cabin allows good headroom, and the mid-engine layout affords plenty of space in the footboxes. This is an exotic you can enjoy without the pain of sacrifice. Warren Mosler has nothing to be ashamed of here.

So what's next? Not only is a four-passenger sedan in the works, Consulier is also developing a 2300-pound, full-size passenger van constructed of the same type of lightweight composites (it's affectionately called—what else—the Van-Go). Both of these vehicles would be ideal for alternative-fuel powerplants. In fact, one firm has already run a Consulier with battery power and a hydrogen fuel cell. The gasoline-powered Consulier has dramatically demonstrated the value of lightweight composite construction—now all that's left is for the world to realize that Mosler has built a better mousetrap. ***KC***

SOURCE

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CONSULIER'S CUTTING-EDGE TECHNOLOGY

By Ken Hankinson, N.A.

What is referred to as "high-tech" is not always as advanced as you may think. Just because a specialty car manufacturer throws in some strands of carbon fiber or swatches of Kevlar fabric, the result is not necessarily cutting edge; builders sometimes add these materials as much for marketing hype as for any real benefit. However, this doesn't seem to be the case with Consulier. It not only uses the latest in composite materials and methods throughout, but also designs around them in ways that maximize their benefits—that's truly advanced technology.

While the innovative Consulier body is a true monocoque—a French term for stress-skin construction—this is not a new concept (Jaguar used it in the famous E-types of the '60s). But Consulier engineers it to the extreme. Instead of solid, heavier (and cheaper) fiberglass laminates, the firm uses lightweight foam-core sandwich laminates with thin, high-modulus (super-stiff) skins. In so doing, a conventional frame becomes redundant. Instead, stresses are taken by the body panels themselves; torsional rigidity comes from the panels and various stiffening devices and ribs within the body's structure.

For comparison, similar construction has been used for years in offshore raceboat hulls. Often these hulls can be made so stiff that few—if any—internal members are necessary. Yet skins on either side of the core material might be less than 1/16-inch thick on a 40-footer! While these skins may include any combination of super-strong reinforcements such as S-glass, Kevlar, or carbon fiber, the key to ultimate strength is in the resin that completes the composite. This resin must stick tenaciously to not only the reinforcing fibers, but also to the core materials; if a skin parts company from the core, all is lost. In addition, the resin must also stretch and compress enough so that the reinforcing fibers can do their job without the resin cracking into pieces.

General-purpose polyester resins—the kind most often used in fiberglass car bodies—are simply too rigid and brittle for these reinforcements in such sandwich laminates. Iso polyesters are only a bit better. Vinylesters (more advanced types of polyester) have better elongation and bonding qualities, but still are not the best. What's the ultimate resin for highly stressed sandwich panels? Epoxy. It costs more but sticks like crazy and has qualities that closely match the reinforcements' demands. This is what Consulier uses.

Can you believe the unitized frame-and-body weighs only 275 pounds?

If epoxy is not used, consider what can happen in a laminate using Kevlar. The laminate depends on the matrix formed between the Kevlar and the resin acting in concert under load. Because of its high flexural and tensile strength, Kevlar laminates tend to bend, dent, or otherwise deflect upon impact rather than fracture. However, ordinary polyester resins tend to be brittle and crack or shatter upon impact, and don't bond well to Kevlar in the first place. The resin fails before the Kevlar by cracking and/or parting from the reinforcement. Once this happens, the Kevlar fabric becomes virtually useless and the structure falls apart. A suitable epoxy, however, flexes much more upon impact, staying bonded to the Kevlar under far greater stresses.

Consulier carries things further by varying composite ingredients at given points in the body to make the best use of specific materials. For example, foam-core density is increased where extra impact resistance is needed. Bi-directional S-glass fiberglass is used on the outside for better finished appearance and extra resistance to dents and dings compared to the somewhat weaker E-glass inside. Vacuum bagging (a method of construction where the layup is surrounded by a bag and the air is sucked out) is used to bond skins to cores rather than by hand layup alone, in order to prevent air entrapment that can lead to core-to-skin bond failure. Vacuum bagging also reduces resin content for lighter weight (you need only enough resin to wet out and maintain bonds).

If done correctly, the result is a body that's not only extremely lightweight, but also strong and resistant to torsional forces. A stiffer body means more easily realized handling and performance expectations; body flex won't interfere as much with steering and handling geometry or alignment. Major components in the car (brakes, engine, accessories, and so on) can be lighter and more compact as well. More usable volume is available, along with better fuel economy, faster acceleration, shorter stopping distances, and more precise handling. Also, such a body won't rust, is highly resistant to dents and body damage, and yet is easily repaired.

If there are any down sides to this construction, they include high cost and labor intensity. Also, a car can be *too* light, especially when high-powered, and become airborne on occasion. That's why, as weight is decreased and power increased, it becomes ever more important to incorporate negative lift (downforce) characteristics in body design so that road holding is not diminished. Consulier is well aware of this fact and has addressed it in both the aerodynamics and suspension components.

Ken Hankinson is a naval architect by profession and an expert on composite technology.