Technical Article: Corvette - New Application Test Car of the Future - by Dave McLellan - Corvette Chief Engineer

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In this the Corvette's 25th Anniversary year, Chevrolet will produce 50,000 Corvettes - a value of product approaching 0.5 billion dollars. In Fortune 500 terms this would compare to companies ranking in the high 400's. In automotive terms this is still small scale. Corvette production is one to two orders of magnitude less than that of General Motors' high volume passenger cars. This small volume is a part of Corvette's uniqueness and also presents us with an opportunity—the subject of this paper—to develop new material applications and process technologies at an intermediate level of production between that of prototyping and high volume production. Also underlying this discussion is the quest for improved fuel efficiency in all of our future cars and the Corvette in particular.

In addition to the average fuel economy standards legislated last year, the Carter Energy Act as of this writing was still in the Congress, and will probably contain in is final version either the Metzenbalm Amendment or the gas guzzler tax. Metzenbalm would not allow the sale of cars that did not achieve fuel economy above a specified minimum. The alternative gas guzzler tax would apply a steeply graduated tax to cars that did not meet a minimum fuel economy requirement.

The "do or die" economics of the Metzenbalm amendment are clear - you won't sell cars that don't meet the minimum. The economic implication of the gas guzzler tax is that as an alternative to the customers paying the tax, the manufacturer can spend the customers' money to make the car more fuel efficient, an alternative to which the customer should be economically indifferent. Translated into weight reduction terms for a car in 1982 getting 19 mpg and subject to a tax of $250, the manufacturer can afford to spend up to $0.70 per pound of weight removed. In addition, a 1 mpg improvement on 19 mpg will save the owners of the car over its lifetime about $100 in fuel cost.

While improved fuel efficiency is being attacked from many directions, this discussion will focus on weight reduction in existing FRP - Fiberglass Reinforced Plastic components and potential weight efficient substitution of FRP in applications where it is not now used. This will be accomplished by reviewing where the Corvette is today in terms of usage of FRP and where we are projecting advances over the next several years in terms of materials, process technologies and new applications. The problems associated with these advances represent major challenges to Chevrolet and to our material suppliers and fabricators of Corvette components.

The 1978 Corvette has a curb weight of approximately 3,500 lbs. High usage options add another 150 lbs. so that with the 300 lb. passenger load, the car is in the 4,000 lb. IWC - Inertia Weight Class. Our goal by 1982 is to reduce the weight of the Corvette by 13% or 450 lbs., thus bringing the car into the 3,500 IWC. At constant power to weight ratio this will improve fuel economy by 2 miles per gallon. FRP materials are expected to contribute 150 lbs. to this total with about 60% coming from existing FRP parts and the other 40% from new applications of FRP.

In 1978, 350 lbs. or 10% of the curb weight of the Corvette is FRP. These FRP applications are almost all non-structural. Most of these parts were originally designed in the wet mat process so that even though today the car is entirely SMC, full advantage has not yet been taken of SMC by incorporating attachments and reinforcements in the as-molded part.

One of Chevrolet's highest priorities with the Corvette is to improve exterior surface finish of the SMC parts. A major step in this direction will be taken with the application of molded coating to all the exterior body panels. This is the coating process developed jointly between General Motors Mfg. Development and General Tire. Tool modifications are now underway to incorporate molded coating on the removable roof. Molded coated roof panels will be produced starting in April and will be used on Corvette production in June. Our plans call for applying molded coating to all exterior body panels by the 1980 model year. It is expected that molded coating will:

1. eliminate porosity and surface defects;

2. greatly reduce sink from back side of part bosses and ribs;

3. greatly reduce the need for prime painting;

4. allow use of higher glass content, i.e., the XMC class materials in class A parts. A further consequence will be to make thinner parts possible;

5. allow use of glass bubble fillers.

- Glass bubbles are being evaluated as a filler to partially replace the talc fillers. If successful, upwards of 90 lbs. can be saved.
- Other applications of FRP being seriously studied for the 1980-82 time frame include:

1. A hood constructed like the removable roof panel with integral ribs and attachment bosses, thus eliminating the conventional hood inner reinforcement - 10 lbs.

2. An FRP spare wheel developed from the concept wheel of General Motors

Mfg.
Development - 10 lbs.

3. A graphite and fiberglass rear leaf spring -
30 lbs.

4. An FRP radiator support - 15 lbs.

5. Some use of XMC in bumper structural parts.

In this quest for weight reduction, stampable thermo plastics will also play an important role. In the 1978 Corvette the complex fabricated steel ignition shield was replaced with a single Azdel part using an aluminum foil liner. In addition to being a considerable cost and weight savings, this plastic part is much less aggressive of the ignition and engine compartment wiring hamesses that can come in contact with it.

The Limited Edition Corvette will introduce a new concept shell bucket seat. The modular design of the cushions and the stamped Azdel shells are economically competitive with the way we used to build Corvette seats and contribute a weight savings of -24 lbs. to our weight reduction program. In gas guzzler tax terms these seats would have an additional value of $17/car.

With the exception of the spring project, these applications represent the current sate of the art in manufacturing technology in terms of being: (1) commercially available, and (2) cost competitive. The spring project has not yet demonstrated commercial feasibility.

With the exception of the spring project, they all represent applications of chopped fiber material in a thermo plastic or thermo set matrix. These technologies, while they produce economical parts, are an order of magnitude away from fully utilizing the capabilities of the fiber composite matrix. An order of magnitude improvement in part stiffness and strength is available if the appropriate designs and manufacturing technologies can be developed.

The emerging HMC-XMC technologies are a step in this direction.

The aerospace industry is currently demonstrating the leading edge of this technology with applications of graphite and glass epoxy composites to all manner as structural components. They are accomplishing 20-25% weight reductions in comparison with the best aluminum honeycomb laminate designs. They are also learning to produce graphite epoxy structures that are cost competitive in spite of the high material cost by using parts consolidation and extensive reliance on adhesive bonding. But alas, the aerospace industry only makes these parts by the 5's and 50's per year; three orders of magnitude lower than even Corvette production, which itself is 2 orders of magnitude smaller than GM production.

These high performance composite structures being demonstrated in aerospace will eventually find their way into automotive applications. The ever-tightening pressure for fuel efficiency will drive them there. But along the way a series of barriers must be crossed. The cost of graphite barrier should fall by a factor of X5 as automotive volume usage is achieved. Kevlar currently used in radial tire applications may also find limited application in future high performance composites. But while looking toward these ultimate materials we shouldn't lose sight of our old friend fiberglass; it's already at good prices and we are far from using it to its maximum efficiency.

In the end, material cost will not be the real barrier to the application of high performance composites. The real barrier will be labor cost. The automobile industry cannot afford the labor intensity required to produce aircraft composite parts. In fact, the aircraft industry cannot afford it either and is beginning to develop new manufacturing technologies in parallel with their component design technologies. The real breakthrough for the automotive applications will come as we learn to design oriented fiber structures that can be automated. The graphite glass epoxy leaf spring may be the first of such examples made possible by designing it in relatively rectangular cross sections that can be readily manufactured. This part can serve as the important transition from our high volume chopped fiber technology to the oriented fiber technology of the future.

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