

WIRED

Ultimate Geek Racer Drives by Guts, Instinct — and Algorithms

By Preston Lerner [✉](#) 09.25.07 | 2:00 AM



Inside the cramped, seething belly of a 550-horsepower, \$500,000 race car, Colin Braun hurtles around the Homestead-Miami Speedway at 177 miles per hour. As he bends the car into Turn One, the chassis shudders over a bump and the back end lurches sideways. In slower hands, this would be the prelude to a catastrophic wreck. But Braun, 18 years old and fearless, responds with a lightning application of opposite lock — what driving instructors call "steering into the skid" — and blithely carves through the corner.

On this sunny Friday morning, Braun is practicing for tomorrow's Grand-Am Grand Prix of Miami. As he roars around the track, electronic sensors embedded in his purpose-built Daytona Prototype monitor the car's behavior in minute detail: suspension travel, exhaust gas temperature, throttle position, wheel speed, and dozens of other variables. This information is radioed back to the pits, where race engineer David Brown squints at a dizzying array of numbers and graphs on his laptop. A serene and methodical wonk, Brown is charged with adjusting the car to optimize performance.

Accelerating out of a hairpin turn, Braun fishtails toward a daunting right-hand kink that can be taken — in a best-case scenario — flat out. But he feels the car losing traction. If he eases off the throttle, the lap will be ruined. If he turns the steering wheel too sharply, he'll spin. If he does nothing, he'll run out of track. Braun opts for plan D: He edges the car to the right a millimeter at a time. The left rear tire kicks up dust. It's just beginning to slide when the other tires suddenly grip the asphalt and launch the vehicle forward.

It's the kind of I-think-I'm-going-to-die moment that causes a driver's hair to stand on end, but when Braun keys his mic to speak with Brown, he sounds laconic, like a military test pilot. "There's a lack of front grip in the middle of the corner, and it doesn't put the power down very good," he says, flying out of the kink at 130 mph. "It feels like it could use a softer spring. Right now, it pushes too much in the middle, and I get snap oversteer at the exit."

Part athlete, part astronaut, Braun is at the forefront of a new generation of drivers who have internalized the mechanical subtleties of the gears, pistons, and tires they control. Once upon a time, racers drove by the seat of their pants. Quick reflexes, a well-balanced inner ear, and substantial cojones were the marks of a winner. But nowadays, the cars are so complicated that drivers need to know not merely how to push them to the limit but how to make adjustments to extend that limit. This means telling the race engineer — precisely, concisely, under pressure — how the car feels, so performance can be improved during practice or even in the middle of a race.

This is a language Braun has spoken since he was a tot. The son of a race engineer, he's the product of a uniquely comprehensive training regimen that began at age 6, when he started analyzing data logged by a unit his father installed on his kiddie car. He learned to commune with his vehicles during tens of thousands of laps on a test track on the family's property. And he has spent countless hours hunched over laptops, deconstructing multicolored graphs of racing data in an effort to "see" what his car is doing. "I look at squiggly lines and know what they mean," he says. "I don't remember learning it. It's something I've always understood."

For the past two years, Braun has been racing on the Grand-Am circuit, driving a sleek closed-wheel racer that's something of a cross between Nascar's beefier stock cars and the spindly exotics of Formula 1. In June 2006, as part of the team headed by billionaire oilman Tracy Krohn, he became the youngest driver ever to win a major pro race in North America. If age restrictions hadn't prevented him from competing in three events, he probably would have shared the Grand-Am Rolex Sports Car Series championship. "You could make a very good case for him being the next great American driver," says Ross Bentley, who runs an elite driver-coaching program. "As a package, he's the best I've ever seen at his age. Maybe the best I've seen at any age."

During practice at Homestead, Braun repeatedly shuttles in and out of the pits to have the car tuned. Although his time improves, he ends the session frustrated that he can't find the sweet spot in the car's handling — the golden compromise between responsiveness and speed. "The car is understeering like crazy," he complains when he climbs out of the cockpit. "We suck on the straightaway." There's a lot of work to be done before tomorrow's qualifying session.

Even with 12 years of high-speed competition under his belt, Braun is still a gangly beanpole who could pass for the treasurer of the high school chess club. Bounding into the portion of the team's big-rig that serves as an office, he flops into a chair in front of a counter holding four laptops that display data from the morning session.

"What do you see, Mr. Priestman?" he asks a compact man who's peering intently at the screens. An electrical engineer by training, Stephen Priestman is the racetrack equivalent of an IT manager. He holds a title that has become standard throughout the racing world: DAG, for data acquisition geek.

"Squiggly lines all over the place," Priestman jokes.

The screens show the five variables that offer the quickest overview of the car's performance: speed, rpm, throttle position, brake pressure, and gear. These channels are displayed lap by lap as lines on an X-Y graph: X is distance and Y is the variable in question.

Braun looks like a kid playing a videogame as he pulls up his fastest lap, then overlays the color-coded traces of other laps for comparison. He runs his cursor along the peaks and valleys to figure out where he gained and lost time. Analysis of a previous session's data suggested it might be faster to take the hairpins in second gear instead of first — but that hadn't helped. Neither did a shallower spoiler angle.

"With less spoiler, it came off the banking a little quicker," Braun murmurs, studying the data on another laptop. "But everywhere else, it made sod bit of difference."

"Sod?" Braun asks. He's a Texan; Braun is a transplanted Brit.

Introduced to the racing world 20 years ago, data acquisition systems are now commonplace. Amateur racers can pick up simple units for less than \$1,000. At the other end of the spectrum, Formula One cars — beneficiaries of hundred-million-dollar

budgets — are packed with enough electronics to launch a satellite. The MoTeC ADL2 data logger in Braun's car is the heart of a \$60,000 system that captures the output of some four dozen sensors. In addition to transmitting vital statistics about how the car is handling, it can trip preset alarms to avert catastrophic mechanical failures. If oil pressure falls below a certain level, for instance, bold red lettering on the screen prompts the race engineer to tell the driver to kill the engine before it explodes.

Mostly, though, the data is used after the fact. As soon as a session ends, Priestman plugs his laptop into a 13-pin connector mounted on Braun's car and downloads the contents of the ADL2. The software formats this data into line graphs, or traces. By overlaying these traces, Braun can see what effect each change had on the car. They also show him where he can find time on the track — say, by going 2 miles per hour faster through the kink or braking 10 feet later for Turn One.

Commercial data acquisition systems have revolutionized racing, but not in the way the industry expected. In the pre-data era, engineers relied on drivers for subjective impressions of how a car was handling. But drivers are athletes, not engineers, selected more for their motor skills than their technical acumen. Their feedback was often ambiguous, even inaccurate. Data acquisition promised a utopian world where race engineers would no longer have to kowtow to the prima donnas behind the wheel. Because data could tell them everything they needed to know, science would reign supreme and drivers would be reduced to the role of glorified chimps.

That didn't happen. Even as data logging lowered lap times across the board, race engineers discovered that data alone means nothing without a driver to put it in perspective. Viewed in a vacuum, it's easily misinterpreted. A classic example is readings that seem to show a car is "loose," meaning the tail tends to slide in corners. In fact, sometimes the car is actually "tight," losing traction in the front end, which forces the driver to turn the steering wheel more than he ought to, causing what appears to be loose behavior. The driver's input is crucial to diagnosing the condition. So instead of marginalizing the people behind the wheel, the data revolution made them even more important. But taking full advantage of data logging requires a different kind of driver — one who can correlate sensory impressions with the data pouring out of the vehicle and articulate this information in language his race engineer understands.

You can't learn this by reading textbooks, and it's not taught in racing schools. Braun got lucky: He had a private tutor every day of the year.

October 1994: Colin Braun is practicing for his first race at a small oval in Austin, Texas. Driving a pint-size car known as a quarter midget, the skinny 6-year-old isn't the fastest kid on the track. But he's got a secret weapon: His father, Jeff Braun, is a professional race engineer, and Jeff has installed a data acquisition unit in his son's vehicle. "You're lifting in the corners," Jeff tells him. "You have to be flat out all around the track."

"No no, Dad," Colin insists. "I'm mashing down that throttle all the way."

Braun senior doesn't buy it. He calls up the throttle trace. He wants to see a line that runs straight across the screen, showing that Colin was at full throttle for an entire lap. Instead, the trace shows a pair of valleys: Colin eased off before each of the two turns.

"The next session," Jeff tells him, "I want you to see if you can make that line completely straight."

Colin finished his first race in second place. Two races later, he notched his first win.

The Braun family lived near the tiny town of Ovalo, Texas — hundreds of miles from the nearest track. So Jeff built a go-kart course on his sprawling property. Watching from a scaffold and dispensing advice via two-way radio, he led Colin through Race Driving 101. He attended kart races, where Colin often competed in three or four separate classes with different karts, all bristling with data loggers. "Colin was the first kid I saw who really analyzed data," says Tony Coello, who ran one of the top shops at the time. "Most kids, if they opened a laptop, it was to play Pac-Man. Not Colin. He worked at it harder than any kid I've ever seen."

But even as Colin was learning to parse traces, Jeff was beginning to wonder how much they were worth. He'd honed his trade during the data acquisition revolution, but a decade of experience from Daytona to Le Mans had taught him that the technology had its limitations. "You can get lost in all the data," he explains. "It can send you in the wrong direction. At the track, there's so much information to sift through that you need the driver to focus his engineer on what he wants changed. The more the driver can tell me, the more I can improve the car."

So Jeff taught Colin not only how to read data but also how to correlate the traces with what he felt in the driver's seat. He showed his son shock absorber profiles in the pits, then sent him out to see how different settings actually behaved. They spent an entire day isolating the effect that suspension adjustments had on the rear roll center. They practiced racing on worn tires, on overinflated tires, on underinflated tires.

By the time he was 14, Colin had spent more time analyzing vehicle dynamics than most drivers twice his age. When he entered his first real car race, he dominated the qualifying rounds and ultimately took the checkered flag on race day, becoming the youngest driver to win a professional formula car race in North America. By 17, he was a full-time pro. Now he's poised to become a star.

Braun is upbeat as qualifying begins for the Grand Prix of Miami. But as soon as he gets up to speed, he finds that the morning's adjustments haven't helped. He ends up placing a discouraging fourth.

Afterward, the mood inside the big-rig is gloomy. Brown and 37-year-old codriver Max Papis are furiously paging through screen after screen of data when Braun walks in. "There's no power-down traction," he announces. "It's like driving in the rain."

"I'm a little confused about what we need to fix," Brown says.

"We absolutely need more rear grip," Braun insists.

The room goes silent. The car has undergone hundreds of changes before, during, and after the four previous sessions. And yet, Braun insists, the handling is still way off.

"Have you ever had a car handle like this before?" Brown asks. "No," Braun answers. "If this is good, and this is bad" — the teenager holds his hands shoulder-width apart — "then we're over here," he says, twisting around to reach behind his body.

Brown adjusts the differential at Braun's insistence, but the car is no better during a brief warm-up on Saturday morning. Brown continues to tweak, even though there's no time to test the changes.

On Saturday afternoon, Braun is back behind the wheel for the race itself. It's a timed event, two and a half hours long. Braun will drive first, with Papis taking over halfway through. The start is promising. "The car's not too bad," Braun radios. "I'm just saving fuel and tires."

Braun is renowned for his unflappable demeanor, but on lap 10 he unleashes a high-pitched complaint against another driver: "Long hit me big-time! He just turned in on me!" The broadcast replay on the pit TV screen shows Patrick Long's car spinning out after colliding with Braun's car. Braun insists Long was at fault. Officials disagree and nail Braun with a penalty, forcing him to drive through the pit lane at reduced speed. By the time he returns to the track, he's in 16th place.

"Let's keep our heads down and do what we can," Brown says. "Copy that," Braun replies, once again all business.

Braun patiently picks off slower cars and climbs back up to third, but not before having a second run-in with Long, a third with a different driver, and a fourth with yet another. The team loses more time while he and Papis trade places. When Braun pulls off his helmet, his face is flushed. He marches through the pits to confront one of the drivers who hit him. Fortunately, his nemesis has already returned to the track.

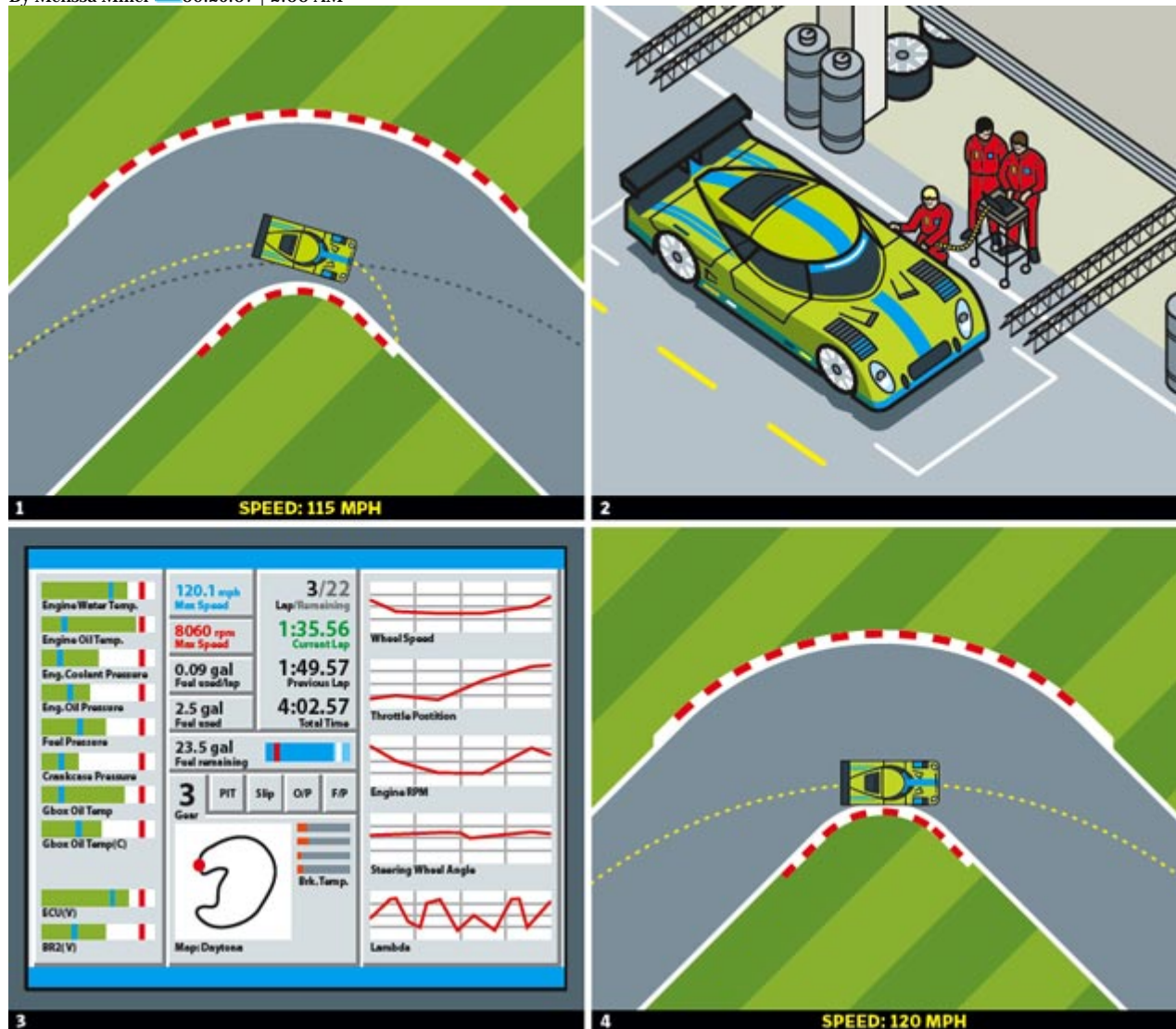
An hour later, the team finishes in eighth place. But there will be other races for Colin Braun. In June, he stepped up to motor sports' major league, signing with a premier Nascar team, Roush Fenway Racing, a perennial contender in the prestigious Nextel Cup series. Nascar is the only major racing organization that prohibits data acquisition during race weekends — but that could be an advantage for Braun. While other drivers might miss the digital connection to their cars, he has learned much of what data logging can teach him — he trusts his own gut more than any digital readout. "I know what I feel," he says. "If that doesn't agree with the data, I don't care what the data says."

Anyway, there's no hurry. He still has plenty of time to become the youngest winner in Nextel Cup history.

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The Racer's Edge

By Melissa Miller 09.25.07 | 2:00 AM



While Colin Braun's car is on the track, 48 sensors measure variables from brake pedal pressure to gear shift lever force. Here's how this system can make the difference between triumph and defeat. **1)** During practice, Braun feels the rear wheels losing traction on a corner, forcing him off the ideal trajectory. He radios a description of the problem to the race engineer and brings the car in for adjustments. **2)** In the pits, the DAG, or data acquisition geek, downloads data the sensors have collected into a laptop. **3)** The driver, engineer, and DAG study the output, combining the data with the driver's subjective description to reduce dozens of possible fixes to the three or four most promising ones. **4)** Lowering the rear by 0.05 inch and decreasing tire pressure by 2 psi improve Braun's path through the corner. Speed through the turn increases by 5 miles per hour, enough to win a race.