
- electronically generated speech and tone signals

Visual
- radar signatures
- multiple display configurations
- number of displays

Cognitive
- control mode configurations
- cooperative action of independent, interactive agents
- periods of situation monitoring with little or no action, and periods of extensive action

Information Management Objective

Explore techniques that present information in a manner that exploits the capabilities the flight crew brings to the cockpit

Key Characteristics of an Information Manager

- Manage several media/formats

- Integrate across several programs and data sources
- Consider both pilot workload and tasking

- Factor in the information demands of the systems

- Account for the interactions among human performance variables, equipment characteristics, and mission/environment imposed demands

Technical Issues

- How do we prioritize information?

- How should new information be melded with old information?

- How will the content of each possible piece of information and its potential impact be evaluated?

- How are priorities ranked relative to goals (mission, tactical, safety)?

- How are the priorities of old messages changed?

- What information sources should be included?

- What hardware and software architectures are suited for supporting information management?

- What kind of feedback from the aircrew is necessary?

- How will it support multimember crews?

COCKPIT INFORMATION MANAGEMENT APPROACH

- Survey the Current State-of-Cockpit Information Environment

  - Identify Management Principles to be Invoiced Near/Long Term

- Abstract Current Information Flow for Designated Flight Phases

- Provide Functional Decomposition for Communication Management

- Design Architecture for Expert Assistance

  1. Prioritize
  2. Compose
  3. Format and Display

- Evaluate Effectiveness

COCKPIT INFORMATION MANAGEMENT: FUNCTIONAL REQUIREMENTS

- **Flight Phase and Aircraft Situation Responsiveness**

- **Flight Crew Responsive Display Configuration**

- **Prioritization and Composition of Information**

- **Facility for Storage, Retrieval, Review and Repetition of Information**

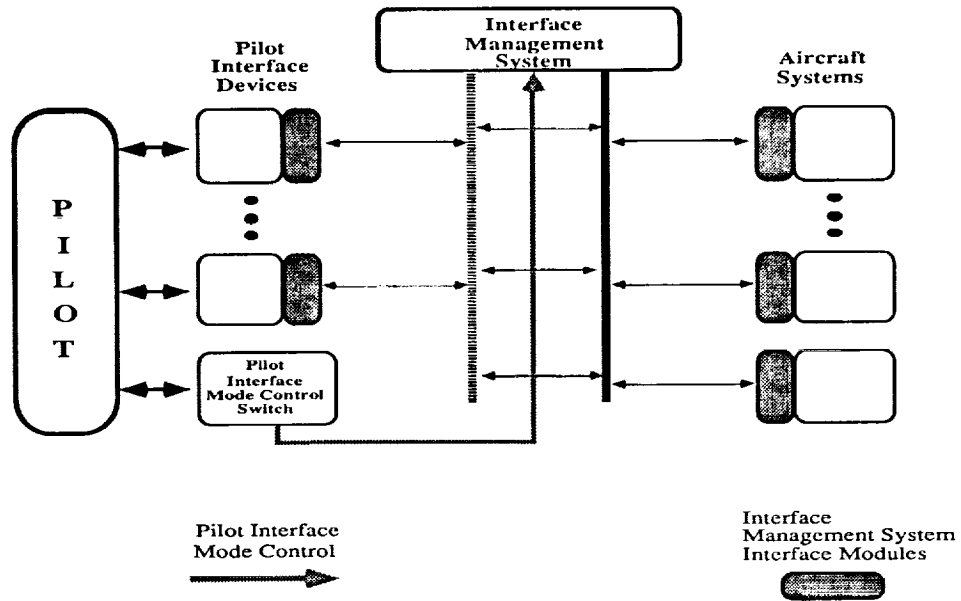# COCKPIT INFORMATION MANAGEMENT SYSTEM: FUNCTION

Integrate Information Across Avionics Devices and Data Sources so that One Interface Provides Full Access to Systems

Integrate Presentation Across Display Modalities so that the System Can Manage Several Formats for Information Display

COCKPIT INFORMATION MANAGEMENT SYSTEM IMPLEMENTATION STAGES

- Specification of Message Interactions that is Format Independent

- Develop Functional Knowledge Base of Information Exchange Requirements and Dialogue Structures

- Abstract Characterization of Data Types, Sensor Systems, and Communications Links

- Develop Methodology for Controlling Media Interaction:

  - Format
  - Timing
  - Consistency/Error Checking
  - Storage

THE INTERFACE MANAGEMENT SYSTEM MANAGES THE FLOW OF INFORMATION AND THE DIALOGS BETWEEN THE SYSTEMS AND THE PILOT

Pilot Interface
Mode Control

Interface
Management System
Interface Modules

AUDIO MAILBOX ARCHITECTURE AND INTERACTIONS WITH IMS
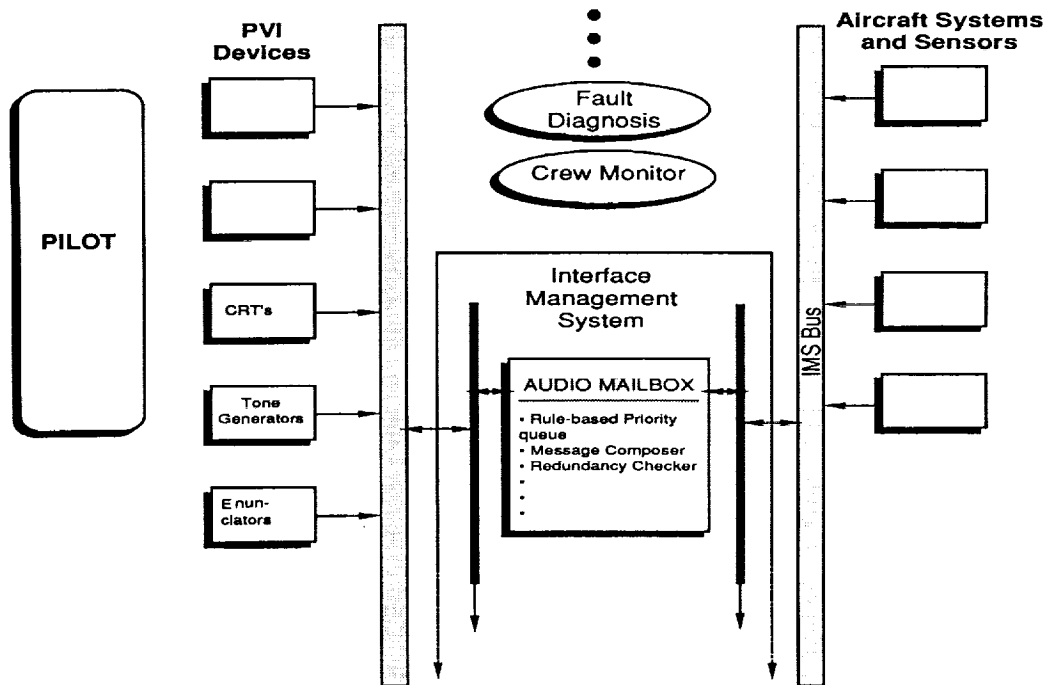
OVERALL A3 ARCHITECTURE

DATA SOURCES — **ANALYSIS / MONITORING EXPERT SYSTEMS** — **INTERNAL REPRESENTATIONS**

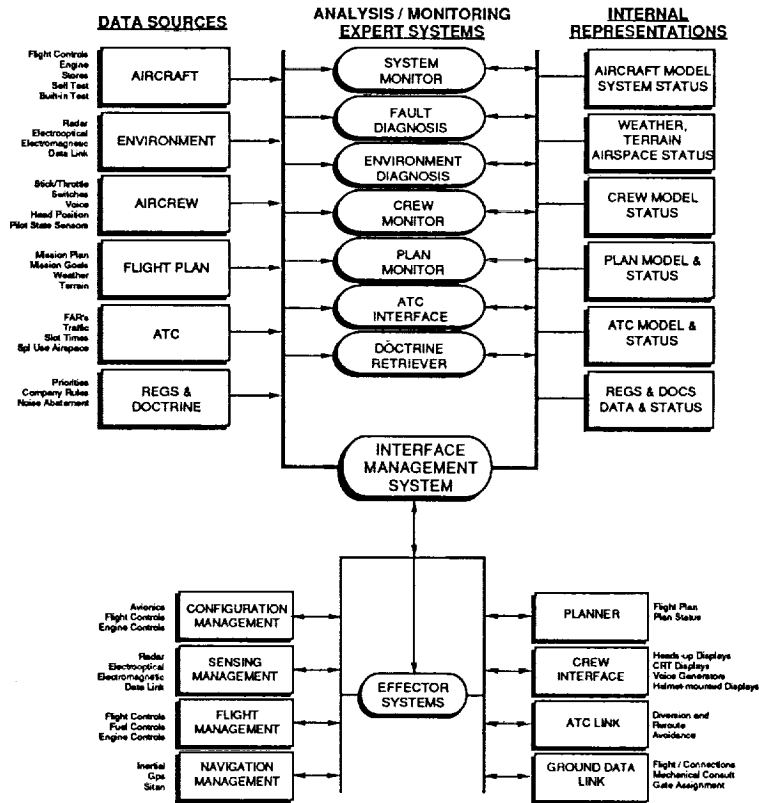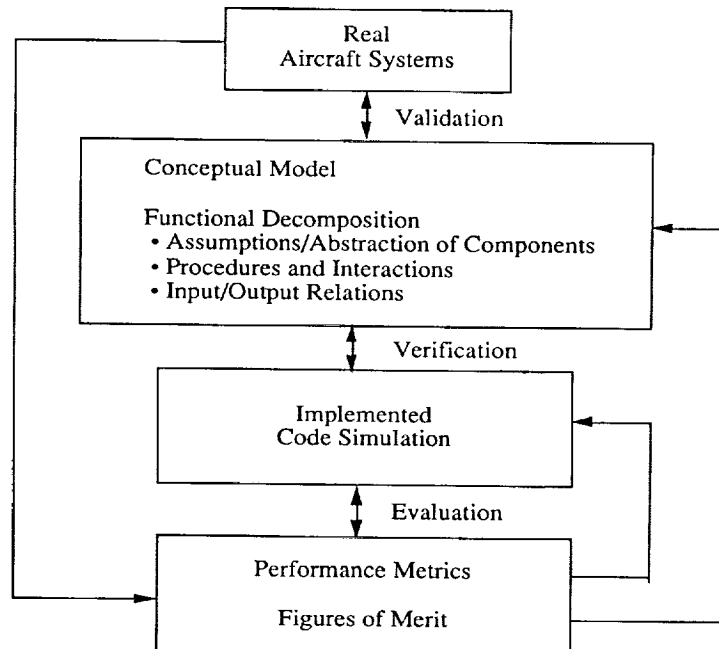Data sources: AIRCRAFT (Flight Controls, Engine, Stores, Self Test, Built-in Test); ENVIRONMENT (Radar, Electrooptical, Electromagnetic, Data Link); AIRCREW (Stick/Throttle, Switches, Voice, Head Position, Pilot State Sensors); FLIGHT PLAN (Mission Plan, Mission Goals, Weather, Terrain); ATC (FAR's, Traffic, Slot Times, Spl Use Airspace); REGS & DOCTRINE (Priorities, Company Rules, Noise Abatement)

Expert Systems: SYSTEM MONITOR, FAULT DIAGNOSIS, ENVIRONMENT DIAGNOSIS, CREW MONITOR, PLAN MONITOR, ATC INTERFACE, DOCTRINE RETRIEVER

Internal Representations: AIRCRAFT MODEL SYSTEM STATUS; WEATHER, TERRAIN AIRSPACE STATUS; CREW MODEL STATUS; PLAN MODEL & STATUS; ATC MODEL & STATUS; REGS & DOCS DATA & STATUS

INTERFACE MANAGEMENT SYSTEM

CONFIGURATION MANAGEMENT (Avionics, Flight Controls, Engine Controls); SENSING MANAGEMENT (Radar, Electrooptical, Electromagnetic, Data Link); FLIGHT MANAGEMENT (Flight Controls, Fuel Controls, Engine Controls); NAVIGATION MANAGEMENT (Inertial, Gps, Sitan)

EFFECTOR SYSTEMS

PLANNER (Flight Plan, Plan Status); CREW INTERFACE (Heads-up Displays, CRT Displays, Voice Generators, Helmet mounted Displays); ATC LINK (Diversion and Reroute Avoidance); GROUND DATA LINK (Flight / Connections, Mechanical Consult, Gate Assignment)

MODEL/IMPLEMENTATION ASSESSMENT PROCESS

Real Aircraft Systems

↕ Validation

Conceptual Model

Functional Decomposition
• Assumptions/Abstraction of Components
• Procedures and Interactions
• Input/Output Relations

↕ Verification

Implemented Code Simulation

↕ Evaluation

Performance Metrics

Figures of Merit

FUNCTIONAL VALIDATION
(SOME DEFINITIONS)

VERIFICATION: Comparison of the Conceptual Model or System Design to the Software that Implements that Design

VALIDATION: Determination of the Accuracy with Which the Model or System Captures the Function of the Real World Operation

EVALUATION: Comparison of the Target System's Operation to Current or Alternative Systems