NASTRAN STATUS AND PLANS

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SUMMARY

Current status and future NASA plans for the NASTRAN program are presented and discussed. Information is also presented to indicate the extent of NASTRAN use throughout the world.

INTRODUCTION

Use of the NASTRAN structural analysis computer program has become widespread since it was released to the public in 1970. The last status report on NASA's plans for NASTRAN was presented two years ago. (See ref. 1.) Since then, some fundamental changes have occurred both in technical aspects of the program and in NASA management policies. This paper summarizes the current status and NASA plans regarding the use, improvement, maintenance, and dissemination of NASTRAN.

CURRENT STATUS OF NASA ACTIVITIES

NASA's efforts are managed through the NASTRAN Systems Management Office (NSMO), which serves as a focal point for dissemination of NASTRAN information. The activities of this office are discussed subsequently in four different categories: use, improvements, maintenance, and dissemination.

Use

To get a better definition of NASTRAN use, 1200 Newsletter Address Up-dating forms were sent to users in May, 1974. Results from the 455 responses to that survey are shown in figure 1. The total number of known computer installations of the program is 269. Each respondee was asked to estimate the number of users at his installation, and an average number of users was determined from all of that company's respondees. Based on this process, the responding organizations have approximately 2300 users. Since not all users responded and not all users get the newsletter, these numbers are probably conservative. One significant fact is the large number of nonaerospace users that appear.

Survey results showing estimates of NASTRAN computer usage by the respondees in CPU hours/month are shown in figure 2. Also shown is the distribution of the number of users among various categories. A total of over 5000 CPU hours per month are being used on NASTRAN activities, with over 3/4 of this computer use being from nongovernment and non-aerospace users. The estimated number of users, however, indicate more persons in the government and aerospace categories.

Improvements

A broad overview of current improvements for NASTRAN is diagramed in figure 3. Since the last public release level, Level 15.5, a large number of improvements have been completed and are undergoing tests. These improvements were defined in some cases as long ago as the last NASTRAN colloquium, and will be included in Level 16. They include:

(1) Static analysis using cyclic symmetry (Rigid Format 14)

(2) Normal modes analysis using cyclic symmetry (Rigid Format 15)

(3) Isoparametric solid hexahedra elements, CIHEXi

(4) Subsonic modal flutter analysis (APP AERO, Rigid Format 10)

(5) Static analysis with differential stiffness (Improved Rigid Format 4)

(6) Normal mode analysis with differential stiffness (Rigid Format 13)

(7) Axisymmetric solid of revolution elements, TRIAAX and TRAPAX

(8) Identical element matrix generation (CNGRNT Feature)

(9) Fully stressed design (OPTPR1 and OPTPR2 Modules)

(10) Element strain energy and grid point force balance (GPFDR Module)

(11) Complex modal displacement plots (CMODAL Plot Option)

The first four of these are mentioned in ref. 2 and are discussed elsewhere. The specific content of the last seven improvements is presented in detail in ref. 2, and is not discussed in the present paper.

Additional improvements identified as current improvements on figure 3 will also be incorporated in Level 16 before it is released. Estimated release date for Level 16 is now March 1976. The most important of these current improvements are discussed in two papers in the proceedings (refs. 3 and 4). Finally, there are also some planned improvements that are in progress or just beginning development and will not be available in time for Level 16 release. They will be incorporated in a post-Level 16 release and are identified in a later section of this paper.

Maintenance

As also shown on figure 3, error correction and dissemination by NASA is continuing and now embodies an Error Correction Information System (ECIS) that allows users to receive information more quickly on all reported errors. This system is described in still another proceeding's paper (ref. 5).

Dissemination

Since the last colloquium, NASA has implemented a new policy on dissemination of technology, including computer software, called FEDD (For Early Domestic Dissemination). This policy requires early dissemination to domestic users of any technology having significant commercial potential and which was developed at government expense. It also requires that such information be controlled for a period (typically two years) before foreign dissemination is permitted. NASTRAN levels above Level 15.5 are currently designated as "FEDD" information and therefore will be constrained from foreign distribution for a two-year period. The possibility of quid-pro-quo exchanges still exist, when it is to the advantage of the government.

Another important new NASA decision is to lease NASA funded software to domestic corporations at a yearly rate sufficient to support a portion of the maintenance costs of the software. Leases will be written to restrict the use of the software to a specific computer at a definite location and thus, facilitates the necessary control of dissemination of future levels, designated as FEDD. The entire leasing arrangement is handled for NASA by the Computer Software Management Information Center (COSMIC) at the University of Georgia. In the case of NASTRAN, levels that are not designated as FEDD information will be leased overseas at higher fees to recoup some of the large development costs of the present NASTRAN system.

CURRENT AND PLANNED IMPROVEMENTS

NSMO has three current improvements in progress. They are shown in figure 4, are nearing completion and, after testing, will be incorporated into Level 16 before it is released. The automated substructuring and DMAP language improvements are discussed in references 3 & 4. NASTRAN users also wanted more complete checks to be made on the condition of generated matrices before and during decomposition not after. These conditioning checks and accuracy estimates are being completed and also will be incorporated in Level 16 before it is released.

Also shown in figure 4 are a number of planned improvements that are scheduled for installation in the next level after Level 16. These capabilities include:

1. The FEER method of eigenvalue extraction (see ref. 6):

   This fast tridiagonal modal reduction has been extended to complex eigenvalue problems and to allow specification of frequency ranges to be searched. This capability is being prepared for installation.

2. Supersonic flutter and gust response:

   The aerodynamic theories include piston theory, strip theory, and Mach box theory. The calculation of gust loads and their power spectral density is included, and Fourier transform modules have been added. For a more detailed discussion of this capability, see references 7 and 8. The supersonic flutter and gust response package is nearly complete, and incorporation in a standard NASTRAN level will commence soon. Some improvements to the previously completed subsonic flutter capability have also been developed under contract.

3. A NASTRAN data generator:

   A general program to generate NASTRAN input data from a minimum of geometric information will be contracted for and installed within NASTRAN, possibly in a link by itself. This effort is just starting.

4. Some new NASTRAN elements:

   A. A rigid element will be added to allow general connection of a number of grid points with a variety of degrees of freedom. This element would essentially allow constraint equations to be generated. The element is generated and currently being debugged.

   B. Two new ring elements will be added (triangular and trapezoidal). These axisymmetric elements would allow nonaxisymmetric loads and calculate the higher harmonics. These elements are also being debugged.

   C. A 6-node triangular membrane element will be added that will have linear varying strain and allow for linear thickness and temperature variations. This element is currently being checked out in a stand-alone version.

   D. A 6-node plate bending element is being developed that will allow a higher order bending displacement. (See ref. 9.)

This element would also allow a linear variation in thickness and temperature and is being checked out in a standalone version.

5. Automated modal synthesis:

   Representing a portion of a structure by means of its natural modes is a common need of many users. This capability, sometimes termed automated modal synthesis, has only been defined and no development work has been started.

All five of these planned improvements will be received after Level 16 is frozen but will be available later. There are several other small improvements beyond the five listed, but these are not defined sufficiently for listing.

Also noted in figure 4 is the continual need for NASTRAN changes to keep abreast of computer hardware and operating system software developments. The required changes to NASTRAN caused by a new operating system on the IBM computers or a new compiler on the CDC computers are examples of recent changes of this type. This effort is hard to predict but is necessary for NASTRAN to remain state of the art.

FUTURE DEVELOPMENT PROCESS

NASA plans for future development of NASTRAN beyond Level 17 are not defined. If expanding user needs cannot be satisfied by NASA, cooperative procedures for new developments might be needed. Such a process is illustrated in figure 5. Individual users would define, develop, and evaluate new capabilities they need. When a new development is complete and verified as correct by the developer, new decks and ALTERS to NASTRAN subroutines requiring modification would be submitted to the NSMO for possible incorporation into the next standard level of NASTRAN to be released. As a potential guide for possible future cooperative development activities, an Interface Requirements Document is being prepared by the maintenance contractor. This document will define general requirements (I/O, stress recovery, data card recognition, etc.) and coding standards to facilitate installation of new capability into the NASTRAN system.

CONCLUDING REMARKS

NASTRAN status and plans have been described and can be summed up with the following observations:

1. Use is widespread and growing.

2. Major improvements to the code (Level 16) and to the error communication process (ECIS) are at hand.

3. Plans for capability to be included in Level 17 are being completed. Future plans beyond Level 17 are not defined.

4. Future dissemination procedures will be different, with leasing, higher costs, and FEDD constraints being applied.

5. A possible cooperative pooling of user developed improvements is suggested as a means for continued enhancement of NASTRAN capabilities.

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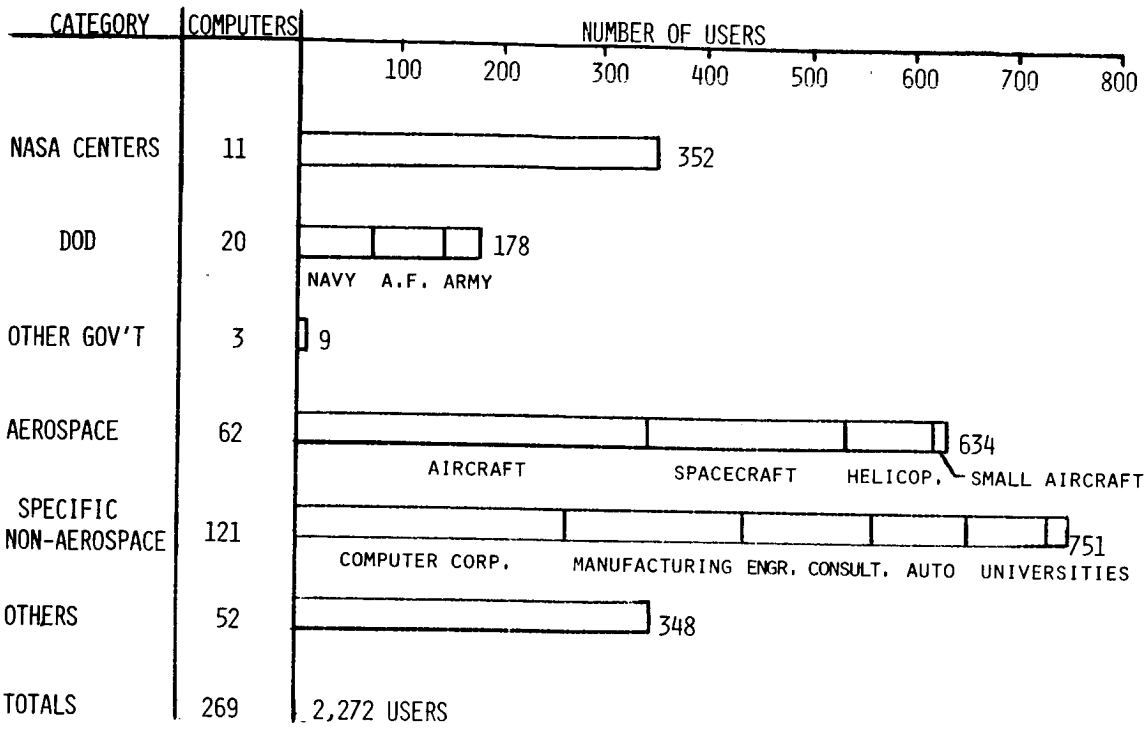

Figure 1.- NASTRAN User Community (For groups responding to Newsletter form - May 1974).

CATEGORY	INDIVIDUAL COMPUTER TIME USED (CPU HRS./MONTH)	% OF TOTAL COMPUTER USE	ESTIMATED NUMBER OF USERS	% OF TOTAL USERS
NASA CENTERS	156.9	3.0	352	15.5
DOD	81.4	1.6	178	7.8
OTHER GOV'T	.3	0.0	9	0.4
AEROSPACE	881.4	17.1	634	27.9
SPECIFIC NON-AEROSPACE	3887.5	75.4	751	33.1
OTHERS	146.8	2.9	348	15.3
TOTALS	5154.3	100.0	2272	100.0

Figure 2.- Computer time used by responding NASTRAN users.

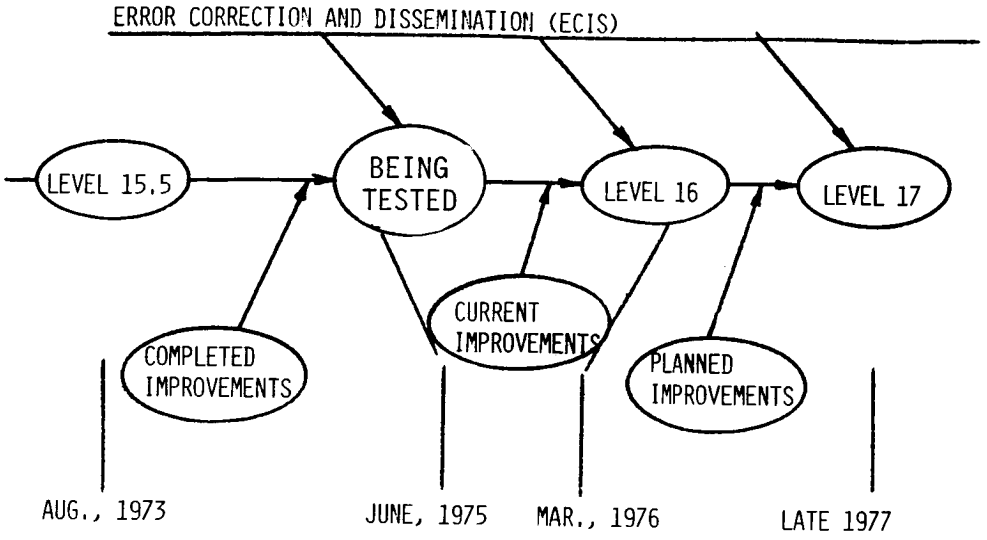

Figure 3.- Current status of NASTRAN improvements.

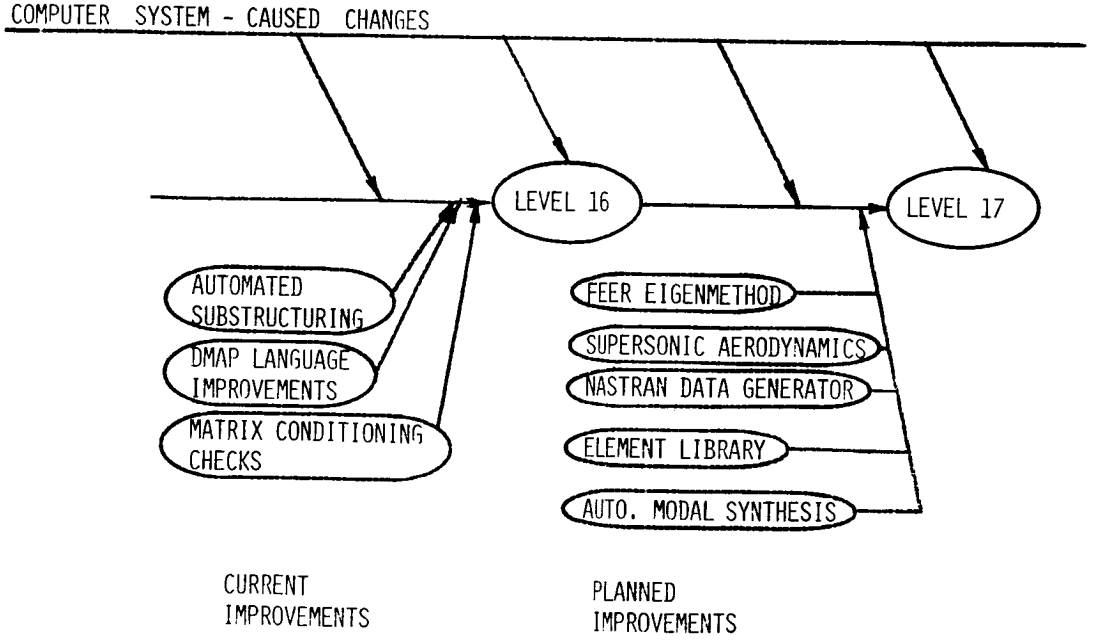

Figure 4.- NASTRAN improvements currently in progress.

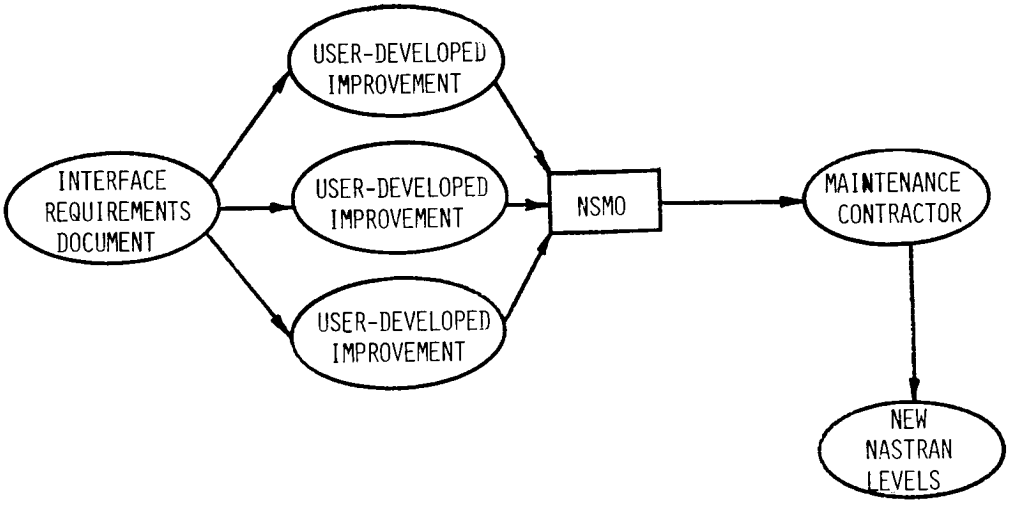

Figure 5.- A possible process for developing needed NASTRAN improvements.