Captain of Change

During his 17-year tenure as Corvette Chief Engineer, Dave McLellan played a crucial role in bringing Chevrolet's sports car into the modern age.

| BY **GARY WITZENBURG** | PHOTOS COURTESY **GM** AND COURTESY DAVE MCLELLAN |

DAVID R. MCLELLAN WAS BORN AND RAISED in Detroit, took pre-engineering courses at Redford High School and earned his bachelor's degree in mechanical engineering at Wayne State University. While there, he worked on and rose to editor of the school's *Wayne Engineer* magazine, developing skills that would come in handy years later when writing his illuminating book, *Corvette from the Inside: The 50-Year Development History.*

McLellan began his career with General Motors as a Noise and Vibration Engineer at the Milford Proving Grounds in 1959. Later, he became manager of vehicle-dynamics testing there. In 1969, he joined Chevrolet Engineering to help finalize development of the 1970-1/2 Camaro, then worked on General Manager John DeLorean's ultimately futile attempt to wed the Corvette and Camaro platforms into one. Chevrolet saw McLellan as a rising star; in 1973, it sent him to the Massachusetts Institute of Technology's Sloan School of Management, where he earned a master's degree in management. Upon his return, he served as a Corvette staff engineer for six months before taking over as Corvette Chief engineer when Zora Arkus-Duntov retired in 1975. McLellan served in that role until his own retirement in 1992.

We sat down with him for a wide-ranging chat at his lovely home (designed by Frank Lloyd Wright disciple John H. Howe) north of Detroit.

Did you aspire to work in the auto industry from the beginning?

Yes, more or less. I knew how to work on cars and had messed with my dad's cars. As a kid, you take your bicycle apart, and you're lucky to be able to get all the parts back together, so you start learning what you're doing with tools at those simpler levels.

What was your first car?

A hand-me-down '55 Ford station wagon with way too many miles on it that used oil like it was fuel. The first car I bought was a used '57 Porsche 1600 coupe, which had the usual rust problems and took a lot of work to keep running well. I sold that car—the guy who bought it proceeded to wreck it—and bought a '62 Porsche SC, which was really a nice car. Then I bought a '67 911 in Europe when my wife, Glenda, and I were there with the Porsche club. It was one of those deals where you bought the car through the dealer here and they delivered it at the factory; Ferry Porsche was there to give us a talk.

You ran the area known as Black Lake at the Milford Proving Grounds when it was new. Did ducks really mistake it for a lake and land on it, as rumored?

I was the first manager of that facility, and yes, they did.

You got the Corvette staff engineer assignment when you returned from MIT.

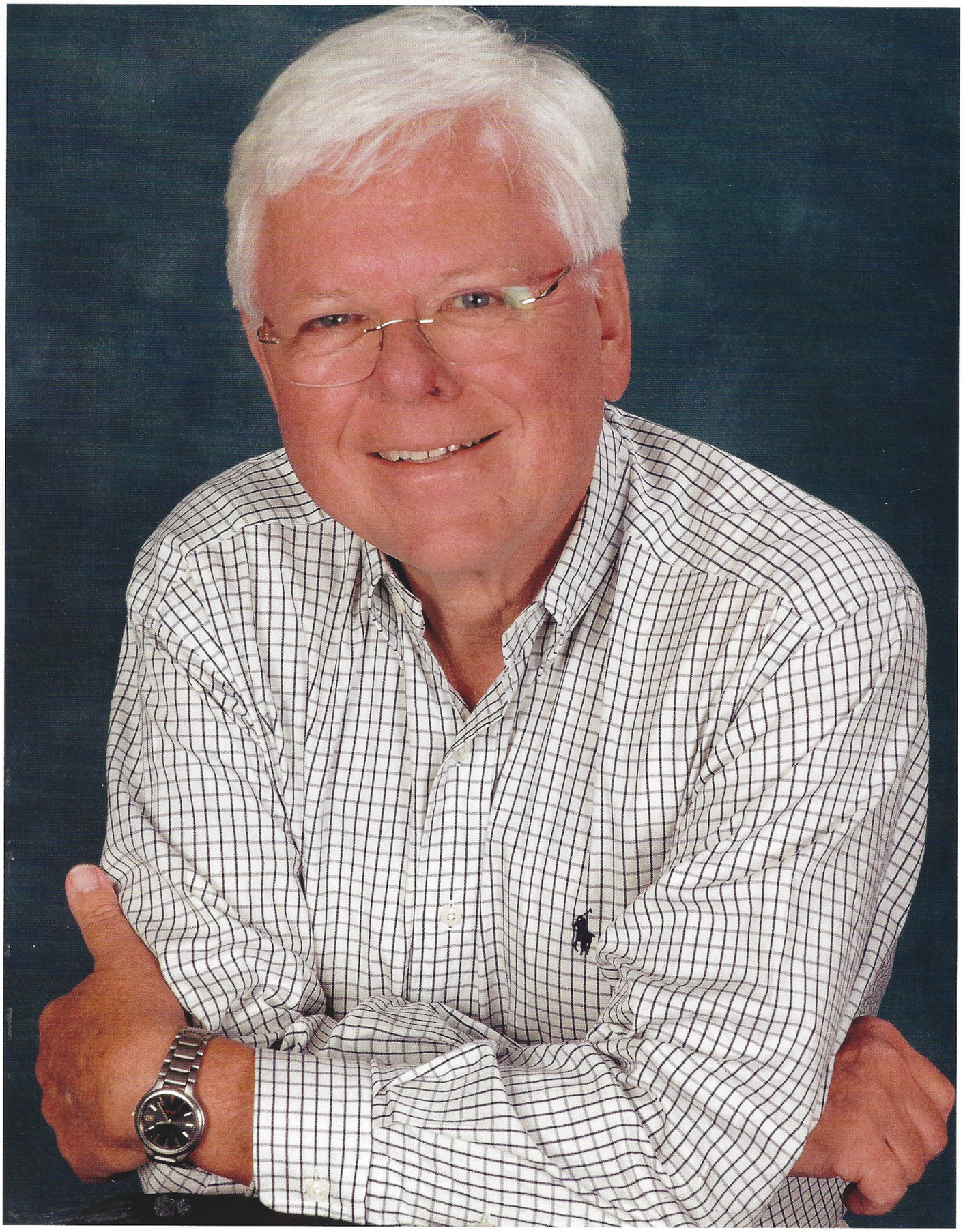
I had some interaction with Zora when DeLorean was trying to combine the Camaro and Corvette platforms into a more economically viable one. That study was done against Zora's wishes; he was dead set against it, and he knew why it wouldn't work before we had to go through and carefully document why you couldn't do that and still have a Corvette.

Why not?

It would have been a two-seat Camaro, like AMC's AMX [was a two-seat Javelin]. The engine in the Camaro was set further forward and higher by several inches—literally sitting over the front axle—but it's virtually behind the front axle in the Corvette, far enough back to put the steering rack in front of it. The Corvette has always had the front-wheel-centerline-to-engine relationship that we still see today. We've changed all the details, but that basic relationship has stayed the same.

In what shape was the Corvette when you took over?

We had gone through the first fuel crisis in '73-'74 and had seen the end of high-compression engines. [Then-GM President] Ed Cole was moving GM and the industry toward catalytic converters to meet the emissions requirements coming for 1975, and the first step toward that was getting the fuel industry to produce low-lead gas, so we had to reduce compression ratios. And Corvettes from that era were not especially robust cars. You could throw fan belts, and hole pistons, because those engines ultimately would detonate when driven hard, though we tried to keep them together as best we could. There was also a problem with the four-piston-caliper brakes where corrosion would set in somewhere during the life of the car. It was a '63 chassis with a '68 body change, and it had some nagging problems.



It was also unprofitable and always fighting cancelation.

The financial guys would complain bitterly that the car wasn't making money, but they couldn't—or wouldn't—tell us why and what to do about it. If you go back to the '63, most of its major component sets were from existing car platforms. The rear suspension and brakes were unique, but the engines, transmissions and front suspensions were pretty much related to the volume cars, so their piece costs were as low as they were ever going to get. But ten years later, most of them—particularly the front suspension, manual transmissions and axle—were no longer being used in volume products, so it was very inefficient to produce just 30-40,000 vehicle sets a year for Corvettes. That and the fiberglass body were very significant reasons why the car cost too much.

How did you win approval for the all-new fourth-generation Corvette?

Over the next few years, the marketing guys succeeded in getting the price raised, so by the late '70s, early '80s, the financial guys were much more positive about the car and we could look to the future, and we ultimately got the go-ahead to do the new car.

Tell us about the C4 development program.

We developed the structure with the GM Research Lab initially as a body/frame integral with a T-bar roof instead of body-on-frame like the C3, but we were later overridden on the T-bar by [then Chevrolet Chief Engineer] Lloyd Reuss, who wanted a Targa roof. And we started to go beyond the GM component set. Up to that point, it was very difficult to step outside of GM to buy components—such as brake calipers, master cylinders and boosters—from anyone outside the corporation because Delco had a powerful hold on what happened.

We were also trying to keep the car as light as possible despite adding structure for crash integrity, and we were in the very early days of being able to model the engineering attributes of a car and predict structural performance in a computer. We were good at analyzing stress and strength, but not at modeling the stiffness of curved-beam structures. Cars are made up of all kinds of curved beams, which are much softer in stiffness than the computer models were predicting. So we hired Grumman Aircraft, who had a Cray super computer, to do a structure analysis for us.

The reason the side sills were so high was to beef up the structure?

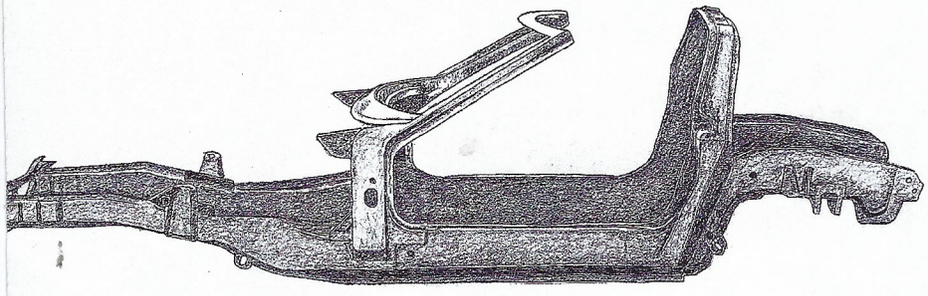
Right, because it ended up being a Targa, and later a convertible, not a T-top, we increased the size of those sills.

In what ways was the C4 superior to the third-gen Corvette?

The forged aluminum [suspension] was a big step forward. We had started doing forged aluminum suspension parts on the C3 to gain experience on their corrosion and durability, and we worked very hard on the C4 to deal with corrosion. The frame structure was two-sided galvanized steel, the body fasteners were stainless steel and all the chassis fasteners were coated, so you could take the car apart ten years later if you needed to; everything was not corroded in place. We had optional Bilstein shocks, and the brakes, which came from Australia through a Girling/Lockheed joint venture, gave a very significant improvement in performance. We also got the drag coefficient down to 0.33-.34, depending on how you pitched the car, compared to the C3, which was up around 0.5. Aerodynamic development was still done physically with full-scale models, and, as I recall, Jerry Palmer and his team did most of that work in Lockheed's wind tunnel in Marietta, Georgia.

The engine was a carryover from '82 with the two throttle-body injectors, which your marketing guys called Cross Fire Injection. Was it possible to do port injection at that time?

GM had done a port-injection system with Bosch for the Cadillac Seville, but there were contractual problems with that, so [then Chevrolet General Manager Bob] Stempel told us to stay away from it. I think the engine guys had to go through that experience with throttle-body injectors in a manifold to realize that, while it might have been less expensive, it did not give the quality of fuel distribution that



Opposite: Shortly after becoming Corvette Chief Engineer, McLellan (far left) helped launch the 1978 Pace Car. Top: McLellan with his predecessor, Zora Arkus-Duntov (right). Above: This hand-drawn sketch by McLellan reveals the C4's tall frame rails, which helped compensate for the loss of rigidity caused by the Targa roof.

you could get with port injection. It had many of the same problems we always had with distributing fuel from carburetor to manifold to eight cylinders, with the air/fuel ratio varying all over the map. We got to Tuned Port Injection for '85 with a mix of AC and Bosch parts, as I recall—fundamentally hot-wire air-meter mass-flow injection with Bosch injectors—and it worked pretty well.

Why was the C4 delayed, resulting in no '83 Corvette model?

It was a big changeover at Bowling Green, and some major components were not going to be available until after the first of the year. The EPA rule is that the model year can only have one January first in it, so if you start on January second, the first January first is the following year. We could have built '83-model cars for seven months, then changed all the paperwork to '84, and that was considered, but Chevrolet elected not to do that.

You got anti-lock brakes for '86 and traction control for '92. Were you working on stability control?

We understood the opportunity with stability control, but it required new hardware that nobody had, along with bigger computers and a lot of development to make it work. One thing we did to prove its worth to ourselves was put [ace Corvette racer and development engineer John] Heinricy into a Corvette to try an ultimate cornering maneuver. Entering Black Lake at speed and going immediately into a curve set up with cones, John could get through the curve at upwards of 70 mph. Then we simulated what would happen with yaw control by shutting off the inside brakes and just applying the outside brakes; he could enter the corner 20 mph faster and by applying the brakes, which were under anti-lock control, slow the car while it was turning in and maintain the curved path. This encouraged us to do yaw control as soon as we could. As it turned out, they didn't get it into production until '98, the second year of the C5, but what a total change it made in the way cars handled at their limit of control.

Tell me about the 1990-95 ZR-1.

We were always pushing the engine guys for more power, and with the first port fuel injection they got to 230, then 250 horsepower. But they were balancing output with emissions and fuel economy, and that's as far as they were willing to go, so we looked initially at turbocharging the small block. Vince Piggins, who was Chevrolet's motorsports manager, had built some earlier turbo packages with the carbureted engine, but you had to pressurize the carburetor to make that work, and they were not efficient systems.

But with the port fuel injection, we were able to build some really extraordinary turbocharged engines, and we used that with Lloyd [Reuss, then Executive Vice President, North American Automotive Operations] to show what was possible. He gave us the go-ahead—but to do a four-cam, four-valve, naturally aspirated engine instead of a turbo because he saw that direction as more high-tech. His goal was to use the program to reposition the Corvette, and he hung in there with us beautifully as we made it all work and got it to production.

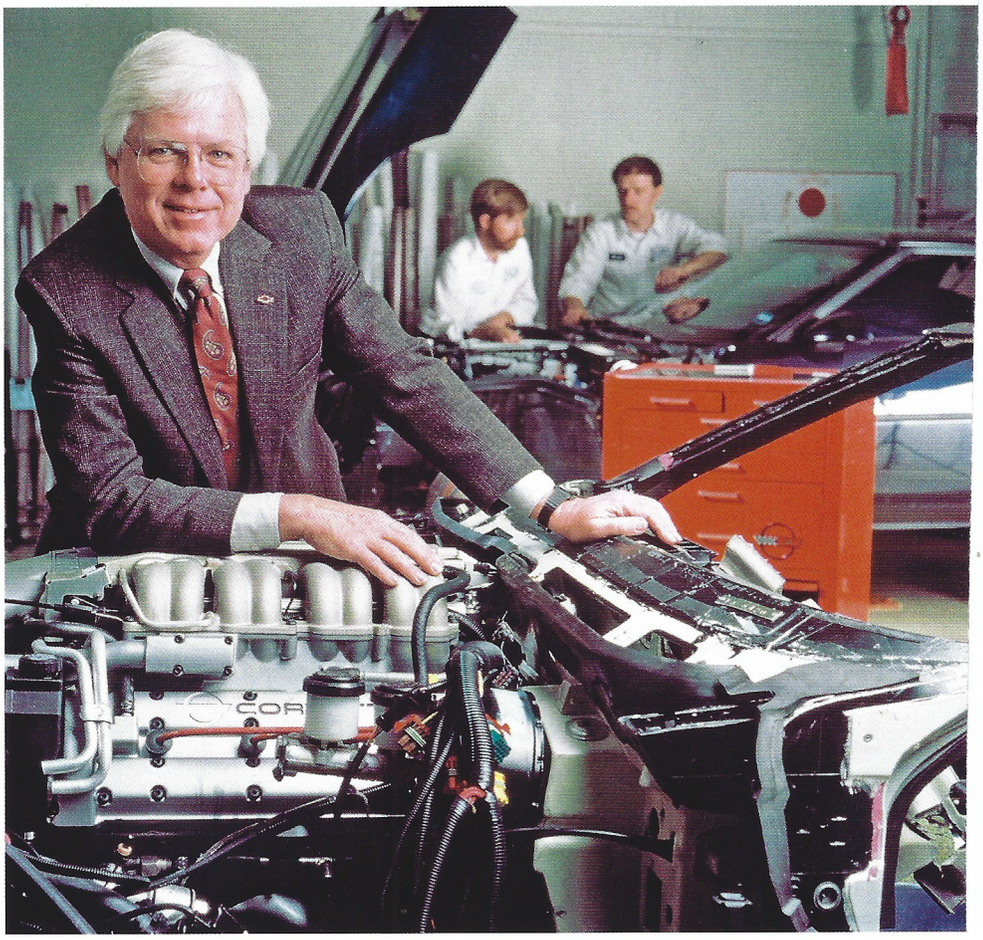
Reuss was a great supporter of the Corvette at that time, right?

One thing the Corvette has always needed was protection within top management levels at GM. There are always detractors, who could care less, and true believers who understand cars and what it takes to develop and produce cars that are truly enjoyed in the marketplace, and I would position him as one of those true believers. Each era of the car has had those kinds of individuals who were not working directly on it but were very helpful and supportive in guiding the car and protecting it from detractors along the way.

Why did you go to Lotus for the LT5 V8?

When Lloyd made the decision to do this engine for the Corvette, Chevrolet powertrain director Russ Gee said he didn't have enough people to do that program. The complexity of engines within Chevrolet was so immense—with V8s, sixes, fours, passenger cars, trucks, manual and automatic transmissions, with each configuration needing its own emissions certification—that his group was completely used up in doing that. So Lloyd told him, if you can't do it, get on an airplane and find someone who can. Russ literally went around the world looking at potential engine developers, and he settled on Lotus for this program.

Those ZR-1s were pretty extraordinary cars for their day, and the Corvette's image in the marketplace really benefitted from that. You may recall that the press introduction was a really big deal.



Above: Thanks to its powerful four-cam, four-valve V8 engine, the C4 ZR-1 put the Corvette on the international supercar map. Opposite: McLellan presided over the building of the one-millionth Corvette, a '92 convertible.

So they designed and developed it, but you had Mercury Marine build it.

V8 Engine Chief Engineer Roy Midgley looked at what Lotus was capable of doing and concluded that they could do the engine development but did not have the necessary manufacturing experience. He decided that Mercury Marine, who used a lot of Chevy engines in boat applications, could build it to what was literally a racing specification. They set up a manufacturing facility that was temperature-controlled, because they were controlling dimensions to where if you changed the room temperature, you changed the measurement.

The project was originally envisioned with four-cam, four-valve heads on the small block.

It started that way, but Lotus chief engineer Tony Rudd convinced Midgley that he could get better performance if he had control of the block as well as the head. So it morphed from heads on the existing block to an all-new engine. And it established a new benchmark for the car. Those ZR-1s were pretty extraordinary cars for their day, and the Corvette's image in the marketplace really benefited from that. You may recall that the press introduction was a really big deal. We introduced it in Europe because of the timing and also because we could drive it on fast autoroutes.

The C5 architecture was pretty much designed on paper by the time you left in 1992.

We had architected it successfully, but had not yet sorted out the cost issues. Given the architectural limitations of the C4, we asked ourselves, "How can we improve it?" And there was no good way other than to re-architect it. Recognizing that the car is a V8-powered two-seat coupe and convertible, we wanted to make it stiff in body torsion as a convertible, and the only way to do that was with a torsionally stiff backbone structure. We looked at all manner of design variations that could get us those attributes, but we ultimately settled on what became the C5. We moved the transmission to the rear and increased the wheelbase, and that's what the guys ultimately were able to package. It kept the weight with the aluminum engine a bit lighter than the C4, and it's a great layout that has proven successful through C5, C6 and now C7.

You have said that Chevy's development of its four-wheel-drive truck automatic transmission paid for the Corvette's gearbox to be beefed up and rear-mounted.

That's correct. The truck guys wanted to increase the bending stiffness of their V8 auto-

matic-transmission, four-wheel-drive transfer-case system, and the key element of that was the stiffness of the bell housing between the engine and transmission. So they ended up paying to tool the automatic transmission case with a separate bell housing for both the trucks and the C5 Corvette.

Was there factory racing when you were Corvette Chief Engineer?

We started factory-supporting SCCA Showroom Stock racing, which allowed minor modifications such as straight exhausts and better tires, with the '85 port-injected car, and over the next few years we were able to pretty dramatically upgrade the chassis with anti-lock brakes, then larger brakes and zero-scrub front and rear suspensions. That led to not only good racing cars but also better production cars.

Were you involved with any of the Corvette concept cars of that era?

The Indy Corvette was between Chevy marketing, Chevy R&D and Lotus. I stayed out of that one. The Stingray III was a transition design from styling, mostly done on their own. They increased the wheelbase and short-coupled the front end to where they could not get a V8 engine up front, so they put a V6 in it. When it was shown, they never opened the hood to let people see that there was a V6 in there. We later wedged in an experimental variant of the small-block V8 that was being developed by Chevy R&D for front-drive passenger cars. Instead of having its distributor and oil pump on the rear of the engine, they ran the oil pump off the crank and the distributor off the front, which made it short enough to fit.

What was your proudest achievement as Corvette chief engineer?

I think it's a continuous progression. The C4 taught us how to do a number of things with a much more aluminum-intensive car. The ZR-1 was a great car that gave us the courage to say, "If we can do a ZR-1, we can do anything." Then we stepped off into new territory with what became the C5, believing that there was no reason we couldn't solve the architectural challenges, and it turned out dramatically lighter than most of its competition.

Any regrets?

Not really, though we would have liked to do it faster. In many cases, we were coming up against technological boundaries and parts and systems that hadn't been developed yet. We would have liked to have had yaw control sooner, but it was a development that had to come in its own time. We were lucky to get 200-250 horsepower out of the old iron engine with carburetors or unit injectors, but look at that small block today! The base engine is 450 horsepower. They've learned to make it breathe and control it better in all aspects, and it's much more reliable. They don't burn holes in pistons or fling belts any more—all that stuff that we put up with early on has been solved—and the component set today is so much better.

What are your impressions of the C7?

My first impression is that the styling is distinctive and fresh, whether seen from afar or up close, yet it's still recognizable as a Corvette. The designers and engineers have produced a beautiful form with lines that give it interest and distinctive detailing. But, just as important, is its low-drag, low-lift shape. Architecturally, the C7 is an evolutionary development of the C5/C6. But it has been rethought in every detail to take advantage of all the latest technology opportunities that will make it the best Corvette ever. I hope it inspires the rest of General Motors to be nothing but the best. ○