RACE CARS: TAKING THE WHEEL
One Engineer's High-Speed Fun

by **Dr. Arthur D. Delagrange,** Massachusetts Beta '62

When I turned 65, a letter from my insurance company informed me that my rates would go up, implying I was no longer a competent driver, in spite of a 40-year record with no claim for body damage to any of my many cars. I was annoyed, to put it mildly. They also suggested that I consider going back to driving school. Humph!

OK. I went on the Internet and, to my delight, found four "schools" where I thought I could exceed 150 mph. I succeeded, each time gleefully sending photographs to my insurance agent (who actually was on my side). I understand these are now posted on a cafeteria wall.

Figure 1. This "Indy" car (above) has a substitute motor that produces *only* 600 hp (roughly 75 percent of normal). This instructor model has been lengthened so that a passenger seat could be added.

INDY

I have driven around the track at Indianapolis, but my recent experience was actually at Chicagoland. At Mario Andretti's school I drove an "Indy" car [Fig. 1]. As you can see, the car is very much like one driven at Indianapolis a few years ago. Some concessions were necessary for the students. The engine is a "stock block" V-8 producing *only* 600 hp. The transmission is a manual one-speed!

There are several unnerving aspects if one has never driven a race car. (I had—underpowered cars about 30 years ago. My, how things have changed! What was a sport is now a business on one hand and a science on the other.) One is seated almost horizontally, looking directly over the tops of the exposed front tires. The cars are smaller than they look on TV; you can't see the pedals at all, but have to locate them with your feet. Because it is a single-seater, you are pretty much on your own; there was no radio in the helmet. You follow an instructor in a similar car and try to do what he does. He adjusts speed according to how well you copy.

Photos: Janice Delagrange

Figure 2. A gas dragster (above) boasts 700 hp on a non-supercharged 4-bbl carburetor and gasoline. The engine is available directly from GM.

Starting is easy. An ATV pushes you to reach idling speed, and you engage the clutch. Once on the track, I had trouble judging distance. "Stay four-to six car-lengths behind your instructor" sounds simple, but at 150 mph that is a quarter of a second, and I unfortunately know what happens when two open-wheel cars touch. I ran on a 1.5-mile banked oval. I was pleased to exit the car with my hand not shaking too much to hold on to a (no-fine) radar ticket showing 155 mph on the straight!

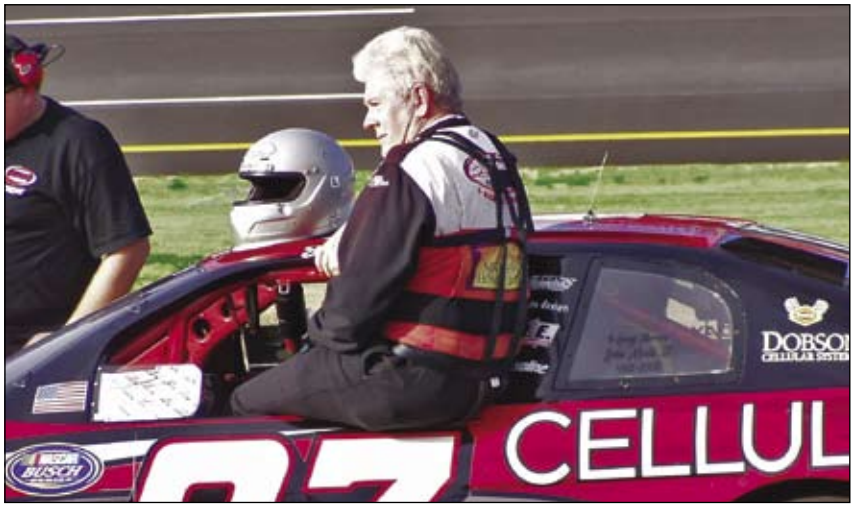

Photo: Janice Delagrange

Figure 3. "Stock" cars originally had their doors welded shut for safety. The body of today's stock cars (above) are fabricated from a single piece—completely eliminating the doors.

TALLADEGA

What do you do with a used "stock car?" With the big teams running two to four new cars, gone are the days when an independent could buy an old one and run at the back of the pack. Today many are finding use in "schools." I have seen one running on a street, but that is a bit extreme.

I chose Dale Jarrett's school, where the instructor is in the car with you. As long as you perform acceptably you can race your friends, including foot-to-the-floor drafting and passing, but no bumping. I personally wasn't interested in being half a car-length behind someone I had never met at 150 mph, which translates to about a thirtieth of a second, even if the bumpers are reinforced. I chose Talladega, the longest super-speedway with banking as steep as any. I figured I could probably run full speed all the way around.

I was particularly happy with the choice as I had met Dale's father Ned at a local track where he brought his then-new 1965 Ford and ran away from the locals. I was also pleased to get a car emblazoned "Joe Nemechek" because I had seen him drive, before he moved up to the NEXTEL Cup series, in a shorter race when he also ran away from the pack.

Race-car clutches have very strong springs and engage immediately as the pedal comes off the floor. I stalled my 600 hp car twice before I got going. I had no trouble shifting the manual four-speed transmission, but the transitions were less than smooth with the aforementioned clutch. Fortunately, you are through shifting before you pull up from the flat apron to the banked track. That is another interesting experience; however, I had been warned at the previous school to do it gently, but with a firm grip on the wheel, or I might go all the way up into the wall.

I had to get used to the steering wheel being put on (the wheel has to be removed to get in or out of the car) [Fig. 3] with the bottom spoke at the top, but the gauges aren't behind the wheel. Plus I quickly learned that if I came out of a turn and put the spoke at the top, I was headed for the infield. The cars are biased to turn left; one has to exert a significant amount of force just to go straight.

I was pleased to try to push the accelerator to the floor coming out of a turn on the third lap and to find it already there. The cars are geared abnormally high so the engine can't reach maximum power rpm, slowing the students (and helping the engines last a lot longer).

GAINESVILLE

My third adventure was drag racing. The concept is deceptively simple: Two cars sit still; when the light turns green, the one that reaches the finish line a quarter-mile ahead wins. But as with many games and sports, simple concept leads to complex execution. Your opponent is really the laws of physics. You need pay no attention to the car in the other lane; in fact, you shouldn't. There are many rules for safety and to define classes so you can compete at a slower speed for less money.

Frank Hawley is a former two-time national champion driver in "Funny Cars," the full-bodied equivalent of Top Fuel Dragsters, and a consultant to some top teams. He does most of the instructing himself, spending time and care with experienced race drivers and clueless civilians alike. His is an honest-to-goodness school where, if you perform satisfactorily, you get an NHRA (National Hot Rod Association) license and go very fast. Gainesville has the longest runoff area in the circuit, which is good if your reaction time is on the slow side.

For the school I chose "Super Comp" class, which is a true dragster but uses a gasoline-burning motor you could conceivably drive on the street. The car is long and narrow [Fig. 2] with huge tires close together in the rear and minimal tires up front to steer the car straight in case of minor imbalances in the thrust of the rear tires. (Major imbalances usually end runs in spectacular fashion.) The engine, which is thankfully behind the driver, was a 572 cu. in. (9.4 liter) Chevrolet semi-hemi V-8 producing 700 hp with a single normally-aspirated four-barrel carburetor. The transmission is a two-speed automatic derived from the ancient GM Powerglide. These cars have a small radiator with electric fan and pump so they can idle back to the starting line and make another run after quick-charging the battery.

The tricky part here is the "burnout." The car is idled through a patch of water, and then the tires are purposely spun at 60 mph for a short distance. This produces a spectacular show of smoke and noise, but the real purpose is to clean the "tread" ("slicks" are perfectly smooth) and make it soft and gummy. As you might suspect, having the car

going slowly while the tires are going fast creates some problems. The noise and vibration are unbelievable, and, when the tires finally grab as you release the throttle, it feels like a raging bull just caught you.

"Launch" is simple. A button engages reverse in addition to forward, and the transmission is locked in "transbrake" mode. Floor the accelerator, release the transbrake button, and try to keep your foot on the accelerator with close to three Gs trying to pull it back, along with all the logic neurons in your brain. Progressing from practice starts through longer and longer runs, I finally made a full-length run at 160 mph in the longest 8.3 seconds of my life. This is a true race car. If you have too much money, Frank will set you up with one of your own, and you can go racing with a good chance of winning.

MORE OF SAME

The next adventure was not part of the master plan. I noticed that Hawley's offered a faster class—well over 200 mph. That was the top-class record when I last attended drag races! I inquired at the school whether I would be a viable candidate for this class. The reply was that because I had made a successful run in the previous class I was certainly qualified to try. The results were up to me.

I signed up, without asking any more questions. As the date grew closer and I learned more about the car I would be driving, I began to have second thoughts. "Top Alcohol" (Table I) is the next class below "Top Fuel" (Table II), which is the quickest. The engine is a 500+ cu. in. Chrysler hemi-based, supercharged, fuel-injected, methanol-burning 2,500 hp monster. The car is pure business, bare bones, with nothing that is not absolutely necessary, even a starter motor. The car is a longer version (see Table I) of the one I had driven, but had a compressed-air-shifted manual transmission with a semi-centrifugal clutch. There were the clutch pedal, accelerator pedal, and hand brake, all three of which must be operated by the driver at precisely the same moment. I was worried about the hand-operated brake, but it is not unlike a center-mounted emergency brake. It is actually less prone to lock than a foot brake because you pull against the g-force instead of pushing with it. By the way, the car has an inverted wing to help keep you on the ground. Daunting, but I'm an engineer, and this is just a machine, right?

The tricky part here, other than operating three controls with a one-track mind, is holding an engine with a supercharger—which is a positive-feedback system and consequently tends toward instability—to exactly 5,000 rpm as you inch into the staging light. Yes, the next step is to floor the accelerator, dump the clutch, and release the brake simultaneously. The result, if you do it right, is that you take off like an arrow released from a bow. If you do it wrong, there are a number of possible consequences, all unpleasant. Because the situation is then "out-of-spec," the car might veer, hop, or oscillate, and the run must be aborted.

So here I was in a car that weighs the same as my old VW Beetle, but has 50 times the power. I never made it past practice starts, but that alone was worth the effort and expense. Twice I hit the 60-ft. line in less than a second. That computes to around 4 Gs and 80 mph. (Speed is not measured until the eighth-mile mark, by which time I was coasting at only 120

Photo: U.S. Army

***Table I* Top Alcohol Dragster Specs**

Weight: 1,500 lbs
Wheel Base: 265 inches
Fuel System: Mechanical Injection
Fuel: Methanol
Horsepower: 2,500
Trap Speed: >>200 mph*
Elapsed Time: <7 sec.
Fuel Mileage (city/country combined): 0.1 mpg
Clutch: Pedal-operated, controlled-slip
Transmission: Three-speed semi-automatic
Supercharger Pressure: 30 psi (above ambient)
Brakes: Hand-operated rear discs
Tire Size, F / R: 22.0 x 2.5 - 17 / 34.5 x 17.0 - 16 in.
Tire Pressure, F / R: 34 / 5 psi
Suspension, F / R: none / none

**Note that if the car were dropped from a height of 1/4 mi., the terminal speed would be less than this.*

***Table II* Top Fuel Dragster Specs**

Weight: one ton
Wheelbase: 3X that of my Viper
Fuel - 100% nitromethane**
(percentage since reduced)
Horsepower: 6,000-7000
(dynamometers not available in this range)
Trap speed: >300 mph
Elapsed time: <5 sec.
Engine life: rebuild after each run
Tire mileage: replace rears after one-four runs
Full-run average acceleration: 4 Gs
Spark-plug life: <one run
(engine diesels the rest of the way)
Transmission: none
Clutch: multiple; computer-controlled
Wing downforce at finish: two tons

***Nitromethane is both a fuel and an explosive, so an unusually large amount of power is available for a given amount of air.*

The author thanks Frank Hawley Racing School for supplying information, proofreading the article, and letting a senior citizen drive its very quick cars.

mph.) Think what this means. I could park that car on any interstate, take off as you drive by at the speed limit, match your speed in one second, and be well past you in two.

What holds you in place during all this? I wore a "seven-way" harness: the two halves of the lap belt, two shoulder belts, an anti-submarine belt (known less than affectionately as a "crotch strap"), and two straps that would keep my arms within the car in case of a crash. Uncomfortable? I prefer it to the asymmetrical "triangle" belt in passenger cars. Getting out of the car in a hurry? One latch on a lap belt releases the other six belts. There are also two straps on the helmet to keep it from flying farther than your neck can stretch, but these are attached to you, not the car.

Here's where I really learned how scientific racing has become. I shut the engine (fuel first, then ignition) and coasted to the end of the track. Shortly the tow vehicle arrived, and the crew hopped out and asked if I were OK. I gave them "thumbs up," which in my case meant, "I think so!" The crew gave the car a quick check, inserted a tow pin, attached a stretchy-strap, and towed me back to the pits. What were easy turns for the extended pickup truck required planning well ahead in my car with its 265 in. wheelbase.

There the clutch would be rebuilt, the fuel tank refilled, and the car thoroughly rechecked. Had I made a full run, the twin parachutes would have been repacked. After cooling, the car would be towed back to the staging area.

Meanwhile, the instructor pulled a "chip" from the on-board computer and inserted it into his laptop. The screen displayed graphs of just about everything I or the car had done: accelerator-pedal movement, clutch-pedal movement, brake pressure, shift-line pressure, oil pressure, manifold pressure, engine rpm, and driveshaft speed—all measured each thousandth of a second. (Racers don't use *millisecond*, probably because the public doesn't have much concept of how quick one is.)

At 8,000 rpm, a light advises you to shift. You have 0.4 seconds to hit the shift button; if not, the "overrev" sensor cuts in at 9,000 rpm, killing the engine and ending your run. The entire run should take about seven seconds. There were also both in-car and fixed videos. My runs were a lot more crooked than I realized. The worst problem was extra hand or foot motion that I was unaware of at the time.

TOP FUEL DRAGSTER

It was hard to believe that there is a class of car two seconds quicker and 100 mph faster than what I was in. Table II provides some of the characteristics of these "Top Fuel" cars in layman's terms; a precise list would be near-meaningless to the average driver. Few people are able to drive one; I must only dream.

ROAD CARS

The final phase of my quest was trickier than anticipated, but I didn't have to go to a school. Years ago when Dodge released the Viper, I quickly learned that the only way I was going to drive one was to buy one, so I did. This year, with my Viper now over halfway to becoming an antique car, I figured all I needed was a straight stretch of country road with no one in front of me to open it up. In the DC area this turned out to be like looking for a regular parking spot directly in front of a Wal-Mart. But on the second day I lucked out and, holding the accelerator to the floor for more than 13 seconds for the first time, easily attained 150 mph.

CONCLUSION

So, what's to be learned from all this? The level of sophistication here should encourage anyone with an engineering bent to enter the field. It's fascinating and fun. Whereas originally nearly everything for the sport had to be hand-built or modified, now most of the cars in a class will use a chassis from the same builder, tires from the same maker, engines from one or two builders, etc. Most parts are mass-produced, although on a small scale. Twice during my Top Alcohol school the engine failed. The crew read the computer chip, replaced the offending part, and the next run was made almost on schedule.

There has been a decades-long argument over whether or not improvements spawned in racing carry over to passenger cars. I say yes. Many of the features standard on today's cars had to be home-installed by "hot-rodders" 50 years ago (or less): wide tires, alloy wheels, electronic ignitions, fuel injection, ram induction, superchargers, bright headlights, and dual exhaust. This year all of the "big three" American auto manufacturers will have 200 mph cars, not to mention the foreign exotics. I don't expect to see 200 mph travel here soon, but if production cars can be driven safely at these speeds, then the carnage on the highways is not because of inadequate engineering or speed limits being too high. There are so few fatalities in racing that they usually make front-page news. And there can't be many crashes at the schools if they can afford to let strangers walk in and drive cars like these.

On the other hand, those who have only seen videos, from either outside or inside the cockpit, or watched live races can have but a faint notion of what it's really like in the driver's seat. It may appear that the drivers aren't doing much. They can't! With today's horsepower and speeds, a car must nearly drive itself. At 200 mph a small (mis)correction causes a lane change or worse. Gone are the days of bravely wrestling a car around the track.

The engineering is impressive, not only from the performance level, but also in the reliability of these machines when pushed to the limit. At least 99 percent of the work is done before the car leaves the starting line. Otherwise, I could never have driven these cars without a long apprenticeship. If you are a competent driver with a valid license and a healthy credit card, you can drive them too!

Arthur D. Delagrange, *Massachusetts Beta '62*, received a B.S. and M.S. from the Massachusetts Institute of Technology in 1962 and a Ph.D. from the University of Maryland in 1974, all in electrical engineering. He worked at the Naval Surface Warfare Center (now closed) in Silver Spring, MD, during 1959-94. Holder of nine patents, Art has authored 68 governmental reports, 22 articles in trade magazines, and a chapter in *The Art and Science of Analog Design* edited by Jim Williams (Butterworth-Heinemann). He has written articles for THE BENT on the C&O Canal (Fall 1999), B&O Railroad (Spring 2000), automobiles (Spring and Fall 2001), power boats (Summer 2002), and music (Winter 2003) *[see www.tbp.org]*.