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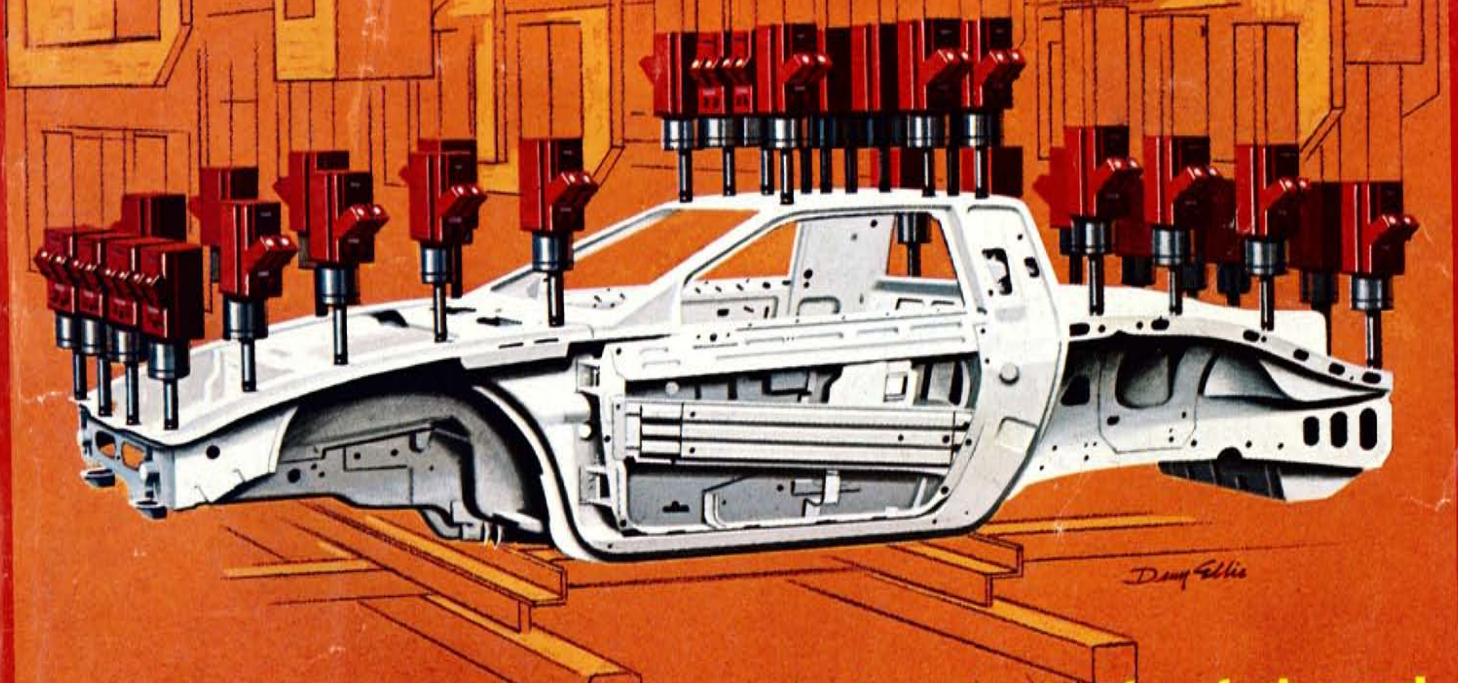
Revolution in car making

New GM machine gives:

- perfect body fit every time
- bolt-on, easy-to-replace body panels



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Revolution in car making

—precision body fit with bolt-on plastic panels

A unique building method yields a rival for the fit and finish of imports

By JIM DUNNE
ILLUSTRATION BY JOE LAPINSKI

The giant machine crouches in the corner of the noisy assembly plant like some mammoth creature eyeing its quarry. A silvery car frame approaches. The machine lashes out with its metal tongue, noisily engorging its skeletal prey. It turns and tips and pushes the car into place, then clamps it hard. A cluster of tentacles descends from above and delicately chews through plastic and metal blocks on the frame—fashioning it in a way never before seen on an automobile assembly line.

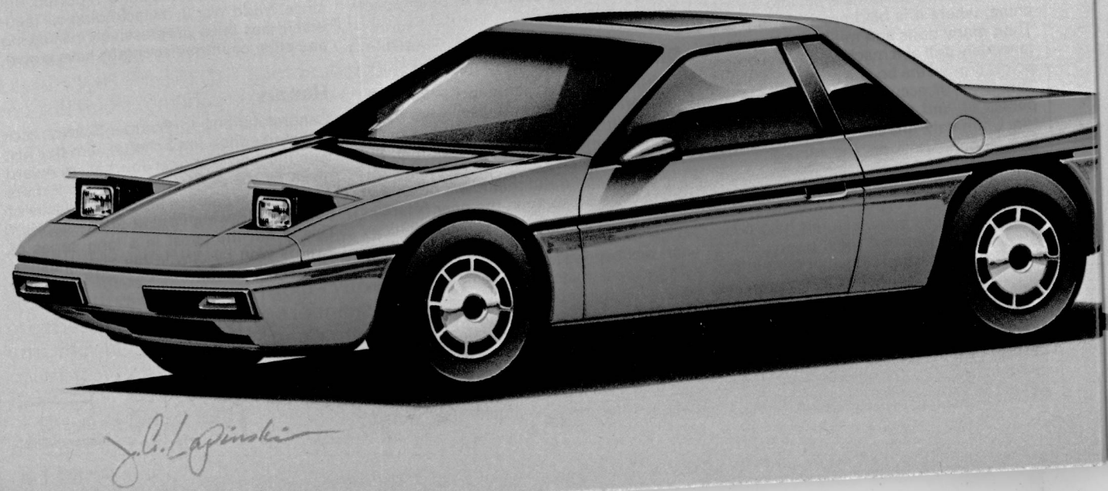
This September, when GM's Pontiac division unveils its new P-car two-seater, Fiero, this scene will be repeated some 30 times an hour. Fiero's construction will mark a major change in the way a car is put together—a revolutionary departure. Where cars were once made with a body and chassis and later with a unit body, Fiero will be made with a space-frame chassis and a separate covering of body panels. And while American manufacturers are sometimes chastised for the poor fit and finish of their cars, GM designers can boast a match for the fit and finish of Japanese and German cars—and go them one better, building body quality and flexibility of design into a car from its initial stages of production.

With the new technique, tolerances of 0.005 inch will be commonplace. What's more, the technology holds a promise of less-expensive body repairs for consumers. In many cases, body parts can be replaced with a few simple tools.

"Now we'll get body fits that can't be measured by the human eye," said Ernie Schaefer, manager of Pontiac's Plant 17 on the northern edge of Pontiac, Mich., where Fiero is to be built. "For instance, our critical door-to-front-fender seams will be held to tolerances that are closer than even skilled workers can gauge by sight."

What is this promising development? The key to the breakthrough is a huge machine tool called the Gilman Drill and Mill machine.

Ernie Schaefer recently escorted me on a tour of his plant, where I got a firsthand look at the machine and the line on which it plays a central role.



When I visited the plant, it was in a state of organized confusion, which is normal with plant changeover. A new assembly line was taking shape. Shiny new chains, coiled hoses, four-foot trenches, computers, and thick electrical cables filled the darkened interior, lighted only by workers' temporary fixtures. Unimates—robot welders, 22 of them—stood poised in flanks along one stretch of the line in the five-acre floor space. Welders, erectors, electricians—some with special skills that you can't find at your local plumbing and heating shop—hurried to get the plant ready.

Our tour took us to the far corner of the plant, to a bay five stories high, where Schaefer explained the operation of a mammoth drilling and milling machine. Made by Gilman, of Janesville, Wis., an old name in machine-tool builders, the 2½-story mechanical complex measures 20 by 30 feet at the base. It's anchored at a station in the assembly line just ahead of where Fiero's running gear is to be installed.

"For the first time we're building an automobile the same way we build an engine," Schaefer explained as we

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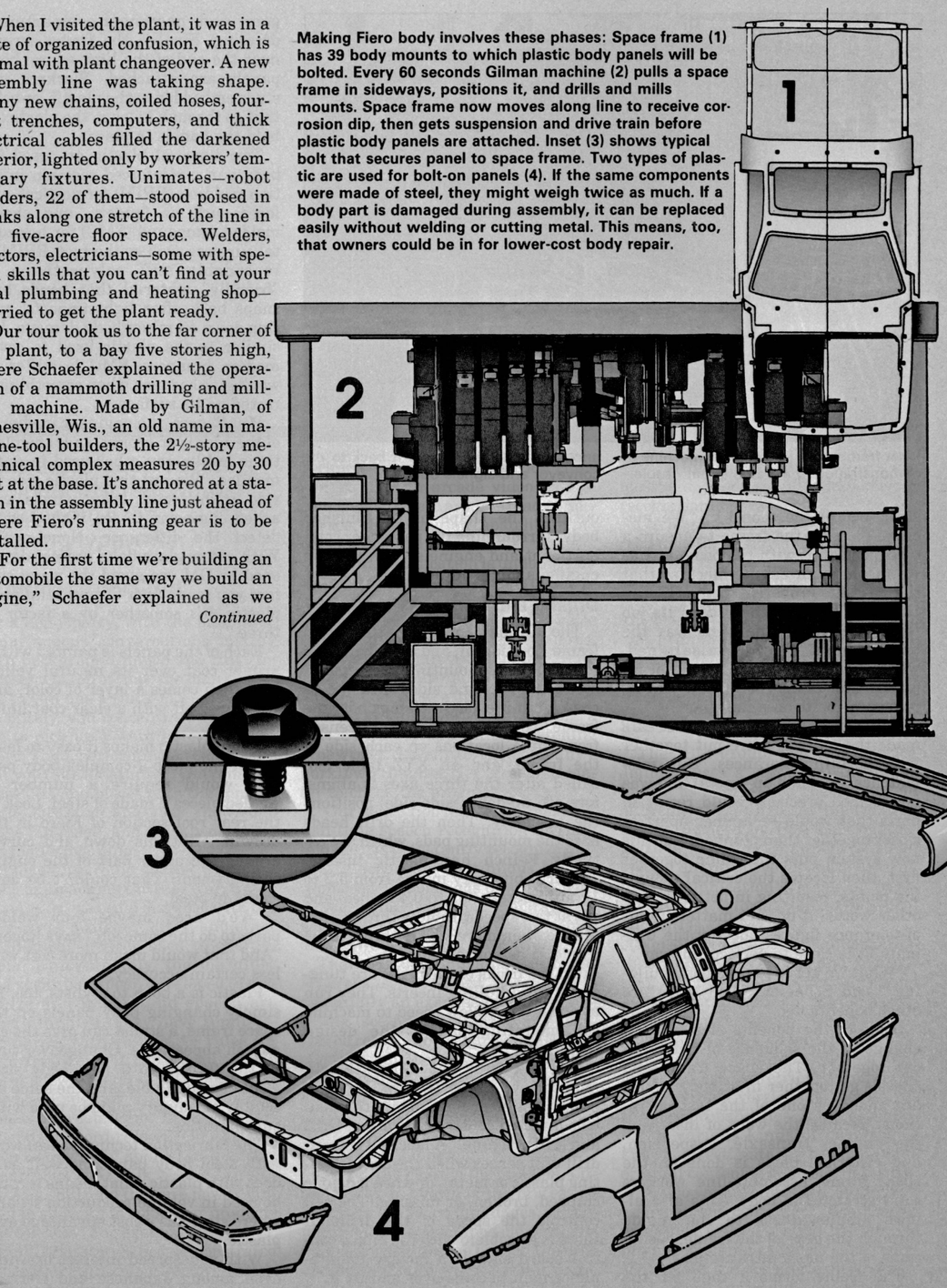
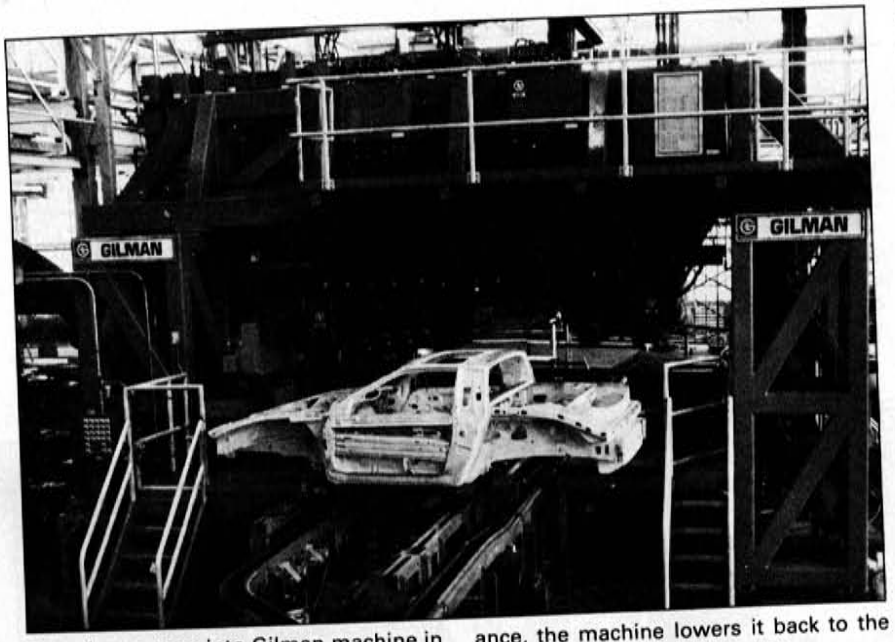


Making Fiero body involves these phases: Space frame (1) has 39 body mounts to which plastic body panels will be bolted. Every 60 seconds Gilman machine (2) pulls a space frame in sideways, positions it, and drills and mills mounts. Space frame now moves along line to receive corrosion dip, then gets suspension and drive train before plastic body panels are attached. Inset (3) shows typical bolt that secures panel to space frame. Two types of plastic are used for bolt-on panels (4). If the same components were made of steel, they might weigh twice as much. If a body part is damaged during assembly, it can be replaced easily without welding or cutting metal. This means, too, that owners could be in for lower-cost body repair.



P-car frame goes into Gilman machine in demonstration. If a frame is out of tolerance, the machine lowers it back to the conveyor and signals operator.

stood before the monster. "We machine parts of the frame to ensure a near-perfect fit with the body, just as we machine an engine block so that the head fits properly." If the Gilman Drill and Mill machine does its job right, there is virtually no way the body panels can be misaligned, whether installed at the factory or replaced later when a body shop—or Fiero owner—bolts on a new part.

Think of it this way: Parts of cars made the old way were put together with certain tolerances. But mismatches could add up—metal that was not formed precisely could result in parts that would be farther apart or closer together than planned. But this new system puts the frame together first, then locates the critical mounting points, resulting in better fits. In other words, it doesn't matter if out-of-tolerance figures add up; the ultimate fit is close to perfect, anyway.

"What we get is precise body building," said Schaefer. "And there are other benefits, too."

Some of the benefits stem from a change in the sequence of putting a car together. The space frame and chassis go together first; body panels are added as one of the last operations. Because the work of installing the engine, transaxle, suspension, and electrical parts is done on the space frame, assembly-line workers can't scratch the body. This also allows ample access to the inside through the gaps of the frame, easing some of the more intricate jobs.

The frame forms a cage for the body. It is built in a traditional way with huge welding fixtures and those robotic welders. The shape of the cage outlines the shape of the finished body, surrounding the passenger compartment and engine section (Fiero's engine is mid-mounted).

Drilling and milling

The Gilman pulls in the Fiero frame, positions it, and then drills and mills 39 body-mounting pads spaced along the top and sides—all in less than a minute. Eight clamps hold the frame. The door openings are sensed from three locations on each side of the frame, and an XYZ table (so-called after the three axes it aligns: fore-aft, up-down, side-side) positions the assembly. Then the drill heads bore the mounting pads, which are actually ¾-inch hard-plastic inserts. The drill bits vary in size from 5.2 to 10 millimeters (0.2 to 0.4 inches) and cut at two speeds: rapidly through the plastic, then more slowly through the frame so as not to distort it.

On the necks of the drills are tungsten-tipped milling inserts. They run at a relatively slow speed to machine the mounting pad to the design height.

"All the drills and mills are self-monitoring," reports Jim Werner, project engineer for Gilman, the man who directed construction of the Drill and Mill machine. "A load cell on each drill unit senses when the drill is cutting plastic or metal, or when a drill is chipped, broken, or missing. The cell controls the speed of the drills. If there is a problem with the bits, a control board signals a factory maintenance man to come over and fix it."

After passing through the Gilman cycle, the Fiero frame moves down the assembly line to take on its running gear and passenger-compartment dressing. Finally, the frame arrives near the end of the line, where body panels are attached. Workers use studs embedded in the plastic, or bolts that go through holes in the plastic, to hold the panels in place.

Two types of plastic are used for body parts: reinforced reaction injection molding (RRIM) for vertical surfaces such as fenders, and sheet-molded compound (SMC) for horizontal surfaces such as the roof. RRIM is reasonably stiff polyurethane, a "friendly" material that bends and snaps back after light impacts, cutting down on minor body damage. It's similar to the plastic used to cover modern bumpers. SMC is stiffer; it won't give as much when something is rested on its surface.

Ron Rogers, the engineer in charge of the Fiero car project, says the plastic is unlike any other used in automobiles. "We put this plastic side by side with metal body panels and asked engineers to see if they could detect the difference. None could. With a new glass-flake process developed by GM, we avoid the wavy surface you see in fiber-strand-reinforced plastic. It's smoother by a factor of three."

Each of the panels is painted with a primer coat over its natural yellow hue, then comes a layer of color, and it's topped off with a clear-coat finish layer.

Using plastic makes it easy to fashion in one piece a complex body part that would require a number of welded pieces if made of steel. Look at the rear roof section of Fiero in the drawing. It trails down and curves around the upper part of the engine compartment. That couldn't be done easily in steel.

"We'd need maybe four welded parts to do the same job," says Rogers. "And that would mean more cost with less certain accuracy."

Plastic is a boon to stylists, too. By simply changing body panels on the space frame, a stylist can give the car a fresh appearance. Changeover time in the factory to a new body style would be negligible, and the same assembly machinery could be used without alteration.

The fabrication technique can work with steel body panels as well as it does with plastic. That means it could be used in volume-production sedans, where steel has a cost advantage over plastic.

With widespread interest brewing, even among Japanese and German car makers, chances are that many of us may have a space-frame car in our garage before the decade is over. PS