theodore

IN THE SHADOW OF GREEN POWERTRAINS

Recently, I was asked by the American Society of Body Engineers to speak about the impact of green vehicles, including electrics and hybrids, on the future of performance vehicles. Being a little perplexed by the choice of topic, I started with that subject, but expanded it to include the impact of green vehicles on body engineering.

People say the first automobile race occurred when the second car was built, and the current emphasis on green vehicles doesn't mean that the competitive nature of human beings will disappear. As new green vehicles appear in greater numbers on the automotive landscape, you can be sure that tinkerers, enthusiasts, and inventors will start to figure out how to make them perform even better. Ultimately, manufacturers will also respond to our need for speed – once they have overcome all the technical hurdles that they face in the current economic climate.

Already, the FIA is supporting regenerative power-boosting systems for F1 cars. The American LeMans series is promoting a green race within a race. Tesla chose to focus attention on its EV by first introducing a high-performance sports car – albeit at US$100,000. So you can expect green performance vehicles to take on many new forms:

EV vehicles will be fitted with more powerful motors and larger, higher voltage battery packs, along with weight reduction and aerodynamic packages.

Hybrids will also receive either enhancements to their electric drive systems, or their IC engines. For example, I had dreams of building a hybrid sports car using Escape Hybrid mechanicals. The Escape is fitted with a naturally aspirated Atkinson cycle engine to maximize fuel efficiency. Few people realize that Atkinson cycle engines love to be supercharged. A turbocharged four-cylinder would provide greater performance when demanded, but deliver essentially equivalent fuel economy.

Diesels and biofuel vehicles will also be modified for performance. For example, if E85 ethanol ever became more readily available, dedicated E85 vehicles could be developed to take advantage of the higher octane rating of ethanol. On the Raptor concept vehicle, we took our 620bhp Extreme 5-liter supercharged motor and modified it to take advantage of E85 so that it put out 650bhp and would still meet stringent emissions standards.

Sooner or later, enthusiasts will start to take the drive systems out of larger green vehicles, and fit them into smaller vehicles – a recreation of Carroll Shelby's (and every other hot rodder's) successful formula of putting a large engine into a lightweight vehicle.

This lightweight approach leads to the broader discussion regarding the implications of green technologies on body engineering. The green challenge is not just one of creating new powertrains. In fact, I suggest that the challenge is just as great for body engineers. Virtually every new green powertrain technology that is being developed will cost more. The body engineering challenge is therefore simple: create solutions to improve fuel economy at a lower equivalent cost than the incremental cost per MPG (or equivalent CO_2 reduction) that new powertrain technologies provide! Perhaps the bigger challenge is to put together a convincing case for management – so that they don't just focus on powertrains as they address increasingly stiff fuel economy regulations. To me, the answer for body engineers is to focus on architecture, weight, and aerodynamics.

Few manufacturers of the first- or second-generation hybrid vehicles have redeveloped vehicle architecture to come up with a more efficient package. Even the revolutionary new Chevy Volt has been designed to fit into an existing platform design. Battery packs are hung in existing tunnels. Fuel tanks, motors, and power control systems are packaged in whatever free space can be found, and little has been done to take a holistic and synergistic approach to vehicle design. Some initial steps are being taken

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toward new architectures. Ford's second-generation hybrid application on the Fusion starts to rethink the systems architecture, and the original Escape Hybrid required a separate cooling and ventilation system for the battery pack – at considerable expense. Upon reflection, Ford engineers figured out that batteries like to operate in the same type of environment as humans – so the same ventilation system could be used.

There is much more to be done, however. Why do we hang the battery pack in heavy containers suspended from the vehicle? Could the battery box become an integral part of the vehicle structure? If you had a clean sheet of paper, would you configure the body architecture in the same way? I think not. It is time for some fresh, innovative thinking regarding body architecture.

With the increased emphasis on cost over the past decade, I believe the focus on weight has been diffused. One bad example is the noble effort of one green manufacturer to develop an all-new luxury plug-in hybrid. The vehicle is so large that the body drives the need for additional heavy batteries to achieve range – which drive heavier suspension and driveline components to support the added mass. The result is a GVW of 6,000 lb – that of a commercial class vehicle – despite extensive use of expensive lightweight materials such as aluminum!

A more positive example is to realize the synergistic effects of weight reduction. A lighter body structure requires a less powerful and lighter powertrain, which makes possible lighter suspension and drivetrain components. We need a cost model that recognizes these synergistic effects so that an optimum outcome is achieved. To be a little thought-provoking and controversial, I tell my engineers that "weight is free", in order to get them out of the cost/lb weight reduction mindset. Each component needs to be optimized for maximum efficiency before you start spending money on lightweight materials.

I was reminded of this recently, while tearing down a Ford GT to use the components for a chassis invention I'm working on. I'm pretty proud of the Ford GT, a world-class supercar we developed in record time. It featured an aluminum spaceframe, aluminum and composite body, aluminum engine, magnesium IP structure, carbon fiber seats, and innovative Azdel-light interior. When I started breaking it down, however, I realized that there was at least another 200 lb that could have been taken out of the vehicle if we had taken a little more time to optimize each component. Due to the short development time and small team, we had focused on the big items for mass reduction, but hadn't paid enough attention to the details. Many brackets were not optimized – which I soon realized as I struggled to remove each component.

In the early days, before CAD, I used to conduct "tin snip and grease pencil" reviews of prototypes, where we'd snip off dead metal, mark up lighting holes, and identify where components could be integrated. Later, we did this in virtual CAD and CAE reviews. This is a discipline that should not be forgotten, as all this weight reduction is indeed free, through lower material usage.

That is not to say we shouldn't continue to explore use of more advanced lightweight materials and technologies. This is where a good accounting system of the synergistic effects comes into play. Body weight reduction is the most effective way of reducing total vehicle mass. The lower the sprung weight, the lighter the supporting components, so that a 1 lb reduction in body weight can yield a 1x reduction in total vehicle weight. Nor am I advocating extreme use of exotic materials – such as on the GM EV1, where so much money was spent on a lightweight body in order to minimize the battery pack requirements that the vehicle could not support a rational business case. Optimization of the total vehicle is the order of the day!

I've seen a de-emphasis on aerodynamics in the last decade. Any shape can be made more aerodynamic, if you pay attention to the details. Future vehicles need not be teardrop shaped – but do need to be aerodynamically optimized. Recently, one US manufacturer introduced a replacement compact vehicle that was wider, taller, and had a multitude of sharp protuberances in the body design. Management panicked when they realized they had created a worst-in-class vehicle for fuel economy. They shouldn't have been surprised. The vehicle justifiably flopped in the marketplace.

The body engineers, working up front with aerodynamicists, can do much to reduce aerodynamic drag with detail changes that don't affect overall aesthetics. The underbody is often overlooked, where improvements can be made with no impact on appearance. Simply put: aerodynamics is an area where improvements in fuel economy are free.

Body engineers need not operate in the shadow of the green movement. Their challenge lies in vehicle architecture, weight reduction and aerodynamics improvements. The green movement provides the impetus for making great strides in body engineering. ❮

Chris Theodore has over 30 years' experience in automotive development, including stints at all of the Big Three in the USA