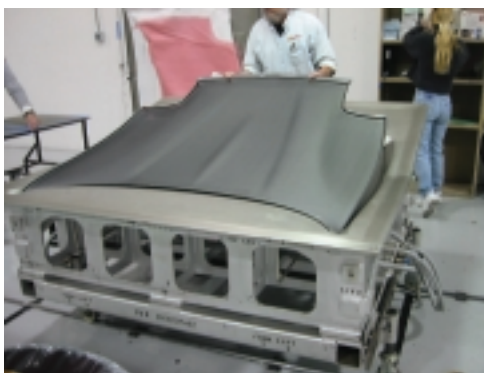
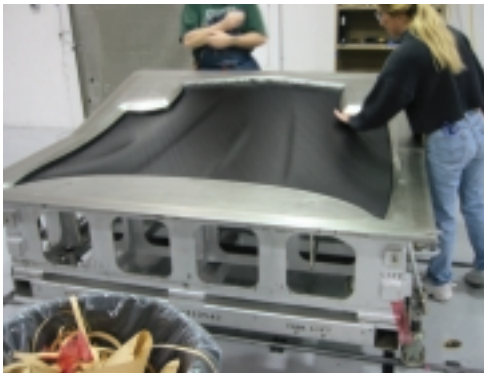


## MacLean Vehicle Systems Produces First Class A Carbon Fiber Body Panel for Mass Production Vehicle

Working with General Motors and a team of industry partners, MacLean Vehicle Systems (MVS) has succeeded in developing, qualifying and entering production of a lightweight, structurally stiff carbon fiber hood for GM's 2004 Collectors Edition Z06 Corvette. The hoods are being supplied to GM's Bowling Green, Kentucky assembly plant where they will be processed identically to current production fiberglass body panels. Approximately 2,500 Corvettes will be

fitted with the carbon fiber hood for the 2004 model year. MVS is the first supplier demonstrating delivery of aerospace quality advanced composites into a traditional automotive assembly environment. "We expect this project is the first of many automotive applications for our carbon fiber technology, from body panels to structural components," emphasizes Jeff Keller, VP and General Manager, Plastics and Composites for MVS.



MacLean Vehicle Systems is an engineered solutions supplier. Our strength lies in creating solutions and identifying opportunities, part consolidation, assembly simplification, and cost and weight reduction. The long-standing relationship we have with General Motors on our other product lines combined with our Composites expertise made us an excellent choice for this Advanced Purchasing New Technology program.

### Key Characteristics

**Weight:** 20.5 lbs (9.3 kg) – 34% lighter than current fiberglass production hood

**Outer skin thickness:** 1.2 mm (0.048 inch) – similar to stamped aluminum and steel

**Composition:** 100% carbon fiber Class A outer skin, hybrid low density fiberglass/carbon fiber inner panel

**Qualification:** Passed all GM requirements for strength, stiffness and durability

### Significant Advancements

- Highest volume production (2,500 per year of a single component) using aerospace autoclave technology
- Lowest skin thickness on a Class A composite component used in production automobiles
- Class A surface finish direct from mold
- Compatible with existing high volume power wash and painting systems without surface preparation
- First production use of Invar molds in volume automotive components

## Manufacturing Process Blends Aerospace Technology and Mass Production Mindset

The aerospace industry has relied on advanced carbon fiber composites for many years to achieve maximum structural performance at minimum weight. Such components are typically produced using laborious processes with slow-reacting epoxy resins, and cured under heat and pressure in an autoclave process, where cycle times often reach 20 hours or more. The challenge facing GM and MVS when the project began in late 2001 was developing a manufacturing system to produce thousands of parts per year, suitable for moderate volumes.

The MVS process relies on cellular manufacturing and a combination of automated and manual techniques. As in aerospace components, an autoclave is used, however, the unidirectional carbon/epoxy prepreg is formulated to cure in only 10 minutes at 300°F and 100 psi pressure. To achieve the volumes required and provide tooling for up to ten years of aftermarket production, Invar, a nickel/iron alloy was selected for the molds. Following cure, the hood outer skins are removed from the mold, automatically routed, and adhesive robotically applied. The outer skins are bonded to a hybrid fiberglass/carbon fiber SMC inner panel, supplied by Meridian Automotive Systems (Dearborn, Michigan), inspected and shipped to Louisville, Kentucky for priming prior to shipment to Bowling Green.



### Partners/Suppliers:

**Carbon fiber prepreg:**

Toray Composites America  
(Tacoma, Washington)

**Structural adhesive:**

Ashland Specialty Chemical Company  
(Dublin, Ohio)

**Prime painting:**

Sport Paint, Inc. (Louisville, Kentucky)

**Invar production molds:**

Visioneering (Fraser, Michigan)  
Models & Tools, Inc. (Troy, Michigan)

**Machining, bonding and check fixtures:**

Models & Tools (Troy, Michigan)

**Reusable vacuum bags:**

Torr Technologies (Tacoma, Washington)



*MacLean Vehicle Systems is a wholly-owned subsidiary of MacLean-Fogg Company. MacLean-Fogg is a privately held manufacturing company, based in suburban Chicago, employing about 2000 people in 24 facilities in eight states*

*and six countries. We produce engineered products and component parts for the automotive, transportation equipment, general industrial, electrical equipment and telecommunications markets worldwide.*

**For more information, contact Jeff Keller 262-473-2333 ext. 375.**