

*A versatile computer program for better design of structures heads a list of aerospace spinoffs improving industrial productivity.*

## industrial productivity

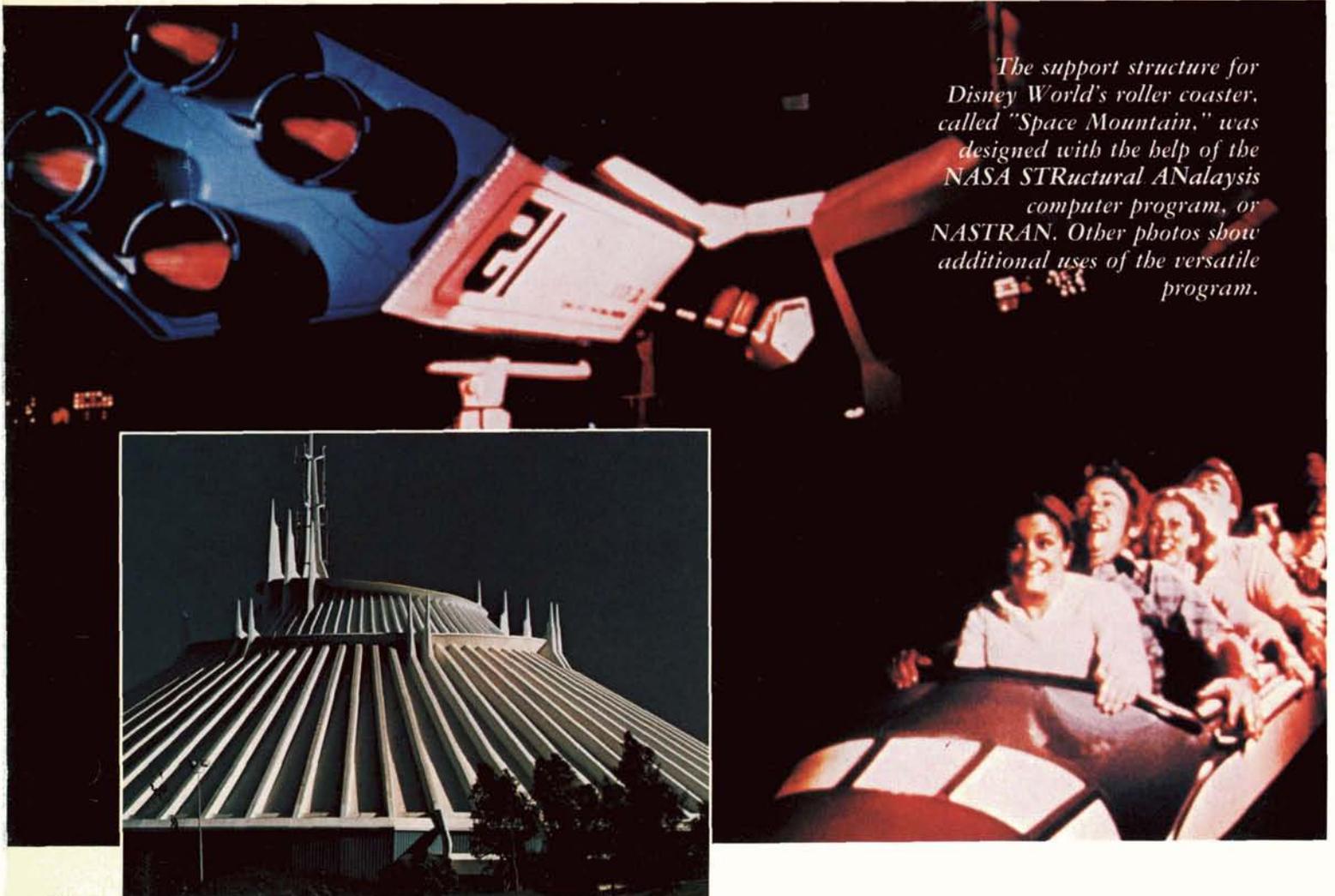
A roller coaster isn't ordinarily associated with space technology. Except, of course, "Space Mountain," the exciting coaster ride at Disney World.

The roller coaster was designed by WED Enterprises, the research division of Walt Disney Productions, Glendale, Cal. The task was to design a support structure for the tracks which would be totally safe and yet not overstrong. Overstrengthening adds nothing to safety; it simply wastes money in unneeded steel. WED engineers heard of a NASA-developed computer program which simplifies the job of analyzing structures and used it to gain substantial savings in labor and materials. Success in

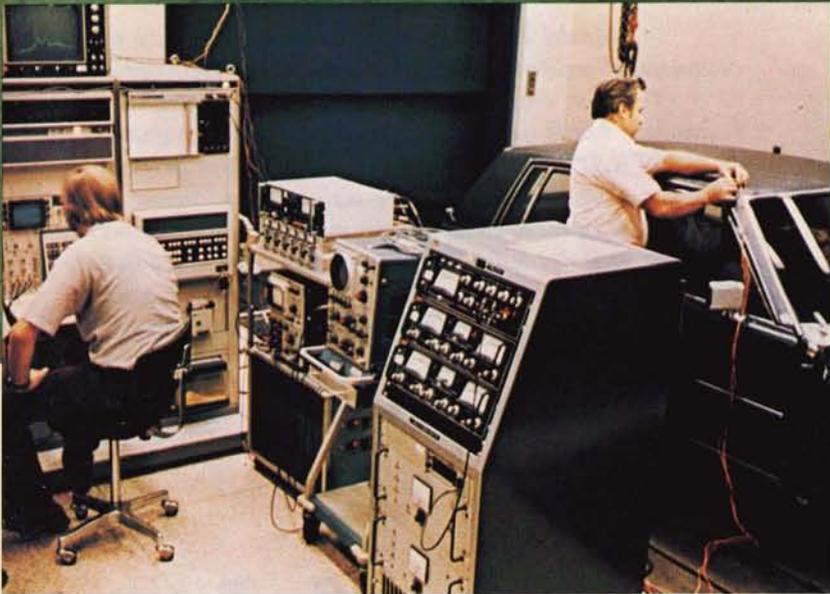
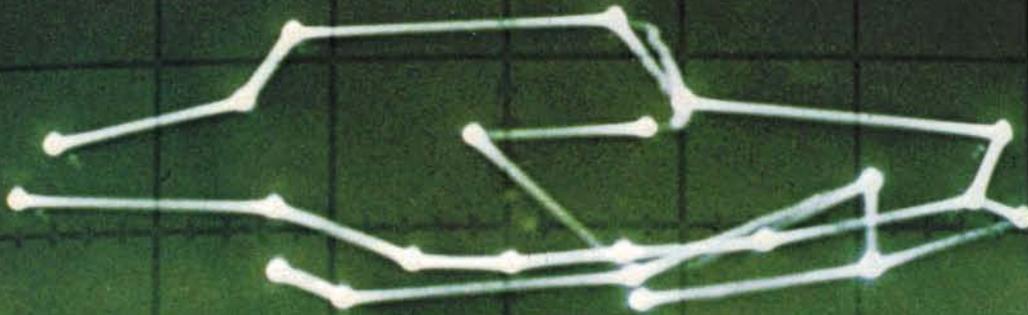
the initial effort led to re-use of the computer program in designing a similar ride at Disneyland, to be available this year.

The roller coaster example is one of hundreds of cases where industry has benefited from NASTRAN, an acronym for NASA Structural Analysis Program. Since 1970, the computer program has been available from NASA's Computer Software Management & Information Center (COSMIC) at the University of Georgia. Cost averages \$3,000 to \$4,000, usually a mere token compared to the savings. In some cases, the NASTRAN investment has returned several millions

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*The support structure for Disney World's roller coaster, called "Space Mountain," was designed with the help of the NASA STRuctural ANalysis computer program, or NASTRAN. Other photos show additional uses of the versatile program.*



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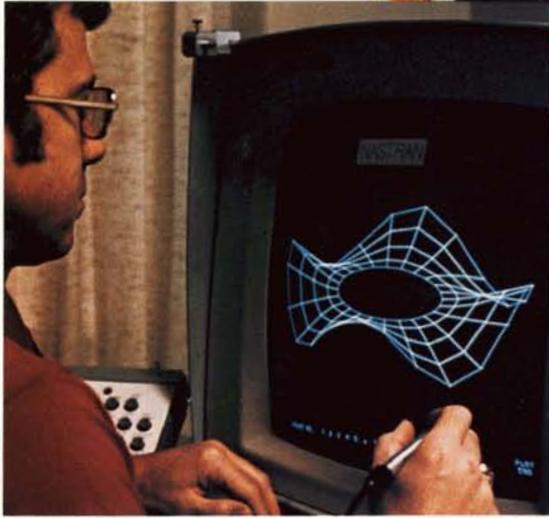
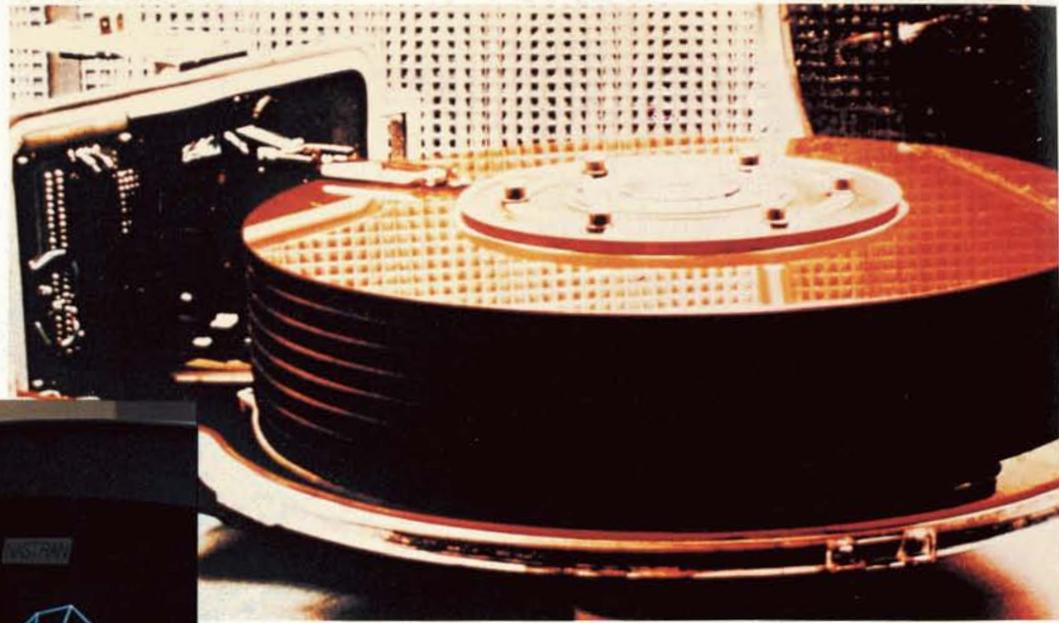
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*Cadillac Seville was the first General Motors car designed by the company's Vehicle Structure Analysis Program, based in part on NASTRAN. The computer program improved the car's ride within weight limits and saved development time. Success of the Seville inspired the company to extend computer analysis to the entire GM line.*



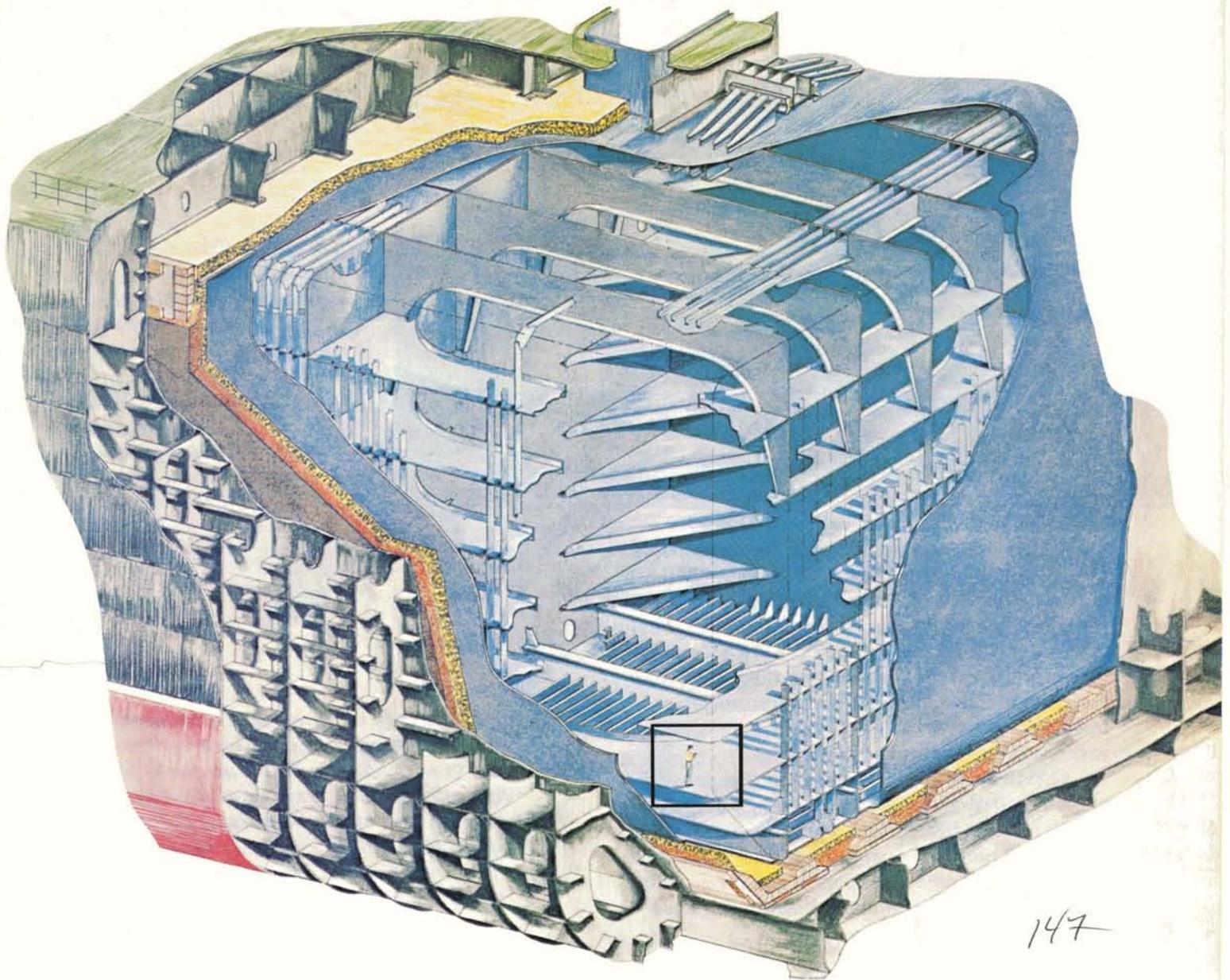
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The vibration caused by spinning computer-storage disks is studied with the NASTRAN program at IBM Corp., San Jose, California. NASTRAN analysis has proved valuable in assuring disk reliability.



Model 222 helicopter is one of a family of commercial-military aircraft built by Bell Helicopter Textron, Fort Worth. Bell uses NASTRAN to analyze loads on all airframes and rotor systems. NASTRAN analyses have provided a five percent savings in airframe structure weight in addition to saving development time. An example: under previous methods, Bell needed 4,550 man-hours to analyze five load conditions per helicopter; with NASTRAN, only 1,675 man-hours are required for 36 load conditions per helicopter.





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of dollars. In most instances the gain is more modest, though still significant. Because NASTRAN is widely employed, it represents an enormous national economic benefit. One study estimated that, in the period from 1971 to 1984, NASTRAN will return more than \$700 million to the U.S. economy.

NASTRAN is an offshoot of the computer-design technique used in construction of airplanes and spacecraft. In this technique engineers create a mathematical model of the aeronautical or space vehicle and "fly" it on the ground by means of computer simulation. The technique enables them to study performance and structural behavior of a number of different designs before settling on the final configuration and proceeding with construction.

From this base of aerospace experience, NASA-Goddard developed the NASTRAN general purpose computer program, which offers an exceptionally

*An LNG tank, designed by Conch LNG, Morristown, N.J. and constructed by Avondale Shipyards Inc. is built into a ship's hull to carry liquefied natural gas at extremely low temperatures. Each of three new Avondale ships has five huge Conch tanks; the largest holding 30,000 cubic meters of LNG. NASTRAN helped analyze such factors as reaction of components to changing temperatures and the structural behavior of tanks under ship motions at sea.*

wide range of analytic capability with regard to structures. NASTRAN has been applied to autos, trucks, railroad cars, ships, nuclear power reactors, steam turbines, bridges, and office buildings. NASA-Langley provides program maintenance services regarded as vital by many NASTRAN users.

NASTRAN is essentially a predictive tool. It takes an electronic look at a computerized design and reports how the structure will react under a great



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The wing of this Gates Learjet Model 35/36 looks simple, but it is actually complex. Because earlier methods of designing and testing the wing were overly time-consuming, Gates Learjet Corp., Wichita, Kansas, developed a NASTRAN wing model for structural analysis of future versions of the popular 10-place business jet.

many different conditions. It can, for example, note areas where high stress levels will occur—potential failure points that need strengthening. Conversely, it can identify over-designed areas where weight and material might be saved safely. NASTRAN can tell how pipes stand up under strong fluid flow, how metals are affected by high temperatures, how a building will fare in an earthquake or how powerful winds will cause a bridge to oscillate.

NASTRAN analysis is quick and inexpensive. It minimizes trial-and-error in the design process and makes possible better, safe, lighter structures while affording large-scale savings in development time and materials. Some examples of the broad utility NASTRAN is finding among industrial firms are shown on these pages.

Sikorsky Aircraft of Stratford, Connecticut, NASTRAN-modeled the fuselages of three of its helicopters, including the S-76. Analyses included vibrational stress and the amount of bend and twist that the helicopters would experience in various maneuvers. The company found NASTRAN highly cost-beneficial and plans to use it in design of all future aircraft.

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