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THE APPLICATION OF NASCAD AS A NASTRAN PRE- AND POST-PROCESSOR*

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INTRODUCTION

NASCAD (NASA Computer Aided Design) is a 3-D computer aided design (CAD) package that was developed under NASA auspices. In 1985, this powerful, low-cost software package was released to COSMIC and became public-domain.

NASCAD is part of the overall Computer Integrated Manufacturing (CIM) package called NEXUS/NASCAD. NEXUS stands for NASA Engineering eXtendible Unified Software. Part of the motivation for developing NASCAD was to create a CAD system which would interconnect with other CAD/CAM related software. This network of connections is what makes NASCAD such an effective engineering tool.

Lloyd Purves, the creator and guiding force behind NASCAD, made sure that the software could be incorporated into a general CIM framework. He anticipated the relational needs of design analysis and manufacturing. Thus, NASCAD was written to hook into other software packages and standards such as APT, IGES, & NASTRAN. To have NASCAD become an "island of automation" would be an anathema. NASCAD is intended not just to be a drafting or design package but to be an intimate part of the overall CIM process. More to the point of this conference, NASCAD is especially attractive as a pre- and post-processor for NASTRAN.

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NASCAD AS A NASTRAN PRE-PROCESSOR

Let us see how NASCAD can be used as a NASTRAN pre-processor by creating a hypothetical scenario involving a 1)designer and 2)NASTRAN analyst (fig. 1). For purposes of illustration we are ignoring the possibility that the designer and the analyst are the same person. In our scenario, a designer has created and refined a geometric model using NASCAD. The NASCAD computer file is given to an analyst. It is understood that the analyst will not alter the design ingredients but will use the design data base primarily as source material. The analyst's task will be to generate a finite element mesh that faithfully represents the properties of the design. The analyst loads the design data file into NASCAD and goes about the task of creating a finite element model. NASCAD's wealth of geometric modules and algorithms enables the user to fashion a mesh to suit the level of detail that he needs. With NASCAD, the analyst can zoom in on a certain area of the model and select only the geometry that interests him. Another special feature is a series of storage bins or buffers called levels. These "levels" (also known as layers) can be employed to partition the model by function, geometry, or any criterion the analyst finds appropiate. Some of the more useful groupings for finite element applications are element type, material properties, loading, and constraints. In figures 2-5, levels are used to group data by element type.

Once an area of the design has been selected for modeling, gridpoints are defined and elements are added to that mesh. The analyst can interactively attach such properties as mass and load constraints to the elements. NASCAD supports lines, polygons, polyhedra, and advanced surfaces such as bicubic splines. NASCAD's macro language allows the user to create super-commands that will speed the generation of meshes. T.G. Butler of Butler Analyses has created a set of macro's to facilitate the creation of NASCAD meshes (fig. 6).

As a visual check, the analyst can display his model from any view (including perspective). Hidden line processing (fig. 7), color, and shading can also be added to enhance the effect. On the basis of these visual checks, the analyst can interactively modify and refine the mesh (as well as change properties). Once the analytic model has been satisfactorily defined, the user can store it off as a NASCAD file for future use.

After completing the NASCAD analytic file, the analyst then invokes "C2N", the NASCAD to NASTRAN translator. C2N converts the NASCAD analytic model into a NASTRAN input data deck (NID). It transforms NASCAD mesh points into NASTRAN grid points. C2N converts the NASCAD finite elements into NASTRAN connection cards (CBAR, CTRETRA, etc.). C2N can also be instructed to create property cards for specific groups of elements.

At this point, the analyst leaves NEXUS/NASCAD and enters the NASTRAN domain.

Once in the NASTRAN domain, the analyst uses a text editor to modify the NID file, adding executive control, case control, and output management statements. The analyst does not have to specify plotting control information because NASCAD can be used to produce very effective plots. The analyst runs NASTRAN which will produce modal analysis, vibration analysis, stress analysis, and deformation analysis at the user's discretion.

NASCAD AS A NASTRAN POST-PROCESSOR

After the NASTRAN run is completed, the analyst will undoubtedly want to display the results. Once again, NASCAD can be used to great benefit. The NASTRAN to NASCAD translator (N2C) will convert the NASTRAN data to NASCAD data. Displacements (fig. 8) and stresses are successfully brought over as NASCAD data. The analyst can display the deformed and undeformed model as well as create stress contour displays using NASCAD's color capabilities. In both post-process and pre-process phases the user will probably want to create plots of his data. The advantage that NASCAD has over NASTRAN is that with NASTRAN the analyst has to anticipate the orientation needed for a structure in order to display pertinent features. He must convert his mental image into specific plot commands prior to his analysis run. Ususally he does a lot of guessing. If he guesses wrong, he is compelled to rerun his job with a new set of guesses. But with NASCAD the analyst need not do any anticipating. He can display the results and reorient different views until a pertinent feature is shown to best advantage. The analyst can then plot that designated view.

In addition to obtaining a best view, NASCAD offers the analyst the ability to edit and highlight his display to focus the reader's attention on essentials of the analysis. He can add boxes, arrows, colors, and text to make the drawing more informative. NASCAD will allow plots of single or multiple views (fig. 9) and support electrostatic plotters, dot matrix printers, and pen plotters. NEXUS also has a pre-plotting capability that allows the user to simulate his plot on a terminal before committing himself to paper (or vellum).

Using NASCAD as a post-processor, the analyst can zoom in on trouble spots and pinpoint where anomalies are occuring. If an analyst's results reveal design defects, NASCAD can assist the analyst with changes in his finite element model. The analyst can also refine the mesh by calling up and changing the stored analytic NASCAD model. NASCAD facilitates the analysis cycle by allowing the user to readily display and alter his analytic model. This allows more NASTRAN runs and greater product refinement.

CONCLUDING REMARKS

The NASCAD graphics package provides an effective way to interactively create, view, and refine analytic data models. NASCAD's macro language, combined with its powerful 3-D geometric data base allows the user important flexibility and speed in constructing his model. This flexibility has the added benefit of enabling the user to keep pace with any new NASTRAN developments. NASCAD allows models to be conveniently viewed and plotted to best advantage in both pre- and post-process phases of development, providing useful visual feedback to the analysis process. NASCAD, used as a graphics complement to NASTRAN, can play a valuable role in the process of finite element modeling. Like NASTRAN, NASCAD is available in the public domain and is distributed, complete with source code, translators, and plotting packages, through COSMIC.

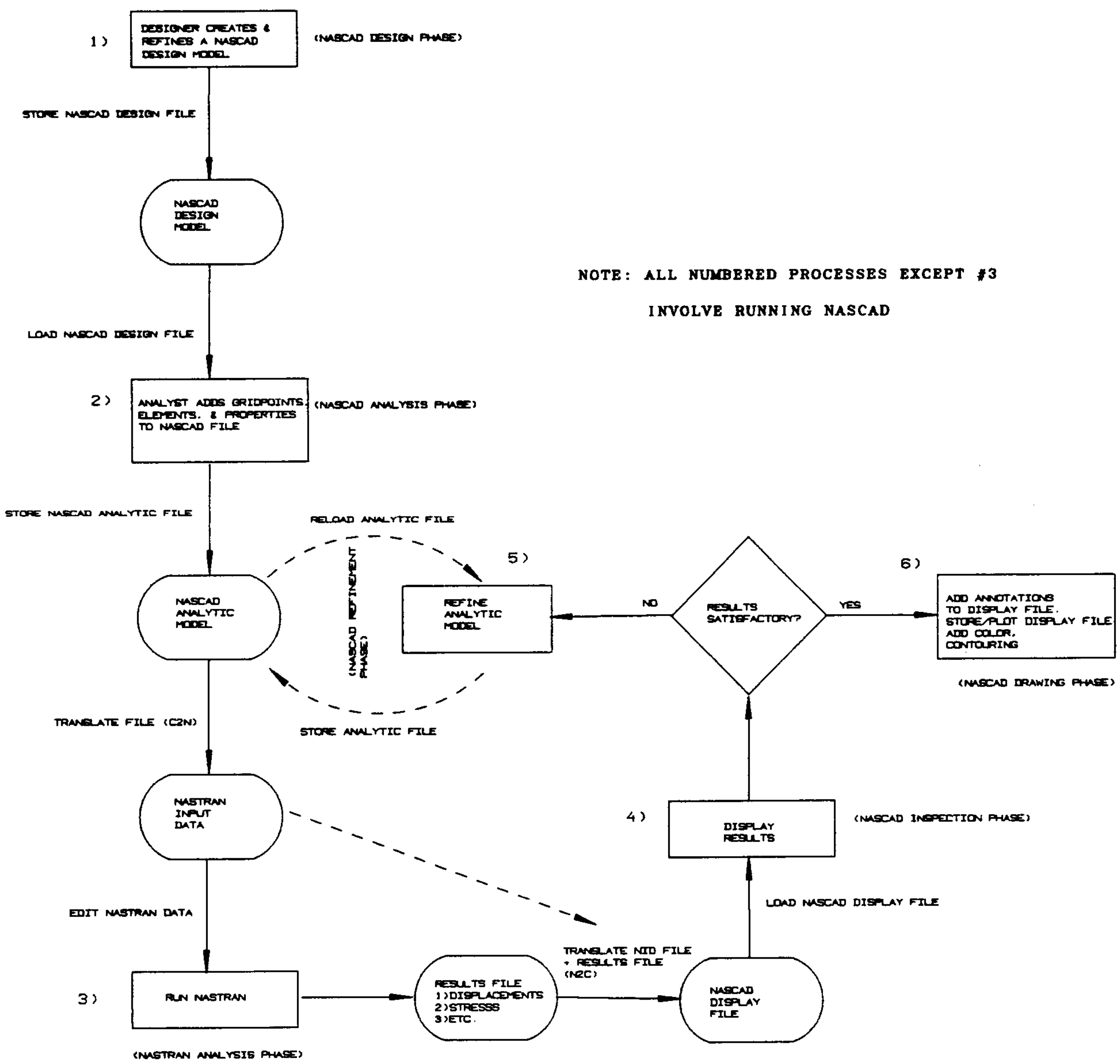

Figure 1. Design and analysis scenario involving NASCAD and NASTRAN

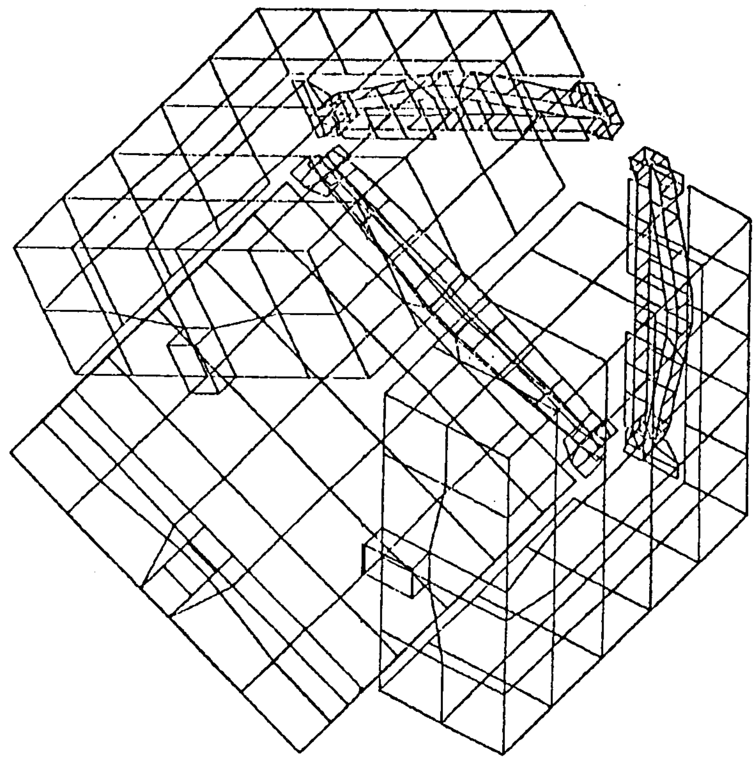

Figure 2. Isometric view of multimission satellite (MMS) - quadrilateral elements only

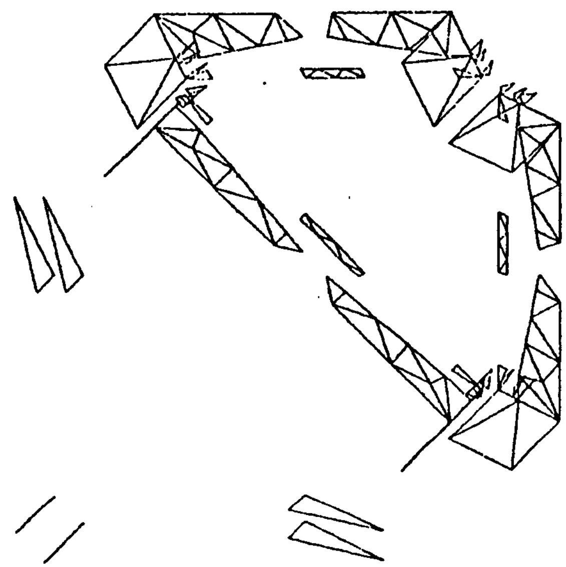

Figure 3. Isometric view of MMS - triangular elements only

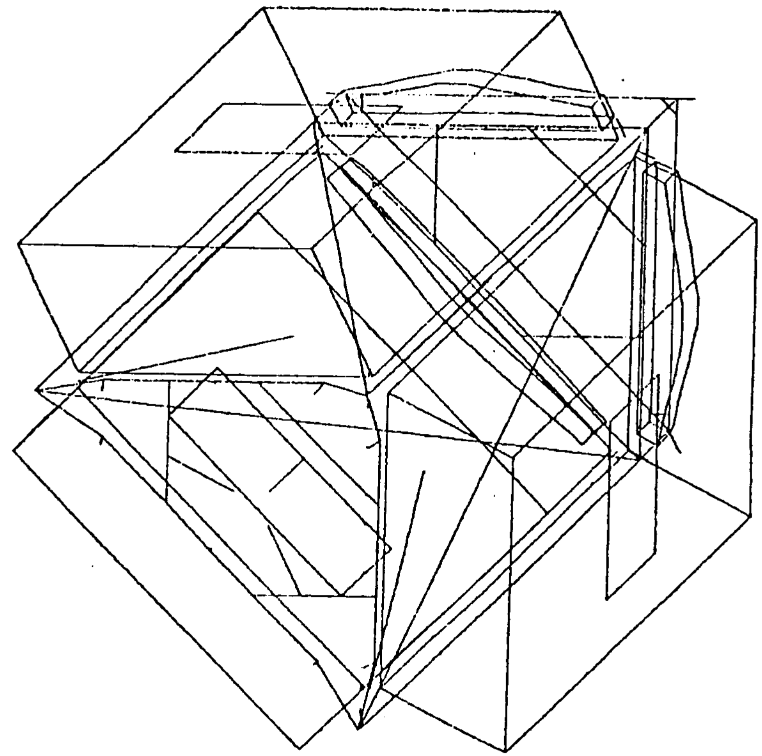

Figure 4. Isometric view of MMS - bar elements only

Figure 5. Isometric view of MMS - rigid elements only

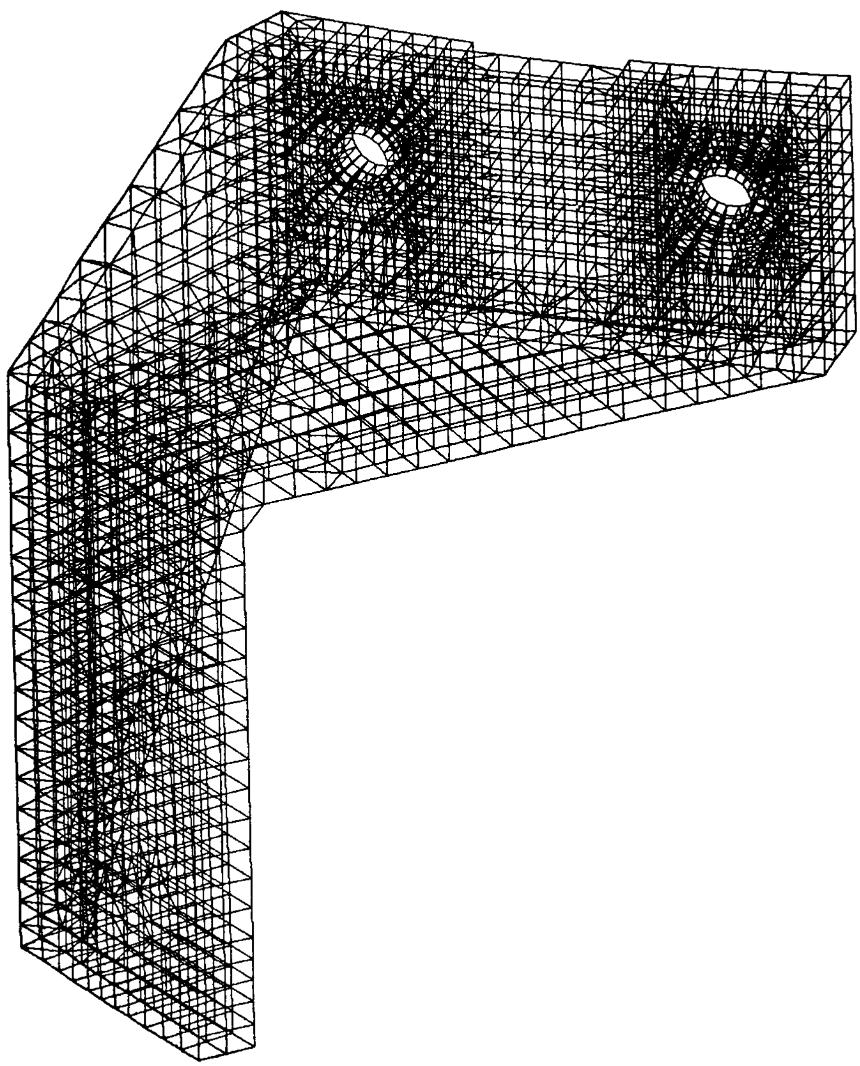

Figure 6. Butler Analyses bracket model.
NASCAD macro's enabled the construction of this complex model.

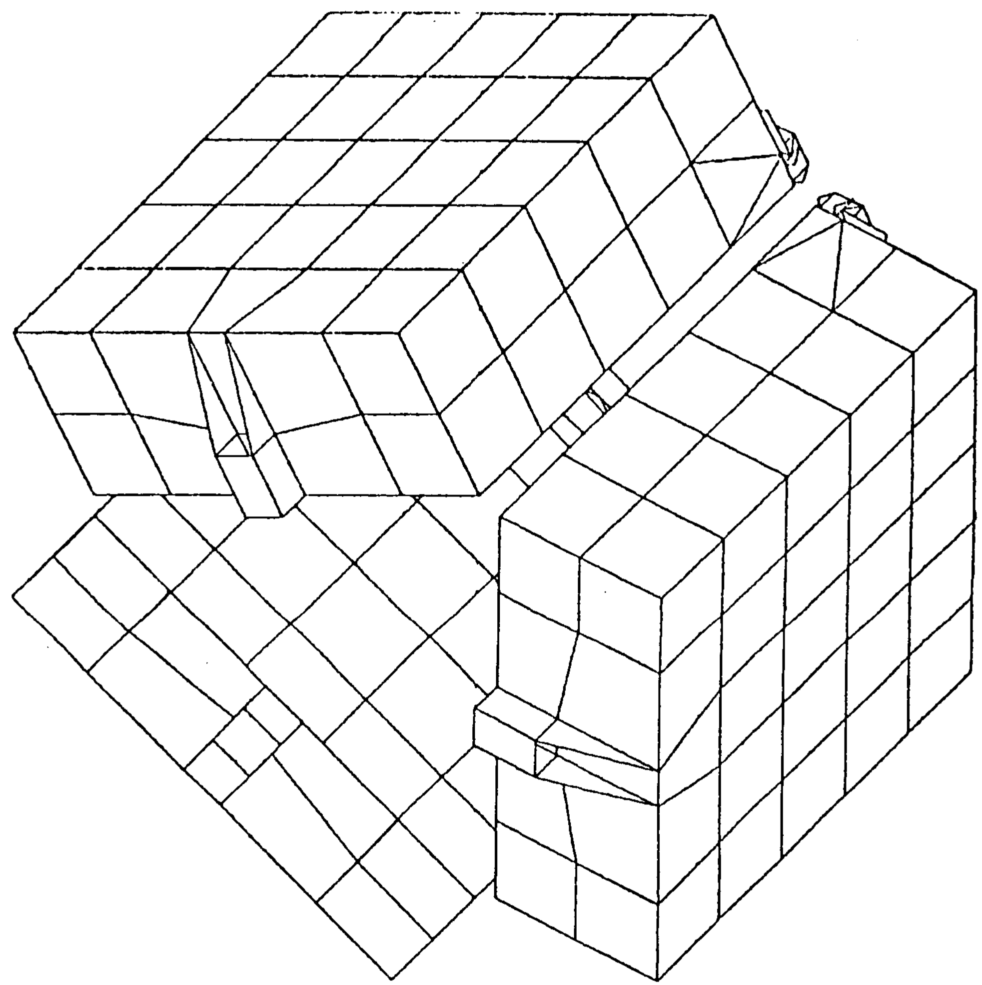

Figure 7. Hidden line drawing of multi-mission satellite

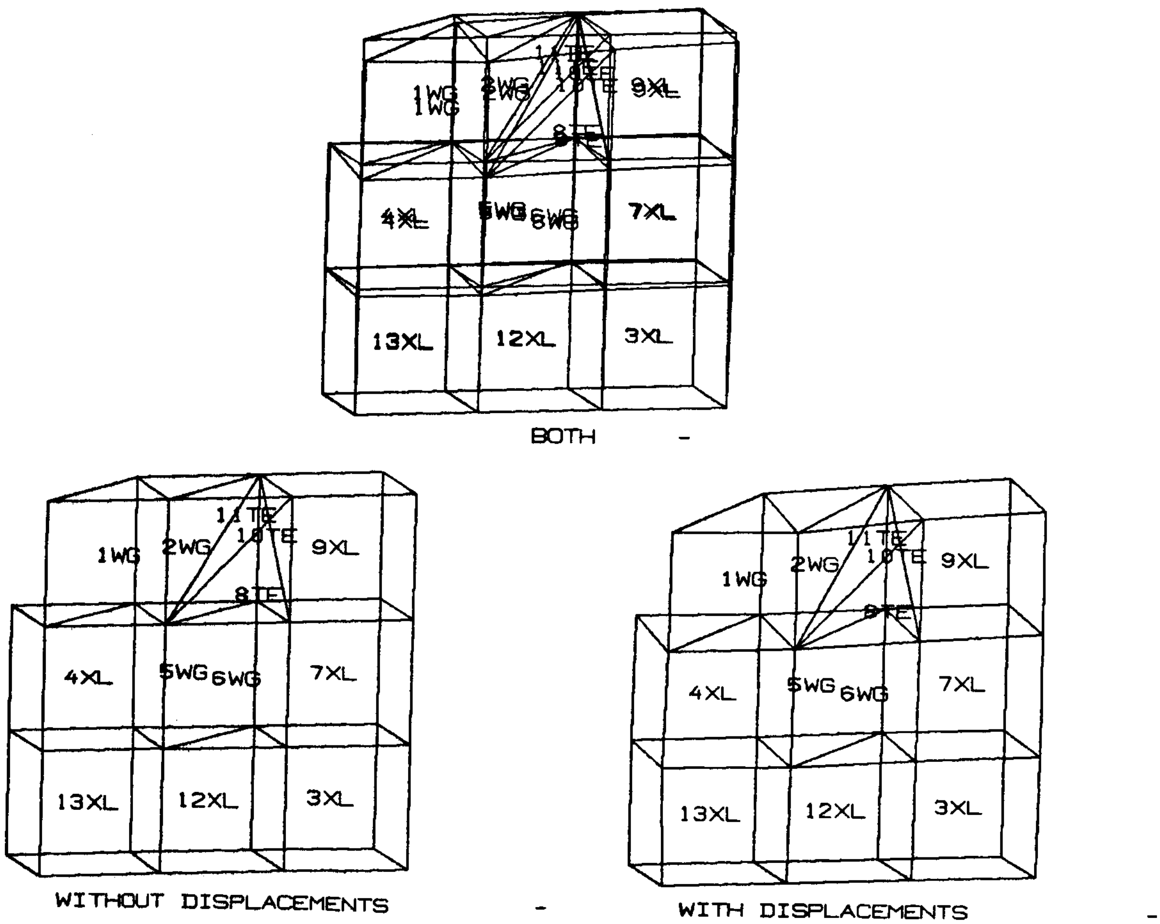

Figure 8. Display of test model with and without displacements

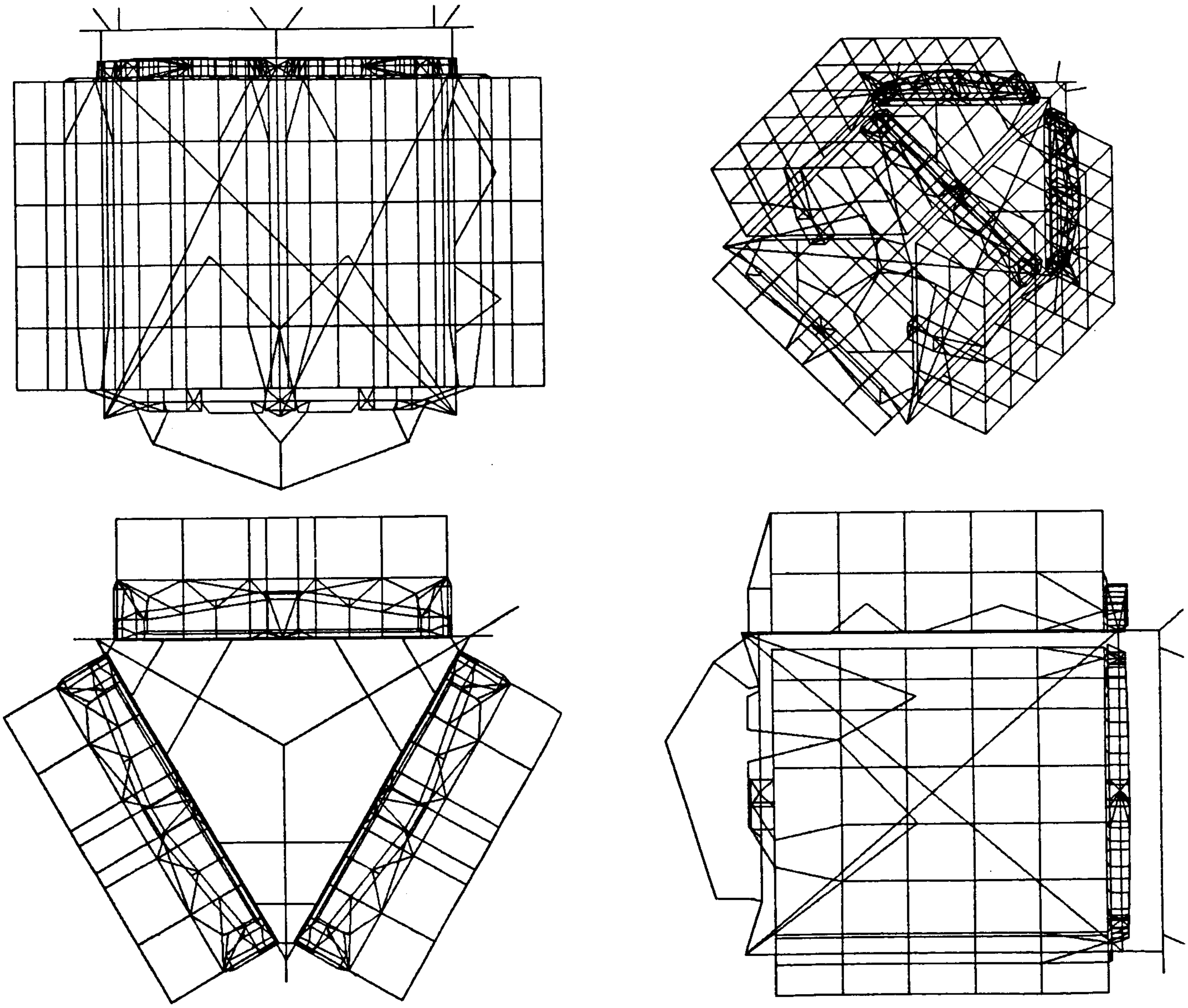

Figure 9. Multiple views of multi-mission satellite