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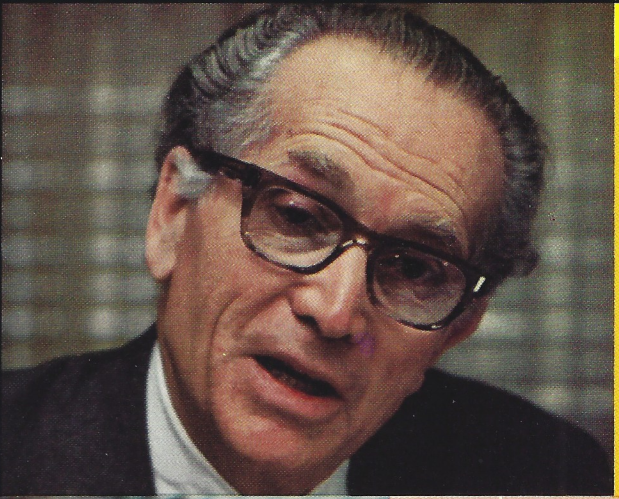

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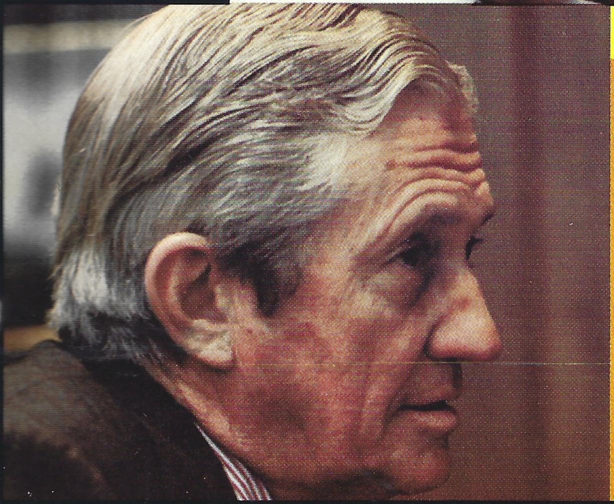

AMC'S ROY D. CHAPIN JR. ON PROFITS:

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Technical Takeout

Why Turbocharging Will Grow in Passenger Cars

by Gary L. Witzenburg

What do a '62 Corvair, a '77 Porsche, a '78 Buick, a '78 Saab, an Indianapolis race car and a sophisticated Renault Formula One racer have in common? Answer: Turbocharged engines.

But why did General Motors Corp.'s turbocharging efforts of the early '60s die? Why is the turbomotor finally making a long-delayed comeback? How do these street turbos differ from the types that've been common on certain kinds of racing machinery for years? And what does the future hold?

Like many good ideas, the concept of supercharging an internal combustion engine is nearly as old as the engine itself. Some 50 years ago a GM research engineer named C. R. Short observed: "The size of the engine could be reduced to that required for normal working conditions on level roads, with the supercharger taking care of the necessary reserve power for hill climbing and acceleration."

But the supercharger has had its problems and deficiencies, not the least of which are added cost and complexity. While the engine-driven type remains popular in drag-racing circles, it robs some 30% of the extra power it provides and its very bulk makes it impractical for passenger car applications. Conversely, exhaust-driven turbine units tend to lag behind throttle demand (because they depend on high exhaust quantity and velocity to be effective) and can destroy themselves and/or the engine if they "overboost."

Oldsmobile Div. was first to market a turbocharged production passenger car engine in mid-1962, followed closely by Chevrolet Div. in certain Corvairs. The Olds unit used water/alcohol injection—which had to be replenished periodically—to cool the intake charge and prevent piston-melting detonation, and the effort was abandoned in 1963. Chevrolet's flat-six turbomotor used a pressure-operated spark retard device to protect the engine from detonation and its availability lasted longer—through the '66 model year—but it still suffered reliability problems. One GM technician dubbed it the "trouble-charged Corvair."

Turbocharging is old hat in racing, where cost is of less concern, and incredible amounts of horsepower can be wrung from fairly small-displacement turbocharged engines. The notorious throttle response lag is little bother on high-speed oval tracks, such as those run by Indianapolis type cars, but can be a problem on twisting race courses. Nevertheless, Porsche turbo-powered sports cars were so powerful that they devastated the competition in the Sports Car Club of America's unlimited Can-Am racing series to the point where the series was canceled a few years ago. Factory-developed 911-based Porsche GT racers are now threatening to dominate the International Motor Sports Association's Camel GT circuit.

World Championship Formula One (F-1) road racing rules require that turbocharged engines be only half the displacement of naturally-aspirated engines, which are limited to 3.0 liters. For that reason, no one had tried turbocharging an F-1 car in recent years—until this past season's Renault factory effort, which has shown brief bursts of competitive form but has yet to finish a race due to technical problems.

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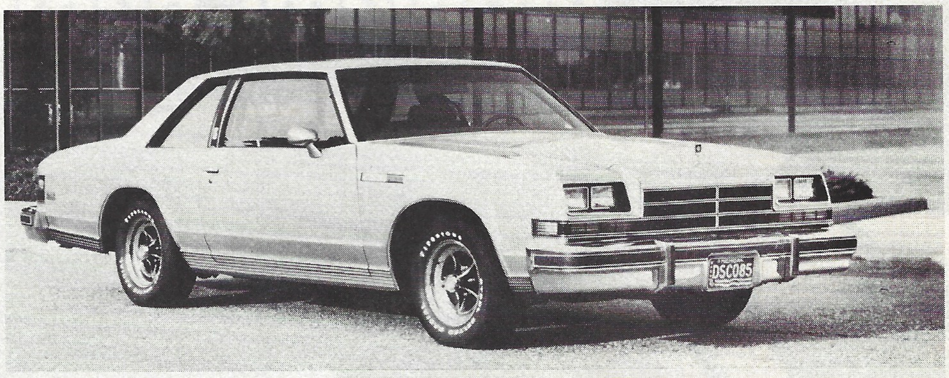
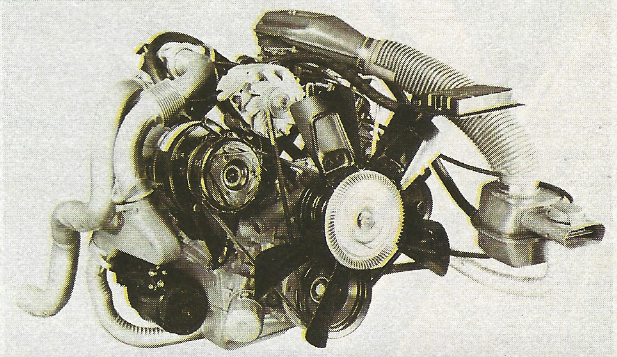
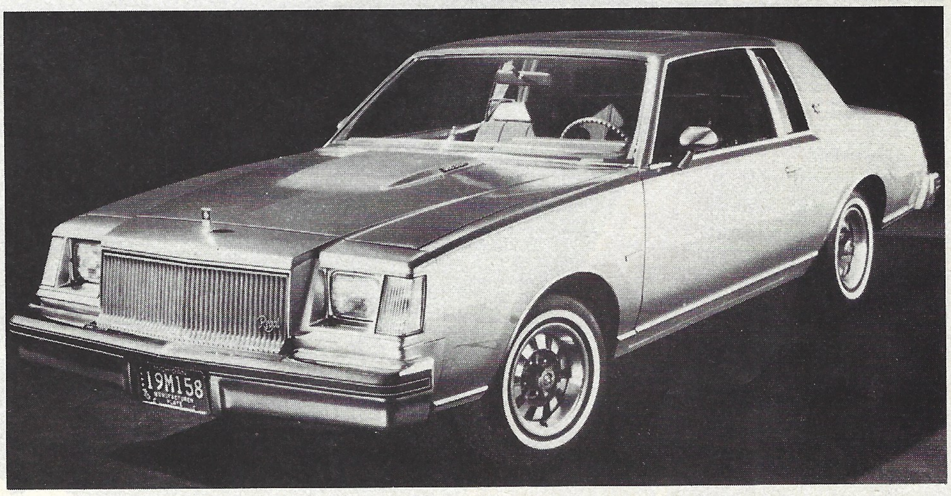




General Motors Corp.'s turbomotor is making a long-delayed comeback as Buick Div.'s turbocharged 231-cid V-6 (right) becomes available in the LeSabre (above) and Regal (below) Sports Coupe models for 1978.



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Renault engineers have squeezed well over 500 hp out of their 1.5-liter turbo engine, but the car is difficult to drive and much development remains. Driver Jean-Pierre Jabouille, who has been with the project since its inception, told *WAW* at the Watkins Glen U.S. Grand Prix that he's still learning to cope with the turbo lag when accelerating out of slower corners. Because the Watkins Glen event was run in the rain, it was a real handful there.

Such all-out racing engines, of course, are designed for maximum power with no thought given to emissions or low-speed driveability. Economy is of concern only to the point where the car gets equivalent mileage to its competition per tankful and can finish a race without having to stop for extra fuel. The over-pressure problem is solved by means of a wastegate valve, which vents excess exhaust pressure (before it goes into the turbine) when necessary, and compression ratios and spark timing are carefully tailored to prevent detonation at full power.

Street engines present an entirely different set of problems. Of the three current production units, Porsche's very expensive Turbo is the closest thing to a racing engine (starship-like acceleration but with considerable throttle lag). The Buick and soon-to-debut Saab turbomotors both use small, quick-to-accelerate turbines that are tuned for good mid-range response rather than top-end power. This sort of design provides a powerplant that accelerates smoothly from any speed with little noticeable lag, delivers fuel economy consistent with its displacement, and yet performs like a much larger engine once you get it rolling.

Of the three, Buick's design is the most innovative. It has a simple flapper-type wastegate valve in the turbine unit itself, combined with a clever electronic spark timing control system that senses detonation and adjusts ignition timing to compensate. This permits the use of low octane unleaded fuel without lowering the V-6's compression ratio from its standard 8.0:1.

Because of the turbocharger's ability to squeeze extra power out of light, compact and fuel-efficient engines on demand and only when needed, its future in meeting increasingly difficult fleet fuel economy averages with reasonably sized automobiles is obvious.

It's a major problem these days to meet government demands for emissions and fuel economy and still meet customer demands for performance, but the turbocharger seems to offer a have-your-cake-and-eat-it-too sort of solution.

To get more power out of an engine, more air must be pushed through it so that more fuel can be efficiently burned. In the past, displacement was increased. But in the future, displacement can be reduced but air flow increased by supercharging the intake charge using a turbine driven by exhaust gases, whose energy would otherwise be lost to the atmosphere.

Airplane engines, long-haul commercial diesels and other fairly constant speed engines have been using turbochargers to improve efficiency for years. Now, as the principle is adapted and developed for multi-speed and multi-load passenger car usage, its use will grow. Nearly every U.S. and foreign automaker is working on turbocharging technology. Germany's Mercedes-Benz should be the first to combine it with another favorite fuel saver, the passenger-car diesel—probably in Europe starting early next year.

Buick's turbo V-6, available in Regal and LeSabre Sport Coupe models for '78, "represents just a first step in the application of turbochargers to automotive powerplants," says Buick Chief Engineer Lloyd E. Reuss. "We see the use of turbocharged engines expanding in the years ahead. By using a smaller displacement turbocharged engine in a full-size car, we should be able to improve overall fuel economy and at the same time provide the passing performance that the customer demands." □

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Santa Monica (Calif.), and most or all of the wiring harnesses will be supplied by Essex International Corp., a division of United Technologies Corp.

Sheller-Globe Corp., Toledo, is ticketed to supply weather stripping and window cranks, and Allen Industries Inc., Troy (Mich.), has been selected to furnish seat covers and interior door panels and trim. Four tire suppliers—Goodyear, Firestone, Michelin and Continental—will furnish the rubber "treads" for VW's American cars. Firestone is scheduled to supply the standard bias ply tires, and Goodyear is expected to furnish around 60% of the optional radial tires, which will probably be ordered on most of the vehicles.

Another VW subsidiary, VW de Mexico, Puebla, Mex., is scheduled to supply a number of components, including radiators, rear axles, and rear brake drums.

Steel wheels will be supplied by Rockwell International's Brazilian operations. Window, windshield and backlite glass is scheduled to come from Combustion Engineering Co., at its C.E. Glass operations in Pennsauken (N.J.). A Canadian firm, Wegu Canada Inc., Whitby (Ont.), has been selected to provide bumper guards and end plates.

VWMA will make many of its own components at its Charleston (W. Va.) stamping plant purchased from American Motors Corp. These include hoods, roofs, outer doors, fenders, and bumpers. Volkswagen Products Corp. of Fort Worth (Tex.) is expected to supply air conditioners and certain other components.

Other components and their suppliers include:

—Clocks, instrument gages; VDO Instruments Co., Detroit.

—Engine emission valves; Delco Products Div., General Motors Corp., Dayton, O.

—Steering wheels; Olsonite Corp., Detroit.

—Window channels; Bailey Div., USM Corp., Seabrook, N.H.

—Arm rests; Detroit Plastic Molding Co., Detroit.

—Seat belts; Allied Chemical Co., Mt. Clemens, Mich.

—Horns; Sparton Mfg. Co., Flora, Ill.

—Batteries; Gould Inc., St. Paul, Minn.

—Spark plugs; Champion Spark Plug Co., Toledo, and Robert Bosch Corp.

—Radios; Motorola Inc., Chicago.

—Mirrors; Standard Mirror Corp., Southfield, Mich., and Tenna Corp., Warrensville Heights, O.

Certain components besides the main engine parts and transmissions will be shipped from Germany by Volkswagenwerk AG, reportedly including front coil springs, steering columns, water pumps and oil pumps.

Mr. Masterson says that North American firms supplied approximately 700 different components and subassemblies for the pilot production program, which got under way in October. VWMA's target is to sign up North American suppliers for at least 2,000 more standard components during the first year or two and they're also expected to supply a high percentage of optional parts. □