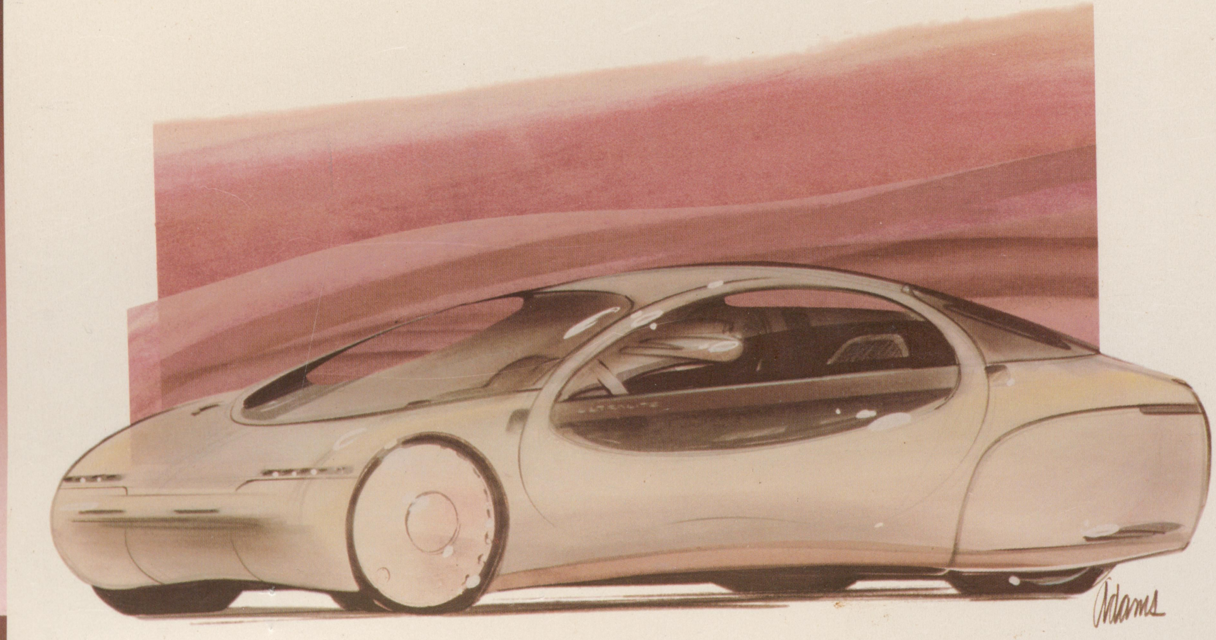

GM Ultralite

General Motors Corporation

GM Ultralite

FOR RELEASE: January 6, 1992

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VEHICLE ARCHITECTURE

DETROIT — Designing cars from the inside out means developing a vehicle's underlying architecture — its basic dimensions and content —before styling its visage. James S. Bieck, chief of GM Design Staff's Advanced #2 design studio where the Ultralite was created, said the challenge to designing the Ultralite architecture was to "keep it simple."

"As we went through the design process, trying different concepts and ideas, we kept coming back to the idea of simple, lightweight, efficient, and ergonomic," Mr. Bieck said.

The car has an organic, tapered shape with the front track five inches wider than the rear track.

"This tapered look is the technically correct look of the future," said Mr. Bieck, "if we are going to meet the kind of fuel economy, aerodynamic and packaging goals of the year 2000 and beyond."

The car was designed to "package" four large adults comfortably with an overall length of 165.6 inches and a 110-inch wheelbase. The use of advanced materials — thin Duoflx seats and a structure made of carbon fiber composites — allowed designers to create a spacious passenger compartment more typical of larger cars. For example, the design team gave the front-seat passengers 37.2 inches of head room, 57.1 inches in shoulder room, and 42.8 inches of leg room. Rear-seat passengers have ample room, also, with 36.3 inches of head room and 33 inches of leg room.

The center tunnel of the structure creates a compartmentalized interior environment. The seats are a lightweight construction, made from Duoflx fabric that was invented at GM's Research Laboratories. Duoflx, an elastomer filament material, was used instead of conventional polyurethane foam in a novel new seat design that is much thinner and lighter than conventional automotive seats.

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Duoflx material enhances comfort in other ways as well. The material has excellent "breathability" and provides superior dynamic comfort (isolation from road vibration).

The design team set an ambitious aerodynamic goal for a sedan-size vehicle and achieved it by working interactively with aerodynamicists. "We were in the wind tunnel frequently, refining our design to meet our aero goals," said Mr. Bieck. The car has an outstanding aerodynamic drag coefficient of 0.192 and an amazing frontal area of 1.713 square meters, which results in a CdA of just 0.329.

Another architectural challenge was to provide proper air flow through the vehicle. "The structural requirements of the car prevented us from having any openings in the front or rear of the car," Mr. Bieck said. The car has an interchangeable, modular "power pod," located in the rear of the structure. This allowed designers to minimize the car's frontal area, but posed a challenge to get sufficient air flow to the engine, radiator and heat exchangers. Air flow channels, called NACA ducts, were incorporated into the vehicle's underbody structure to deliver air to these components.

The Ultralite team took a systems approach when developing the heating, ventilation, and air conditioning system (HVAC). Before outside air reaches Ultralite's occupants, it passes through an electrostatic filter to remove dust and pollen. Cool and warm air for passenger comfort is then moved through the center tunnel to vents placed throughout the passenger compartment. The driver position has air ducts around the speedometer, and a pivoting vent that functions as windshield defogger, can also be used to direct air to the front seat passenger.

Rear seat passengers benefit from vents mounted in the center tunnel and vents positioned under their seats.

The environmentally friendly air conditioning unit uses the refrigerant R134-a, which does not damage the earth's ozone layer. The unit is packaged inside the rear of the center tunnel to conserve space and utilize the thermal characteristics of the carbon fiber composite material.

The Ultralite's energy-efficient lighting system consists of several different technologies: light-emitting diodes (LED), fiber optics, electroluminescence, fluorescent tubes and incandescent bulbs.

"We started with the idea of using fiber optics throughout the car, but we soon discovered that wasn't the most efficient solution," Mr. Bieck said. "By using the right technology in the right place, our lighting system consumes 60 percent less energy than conventional systems," he added.

The headlamps are high intensity discharge lamps with fiber optic light distribution. Turn signals and taillamps are LEDs, while the speedometer and HVAC gages are illuminated using electroluminescence technology. Incandescent bulbs are used for interior lighting and license plate, and fluorescent tubes are used for rear back-up lamps.

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VEHICLE BODY STRUCTURE

DETROIT — The collaboration between designers and engineers at General Motors in Warren, Mich., and Scaled Composites, Inc. in Mojave, Calif., brought forth an ingenious vehicle body structure that establishes a benchmark in the use of advanced structural composite materials.

Made entirely from carbon fiber composites, the Ultralite body structure weighs only 420 pounds and consists of only six basic parts — the floor tub, the right and left halves and doors, and the rear panel. The structure is also remarkably stiff — with a frequency (stiffness) several times higher than a traditional vehicle.

The characteristics of the carbon fiber composite material give the car its unprecedented lightness and strength. The material, increasingly used in the aerospace industry, is half the weight of aluminum, yet has two times the stiffness. It has one-quarter the density of steel with slightly better stiffness.

These high-powered characteristics come at a cost, however. The material cost alone for the Ultralite structure was approximately $13,000 — several times the cost of aluminum, steel or fiberglass. Additionally, the Ultralite had to be handcrafted because manufacturing processes for shaping carbon fiber composites into products are still in their infancy.

The structural components were handmade using carbon fiber yarns and fabric. The initial design was crafted at GM's Design Studios in Warren, Mich., where early sketches evolved into clay models, which led to fiberglass molds. The molds were shipped to Scaled Composites, Inc. where tooling was developed and used to form the actual structure.

There, experienced hands laid bi-directional carbon fiber fabric and uni-directional strands known as "roving" in the molds, using an epoxy matrix. Most of the car's structure is comprised of a carbon fiber "sandwich," with polyurethane foam sandwiched between thin layers of carbon fiber fabric.

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The integrated design of the Ultralite structure was carefully calculated before the components were constructed. Structural reinforcements using roving were designed-in to help distribute high stress loads. For example, the rear power pod is secured to the vehicle structure in only six key points, yet its load is carefully distributed throughout the car's structure via the long carbon fiber roving that runs from the anchor points down through the car's body.

The large gull-wing door design also was made possible because of the high-powered characteristics of the carbon fiber composite material. The strength, stiffness, and weight characteristics of the material allowed for the unique pillarless door design in which reinforced hinges are integrated into the vehicle roof structure. Solid yet feather-light, the 84-by-38-inch door swings upward on a gas strut to allow unobstructed entry into both the front and rear seating area.

The car's interior architecture is integrated into the structure, as are the five-gallon fuel tank and intricate air flow ducts. The heating, ventilation and air conditioning system is fitted into the structure's center tunnel.

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REAR POD LEADS TO EFFICIENT PACKAGE

DETROIT — The GM Ultralite's modular power pod packs an 111-horsepower, two-stroke engine with a state-of-the-art four-speed automatic transaxle that makes the Ultralite exciting and friendly to drive.

"This is one high-efficiency car you don't need a motorcycle operator's license to drive," said James K. Lutz, Advanced Engineering Staff program manager for the Ultralite. "The Ultralite's fuel efficiency was very difficult to achieve. The automatic made it even more difficult, but we know that's what GM customers want to buy."

The engine and transaxle, as well as the exhaust and suspension systems, are all housed in a futuristic rear power pod. The tubular space frame unit is pre-assembled and pre-aligned to actually make it interchangeable. This unique modular concept allows GM to look at a variety of powertrains for the car. "We could insert an appropriate powertrain depending on the market for which we would target the car," said Mr. Lutz. He said that an electric version is a logical candidate for an air quality problem area like Los Angeles. Another possibility would be a small gas turbine engine when the technology becomes available.

"For now, the two-stroke makes this a hot little high-mileage sedan," Mr. Lutz said.

Code named CDS-2, the experimental 1.5-1iter, three-cylinder engine generates 111 horsepower at 4,500 rpm. It moves the 1,400 pound car from a standing start to 60 miles per hour in 7.8 seconds. Weighing in at 173 pounds, with a two-stroke engine's characteristic low engine height and excellent fuel economy, the all-aluminum CDS-2 was a good fit for the Ultralite.

A small panel on the power pod's carbon fiber skin makes spark plugs accessible. The two-stroke engine's lubrication system eliminates the need for oil changes and disposal of used oil. Consumption of oil is similar to that of a four-stroke engine. The Ultralite's modular power pod highlights another possible service concept of the future — an interchangeable GM dealer loaner pod attached to the structure of the owner's car for overnight service visits.

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The four-speed automatic transaxle was borrowed from GM's Saturn subsidiary. The all-alloy, electronically controlled unit offered the kind of efficiency sought by the Ultralite team. The clutch-to-clutch automatic was designed for low spin losses and minimal internal friction. "We didn't have to go far to find an excellent transaxle for the Ultralite," said Mr. Lutz. "The only gear ratio modifications we had to make were to fourth gear and the final drive."

"The exhaust system is another trick," said Mr. Lutz. The mostly stainless steel system incorporates an aluminum muffler that serves a dual purpose. The muffler is configured in the lower bumper area as an aerodynamic wing for more efficient airflow under the car.

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ULTRALITE MEETS EDUCATION GOALS

DETROIT — Aside from providing General Motors engineers a test bed for future fuel economy technology, the GM Ultralite carries with it two important educational objectives: to inform American consumers about GM's fuel economy leadership and to bring the realities of future automobile technology into the fuel economy debate.

"Like all concept cars, the Ultralite lets us peek into the next generation of vehicles," said Gary W. Dickinson, Technical Staffs Group vice president. "In this case, we're exploring advanced materials and efficient systems. But fuel economy has become such a misunderstood and very political issue, we're eager to use the Ultralite as an educational tool as well."

Corporate Average Fuel Economy (CAFE), a law enacted in 1975 which sets average fuel economy standards for manufacturers' motor vehicle fleets, has been called ineffectual by experts from Detroit to Capitol Hill. Nevertheless, the industry's opposition to the law's counterproductive effects has branded American auto companies as laggards in fuel economy technology.

"That's the image we're trying to dispel, because it's absolutely not true," said Mr. Dickinson. "GM is the fuel economy leader in six of the Environmental Protection Agency's (EPA) 18 car and light truck classifications for vehicles equipped with automatic transmissions. No other manufacturer leads in as many EPA classifications."

"GM is in favor of fuel economy; we're against bad legislation and poor policy," said Mr. Dickinson.

GM has always coupled its fuel economy with performance, utility and comfort. The Buick Park Avenue serves as an example. The full-size luxury car holds six adults and all their luggage. Powered by GM's 3800 V6 engine that generates 170 horsepower, it still gets better highway fuel economy than the compact Toyota Camry with an engine of smaller displacement.

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"That's why we were purposeful in creating a concept car that afforded customers roominess, acceleration, handling, and striking design — in addition to triple-digit fuel economy," said Mr. Dickinson. "It's what GM owners would expect."

GM has long excelled at incorporating fuel economy technology into production. The use of lightweight materials is an example. GM introduced fiberglass leaf springs in the Chevrolet Corvette in 1981 which was the first truly structural application of composites in mass-produced vehicles. The technology was later added to GM's line of personal luxury cars and mid-size vans.

GM's "Lost Foam" casting process has enabled its Saturn subsidiary to use lightweight aluminum in its engine and transmission. Aluminum components are also used in the Corvette's suspension system.

In engine control technology, GM's fuel control systems throughout its product lines are recognized industry leaders.

"On the Ultralite project, we're attacking the same fundamentals that we do in production, but we're using technology from future generations," said Mr. Dickinson.

"It's very important for General Motors to look at a future technology like aerospace carbon fiber," said Donald L. Runkle, Advanced Engineering Staff vice president. "We're not claiming it will be ready for widespread use in the near future, but at some point we need to bring the realities of future technology into the fuel economy debate."

"The question is: How far can we go with the use of carbon fiber?" said Mr. Runkle. "In the case of the Ultralite, we don't have all the answers, but the project is proof that we're actively pursuing them."

"The Ultralite is our new benchmark. Now we will work to see what makes technical and economic sense. We hope it shows our leaders in government that we're working hard to give our customers outstanding fuel economy — in concept and in production."

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DESIGNING THE ULTRALITE

DETROIT -- Design is an important factor in the Ultralite, General Motors' newest concept vehicle, according to GM's vice president in charge of the Design Staff.

"Just because a car is efficient and environmentally friendly," Charles M. Jordan said, "doesn't mean it has to be ill-proportioned and strange looking."

The Ultralite is the fourth in a series of concept vehicles in GM's search for increasingly efficient, environmentally sensitive vehicles. Included are: the record-setting Sunraycer, a solar-powered vehicle; the Impact, a two-passenger pure electric car; and the HX3, a gasoline-electric hybrid six-passenger van. Unlike its predecessors, the Ultralite is a sedan that seats four people.

"It's tough developing an efficient, aerodynamic package for four people," Mr. Jordan said. "It's even tougher turning that package into an exciting car."

Beginning as a sketch, the vehicle went through each design phase during its five-month design life: from scale model, to interior seating buck, to a full-size clay model, and finally master molds which were used to construct the body.

Designed from the inside out, the Ultralite has seating comfort and interior room comparable to the Chevrolet Corsica with an exterior size that is 18 inches shorter and four inches narrower than the Corsica.

The Ultralite's strength is in its unity. The body structure, inside and out, is one integral shell made of lightweight carbon fiber. This carbon fiber body design, with its low cowl and belt line, provides extraordinary all-around visibility and an open, spacious feel in the interior. In addition, the strength of the carbon fiber structure eliminates

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the need for a center pillar, permitting unobstructed passenger entry through the lightweight gull-wing doors.

The Ultralite's sleek shape was strongly influenced by aerodynamics. Its drag coefficient is a low 0.192. This compares with a drag coefficient of 0.314 for the Chevrolet Corsica. In other words, the power required to push the Ultralite through the air at 55 mph is 4.0 horsepower compared to 15.0 horsepower for a contemporary mid-size sedan.

Another important element in the car's design character is the prominence of the wheels and tires. Advanced low rolling resistance tires developed by Goodyear, and mounted on 18-inch wheels, further contribute to the Ultralite's overall efficiency.

Mr. Jordan sums it up: "The design of the Ultralite meets some difficult physical and technical goals. What sets it apart is its emotional appeal and its friendly, inviting character. The Ultralite demonstrates that a small car can be efficient and exciting at the same time."

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