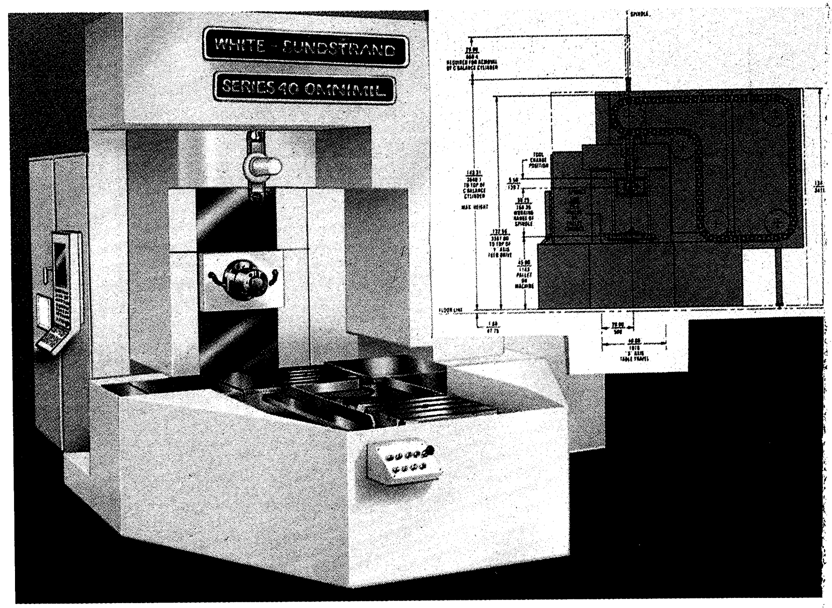
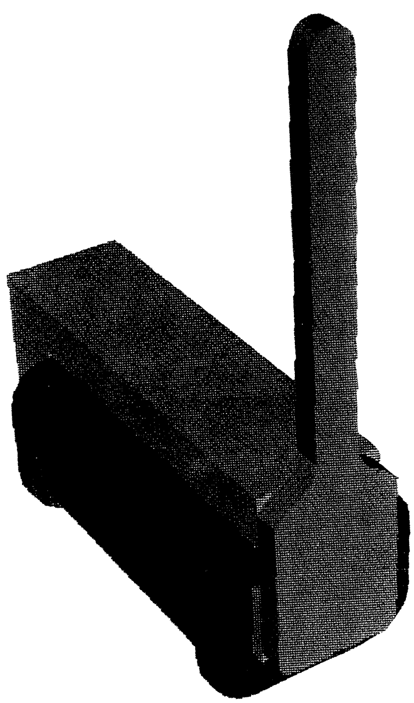
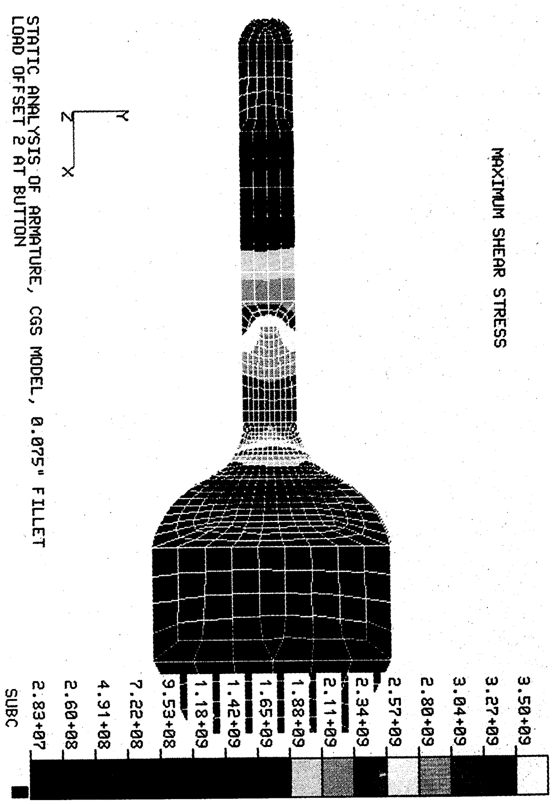
Structural Analysis

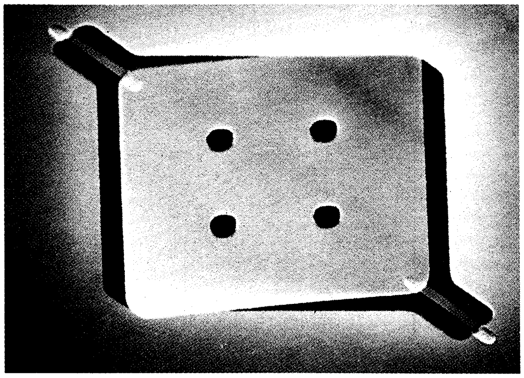
One of the most widely used NASA computer programs is NASTRAN®, an acronym for NASA Structural Analysis Program. Originally developed by Goddard Space Flight Center as an aid to aerospace vehicle design, NASTRAN has been used in hundreds of non-aerospace applications. Basically, it performs complex analyses of a structural design and predicts how various elements of the design will react to many different conditions of stress and strain.

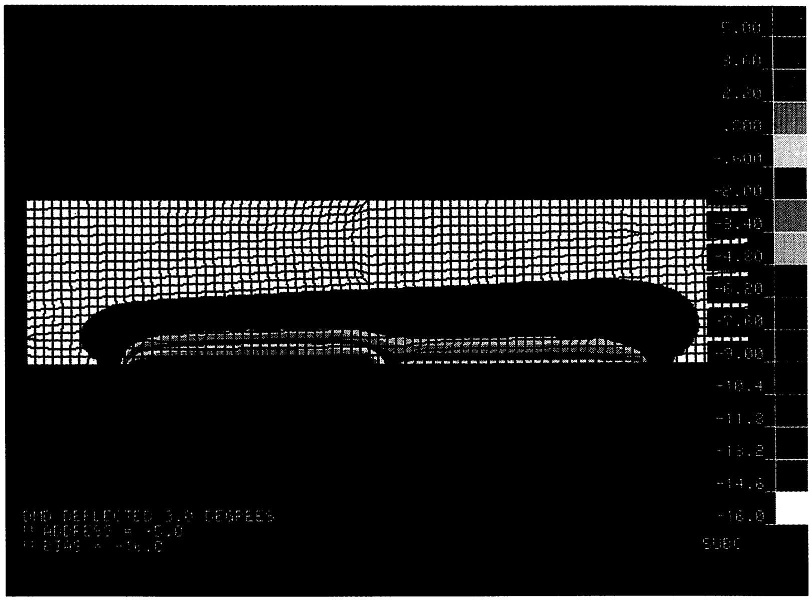
Over the years, NASA has improved NASTRAN to broaden its range of utility. NASTRAN applications include almost every kind of structure and construction, and the program's substructuring capability allows different segments of a structure to be modeled jointly after having been modeled separately. NASTRAN permits the effects of control systems, aerodynamic transfer functions and other nonstructural problems, such as static response to thermal expansion, to be incorporated in the solution of the structural problem.











An example of industrial use of NASTRAN is its employment by DeVlieg-Sundstrand, Belvidere, Illinois, a company which manufactures machine tools that produce parts for other machines; shown at left above is the company's horizontal machining center. These machine tools must be able to maintain a certain rigidity during temperature and load changes associated with the manufacturing process; their rigidity determines their accuracy and prevents production errors in the machine parts. NASTRAN is used in the design of machine tools to predict the design's rigidity.

Another NASTRAN user is Texas Instruments (TI), Temple, Texas, which uses the program as an aid in designing impact and non-impact printers.

Dot matrix impact printers form characters by means of a series of actuator mechanisms that fire needles at an ink ribbon to transfer ink dots to paper. Each actuator mechanism has a tiny magnetic core and an actuator coil, an armature and a print needle. The printhead is a circular arrangement of a large number of such assemblies; in operation, the printhead moves across the paper to produce characters.

Generation of a magnetic field causes the armature to propel the needle toward the ribbon. To optimize the design of the printhead, it is necessary to maximize the magnetic force propelling the armature—and that requires extremely accurate calculations of the magnetic field. TI used NASTRAN for that purpose and was able to develop the optimum geometry for a new printhead entirely by NASTRAN simulation. At far left is the printhead cone and armature of TI's impact printer; at left is a NASTRAN analysis of the armature and the magnetic field.

NASTRAN predictions were proved accurate by testing of the first prototype, which sharply reduced the very substantial prototyping costs of conventional test models. NASTRAN was then employed to develop all of the mechanical and structural parts of the printhead, such as the needles, wire guides and housing.

TI's Central Research Laboratories also used NASTRAN in designing a deformable mirror device (DMD) that has several applications in non-impact printing, where it can replace the laser and the rotating mirror of conventional laser printers. TI was unable to predict accurately the behavior of the DMD (top photo), which was dependent upon the electric field and mechanical properties. Researchers employed NASTRAN to model the DMD and, with the combined results of various analyses, were able to predict the voltages required for operation and indicate ways in which efficiency might be increased. At left above is a NASTRAN analysis of electric potential in the DMD. Here again, NASTRAN allowed accurate prediction of the effect of design changes without the large expense of prototype production.

NASTRAN is available to private industry through NASA's Computer Software Management and Information Center (COSMIC)®. Located at the University of Georgia, COSMIC maintains a library of computer programs from NASA and other technology-generating agencies of the government, and offers them for sale at a fraction of the cost of developing a new program.

® NASTRAN and COSMIC are registered trademarks of the National Aeronautics and Space Administration.