

INTEGRATED ANALYSIS CAPABILITY
FOR LARGE SPACE SYSTEMS

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Program Objective

Develop "an integrated analysis computer program capable of performing the conceptual/preliminary structural system design analysis of large space systems in a highly efficient and rapid fashion."

Program Status

Contract NAS5-25767

Starting date: June 28, 1979

Duration of phase I: 10 months

Phase I:

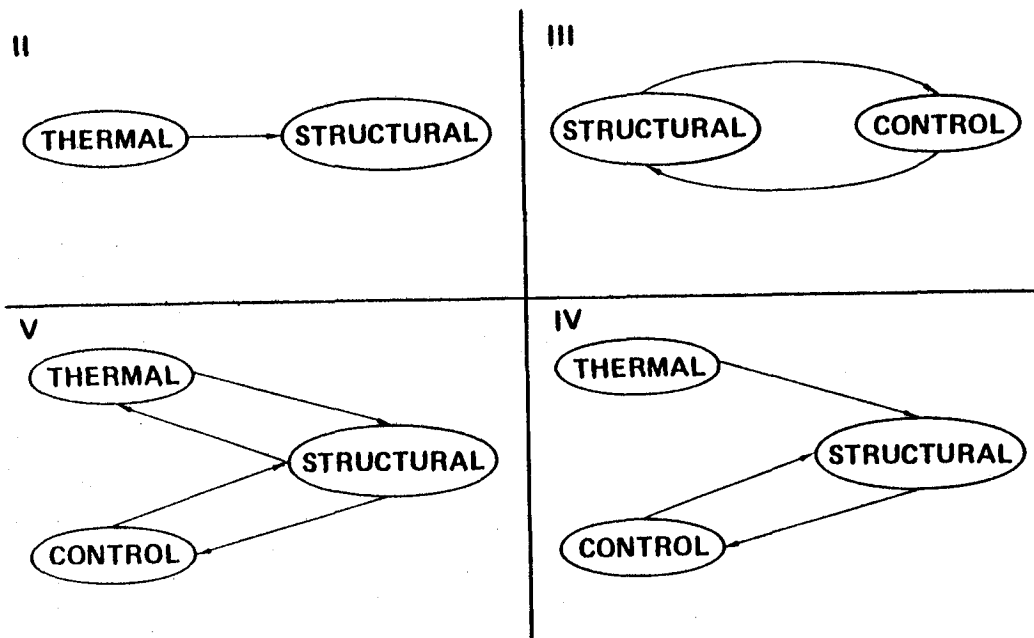
Task 1—Generate a detailed development plan for the IAC

Task 2—Produce a simplified pilot analysis code

IAC Specifications

- LARGE SPACE STRUCTURES DESIGN ANALYSIS
- THERMAL/STRUCTURAL/CONTROLS INTEGRATION
- LATE-CONCEPTUAL/EARLY-FINAL DESIGN
- EMPHASIZE EXISTING SOFTWARE
- EMPHASIZE NON-PROPRIETARY SOFTWARE
- PROJECT SIZE
 - 1 TO 50 USERS
 - 1 TO 5 USERS CONCURRENT
- HOST COMPUTERS — "VAX-LIKE"
 - LARGE VIRTUAL MEMORY
 - HANDS-ON USER ENVIRONMENT
 - LOW COST ANALYSIS
 - MODERATE SIZE PROBLEMS (500 NODES)
- EMPHASIZE INTERACTIVE GRAPHICS AND I/O
- GROWTH POTENTIAL — EASY INCORPORATION OF NEW MODULES
- PROGRAMMING LANGUAGE — FORTRAN '77
- SCHEDULE — OPERATIONAL FY-83

IAC - CAPABLE OF PERFORMING



IAC—Capable of Performing

- Thermal/structural analysis in a standalone mode
- Thermal/structural coupled analysis in a sequential mode
- Structural/control system coupled analysis
- Quasi-static thermal/structural/control system coupled analysis
- Fully coupled thermal/structural/control system analysis

INTERDISCIPLINARY DATA FLOW ITEMS

- II - THERMAL/STRUCTURAL
 - 0 THERMAL-LOADING (NODAL-TEMPERATURE) MATRIX
 - 0 MODEL DESCRIPTION
 - 0 MATERIAL DEFINITION

- III - STRUCTURAL/CONTROL
 - 0 NODE LOCATIONS
 - 0 MASS PROPERTIES
 - 0 STIFFNESS MATRIX
 - 0 DAMPING MATRIX
 - 0 MODE SHAPES
 - 0 "A" AND "B" MATRICES
 - 0 CONTROL ROUTINES

- IV - THERMAL/STRUCTURAL/CONTROL (TRANSIENT)
 - 0 ITEMS IN (II)
 - 0 ITEMS IN (III)
 - 0 THERMAL DEFORMATION (ELASTIC MODES)

- V - THERMAL/STRUCTURAL/CONTROL (FREQUENCY DOMAIN)
 - 0 ITEMS IN (III)
 - 0 CAPACITANCE/CONDUCTANCE MATRICES
 - 0 LINEARIZED RADIATION MATRIX
 - 0 NEW "THERMAL MODE" TECHNOLOGY ROUTINES/MODULES

Technical Modules

SYSTEM DYNAMICS

DISCOS

THERMAL

MSC NASTRAN

COSMIC NASTRAN

SPAR

TRASYS

SINDA

STRUCTURAL

MSC NASTRAN

COSMIC NASTRAN

SPAR

CONTROLS

ORACLS

Structural/System Dynamics

COMPUTER PROGRAMS

DISCOS - DYNAMIC INTERACTION SIMULATION OF CONTROLS AND STRUCTURE

- o APPLICABLE FOR LARGE SPACE STRUCTURES
 - MULTI-BODY CAPABILITY
 - CONTROL SYSTEM/STRUCTURE INTERACTION
 - LARGE DISPLACEMENT (NONLINEAR) TIME DOMAIN ANALYSIS
 - LINEAR TIME AND FREQUENCY DOMAIN ANALYSIS
- o USER CONVENIENCES
 - GRAPHICS OUTPUT
 - COMPUTER CODE MAINTAINED BY COSMIC
 - FLEXIBILITY FOR USER SUPPLIED SUBROUTINES

NASTRAN - NASA STRUCTURAL ANALYZER

- o WIDELY USED AND AVAILABLE COMPUTER CODE
- o MAINTAINED BY MACNEAL-SCHWENDLER CORP. (MSC) AND COSMIC
- o MANY TYPES OF STRUCTURAL ELEMENTS AVAILABLE
- o NASTRAN/DISCOS INTERFACE PROGRAM EXISTS

Thermal Programs

IN: TRAJECTORY, MOTIONS	RADIANT HEAT LOADS			THERMAL RESPONSE			OUT: TEMP. ON STRUCTURAL MODEL
	GENERALIZED GEOMETRY	INCIDENT FLUX		RADIATION		DIFFUSION (CONDUCTION, CONVECTION)	
		SIMPLE SHAPES	BLOCKAGE	EXCH. FACT.	HEAT TRANS.		
AVAILABLE PROGRAMS:	NASTRAN			NASTRAN			
	SINDA			SINDA			
	TRASYS-2						

RECOMMENDATIONS FOR INCLUSION IN IAC

<u>INCLUDE</u>	<u>DO NOT INCLUDE</u>	<u>TO BE DETERMINED</u>
ORACLES	EASYS MDELTA LAMP CSAP TAF OPTSYS	DOPTSYS DIGIKON MODEL ROMP

INTERDISCIPLINARY DATA FLOW

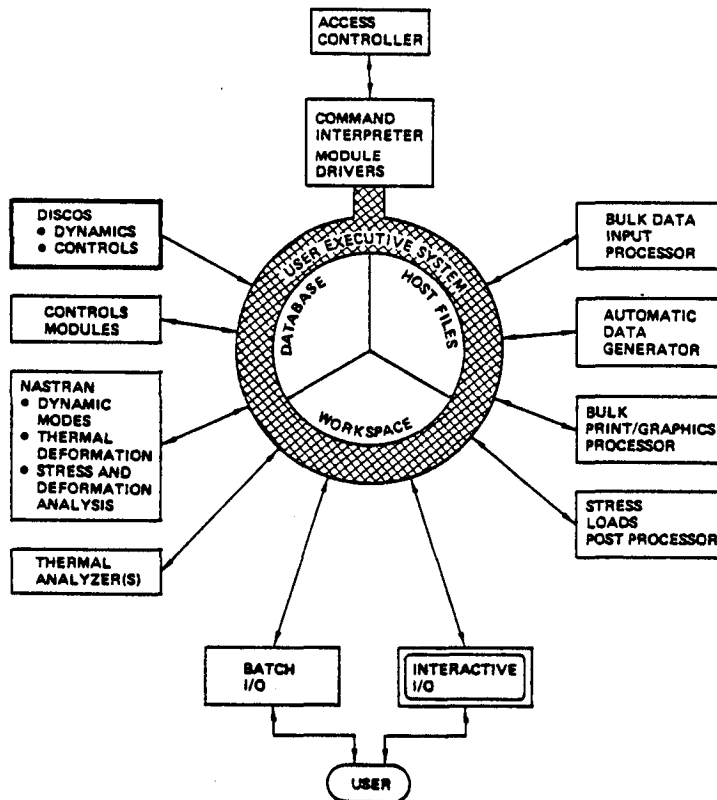
WHAT ARE THE BARRIERS?

- POOR GROSS-LEVEL COMMUNICATION TOOLS
 - ANALYSIS ON DIFFERENT MACHINES
 - STORAGE IN SEPARATE FILES
 - NON-STANDARD DATA ACCESS
- SPECIFIC DATA-FLOW ITEMS ARE ILL-DEFINED
- DATA INCONSISTENCIES
 - TECHNICAL FORM
 - FINITE-DIFFERENCE VS. FINITE ELEMENT MODELS
 - LUMPED VS. CONSISTENT MASS MATRICES
 - ABSOLUTE VS. RELATIVE ACCELERATION SOLUTIONS
 - BODY DEFINITIONS, TYPE OF CONNECTIONS
 - NUMBER AND TYPE OF MODES REPRESENTED
 - LEVEL OF DISCRETIZATION
 - ETC.
 - STRUCTURE
 - UNSTRUCTURED FILES
 - SPARSE/FULL MATRICES
 - RELATIONS
 - RECORD STRUCTURES
 - FORMAT
 - REAL VS. DOUBLE PRECISION
 - FORMATTED VS. BINARY
 - FIXED VS. FREE FIELD

HOW CAN BARRIERS BE OVERCOME?

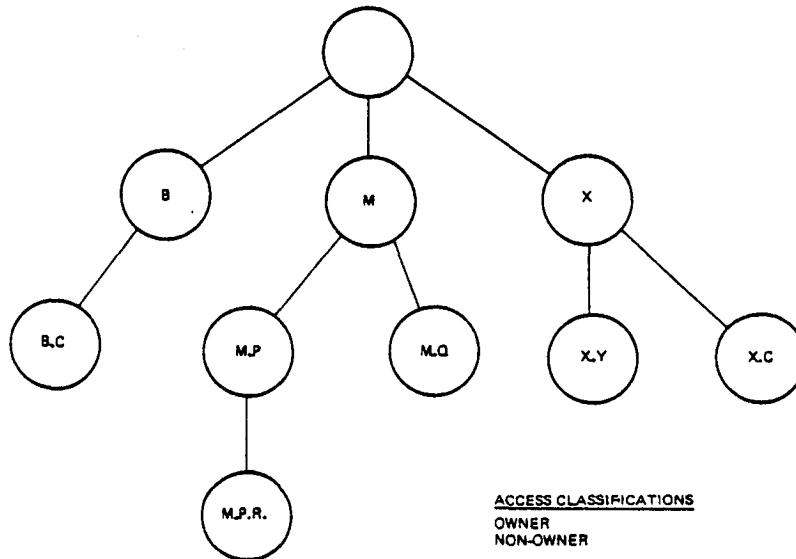
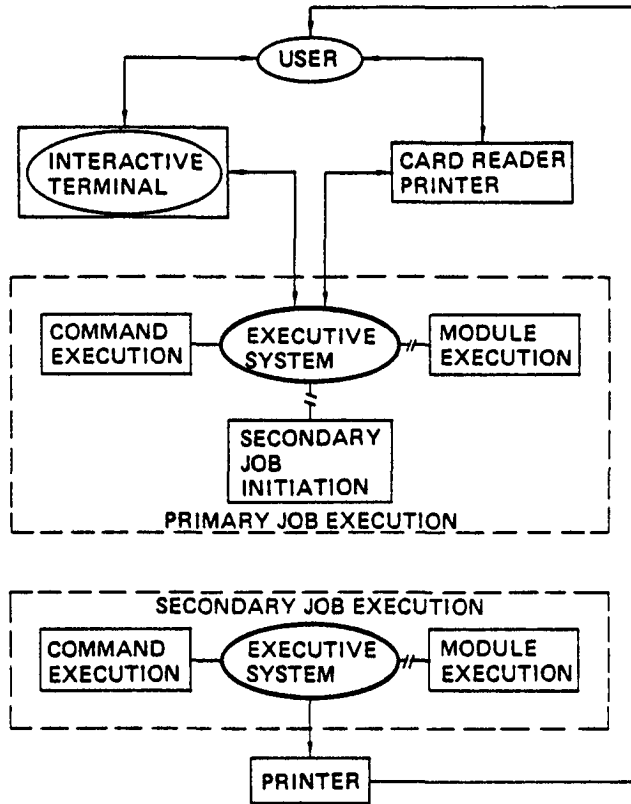
- PROVIDE A COMMON ANALYSIS SYSTEM AND DATABASE TOOL
- DEFINE AND ACCESS REQUIRED DATA-FLOW ITEMS
- OVERCOME DATA INCONSISTENCIES
 - INTEGRATE THE TECHNOLOGIES
 - DESIRABLE WHERE POSSIBLE
 - SOME REQUIREMENTS INHERENTLY DIFFERENT
 - PREVENTS USE OF SOME EXISTING SOFTWARE
 - CHANGES UNACCEPTABLE TO SOME USERS
 - ESTABLISH STANDARDS BUT PROVIDE INTERFACES
 - PREDEFINED FORMS/STRUCTURES/FORMATS
 - PERMANENT DATA STORAGE IS UNIQUE, NON-REDUNDANT
 - CONVERSIONS PERFORMED EACH TIME NEEDED
 - DEFINED BY SYSTEM SOFTWARE/MANAGER/USERS
 - IMPLEMENTED VIA MANDATE/GUIDELINE/COORDINATION
 - USE DATA REDUNDANCY
 - PERMANENT STORAGE OF ALTERNATE DATA FORMS
 - EACH USER/TECHNOLOGY KEEPS OWN FORMS
 - CONVERSION REQUIRED WHEN DATA IS GENERATED/MODIFIED
 - REVERSIONS NOT ALWAYS POSSIBLE (ESSENTIAL FEATURES DESTROYED)

INTEGRATED ANALYSIS CAPABILITY FOR DESIGN OF LARGE SPACE SYSTEMS



IAC Executive

COMMAND/MODULE/JOB FLOW



ACCESS CLASSIFICATIONS

OWNER
NON-OWNER

ACCESS PRIVILEGES

PARTITION - CREATE, GATE
PARTITION INDEX - READ, DELETE
DATA STRUCTURE - READ, WRITE, DELETE

Database Logical Organization

IAC/IPIP Study

PURPOSE

EVALUATE TECHNICAL FEATURES AND SOFTWARE OF IPIP FOR
POSSIBLE USE IN THE IAC

GROUND RULES

IPIP AVAILABLE ON VAX SYSTEM
IPIP SOFTWARE OF OPERATIONAL QUALITY
IPIP USER MODE (i.e., NO MODIFICATIONS OR MAINTENANCE)

EVALUATION CRITERIA

TECHNICAL COMPATIBILITY WITH IAC REQUIREMENTS
COMPATIBILITY WITH SHARED-USAGE VAX-LIKE ENVIRONMENT
RISK/PORTABILITY/GROWTH
IPIP/IAC DEVELOPMENT SCHEDULE
IAC COST (DEVELOPMENT/OPERATIONAL/MAINTENANCE)

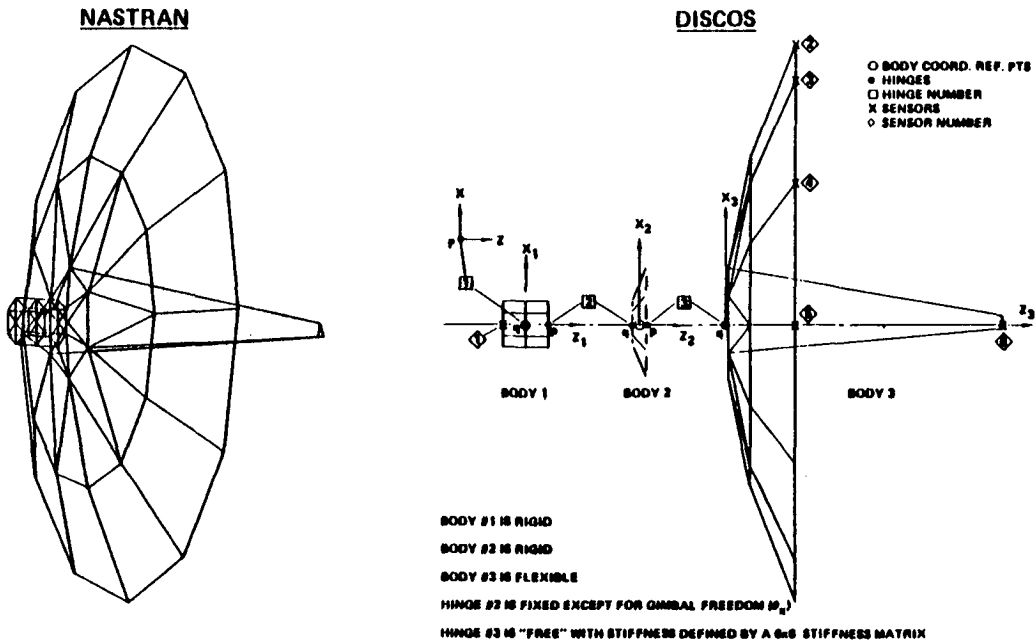
IAC Pilot Program

- TECHNICAL MODULES
DISCOS
MSC NASTRAN
- INTERFACE MODULES
NASTRAN THERMAL/STRUCTURAL
NASTRAN/DISCOS
- SOLUTION PATHS
THERMAL/STRUCTURAL
STRUCTURAL/CONTORLS
- EXECUTIVE
- DATABASE
- INTERACTIVE GRAPHICS
- VAX COMPUTER

Demonstration Problem

- 30-metre antenna
 - Bus
 - Reflector
 - Feed
- Solve two problem types:
 - Thermal/structural analysis
 - Structural/control analysis

IAC Demonstration Problem Structural Models



Work Breakdown Structure

1. MODULE INTERDISCIPLINARY DATA FLOW
2. EXECUTIVE SYSTEM
3. DATA HANDLING TOOLS
4. INTERACTIVE GRAPHICS
5. DEMONSTRATION AND ACCEPTANCE TESTING
6. MULTI-HOST COMPUTERS
7. DOCUMENTATION