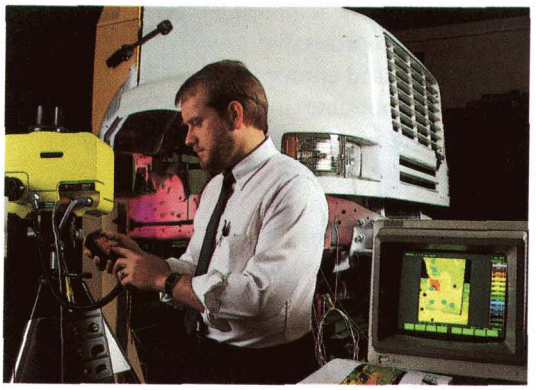
Aids to School Bus Design

Technology transfers that help assure safety and reliability in pupil transport highlight spinoffs in the field of transportation

Historically, a school bus chassis was nothing more than a medium truck chassis. However, escalating parent demands for maximum safety and reliability prompted some manufacturers to introduce chassis designed specifically for the special considerations of school transport.

The industry leader is Navistar International Transportation Corporation, Chicago, Illinois, manufacturer of the International® line of truck and bus chassis. Engineers at the Navistar Technical Center, Fort Wayne, Indiana, devoted two years of sophisticated research and development to the company's 3000 Series Bus Chassis, designed expressly for school bus applications. The first of this series was introduced in 1989; the latest, the International 3900 FC, was introduced in 1991. Design of all of the 3000 Series was aided by NASA technology originally developed for aviation and space use.



Shown in use at Navistar Technical Center is the SPATE 9000 system (yellow scanner and display unit), which measures stress in truck and bus components by detecting temperature changes.

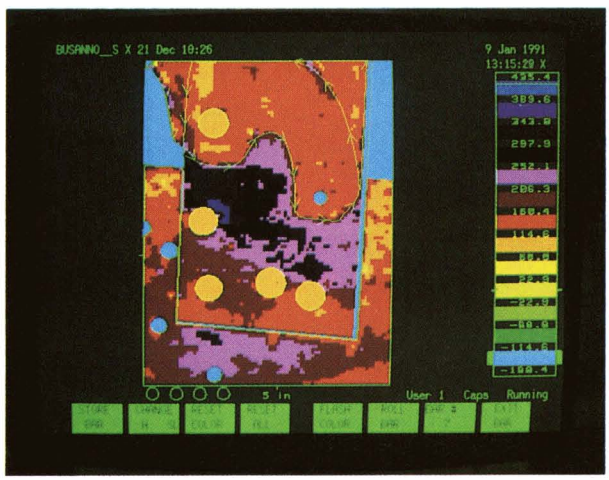
Navistar International does not manufacture school bus bodies. For the Series 3000, the company provides the chassis — which includes the frame, wheels and powertrain — the hood, cowl and instrument panel; other manufacturers integrate their bodies with the International chassis. Navistar prides itself on the durability, reliability and safety of its chassis, due in no small part to the Technical Center's exacting analysis and testing in every phase of the product development process.

An instrument that evaluates "ride quality" (box in foreground) awaits loading aboard a school bus for testing. It is one of three NASA technologies employed by Navistar International in designing school bus chassis.

In development of a new product line like the Series 3000, the Technical Center employs a state-of-the-art Unigraphic CAD/CAM (computer aided design and manufacturing) system. It enables designers to create three-dimensional models of the product and each of its parts and subject them to exhaustive analysis "to see if it all works" before actual construction. Three separate NASA-developed technologies contribute to this process.

For structural analysis of chassis and components, the Technical Center uses the MSC/NASTRAN® computer program. NASTRAN is an acronym for NASA Structural Analysis; MSC/NASTRAN is an enhanced proprietary version by MacNeal-Schwendler Corporation. NASTRAN mathematically analyzes a design and predicts how it will hold up under the various conditions of stress and strain it will encounter in operational service. The program permits Navistar engineers to study the structural behavior of different designs before locking in on the final design.

Another type of stress analyzer in use at the Technical Center is the SPATE 9000 system, which is based on infrared stress measurement technology developed by Langley Research Center in the 1960s. Manufactured by Ometron Ltd., London, England, and distributed in the U.S. by Ometron Inc., Herndon, Virginia, the SPATE 9000 is a non-contact system (not attached to the structure it is testing) that



A typical stress display; the black area (center photo) represents the greatest temperature change, reflecting the area of greatest stress.

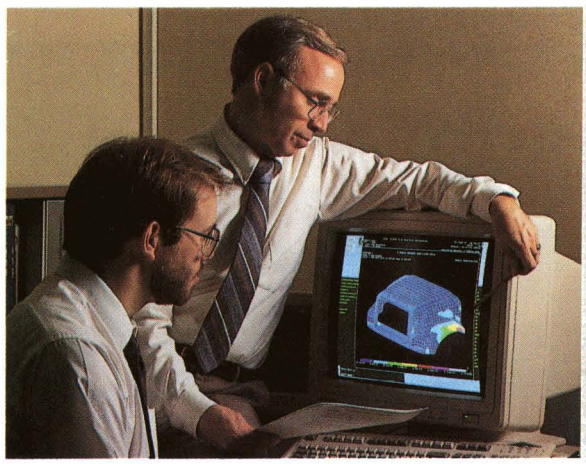
relies on infrared detection of minute temperature fluctuations that accompany changes in stress levels.

The SPATE 9000 includes a scanner and a data processing unit with a visual display. The display presents a stress map, in calibrated colors, of parts as small as a pencil or as large as the side of a tractor cab. The data is used for stress measurements, load transfer mechanisms, detection of hidden material flaws, and for monitoring structural changes that occur during fatigue testing.

The third NASA technology employed by the Technical Center is the Wyle Ride Quality Meter, developed by Langley Research Center as an aid to passenger aircraft design and manufactured under NASA license by Wyle Laboratories, Hampton, Virginia. The meter is a vehicle design aid which assures that passengers get a smooth, comfortable ride by providing an *accurate* measurement of the "ride quality" of the vehicle being developed, obviating reliance on the imprecise subjective judgments of individuals involved in the test program.

Mounted on the vehicle being tested, the Ride Quality Meter employs a package of sensors to measure vibration and a sound level meter to measure noise. The vibration signals are computer processed to get a set of indices representative of the subjective discomfort level produced by vibration. It serves, in effect, as a "passenger jury," advising vehicle developers of the vehicle's ride quality in order that they may improve it if necessary.

These technologies are part of a much broader, sophisticated process of design, analysis, test and construction that has made the International line of trucks and buses highly respected and captured for the company an estimated 45-48 percent of the total school bus chassis market.



Navistar's Pat Gerardot (standing) and Les Grundman model a school bus hood, using a NASA computer program that predicts where areas of stress may lead to material fatigue.

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