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WHEELS

Turbocharging Jumps From Racetrack to Cul-de-Sac

By Stephen Williams

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When an engineer suggested installing a supercharger into one of Walter Owen Bentley's cars to give it more power for the 24 Hours of Le Mans road race, the British industrialist bristled. He believed in only one way to make his 4.5-liter Bentleys go faster: Make the engines even bigger.

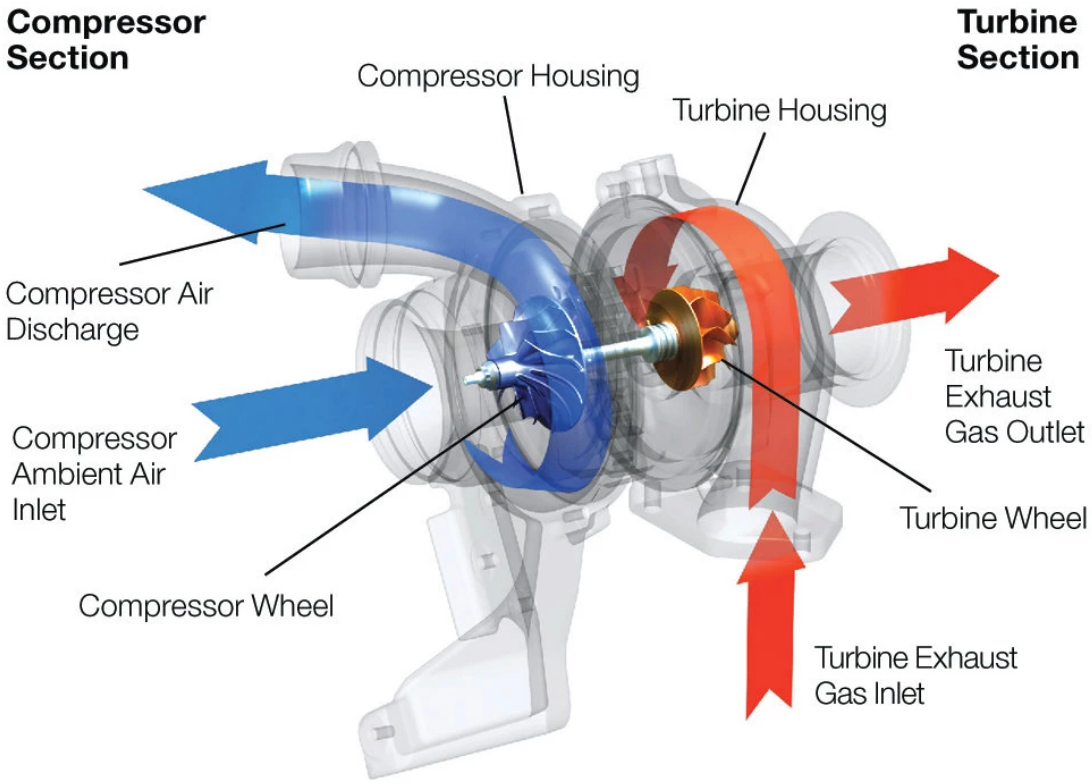
"There's no replacement for displacement," Mr. Bentley famously announced 90 years ago. He was referring to the historical automotive equation that more "air" inside an engine's metal block, and more pistons in that block to pump the power to the wheels, were the keys to speed.

A supercharged version found its way into the "Blower Bentley" in the 1920s, even though the stubborn Mr. Bentley insisted its function was only to "pervert" the engine design and "corrupt its performance."

Fast-forward nearly a century, and welcome to the era of the ubiquitous turbocharger, which is the fashionable version of forced induction.

Unlike the supercharger, which is mechanically driven by the engine, the modern turbo is essentially a small turbine attached to the engine, driven by exhaust gases, that forces more air into the combustion chamber. Most industry experts expect that by 2027, more than half the vehicles sold in the United States will be powered by one.

Because of the pressures put on car and truck makers to meet federal regulations — to increase fuel efficiency and reduce carbon dioxide emissions — the future of the automobile is turbocharged almost by default. Advancements in turbo technology, materials and efficiency are being developed to make the transition from your father's gas-guzzling Oldsmobile to today's fuel-sipping Honda as seamless as possible.



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Garrett Motion

Automakers that have embraced turbo tech — that's most of them — claim improvement of up to 30 percent over formal mileage estimates from the Environmental Protection Agency.

"It's a global phenomenon," said Craig Balis, chief technology officer at Garrett Motion, one of the major suppliers of turbochargers, which until this month was part of Honeywell.

"If you look at the maturity we have now as opposed to 10 years ago, all methodologies are improved: aerodynamics, exhaust streams, thermal management," he added. "And there are advances in control technologies" — like variable geometry, so-called V.N.T. — that Garrett says improves thermal efficiency and emissions in the next generation of gasoline turbo engines.

While most consumers may be agnostic about the machinery that whirs and whines under the hoods of their vehicles, automakers cheer the turbo advance despite the gremlins that bedevil the process: turbo lag, or hesitation, when a driver accelerates, and the high heat generated by the spinning turbos. Still, many of the problems associated with turbocharging in decades past — the special maintenance, the oil consumption, the need to idle the engine before shut-off — have been solved.

"Decades ago, the turbo was seen as a fun aggregate to increase performance, but we are targeted now toward efficiency and CO_2 reductions," said Marco Damen, engineering group manager for charging systems at General Motors in Pontiac, Mich. (In 1962, Oldsmobile created

the turbo-powered JetFire V8, but it was essentially a novelty.)

“In normal customer operating conditions, the fuel economy benefit is certainly there,” Mr. Damen said. “And we haven’t observed any limiting factors that would prohibit use of turbochargers” in any General Motors engine.

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Turbocharging is among the few high-priority items on the agendas of both G.M. and its crosstown rival, Ford.

“Something that was niche 15 years ago we at Ford have made mainstream,” said Dave Filipe, the company’s vice president for global powertrain engineering. “We downsize the engine and boost with the turbo — you get great torque response, great performance feel, better fuel economy, better emissions.”

Mr. Felipe said Ford’s EcoBoost program had filtered down to its F-150 trucks: 70 percent of current F-150 sales are for turbo-equipped engines. “We haven’t been force-feeding this to our customers,” he said. “They’re the ones who are telling us, with the high take rate, that they like turbos.”

A turbocharger adds about $200 to the cost of an engine, but that increase is often offset because a smaller engine is cheaper to build. “If we go from a V configuration to an in-line configuration, there’s cost optimization,” Mr. Damen said. Most four-cylinder engines use an in-line configuration.

“A V engine has a more elaborate block, two cylinder heads, two valve trains,” Mr. Damen said. “Go to an in-line, you only have one cylinder head, one valve train, and that’s considerable.”

One alternative to the turbocharger is still the supercharger, usually found in the powertrain architecture of high-performance cars.

Cadillac introduced a twin-turbo V6 engine for its 2014 CTS and XTS sedans. It was the brand's first twin-turbo engine. General Motors

Mr. Damen isn’t convinced it’s a viable choice for mainstream vehicles. “The big advantage is that it takes energy directly from the crankshaft, so there is no lag in engine response,” he said. “The downfall is that it uses primary energy — energy from the crankshaft — that you want to give to the wheels. Whereas a turbo uses waste energy that would otherwise be exhausted.”

More development is underway to meet other challenges. BorgWarner, a key supplier for the industry, has shown an “e-booster” that it says will improve torque and vanquish the turbo-lag gremlin in current internal combustion engines by using electricity to spin the turbo up to 70,000 revolutions per minute in less than a second.

At Garrett, the emphasis is also on refining an electrified, or e-turbo, booster, meant for hybrids that use the evolving 48-volt power system, which is replacing the 12-volt electrical networks in many cars.

“The e-turbo gives you good low-end torque, lets you downsize the engine and regenerates some of the electricity it takes when you let off the throttle,” said Mr. Balis, the Garrett official. The company demonstrated an e-turbo-equipped Audi Q7 this year.

Mr. Bentley might be pleased to know that engines with big displacements and no forced induction — most of these are called naturally aspirated engines — live on in cars like Chevrolet’s Corvette and Ford’s Mustang GT.

Innovations in lightweight engine materials and fuel-injection methods have led to improvements in these engines as well. And dedicated enthusiasts still regard them with affection: When Porsche announced that it would replace its naturally aspirated flat-six engine in its 718 models with a turbo four-cylinder, one wag wrote on a blog, “Porsche Embraces Satan!”

Despite the assurance of Mr. Filipe of G.M. that “in our lineup, there will always be a mix of turbo and naturally aspirated engines,” Noah Charlap isn’t convinced.

“It’s so sad when you pop open the hood of a four-cylinder Mustang and see a turbo,” said Mr. Charlap, 37, who works as a mechanic at a Chevrolet store in Queens. Turbocharged cars are fine “if you’re the type of person who just likes to go from Point A to Point B. But if you enjoy driving, like I do, you’re just not going to have that power on demand.” With his voice trailing off, he added, “So, until internal combustion engines are banned entirely ...”

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