SAE 100 *Future look*

In celebration of SAE's Centennial in 2005, industry executives discuss the future of mobility technology.

Diesels ready for U.S. prime time

*by **Don Manvel**, Chairman and CEO, AVL North America*

AVL GENIOS HSDI (high-speed, direct-injection) diesel concept

The scenario is hauntingly familiar. Daily news stories on gas and crude oil prices climbing to record highs, accompanied by reports of tight supplies and increasing demand, have analysts and experts talking about an "oil crisis" in 2005. Some are even predicting an early demise of the personal-mobility dinosaur—the internal-combustion engine.

Well, not so fast. Few people realize the evolution of internal-combustion engines is accelerating right now, more quickly than ever before. Diesel technology, in particular, is delivering greater fuel efficiency and performance to car and truck owners and promises to play a major role in advanced propulsion systems such as diesel-electric hybrids.

As an industry, we need to plan for our common energy future not by seeking quick "silver bullet" cures, but by rationally examining the full spectrum of issues. In order to plan, we need to know what technical challenges face us, and what will be determining factors in the near and long term. These factors may be CO_2-emissions reduction, decreased dependence on foreign energy sources, increased overall efficiency, or more likely, a combination of all these.

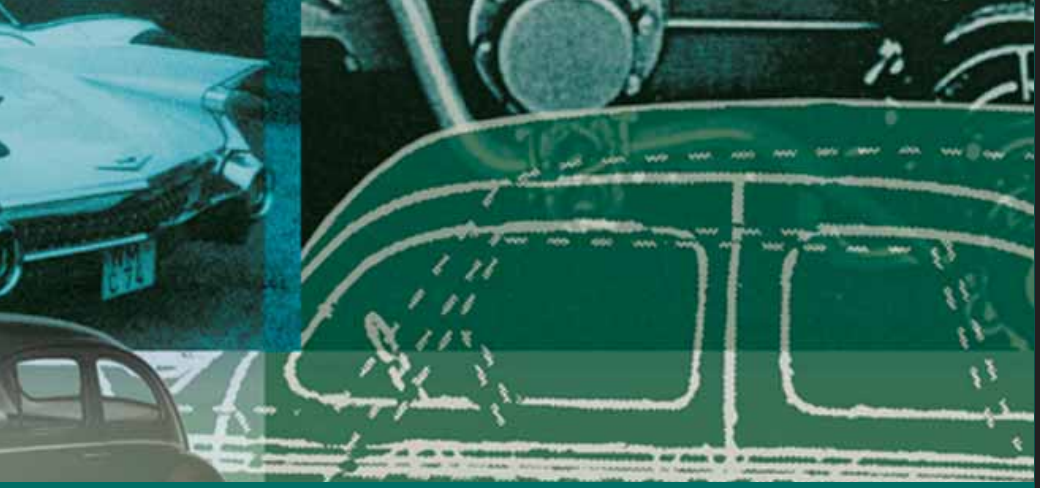
Thirty years ago, the industrialized world was in a somewhat similar position of searching for ways to cope with rising energy prices. At **AVL**, for example, we were trying to adapt direct-injection diesel technology, which worked so well for heavy-duty applications, to work in light-duty vehicles. In this case, we were fortunate to enjoy success. Today, we are looking at a variety of promising technologies such as increased injection pressures, nozzles with variable orifices, cylinder-based control, variable valve actuation, and advanced pressure-charging systems, which will lead to significant advances in engine performance.

AVL began this research in 1974, right after the first oil crisis. By 1976, we were working with **Audi** on direct-injection diesels. Then, in 1984, we helped **Ford** introduce the world's first light-duty direct-injection diesel engine in the Ford Transit van. By 1989, AVL helped Audi take the lead with direct-injection diesels for production passenger cars. From there, many additional projects followed with other automakers. Of course, we cannot take all the credit for direct-injection diesels, but we are proud of our leading contribution.

Modern high-speed direct-injection diesel engines have come a very long way even from those we developed in the '80s. Specific power and torque outputs have roughly doubled. These increases have been achieved while reducing emissions emitted by diesels to a mere fraction of what they were then.

Staying true to our roots, we have a global network of research centers, including a Detroit-area facility with 21 test cells. As of today, more than 80% of our Detroit-based test facilities are being employed on the development of advanced diesel engines, for use in both heavy- and light-duty U.S. applications. Many of these engines will see production within the next 3-5 years. Our research staff is pursuing promising technologies in the areas of emissions aftertreatment, cold-starting, and state-of-the-art computer simulation tools.

A holistic approach is essential. For example, AVL's combustion-optimization work takes into account engine design, thermodynamic cycle management, and gas- and cooling-flow requirements. The implications of the clients' specific production requirements and the need for robust, cost-effective solutions are considered from the very start of total engine, system, or component design. Taking a highly focused approach to key areas such as power cylinder, cooling, lubrication,



valvetrain, and timing drive systems reduces development time. Then there are the external regulatory changes to be managed. We are working with our OEM and Tier 1 customers to help them prepare for the introduction of low-sulfur fuels to the U.S. market in 2006-07.

Today, diesels are not only acceptable in Europe, but are the preferred powertrain in an increasing number of countries. Especially interesting is the European luxury market for "executive class"—known as "luxury sedans" in North America—where diesels structure nearly 70% of the market. These consumers are the least sensitive to fuel consumption, just like North American luxury SUV owners, but they select diesels anyway. Why? It is simple: performance, and more specifically, torque.

The diesel story has been a fascinating, real-world illustration of what can happen when a more creative approach to fuel efficiency is fully pursued. Early on, we knew a great deal of acoustic work on reducing the unpleasant noises of diesels was needed. We harmonized consumer acceptability of the noise with the feel of the powertrain. Mission accomplished.

The challenges with diesel may serve as an example for any future powertrain options. In some cases, the technical challenges may be easier to overcome than the perception problems.

For example, maybe fuel cells will be too quiet. We know the Japanese like to make cars as quiet as possible, but Europeans really enjoy certain powertrain sounds. Americans, it seems, are somewhere in between. AVL has been working for many years on what we call "Brand Sound"—a method to control and optimize the inherent powertrain sound signature to create improved end-user perception and allow branding of vehicles. Some of this vehicle character may be lost with the advent of fuel cells.

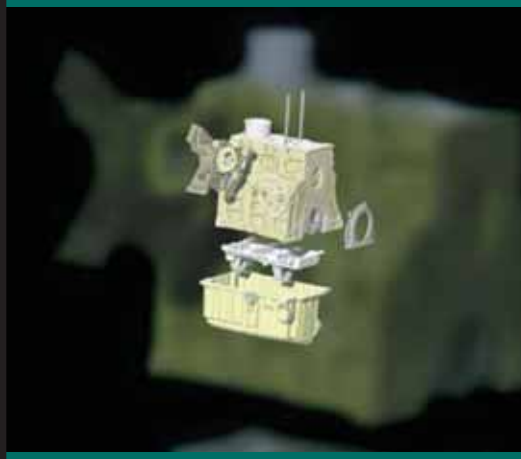
Attitudes and perceptions are extremely important and are often overlooked in these kinds of discussions. For instance, an increasing number of buyers, especially younger buyers, care very much about the technical aspects of performance. Look at all the interest in **DaimlerChrysler**'s Hemi engine. Powertrains can be a very important market differentiator.

In many of our discussions about the future of transportation, it seems as though we are focusing on only one long-term scenario: hydrogen-powered fuel cells. But we should be planning for more than one scenario. Call it a portfolio approach. We need to ask key questions: What options do we have in terms of primary energy, such as fossil fuels, solar, or nuclear? What are the alternatives for energy storage? Are there specific fuels or energy carriers that promise major advances? And, lastly, what are our options with propulsion systems?

We cannot predict with any degree of certainty the course of political and economic events. Likewise, those of us who do automotive research for a living know this: One cannot predict outcomes. If research were predictable, it would not be research. In the near and mid-term, we have a fairly good idea of the evolutionary changes we can expect of existing technologies—*i.e.*, the internal-combustion engine—and we are continuing to pursue them.

Making new technologies feasible for future vehicles can be a daunting task, but many companies, including AVL, as well as other **SAE** members, government agencies, and universities around the world, are working diligently to overcome the many challenges and barriers to achieve the success that comes with those technologies.

We may not be able to predict the future, but we have every opportunity to shape it. ***aei***



Magnesium HSDI diesel cylinder block CAD model

Magnesium cylinder block casting

Heavy-duty diesel undergoing dyno testing