# A PRAGMATIC MSC/NASTRAN ENVIRONMENT

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Presented at
MSC/NASTRAN Users Conference, March 15-16, 1979, Pasadena, California

## Abstract

The Vought Corporation has taken a pragmatic approach to the development and control of its MSC/NASTRAN environment which involves the users, the computer system and operation, related software, and applications. This presentation describes Vought's overall organization and approach for dealing with the MSC/NASTRAN environment. This environment has evolved over a nine year period into a workable, adequate situation keyed toward an efficient man and machine utilization.

## Introduction

As a hardware, production oriented company, the Vought Corporation takes a pragmatic approach to organizing and standardizing its analytical efforts involving MSC/NASTRAN. This pragmatic approach has been fully adaptable to previous analytical applications. It is undergoing a constant evolution as the capability and efficiency are enhanced to meet the requirements of new analytical applications. The assemblage of all MSC/NASTRAN related entities at Vought comprise an environment. The entities:

- MacNeal Schwendler Corporation's (MSC) technical services
- Vought's CDC 6600 computing system
- Documentation
- Users
- Pre and Post Processors
- Applications

make up Vought's MSC/NASTRAN environment.

This paper describes Vought's practical integration of these entities into a controlled, workable environment.

## Background

Vought's first analytical efforts using finite element analyses were of a Navy supersonic fighter wing skin in the late 1950's. The matrix force method was used with handwritten equations and sliderule computations of flexibility coefficients. An IBM 704 computer solved the equations based on hand-picked redundants. This force method evolved to include automatic equation writers, automatic redundant selection, substructuring, strength and stiffness resize, large load case capacity, and sophisticated output formatting. The resulting

Force Analysis Program System (FAPS) was executed on an IBM 360. At its peak, FAPS interfaced with the Lockheed California force method system where substructure influence and loads matrices were passed between the two companies. Tapes and documentation for COSMIC/NASTRAN were obtained by Vought in January 1970. The following March, MSC's Mac McCormick and Keith Redner installed COSMIC/NASTRAN on Vought's IBM triplex system. Training classes and evaluation studies followed. The advent of advanced composites, new trends in structural analysis and NASTRAN's promosing capability signaled an end to the force method and FAPS. Maintenance of COSMIC/NASTRAN proved to be a formidable task. In April 1972, MSC/NASTRAN was leased and installed at Vought. The technical services, enhanced efficiency of new versions, and documentation supplied by MSC under terms of its lease have proven to be a cost effective and beneficial arrangement for Vought. Currently, MSC/NASTRAN, Version 48A, executes on Vought's CDC 6600 which is dedicated to engineering jobs.

Vought's practical MSC/NASTRAN environment has evolved from its business base. Analytical requirements of this base have necessitated the interface of numerous structural analyses and related software packages. Prime and sub-contract design analysis activities have included data interfaces between technical disciplines and companies. These software and data interfaces have had dependancies on MSC/NASTRAN. The interfaces, accomplished by numerous methods, contributed to an environment that demonstrates adaptability. The business base has included applications for:

- o Aircraft
- o Spacecraft
- o Missiles
- o Ground Transportation
- o Automotive

No single analytical endeavor among the above applications has been like a previous endeavor. Needed changes have resulted and the environment and its capability have grown.

The most significant factor in the evolution of Vought's Pragmatic MSC/NASTRAN Environment has been the lessons learned. Errors in applications or approaches have revealed a better way to get the job done. Better ways of getting the job done with NASTRAN have been evolving for nine years at Vought and they will continue to evolve as manpower and cost efficiencies become prime objectives for the Pragmatic MSC/NASTRAN Environment.

NASTRAN Support Engineer

For any software system, regardless of size, there must be a key person or persons who are knowledgeable and experienced with that software. The Vought Structural Technologies Section's software is keyed by Computer Applications Specialists. One of these specialists also assumes the role of the NASTRAN Support Engineer (NSE). The NSE provides and controls the continuity between Vought's Computing and Engineering Departments and MSC's Manager of Engineering Applications in all matters involving the MSC/NASTRAN environment. Vought

employs a project/technical discipline matrix organization system. The technical disciplines provide the "how-to-do-the-job" to the project's "what-job-is-to-be-done." Vought's NASTRAN users are stress and dynamic analysts conducting actual hardware, production design. Vought's nine year NASTRAN experience has shown that a specialized finite element modeling (FEM) group is not always fully cognizant of design problems. Additionally, zero base budgeting has proven that such modeling groups are a luxury that are not necessarily essential. Vought utilizes its experience, the NSE's ability, the cooperation of management, the Computer Department's cooperation, and the stress and dynamic analyst's capabilities to provide adequate structural analyses with its MSC/NASTRAN environment.

The NSE's duties are well defined. As the key NASTRAN person, the NSE oversees the company's MSC/NASTRAN operation and everything applicable to it. Vought is an open-shop programming company which facilitates direct involvement of the NSE in all computer related aspects of the environment. The NSE conducts the complete installation of the MSC/NASTRAN deliverable. The deliverable has been highly refined by MSC since Vought's 1972 initial installation. The installation is systematic and straightforward. The Computer Department's systems and programming staffs are available for consultation. However, MSC provides a clear deliverable processing method requiring little debugging.

The NSE maintains, interprets and distributes all the environment's documentation. This documentation has both MSC and Vought origins. Interfacing with the Computer Department to provide for the best possible handling and turn-around of MSC/NASTRAN jobs is the NSE's responsibility. The users look to the NSE for problem approaches, methods, data generation techniques, and MSC/NASTRAN applications. The execution procedures, providing a standard way of running jobs within the MSC/NASTRAN environment, are maintained by the NSE.

The NSE provides inputs to management in regards to past, present and future requirements for MSC/NASTRAN. Additionally, the NSE provides for user mini-training classes in Fortran, job control cards, intercom terminals, modeling and applications.

The NSE is the single point contact with MSC. All Vought contacts with MSC must be made by the NSE or be made with his approval based on the type of contact. This mode of operation has resulted in a better learning curve, the collation of user errors, and minimal disruption to both Vought and MSC. Since the NSE filters user errors and problems, quick resolution through fixes or alternate applications often results.

The practicalities and philosophies of the MSC/NASTRAN environment described in this paper result in a minimum effort by the NSE. The primary objective of the NSE is to standardize and control the environment in such a manner that his time is devoted to user assistance.

## Computer Turn-Around

Efficient computer turn-around is necessary for all of Vought's engineering problem analyses. Vought's Scientific Computer Center is configured to provide

rapid response to on-demand work loads. This dedicated to engineering computer system is continually evaluated for utilization and through put. Changes in hardware and/or software are often made to enhance turn-around efficiency in response to current or particular utilization and through put.

The Scientific Computer Center is equipped with a CDC 6600 system having a 131,072 word central memory and 589.5 million character mass storage. The Network Operation System/Batch Environment (NOS/BE 1.1) operating system software is used. Vought engineering jobs are disk oriented but tape storage is provided by both 7 and 9 track drives. A CDC 1700, used as a hardwired high speed remote terminal to the 6600 mainframe, is the primary batch station for Vought engineering. Four Harris low speed remote terminals meet the batch communication needs of engineering projects located throughout Vought's Dallas facility.

Interactive graphics capability is provided by a CDC 777 Cybergraphics Console. Additionally, Tektronix 4014 terminals offer low speed graphics capability. Numerous terminals provide INTERCOM interactive capability. Typewriter terminals include Decwriter II, Teletype, and Texas Instrument types. CRT terminals are ADDS 980. These terminals are located throughout the Vought facility. Utilization records on each terminal allow their movement to meet the job demand requirements of engineering projects. A Tektronix FEM 181 interactive, off-line graphics system is on order with a June 1979 delivery date.

The configuration and utilization of this computer center along with continual monitoring of resource usage and requirements is a substantial plus to the MSC/NASTRAN environment. The characteristics of high central memory, high mass storage, and I/O bound computations often vary substantially from the engineering job norm. Operations handling of MSC/NASTRAN jobs have been set up to provide special handling. The previous mentioned characteristics and MSC/NASTRAN executing on a mainframe with special handling privileges could be a detriment to the majority of other engineering jobs. However, these detriments have been avoided by a prescribed queueing procedure. MSC/NASTRAN and all files in the MSC/NASTRAN environment are disk resident. All jobs executing MSC/NASTRAN fall into three batch classes. No MSC/NASTRAN executions are allowed to be interactive. There are time (T), central memory (CM), mass storage (MS), and tape (TP) constraints placed on these job classes as follows:

| CLASS | JOB NAME | T(SEC) | CM(WORDS) | MS(BLOCKS) | TP |
|---|---|---|---|---|---|
| Normal | YNAS | $<500_8$ | $\leq 160K_8$ | $\leq 1200_8$ | None |
| Zero Priority | ZNAS | No Limit | $<300K_8$ | $\leq 6400_8$ | No Limit |
| Special Handling | ZNAS | No Limit | $>300K_8$ | No Limit | No Limit |

The above constraints can be altered depending on the CDC 6600 utilization. All MSC/NASTRAN jobs are front ended by the program NASGATE. NASGATE checks the job name and compares it against the class and its constraints. If any constraints are violated, NASGATE aborts the job. All YNAS jobs are queued and executed automatically by the system. ZNAS, having zero priority (P0), jobs must be queued by the mainframe operator. Once queued into execution, NASGATE takes over. Two ZNAS jobs will not be allowed to execute simultaneously. The operator exercises this control by queueing up one ZNAS at a time. If he accidentally queues up a second ZNAS for execution prior to the first's

completion, NASGATE aborts the second. Special handling jobs require pre-submittal communications. NASGATE does not recognize special handling, but operators are authorized to flush any ZNAS job from the system which requires special handling which has not been communicated.

These operational handling procedures are extremely productive, both in heavy utilization and low utilization periods. Vought's Systems and Operations and Programming Support Service staffs have been extremely cooperative in developing an efficient execution for the MSC/NASTRAN environment.

Although not totally turn-around related, cost utilization of the computer resources is highly important. It is the NSE's duty to interpret job costs for the MSC/NASTRAN user. Efficiency of getting the job done and the specific application requirements along with data handling dictate the options of what and how resources are to be used. The resources must be parlayed with costs to provide the best utilization of both manhour and computer budgets.

Documentation

The MSC/NASTRAN documentation published by MSC consists of a superior set of manuals which is being revised constantly. The MSC/NASTRAN Users Manual and MSC/NASTRAN Applications Manual are comprehensive and complete. The MSC/NASTRAN Programmer's Manual has been a tremendous aid to Vought. This manual has enhanced Vought's ability to interface MSC/NASTRAN with other software and data. Additional usage of this manual has been the debugging of user errors by determining just what NASTRAN was doing when an error message and/or an abort occurred.

The MSC/NASTRAN environment is heavily dependent on Control Data Corporation publications for languages and utilities. The Vought CDC 6600 Users Guide is a comprehensive manual describing special installation features such as control cards, system mods, cataloged procedures, and special libraries. The Structural Technologies Section documents its MSC/NASTRAN pre and post processors as Structural Computer Applications Procedures (SCAP). The SCAP system is also used to describe special applications such as the deliverable installation and use of the CDC/UPDATE facility to maintain NASTRAN data decks.

The Nastran Operations Manual is the key to execution of MSC/NASTRAN on the Vought CDC 6600. This manual will be discussed more fully in the next section of this paper. User Memos are used to describe handling or clarification of a MSC/NASTRAN data item for input and/or output. A Flash Bulletin publishes the latest general limitations, error lists, and special idiosyncrasies.

Vought uses the SITESUB routine to XBOOT, the MSC/NASTRAN CDC loader, as a means of broadcasting the status of documentation. Entries are made in the output file and dayfile of each MSC/NASTRAN execution providing applicable documentation and assistance information.

## Operations Manual

Vought has had some form of a NASTRAN job control card manual since the first NASTRAN installation on an IBM 360. The manual, having varied names, has taken the form of crude handwritten notes and typed reports including handwritten revisions on every page. The current Operations Manual is fully computerized. The complete text is a BCD image disk file. This manual is maintained with CDC/UPDATE and INTERCOM. It can be deprinted by the user at any time.

The Operations Manual lists the primary MSC/NASTRAN environment documentation and latest dates of revision. A complete description of Computer Department interfaces is given including:

- Operations Manager
- Mainframe Operators
- Batch Terminal Operators
- Tape Librarian
- Systems Analysts
- Programmer Analysts

The use of computer resources are also discussed. Usage of tapes and disks and the options for selection of either are discussed. The entry, use and meaning of job time estimates, central memory, and mass storage are related. Convenient conversion tables between octal and decimal numbers are provided.

The primary purpose of the Operations Manual is to describe the execution procedures (NASTRANPROC) for the MSC/NASTRAN environment. The manual describes how the NASTRANPROC is constructed and used based on defaults and acceptable overrides. The manual describes over twenty example setups for executing activities in the MSC/NASTRAN environment. These example setups are for standardized, basic runs. Additional manuals are referenced to obtain access to additional features of the MSC/NASTRAN environment.

The current form of the Operations Manual and its computerization has provided a significant aid to standardization. It has simplified the NSE's internal documentation distribution and has resulted in an always up to date manual immediately accessible to the user.

## NASTRANPROC

Vought computer applications include many cataloged procedures to simplify the man/machine interface. A cataloged procedure contains all the job control cards necessary to execute a specific application and the user need only name the procedure instead of inputting all the applicable job control cards. There are defaults and an override capability exists. The University of Washington's BEGIN/REVERT system, modified by Vought, is the procedure system used. The procedures executing the MSC/NASTRAN environment currently reside in the NASTRANPROC file. A command to NASTRANPROC takes the form of:

```
BEGIN(NASTRAN,P2,P3,....,P15)
```

where P2 through P15 are parameters. The parameters have defaults and may be overridden by sequentially supplying a replacement. The BEGIN command is somewhat analogous to a subroutine call argument list in Fortran.

Sample uses of NASTRANPROC are:

- Simple NASTRAN execution

```
YNAS,_ _ _ .
PROJECT,_ _ _ .
BEGIN(NASTRAN)
```

- Disk checkpointed NASTRAN execution

```
ZNAS,_ _ _ .
PROJECT,_ _ _ .
BEGIN(NASTRAN,,DCE,215,24,ION,,GRATKE,,,30,XWING)
```

- Tektronix 4014 display of cataloged PLT2 File

```
LOGIN,_ _ _
ATTACH,PLT2,_ _ _
BEGIN(NASTRAN,,PG)
```

The simple example makes use of all defaults. The disk checkpointed execution (DCE) makes appropriate overrides for:

- CM (215 for $215000_8$ words)
- MS (24 for $2400_8$ blocks)
- ION for INPUT,OUTPUT,NASPUN where the restart dictionary is written to NASPUN
- Gratke for the file owner of the dictionary and NPTP
- 30 for retention period days of the file
- XWING for the permanent file name (XWINGREST for the dictionary and XWINGNPTP for NPTP).

The Tektronix 4014 procedure displays a MSC/NASTRAN PLT2 file catalogued in a previous batch job. The interactive plot graphics (PG) procedure executes NASPLOT loaded with the Vought developed CALTEK library in place of the CALCOMP library. The CALTEK library accepts CALCOMP calls but converts them to Tektronix 4014 displays.

NASTRANPROC provides access to approximately 109 procedures including other PROCs which are slaved to it for additional applications or processing. In summary, NASTRANPROC provides various ways of executing, handling or calling up:

- o MSC/NASTRAN execution
- o Checkpoint with disk or tape
- o Restart with disk or tape
- o Plotting, CALCOMP
- o Graphics, Tektronix 4014
- o Operations Manual print
- o NASTRANPROC print
- o PPNOD (processing of MSC/NASTRAN OUTPUT2 and OUTPUT4 files)
- o NERPSPROC (element resizing, strength and stiffness)
- o STRESSPROC (processors and general utilities)
- o INSTALPROC (installation of deliverable)

NASTRANPROC and the MSC/NASTRAN environment software developed by Vought utilize many special approaches to accomplish a desired task. Some of these approaches might be classified as "tricks"; however, their intent is toward a pragmatic job result. These tricks are contained in the Computer Department's user library, ESSLIB, and their public procedures file, PROFIL. Additionally, the Structural Technologies library UTILITYLIB contains routines and processors oriented towards the MSC/NASTRAN environment.

The NASTRANPROC is maintained by the NSE. It is readily accessible for updating via an interactive terminal and INTERCOM. The NASTRANPROC is experiencing continued growth and revision as capability and better approaches are realized. The NASTRANPROC standardization has reduced job control card errors and has simplified the consultation between the NSE and users.

## Conclusion

The Vought Corporation has taken a practical approach to the organization, standardization, adaptability and efficiency of all entities making up the MSC/NASTRAN environment. Nine years of NASTRAN experience, activity on two different computer mainframes, a multitude of applications, and the technical services of the MacNeal Schwendler Corporation have resulted in a smooth working environment. Efforts of a NASTRAN Support Engineer, efficient computer turn-around, supportive documentation, and the NASTRANPROC provide a fully adequate analysis capability for the Vought MSC/NASTRAN users.

This paper could assist other MSC/NASTRAN user shops in developing their environment. The common goal of such user shops is to provide adequate structural analysis, ensuring structural integrity, in the most efficient manner. Vought believes its Pragmatic MSC/NASTRAN Environment exhibits such efficiency.

# A PRAGMATIC MSC/NASTRAN ENVIRONMENT

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PRESENTED AT

MSC/NASTRAN USERS CONFERENCE

MARCH 15 - 16, 1979

PASADENA, CALIFORNIA

- PRAGMATIC
  - ORGANIZATION
  - STANDARDIZATION
  - ADAPTABILITY
  - EFFICIENCY
- MSC/NASTRAN
  - STRUCTURAL ANALYSIS SYSTEM
  - LARGE SCALE, GENERAL PURPOSE
- ENVIRONMENT
  - MSC's TECHNICAL SERVICES
  - VOUGHT's CDC 6600
  - DOCUMENTATION
  - USERS
  - PRE AND POST PROCESSORS
  - APPLICATIONS

# TOPICS FOR CONSIDERATION

BACKGROUND

NASTRAN SUPPORT ENGINEER (NSE)

COMPUTER TURN-AROUND

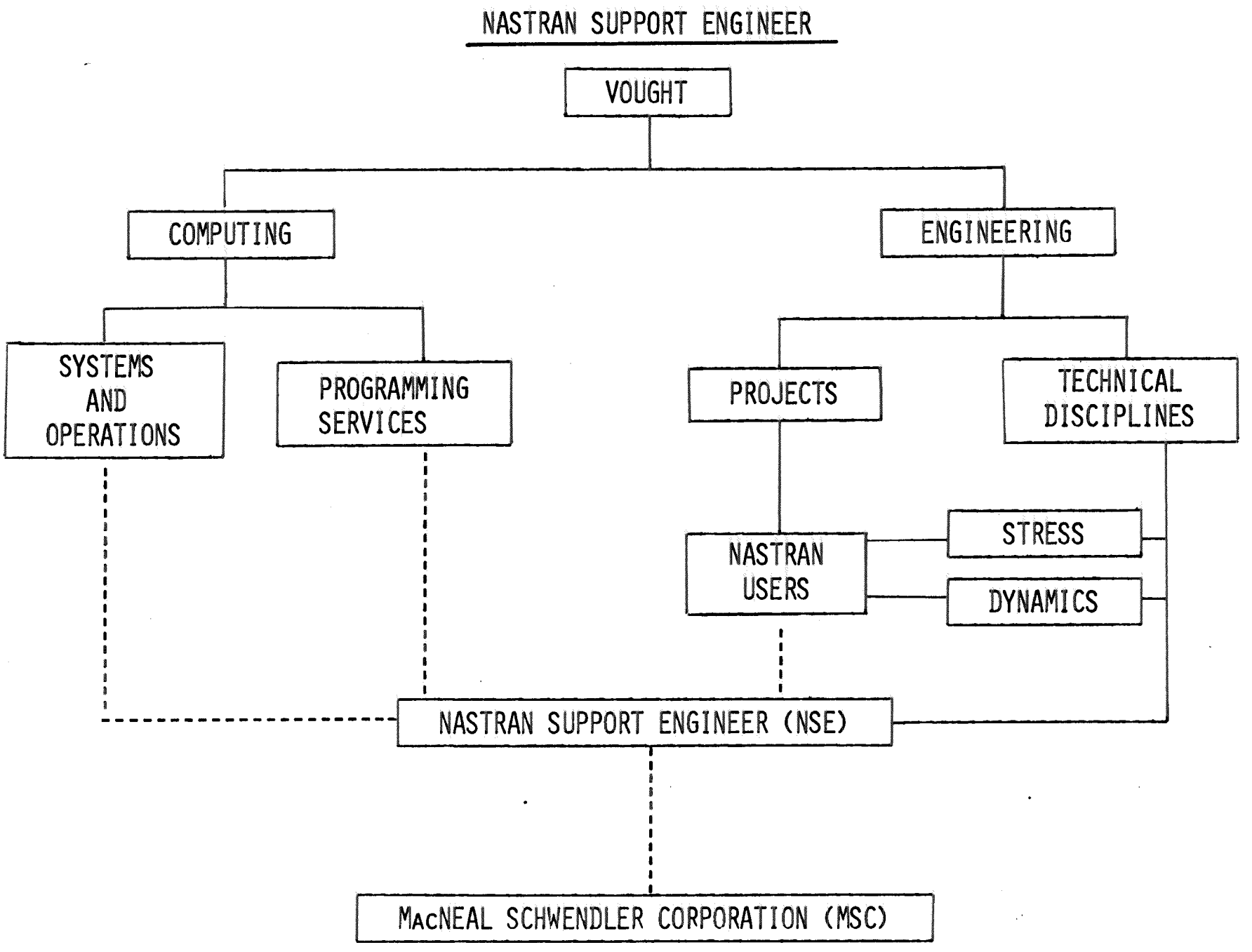
DOCUMENTATION

OPERATIONS MANUAL

NASTRANPROC

# BACKGROUND

- HISTORY WITH NASTRAN
  - MARCH 1970 — COSMIC/NASTRAN INSTALLATION
  - APRIL 1972 — MSC/NASTRAN INSTALLATION
  - JANUARY 1979 — MSC/NASTRAN, VERSION 48A
- APPROACH
  - INTERFACE STRUCTURAL ANALYSIS SOFTWARE
  - INTER DISCIPLINE DATA INTERFACE
  - INTER COMPANY DATA INTERFACE
- APPLICATIONS AND REQUIREMENTS
  - AIRCRAFT
  - SPACECRAFT
  - MISSILES
  - GROUND TRANSPORTATION
  - AUTOMOTIVE
- LESSONS LEARNED
  - EXPERIENCE
  - ERRORS


NASTRAN SUPPORT ENGINEER
VOUGHT
COMPUTING
ENGINEERING
SYSTEMS AND OPERATIONS
PROGRAMMING SERVICES
PROJECTS
TECHNICAL DISCIPLINES
NASTRAN USERS
STRESS
DYNAMICS
NASTRAN SUPPORT ENGINEER (NSE)
MacNEAL SCHWENDLER CORPORATION (MSC)

## NASTRAN SUPPORT ENGINEER

- OVERSEES MSC/NASTRAN ENVIRONMENT
- CONDUCTS INSTALLATION OF DELIVERABLE
- MAINTAINS AND INTERPRETS DOCUMENTATION
- INTERFACES WITH COMPUTER DEPARTMENT
- CONSULTS WITH USERS
- MAINTAINS EXECUTION PROCEDURES
- PROVIDES INPUTS TO MANAGEMENT
- SINGLE POINT CONTACT WITH MSC

## COMPUTER TURN-AROUND

- COOPERATION WITH COMPUTER DEPARTMENT
- COMPUTER RESOURCE UTILIZATION
- NASTRAN EFFECTS ON ALL COMPUTER JOBS
- NASTRAN SUBMITTAL (BATCH)
  - CONSTRAINTS (DESIGNED FOR ON DEMAND RESPONSE)

| JOB NAME | TYPE | $T_8$ | $CM_8$ | $MS_8$ | TAPES |
|---|---|---|---|---|---|
| YNASI | NORMAL | $\leq$500 | $\leq$160K | $\leq$1200 | NONE |
| ZNASI | '0' PRIORITY | NO LIMIT | $\leq$300K | $\leq$6400 | NO LIMIT |

  - CONTROL - NASGATE

    CHECKS CONSTRAINTS

    ABORTS IF CONSTRAINTS VIOLATED

  - SPECIAL HANDLING

    CM > 300 $K_8$

    MS UNLIMITED

- COST UTILIZATION OF COMPUTER RESOURCES
  - EFFICIENCY
  - APPLICATION REQUIREMENTS

# DOCUMENTATION

- MSC MANUALS
- CONTROL DATA MANUALS
- VOUGHT CDC 6600 USERS GUIDE
- STRUCTURAL COMPUTER APPLICATIONS PROCEDURE (SCAP)
  - PRE AND POST PROCESSOR USER MANUALS
  - SPECIAL APPLICATIONS MANUALS
- NASTRAN OPERATIONS MANUAL FOR VOUGHT CDC 6600
- USER MEMOS
- FLASH BULLETIN
- SITESUB (XBOOT SUBROUTINE)

## OPERATIONS MANUAL

- STORED AS A DISK FILE
- MAINTAINED WITH CDC INTERCOM AND UPDATE
- LISTS DOCUMENTATION DATA STATUS
- DESCRIBES INTERFACES WITH
  - OPERATIONS MANAGER
  - MAINFRAME OPERATORS
  - BATCH TERMINAL OPERATORS
  - TAPE LIBRARIAN
  - SYSTEMS ANALYSTS
  - PROGRAMMER ANALYSTS
- DISCUSSES COMPUTER RESOURCES
  - DISK AND TAPE
  - TIME, CENTRAL MEMORY, MASS STORAGE
  - OCTAL/DECIMAL CONVERSION
- DESCRIBES USE OF EXECUTION PROCEDURES (NASTRANPROC)
  - BEGIN/REVERT PROCEDURES OVERVIEWED
  - DEFAULTS AND OVERRIDES
  - EXAMPLE SET-UPS

## NASTRANPROC

- o DESIGNED TO SIMPLIFY MAN/MACHINE INTERFACE
- o WRITTEN AND MAINTAINED BY NSE
- o DESIGNED TO STANDARDIZE ALL NASTRAN JOBS
  - DOCUMENTATION EFFORT IS SIMPLIIFED
  - PHONE CALL CONSULTATION WITH USERS SIMPLIFIED
  - JOB CONTROL CARD ERROR TRACEBACK SIMPLIFIED
- o FULLY ADAPTABLE
  - IMMEDIATE ACCESS BY NSE FOR SPECIAL MODIFICATION OR REVISION
- o USER TIME EMPHASIZES MODELING AND ANALYSIS VS. JOB CARD SET-UPS
- o DELIVERABLE INSTALLATION DONE WITH PROCS

## NASTRANPROC SAMPLE USES

- SIMPLE NASTRAN EXECUTION

```
YNASG,T400,CM160000.
PROJECT, _ _ _ .
BEGIN(NASTRAN)
```

- DISK CHECKPOINTED NASTRAN EXECUTION

```
ZNASG,T1500,CM215000,PO.
PROJECT, _ _ _ .
BEGIN(NASTRAN,,DCE,215,24,IØN,,GRATKE,,,30,XWING)
```

- TEKTRONIX 4014 DISPLAY OF PLT2 FILE

```
LOGIN, _ _ _
ATTACH,PLT2, _ _ _
BEGIN(NASTRAN,,PG)
```

## NASTRANPROC (ACCESS TO 109 PROCEDURES)

- o MSC/NASTRAN EXECUTION
- o CHECKPOINT (DISK OR TAPE)
- o RESTART (DISK OR TAPE)
- o PLOTTING (NASPLOT OR SPLOTS) CALCOMP
- o GRAPHICS (NASPLOT OR SPLOTS) TEKTRONIX 4014
- o OPERATIONS MANUAL PRINT
- o NASTRANPROC PRINT
- o PPNOD (PROCESSING OF ØUTPUT2 AND ØUTPUT4 FILES)
- o NERPSPROC (ELEMENT RESIZE)
- o STRESSPROC (PRE/POST PROCESSORS AND GENERAL UTILITY)
- o INSTALPROC (INSTALLATION OF DELIVERABLE)

## CONCLUSION

NASTRAN SUPPORT ENGINEER

+

COMPUTER TURN-AROUND

+

DOCUMENTATION

+

OPERATIONS MANUAL

+

NASTRANPROC

=

PRACTICAL

- o ORGANIZATION
- o STANDARDIZATION
- o ADAPTABILITY
- o EFFICIENCY