NOVEMBER 1988

automotive engineering

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space

contents

Articles

Automotive Engineering (ISSN 0098-2571) **November 1988** Volume 96, Number 11. Published monthly with an additional issue to members only in March by Society of Automotive Engineers, Inc. Printed in Brimfield, Ohio. Annual subscription for SAE members: first subscription, $8.00 included in dues; additional single copies, $4.00 each. Prices for non-member subscriptions and single copies are available upon request. Second class postage paid at Warrendale, Pa. and additional mailing offices. **POSTMASTER:** Please return form 3579 to Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, Pa. 15096.

FUTURE TRUCK TECHNOLOGY

Automotive Engineering's Ed Dellis talks to executives at major truck and component manufacturers to see what the future holds for the workhorses of the mobility industry.

Kenworth's aerodynamic tractor pulls the Corvette Challenge Race Series support trailer to Riverside's Chevrolet long-lead program.

Thus far, advanced truck technology has been limited primarily to aesthetically pleasing, wind-cheating tractor fairing designs to cover their pulling-power muscle. On the surface, truck technology *appears* to lag behind passenger car technology, which in turn *seems* to lag behind that of the aerospace industry. *Automotive Engineering* asked the following individuals to look into the multi-axle crystal ball and uncover some secrets of tomorrow's trucks.

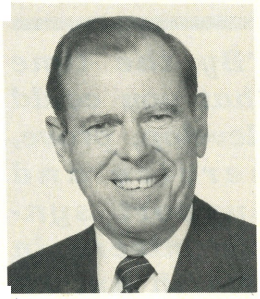
- *Edward T. Mabley,* Ford's Heavy Truck Product Development Manager, Truck Operations;
- *James V. Shannon,* Manager - Advanced Markets, and *Gerry DeClaire,* Vice President of Research & Engineering, both of Rockwell International Corp., Automotive Operations;
- *Robert Denes,* Eaton's General Manager, Drivetrain Systems Div.;
- *Dean P Stanley,* Navistar's Vice President—Engineering; and
- *Paul Sheridan,* Jeep and Truck Engine Program Manager, Chrysler Corp.

Ford

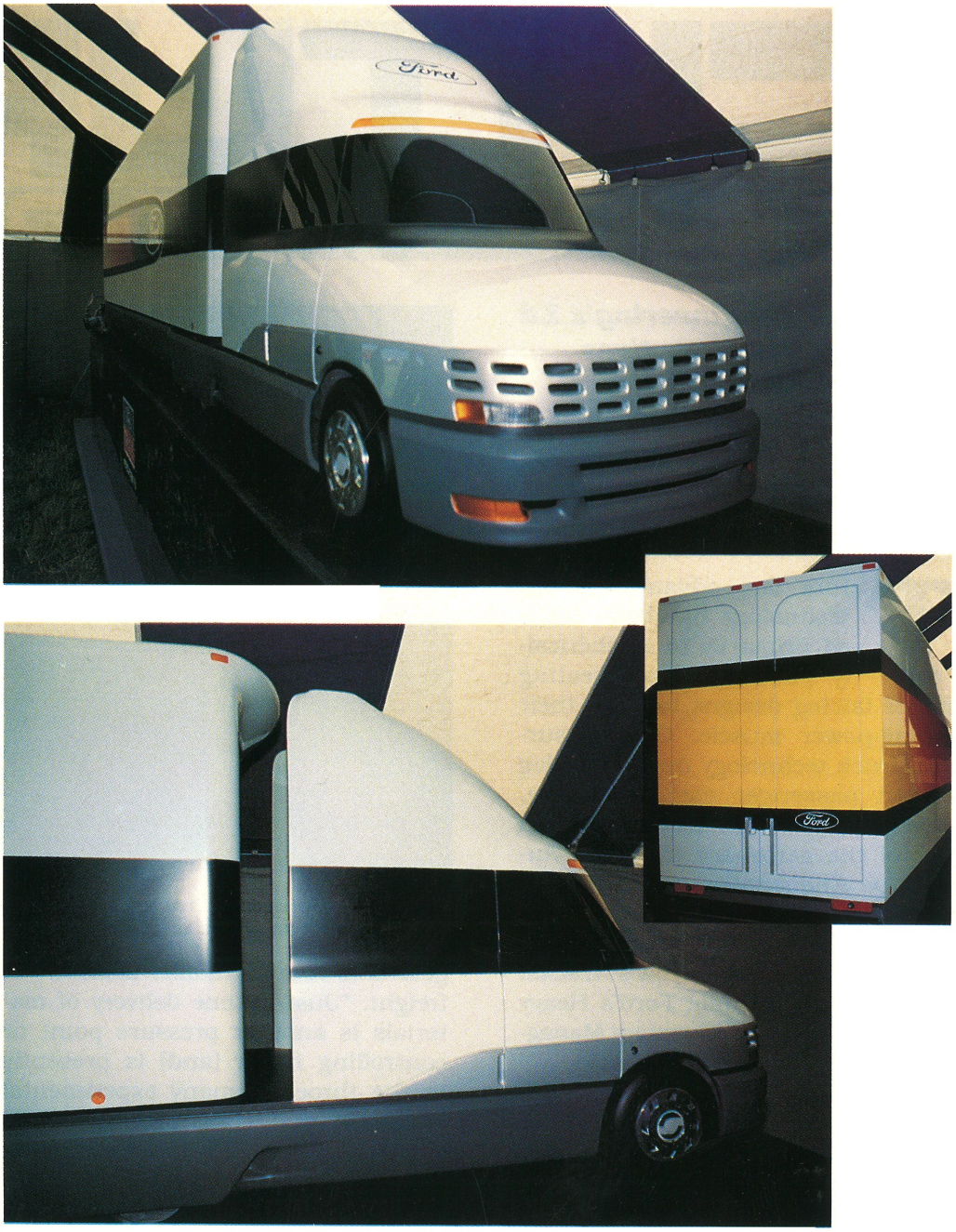
Ed Mabley believes that the trucking industry is essentially a materials handling business that will still receive most of its pressure from the shippers subjected to tighter delivery schedules. He also believes future assembly plants, for complicated items such as passenger cars, will have less storage space and will be geared to receive smaller amounts of freight. "Just-in-time delivery of materials is another pressure point or controlling factor [and] is presently in the throes of many experimental kinds of materials handling and shipping. In many instances the materials will come right off the truck and go directly to the [assembly] line."

This is giving rise to a new classification of trucks called "Baby Eights" which service regional, shorter-haul "Hub-and-Spoke" freight operations. Mabley continues, "So, in the end, trucks of tomorrow will have to recognize these trends in freight. Any changes will have to be cost-effective to compete with the resurgence of the railroad system. Systems like the double stacking of cargo containers in the 'Stack Trains' and the 'TOFC' (Trailer On Flat Car) will have to be dealt with as well as a new concept called the Road Railer. This system uses a trailer with conventional highway air suspensions but also has a set of

Ed Mabley

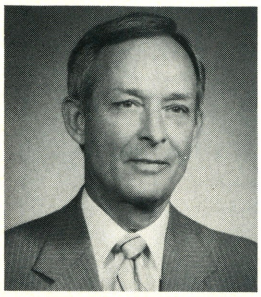


"The plants of the future are now being geared to the arrival of small amounts of freight [and] they have no intention of a long-term storage," said Ed Mabley.

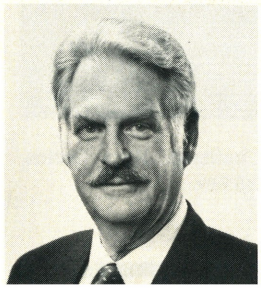


Ford's concept tractor/trailer features wind-cheating trailer-top fairings, side skirts, and fold-out rear "doors" that simulate a longer tapered tail.

Gerry DeClaire



Jim Shannon

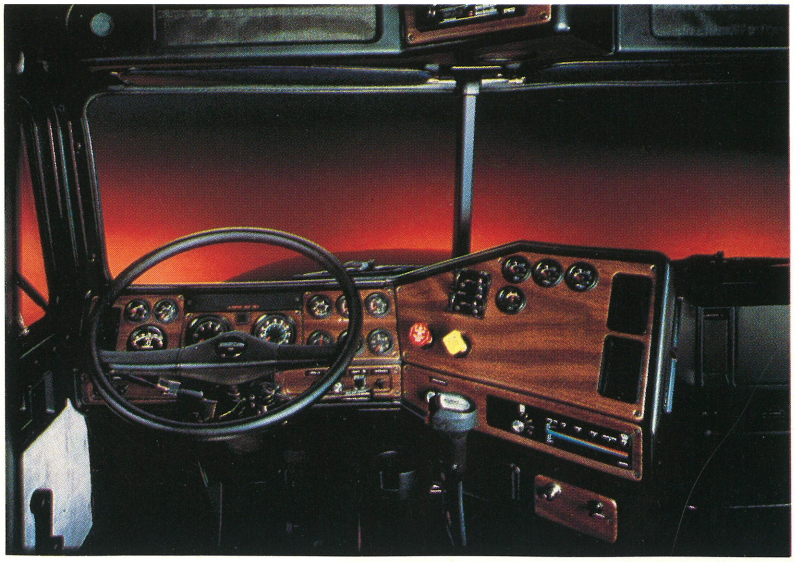


"By the time that you could develop, prove, service and support synchronizers in [North America], I expect that automation will have made them redundant," says Jim Shannon on the differences between the evolution of European and North American transmission.

air-suspended railroad wheels that can be lowered. Its advantages include quick assembly and disassembly of trains."

Mabley expects steering systems to be more precise, with some form of electronic modulation for better road feel. Improved road feel, he believes, is necessary to communicate more information to the driver. However, along that line, due to the biomechanics involved with operating the rig in an unassisted mode, he doesn't expect steering wheels to move to a more vertical plane or become much smaller than 20 in. (down from 21-22 in. presently in use).

Since braking systems cannot compromise reliability, he expects some form of electronic modulation to shift braking effort to the axles with the greater loads. Some form of accelerometer will be used to detect when such augmentation will be necessary. Improvements in top speed achieved from better aerodynamics—which have allowed the use of smaller, more-efficient engines—have also created a need for improved braking systems. These aerodynamics, although decade-old technology for trucks now, can also be expected to improve splash-and-spray for passers-by. Already the Aeromax,



Truck ergonomics will feature "car-like" appointments that will demand less from its driver while still providing important "road-feel" information through the controls. (photo courtesy of Freightliner Corp.)

The "Baby 8" is emerging to service hub-and-spoke routes. (photo courtesy of Freightliner Corp.)

with its fairings, is five times better in this regard than untreated versions.

Finally, Mabley expects to see the use of more steel and composite materials. Aluminum is starting to lose its glamour, is expensive, and has too low an endurance limit for extensive use on tomorrow's million-mile truck, believes Mabley.

Rockwell

Dry friction brakes are here to stay— at least for the near future. Regenerative braking might be useful for some detailed short-haul routes but not for over-the-road rigs. Discs can be problem-solvers as electronically-assisted steering systems begin to permeate the industry. The problem would arise in the event of power steering system failure in a rig that has a heavy, uneven left-to-right brake bias. Due to the perpendicular direction of the actuating force to the rotor surface, front-axle discs eliminate the self-energizing-amplification effect inherent in the drum brake design. Therefore, when the driver is faced with controlling the rig under heavy braking, the discs would impart less pull to the stronger-braking side.

"Subsystems" is the buzzword at Rockwell. Expect to see more *integration* of subsystems in the future. This integration will rely heavily upon communication devices. And, until high reliability is achieved in the transfer of information to system components, do not expect to see drive- and brake-by-wire systems. However, when it does happen, electronically-controlled suspension systems could reduce highway damage and automatically lift axles not in use. A ground radar system could be used for proximity awareness to assist the driver in recognizing dangerous situations that exceed a particular vehicle's dynamic capability, such as a driver outdriving its stopping distance.

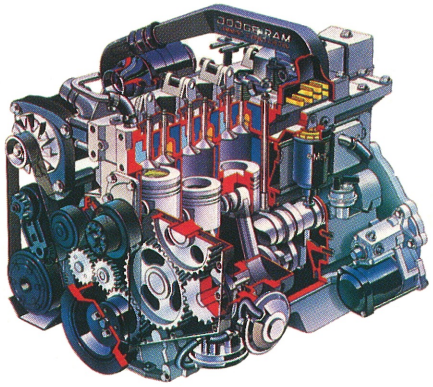
Jim Shannon sees electronics as "an enabling technology." "Torque is a problem at the start. . . .put a blade in the ground, and you need an automatic." Shannon is referring to graders, snow plows, and similar devices which require smooth torque transfer. Rockwell is working on an electronically-controlled automatic transmission for this application. Other uses include pick-up and deliver cycles, or school buses. And, although standard mechanical transmissions are already ~97% efficient, Rockwell knows where another 1% is hiding. However, we will have to wait to see where they found it.

Eaton

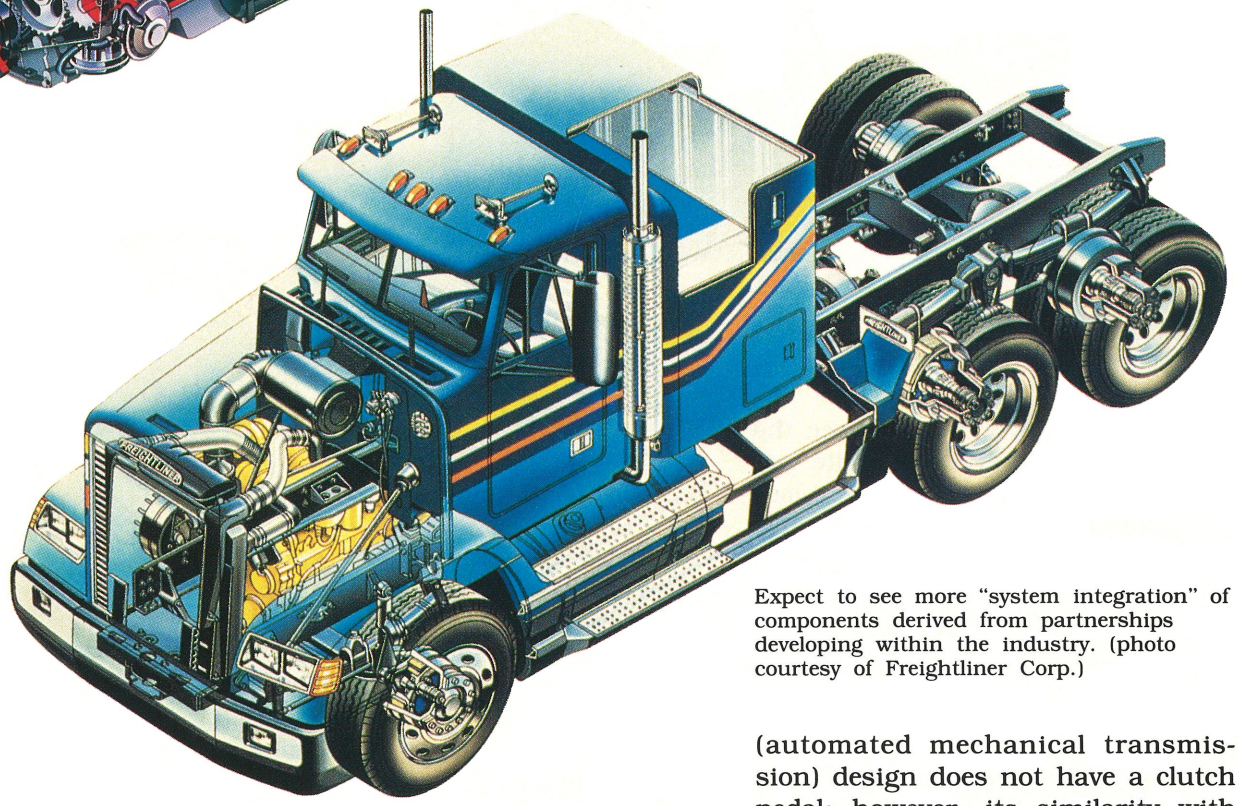
Robert Denes brought to light some important differences between the North American and European

Bob Denes

"You can automate to be able to use high technology, [or] you can automate to make it easier for the driver, enabling him/her to pay more attention to the traffic and other social responsibilities," says Bob Denes.



Dodge/Cummins 6.9-L diesel cutaway.



Expect to see more "system integration" of components derived from partnerships developing within the industry. (photo courtesy of Freightliner Corp.)

Dean P. Stanley

"Certainly in the '90s we are going to be faced with some new ruling that will enhance the safety of trucks," believes Dean P. Stanley.

trucking industries. He mentioned that North American shippers and drivers are more profit oriented and operate fleets that are huge when compared with the European counterparts. Even driving styles are different with the Europeans strongly favoring the synchromesh—rather than the constant mesh—transmissions. Therefore, one must take these factors into account and have a global perspective for future designs.

With the million-mile truck not too far off into the future, the key in building transmissions is to automate the biggest wear factor—the driver. The SAMT (semi-automated mechanical transmission) used in Europe has a clutch pedal that is used only when moving off from rest. During shifting, the clutch is disengaged automatically by an air actuator. By comparison, an AMT (automated mechanical transmission) design does not have a clutch pedal; however, its similarity with the passenger car-type, epicyclic automatic transmission ends there. The AMT is essentially a robot-controlled, constant mesh transmission. Such automation represents the ultimate in efficiency as fluid drives are not used and optimum operating conditions are constantly executed by on-board electronics.

Denes stated, "There is a lot of resistance to electronics in the truck area because people are concerned about things they don't know. Since the truck is there for them to make money, their concern is 'What is going to happen if it breaks down? Will it break down frequently? How can I repair it? How long will it live?' These are all well justified questions. And, before this type of product is really accepted, these four questions must be answered. It is your cost of doing business. You owe it to your customer. Your customer doesn't want to get your experience

Dodge Dakota goes topless.

on his account. With reliability verification testing, you shoot for proving, with an acceptable level of confidence, that you will achieve your target life and target reliability."

Navistar

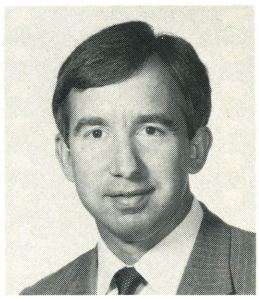
Dean Stanley believes skirting trailers will find another 6-8% "air power." More attention to the driver is expected with the emphasis on better ride and handling, less noise, and improved steering. Powertrain design will see more cooperation between manufacturers. Navistar's "Power Demand Cruise Control" was the result of a partnership established between Navistar, Dana, and Caterpillar. Expect to see more satellite communication in the future and more electronic recording devices as well. However, radar systems might not be here until the turn of the century.

Stanley on active control or air suspensions: "You won't have active control of the primary suspension because of the weights and the over 150 hp hydraulic motor [required] to drive the 80,000 lb [machine]. So active primary suspension is really not a consideration on trucks as is on cars. Some of the manufacturers have suspended cabs, but we've actually been able to design around that over the years but we've pretty well run the string. We've been able to keep the cab suspended on the frames in a solid manner which is [a lot] more reliable. So you are [going to] see enhancements in both the primary suspension systems and you will probably see suspended cabs on most of the trucks down the road."

Chrysler

Paul Sheridan sees overhead cams, sophisticated multivalve valvetrain, distributorless ignition, multipoint fuel injection, and tubular and/ or tuned exhaust designs as part of the overall trend toward higher technology in the light- and medium-duty

Paul Sheridan



Paul Sheridan believes, "The top end of the light-duty trucks has gradually moved into the medium-duty truck business without anyone really paying attention."

Another Dakota receives a Shelby-modified 318 CID V8 capable of exceeding its static coefficient of friction.

truck segment. He cites gains in serviceability, higher specific outputs, and better fuel economy as major incentives. Federal regulations and competition from the Japanese are also responsible for these changes. Toyota's new Dakota-size pick up truck follows the general trend of the Japanese moving into the larger vehicle market. "The top end of the light-duty trucks has gradually moved into the medium-duty truck business without anyone really paying attention," says Sheridan. Also, federal regulations have catalyzed the move towards more efficient lock-up, overdrive automatic transmissions.

In the near future, expect to see more gas, rather than diesel, engines in this segment because of the "time-loading" effect on the drivetrain. We can expect to see this trend continue until transmissions are developed that can handle the low-rpm/high-torque output characteristics of diesel engines, such as the detuned-for-production Dodge-Cummins direct injection turbodiesel. This time-loading effect occurs when high torque is produced at relatively low rpm. In this case, for the diesel, high forces exist at the gear faces for longer periods of time when compared with the same torque output of a gasoline engine at higher rpm. The straight-six configuration, due to its inherent natural balance, will be around for a while. Production of the Vees will become modular around '95. The modular concept will enable manufacturers to use common parts for V4s, V6s, V8s, and perhaps V10s and V12s. Rods, pistons, and other parts will be common, but so will the heads and combustion chamber designs which will simplify machining processes. All should be overhead cam designs by that time. Larger displacement versions—such as the flexible Eagle design—should begin to permeate this industry and may have marine applications as well.