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***Mission Critical Technology Development******Nancy Sliwa, NASA/Ames Research Center  
Intelligent Systems Technology Branch***

***This talk will cover specific technology developments in system reliability modeling, fault tolerance and fault diagnosis. In addition, it will present future mission control applications of optical processing.***

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# MISSION CRITICAL TECHNOLOGY DEVELOPMENT

**Nancy Sliwa, Assistant Chief  
Intelligent Systems Technology Branch**

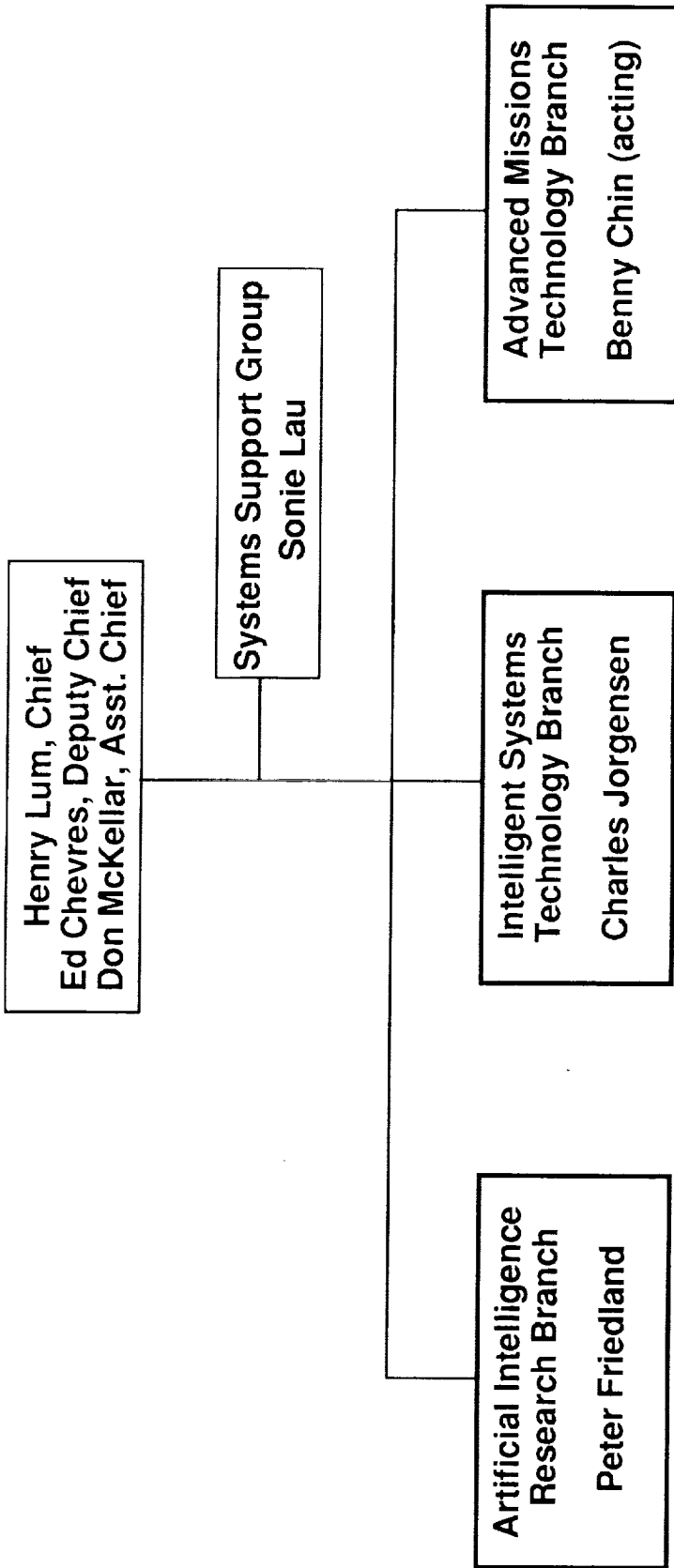


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## **OUTLINE**

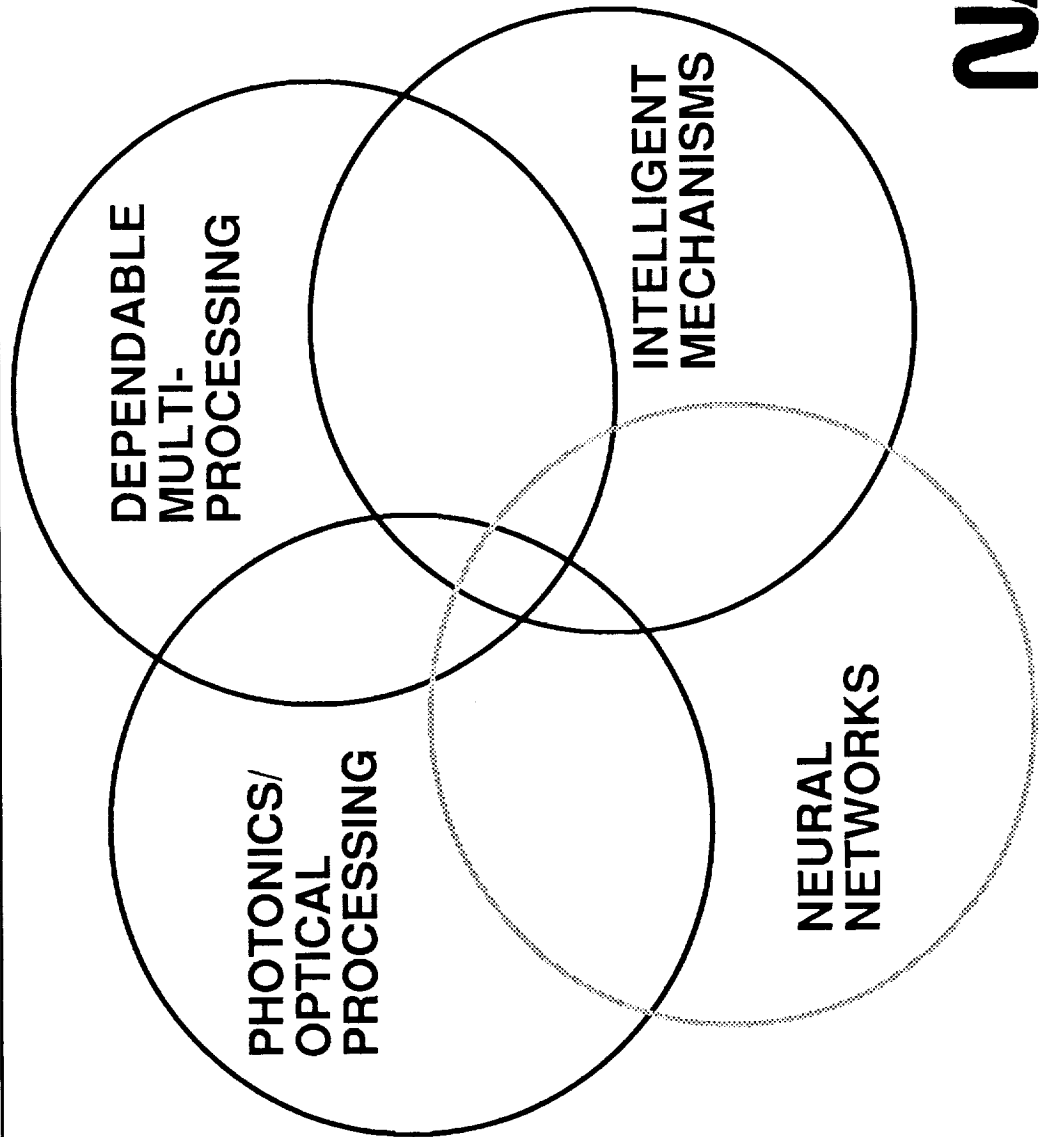
- **Organization/Philosophy Overview**
- **Fault Management Technology**
- **Introduction to Optical Processing**

# INFORMATION SCIENCES DIVISION ORGANIZATION



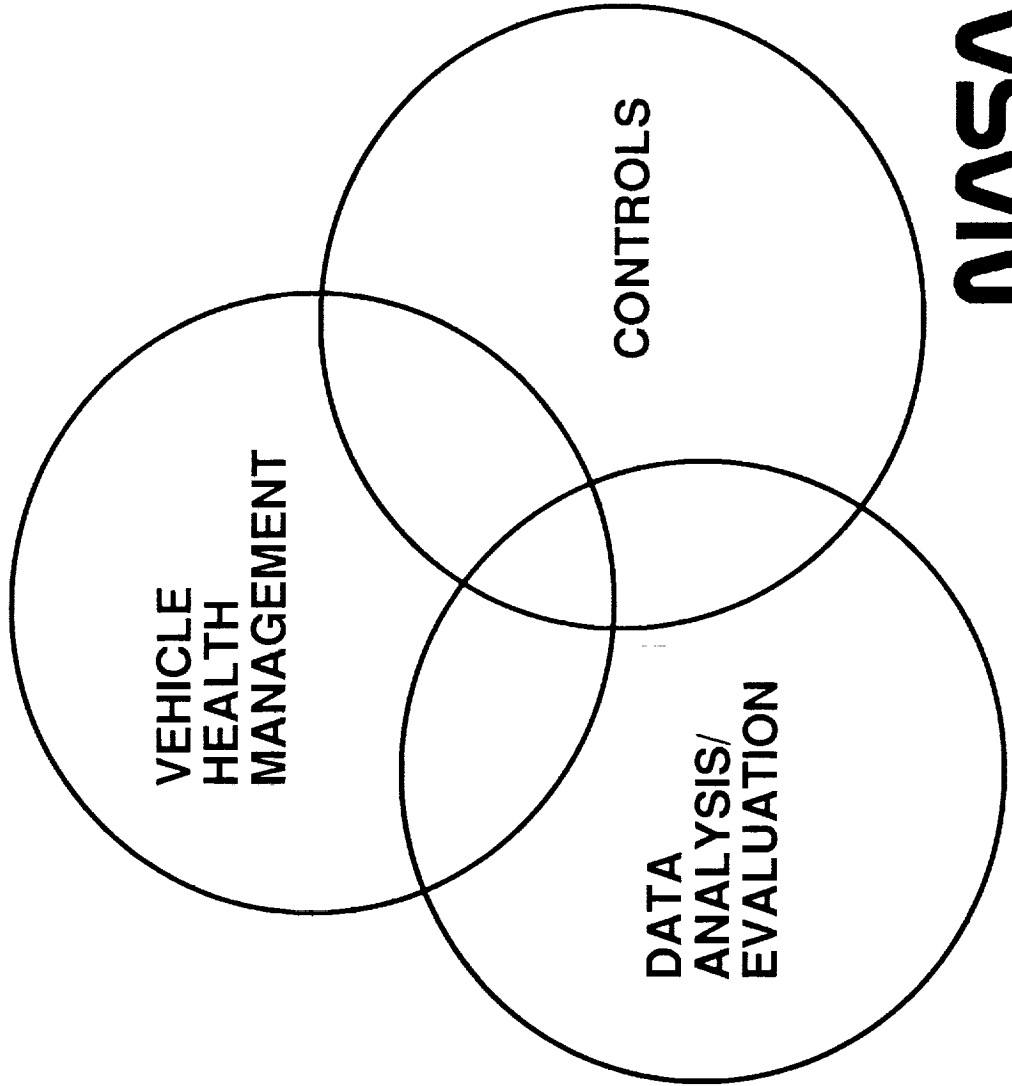
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# DISCIPLINES



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# GENERAL APPLICATION AREAS



## TECHNOLOGY TRANSITION

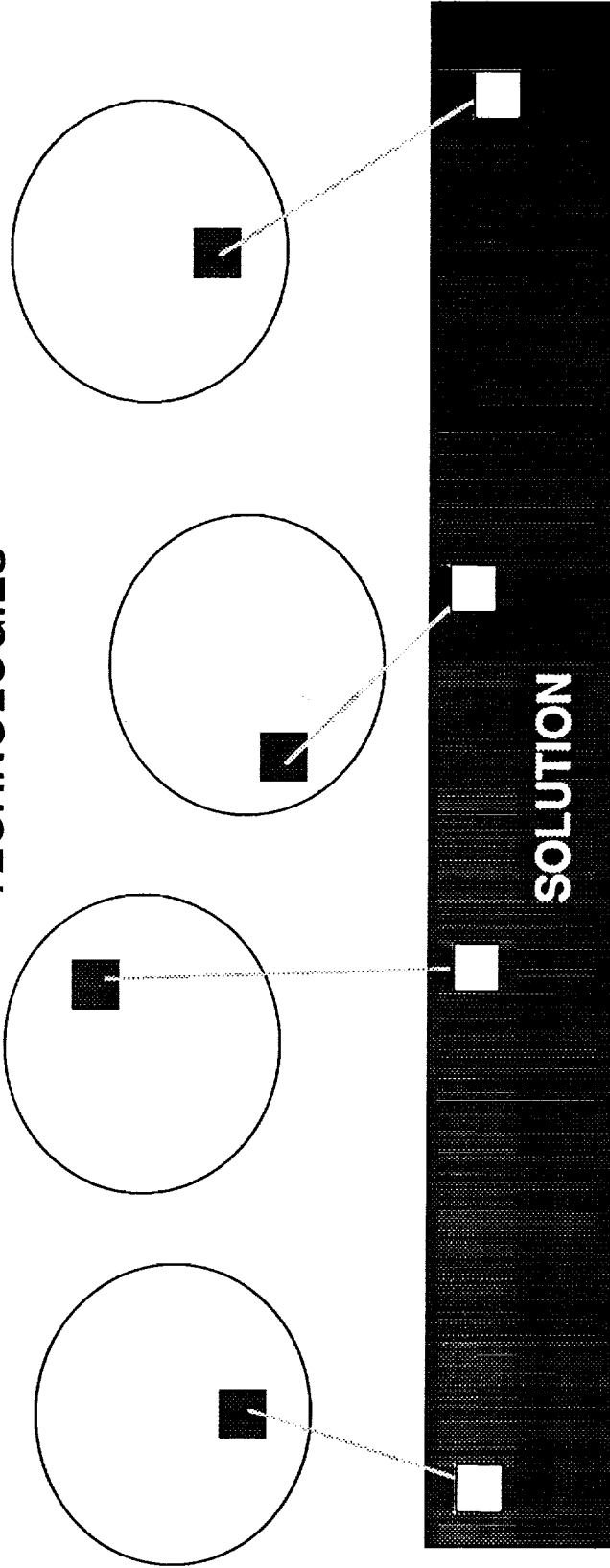
- Technology has a wide gulf to traverse to become useful operationally
  - Technology developers have solutions looking for problems
  - Project managers have problems that need a solution, the best given a number of constraints
- Project managers need to build confidence in a newer technology to minimize perceived project risk
- Technology developers need to be cognizant of full spectrum of demands on project managers, and not inappropriately recommend an immature technology



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# TECHNOLOGY TRANSITION

## TECHNOLOGIES



- Essential to get the right pieces of different technologies to form the solution to a particular problem



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## ISSUES

- ISD is fundamentally an R&D organization and no apologies
  - Agency needs some percentage of very long range technology development
- Intend to change OAET's heretofore poor reputation in the transition of technology to operational uses
- Using "vertical integration" approach within each technical discipline
  - Each group responsible for broad range of technology maturity development, from theoretical to lab demo to flight test
- "Technology transfer is a body contact sport"
  - Most important to get the people together: those with problems and those with solutions
- Mission Control is an ideal NASA proving ground for new information sciences technology
  - Has already been on the cutting edge of introducing technology to NASA operational use

The NASA logo, consisting of the word "NASA" in a bold, italicized, sans-serif font.

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## **FAULT MANAGEMENT TECHNOLOGY**

- Fault management covers the development/operations spectrum
  - Requirements, design, manufacturing, assembly/integration, operations, maintenance
- Reliability vs. Fault Management
  - A system is reliable if it has a long mean time between failures (MTBF)
  - Fault management allows failures to occur, while maintaining system functionality through intelligent control of the system configuration and function
- Fault Management integrates Modeling, Testing, and System Diagnosis/Troubleshooting



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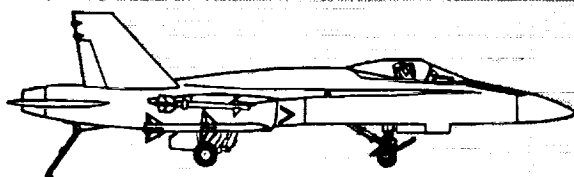
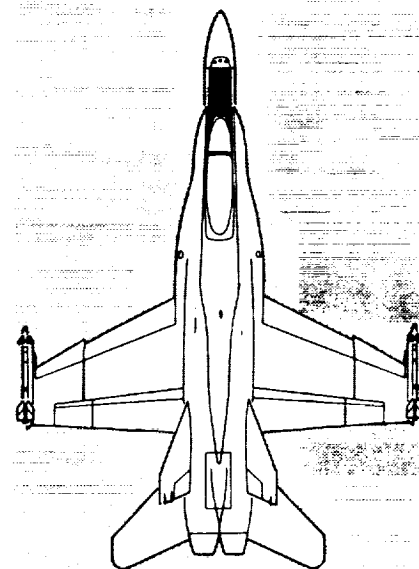
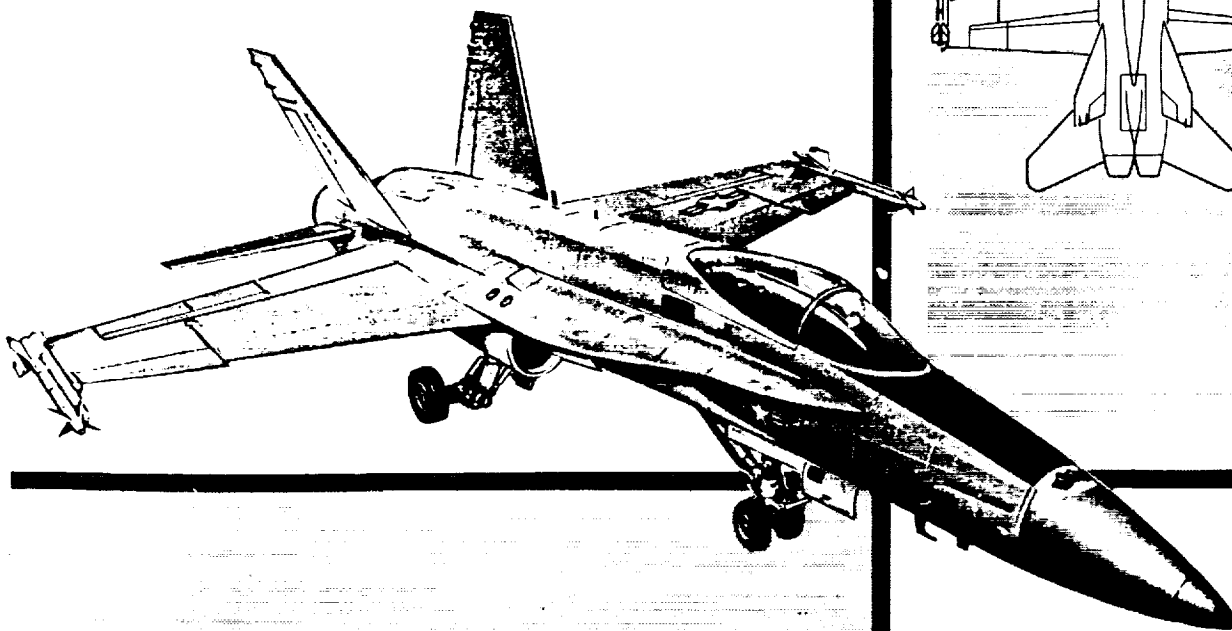
## **FAILURE ENVIRONMENT ANALYSIS TOOL (FEAT)**

- Developed by Lockheed for Space Station
  - funded by EF/JSC
- Builds models in digraphs and schematics
- Propagates failures forwards and backwards
- Propagates single or double failures
- Shows single- and double-point failure effects
- Does not account for probability of failure, or temporal effects



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# F-18A



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Figure 1-0. Three-quarter View  
626



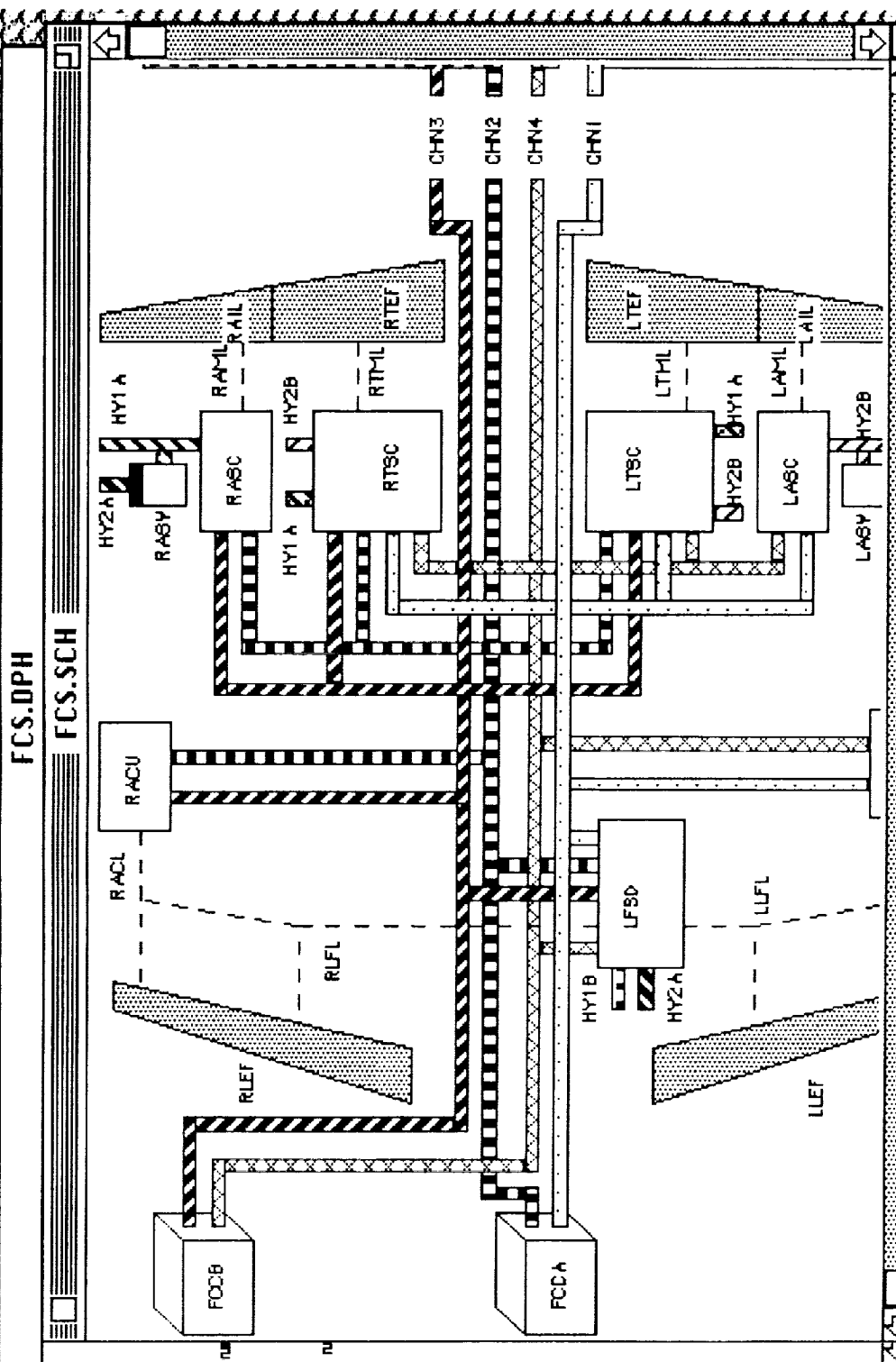




FCS.DPH  
FCS.SCH

- Source
- Target
- Target-1
- Clear
- Set
- UnSet
- Path
- Partner

64  
Cmpnts



Node HFCCB

Failure description(s)  
FLIGHT CONTROL COMPUTER B



MacX window



Trash



## **FAULT TREES**

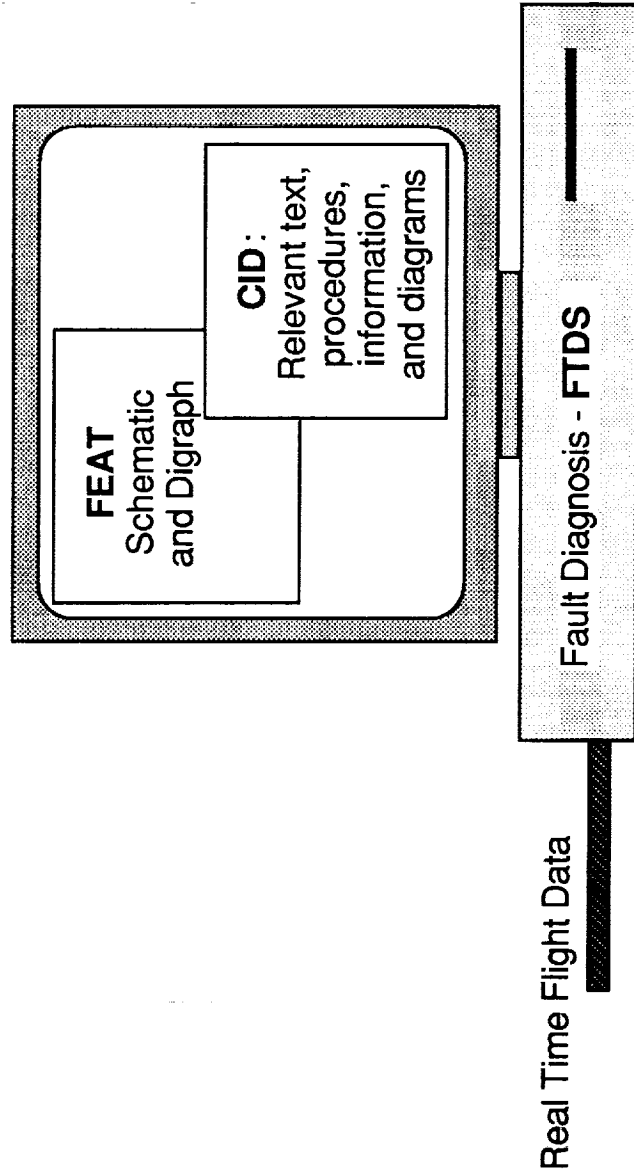
- **Fault trees allow propagation of component reliability/event probability information, and temporal failure relationships**
- **OBREL - An object-oriented programming tool for modelling systems using fault trees, and analyzing reliability at any node of the tree**
- **FTDS (Fault Tree Diagnosis System) - uses fault tree models combined with expert heuristics to diagnose system failures**
- **Digraph-to-Fault-Tree conversion code allows FEAT models to be converted to fault trees for reliability analysis and fault diagnosis modelling**
- **Modelling and diagnosis projects in progress:**
  - **F-18**
  - **Research Animal Holding Facility**



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# Control Room Advisory Tool

- Accesses real time data stream and activates failed nodes in FEAT and FTDS
- Displays appropriate FEAT Schematic and Digraph
- Diagnoses cause of failure(s) using FTDS
- Processes failure information/fault diagnosis and displays relevant text, procedures, information and diagrams using CID



# **F-18 Fault Diagnosis and Emergency Procedures**

## **APPROACH**

- **Incorporate F-18 HARV system information into:**
  - **Failure Environment Analysis Tool (FEAT)**
  - **Fault Tree Diagnosis System (FTDS)**
  - **Computer Integrated Documentation (CID)**
- **Restructure digraph models into fault tree format**
- **Integrate FTDS and CID into a real time advisory tool**

## BENEFITS OF OPTICAL PROCESSING

- Emphasis on hybrid digital/optical solutions, for a particular set of specialized problems
  - Not general purpose optical processing
- Low weight, power (thermal), and volume
  - Wire bundling not a problem
- Large geometries less susceptible to single event upsets
- Very high speeds for very large problems
  - Tradeoff = low resolution



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