proving ground for Adapco's unusually complex finite-element methods.

During the initial stages of Adapco's analysis, substructuring techniques were used often to characterize all the attaching brackets and the major structural assemblies. Analytical equations describing forces and displacements applied to the structure were formulated. The finite element model contained all the information necessary to characterize the stiffness and mass distribution of the antenna assembly.

### Solution without supercomputer

The solution phase of the entire assembly was run three or four times because of its complexity. (At least three engineers were occupied with the assembly part of the analysis where the generated superelements were joined and analyzed.) The superelement assembly and final set of stress passes required 25 to 30 hours of computation time on their Floating Point Systems 164 scientific computer.

The four-year-old company could not afford a vector supercomputer, yet the massive computations called for near supercomputer speeds. Adapco engineers claim that without the dual-processing capability of the Vax 11/780 and the Floating Point Systems scientific computer, they would not have attempted this kind of an analysis.

After the scientific computer returned the finite element solution, enormous amounts of data had to be postprocessed before the analysis results were clear. The output was analyzed on Adapco's dual-processing system and displayed on a Tektronix 4691 ink-jet color plotter driven directly through the Vax processor. The postprocessing-result file is a large binary data file that cannot be printed but is interrogated to locate and plot high stress points by means of color contour maps. The pertinent information within the database is rasterized and sent to the color plotter directly. Graphics and postprocessing were heavily used to assimilate and keep track of the enormous quantities of output.

There were four main assemblies in the antenna. Models of individual assemblies contained from 2500 to 6500 elements and solution wavefronts from 700 to 900 degrees of freedom. Although Adapco has run models containing 8000 elements successfully, a model containing 7000 elements is pushing the system with respect to timely throughput.) Individual analyses took from two and a half to eight hours to complete.

Prior to the introduction of low-cost, high-speed computer systems and the software capable of solving large multibody problems, engineers were forced to make broad assumptions when analyzing large structural problems. Using the Vax/FPS-164 computer system and the Ansys software package, Adapco can more accurately determine how each part interacts with its surroundings. These unusually large models predicted the actual failure points with surprising accuracy and provided a valuable database from which an improved structural design was generated.