QUICK OFF THE STRAW

A team of amateur race car drivers made history in December, powering a pair of Le Mans prototype race cars on cellulose-based E85 in the world's longest road race.

By Tom Bryan

PHOTOS: JIM PARKS AND GREEN ALTERNATIVE MOTORSPORTS


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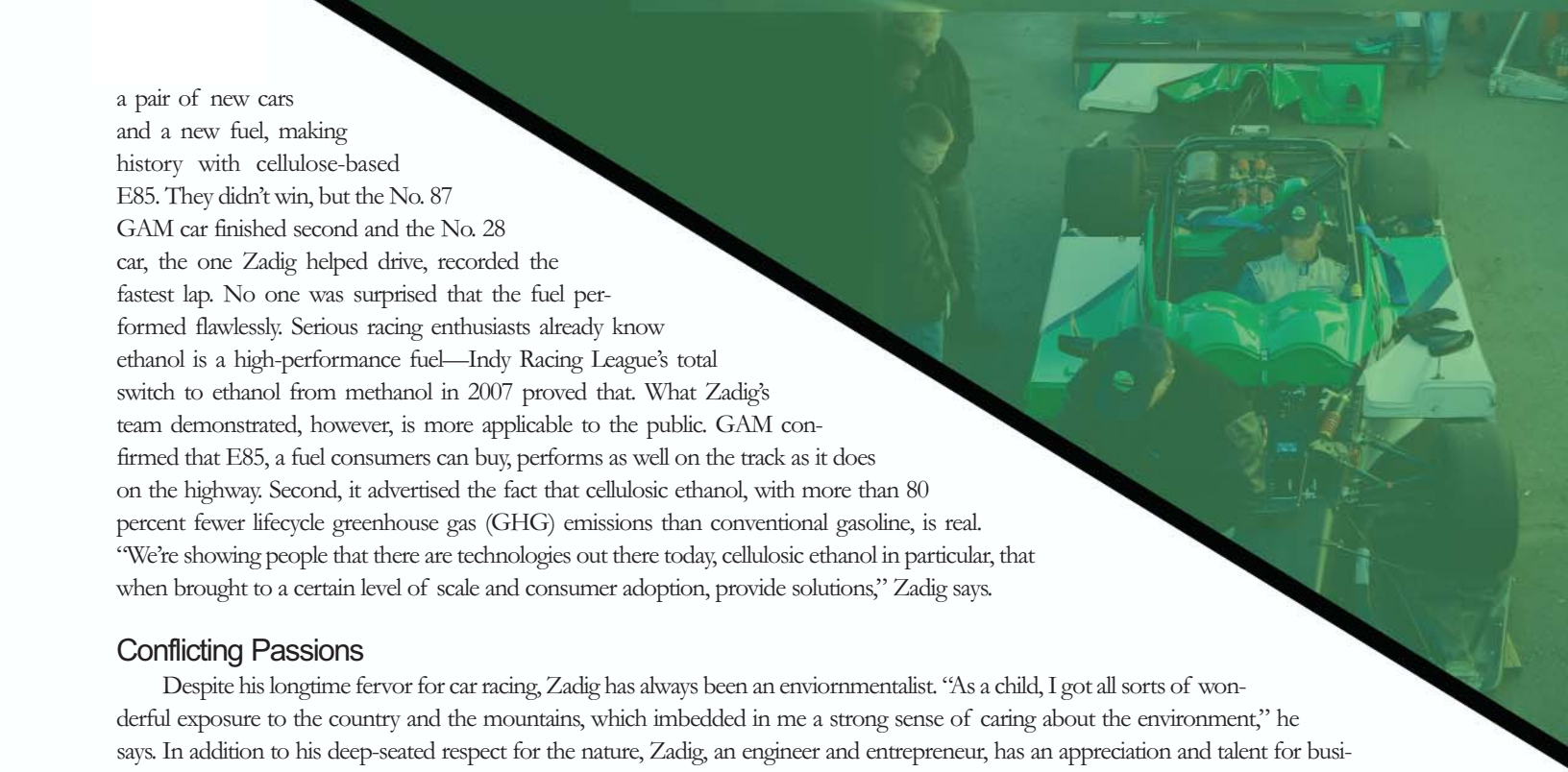
CAR DRIVER

It is 2 a.m., 15 hours into the world's longest auto race and seemingly the most precarious stretch of the 25 Hours of Thunderhill. Some 70 cars zip around an unlit track, exceeding 140 mph at times. The road is imperfect—it's no glass-like European surface—and sporadic bumps and dips send sparks flying, headlights flickering in the California night sky. Surprisingly, the real hazard is yet to come. "When a few hundred drivers who haven't slept in 30 or 40 hours pack up and drive home … now that's scary," quips Steve Zadig, vice president of a Silicon Valley startup and the driver-in-chief behind Green Alternative Motorsports' successful demonstration of cellulose-based E85 in a sanctioned auto race.

Sleep deprivation jokes aside, Zadig and his teammates are now as serious about using E85 as they are about winning races. What's more, they plan to burn cellulose-based E85 whenever possible, and at the 25 Hours of Thunderhill in early December, they did. The endurance race is held each year in Willows, Calif. This year about 70 cars and 280 mostly amateur drivers raced for a title that, by duration if not prestige, trumps even the famed 24 Hours of Le Mans and the Rolex 24 at Daytona. "It's the poor man's version of those races," Zadig says.

In 2006, Zadig's team finished third overall at Thunderhill, running a car with a gas-guzzling rotary motor—a good engine but one that consumed a lot of fuel, Zadig explains. "I liken it to pouring gasoline on an open flame," he says. Zadig and his team returned to Thunderhill this year with a new name,



a pair of new cars and a new fuel, making history with cellulose-based E85. They didn't win, but the No. 87 GAM car finished second and the No. 28 car, the one Zadig helped drive, recorded the fastest lap. No one was surprised that the fuel performed flawlessly. Serious racing enthusiasts already know ethanol is a high-performance fuel—Indy Racing League's total switch to ethanol from methanol in 2007 proved that. What Zadig's team demonstrated, however, is more applicable to the public. GAM confirmed that E85, a fuel consumers can buy, performs as well on the track as it does on the highway. Second, it advertised the fact that cellulosic ethanol, with more than 80 percent fewer lifecycle greenhouse gas (GHG) emissions than conventional gasoline, is real. "We're showing people that there are technologies out there today, cellulosic ethanol in particular, that when brought to a certain level of scale and consumer adoption, provide solutions," Zadig says.

Conflicting Passions

Despite his longtime fervor for car racing, Zadig has always been an enviornmentalist. "As a child, I got all sorts of wonderful exposure to the country and the mountains, which imbedded in me a strong sense of caring about the environment," he says. In addition to his deep-seated respect for the nature, Zadig, an engineer and entrepreneur, has an appreciation and talent for business and invention. He now oversees the global operations for Telegent Systems, a start-up semiconductor company that's bringing mobile TV to cellular phones and portable media devices. "I wouldn't typify myself as someone who is a fanatical environmentalist, but one who sees the need for balance between reducing the human mark on the world and the need to make the economies of it all work," he says.

"Going green" is no flight of fancy for Zaidig. He holds a patent for a wave energy converter for use in offshore and deep-sea locations. So how does Steve Zadig, the entrepreneurial inventor, become Steve Zadig, the environmentally conscious race car driver? As it turns out, he's been interested in racing longer than he's been successful in business. In fact, Zadig dropped out of college in 1970 to pursue racing full time. He planned work principally to finance his need for speed, but ended up in another race: the booming semiconductor business. In the late '70s, he decided to focus on his career and his family. "I stopped racing for the better part of three decades," he says.

Then, in 2001, after guiding a few companies through initial public offerings, Zaidig retired. But he didn't slow down. "I decided to take up the sport of racing again," he says. "It was an unfinished piece of business for me." This time around Zadig got his fix from endurance racing, otherwise known as road racing. "I got hooked on the team aspect of it," he explains. Working with teams is one of his many talents, and it's something he enjoys as much as racing itself. "That's really what I do best," he says. "I build teams. In my professional career it was building teams to develop chips. In this case, it's winning endurance races."

Bear in mind that the type of racing Zadig is involved with is characteristically amateur. These drivers pay to play. With the exception of the world's elite racing leagues—Indy, NASCAR, Formula One, etc.—auto racing is not a sport in which wealth is created, but burned up. "The best

PHOTO: JIM PARKS

Zadig talks to his teammates during the 25 Hours of Thunderhill

way to make a small fortune in racing is to start with a big one," Zadig quips.

By 2005, Zadig set his sights on Thunderhill. He found a good racing partner in businessman and fellow driver Richard Hatfield. They took their purpose-built sports racer, landed the pole position in 2006 and at one point led the 25-hour race. Ultimately, they finished third overall, but it was the highest finish by a sports racer in the event's 10-year history. Zadig was living his dream.

Then guilt set in. Seeing his rotary motor-powered race car refuel a dozen times, burning more than 500 gallons of fuel in 25 hours, didn't sit well. He was torn between his passion for racing and his responsibility to the environment. "My interest in renewable fuels in the context of global warming and greenhouse gas reduction strategies—especially considering my long history as someone interested in environmental issues—placed me in a rather peculiar conflict," he says.

After the 2006 Thunderhill, Zadig told his partner he was through with racing unless he could do it in a more sustainable way. "I didn't feel I could continue racing unless we made a dramatic change and tried to take our success and use it as a vehicle to promote alternatives," he says. That was the start of Zadig's search for a clean, renewable racing fuel.

Finding a New Fuel

In early 2007, with Hatfield's backing, Zadig marched off on a quest to find an alternative fuel that would allow him to indulge in a hobby not typically deemed environmentally sound. He evaluated an array of fuels and technologies, from electric hybrids to hydrogen fuel cells. He considered biodiesel but couldn't get past one major sticking point. Despite great advances, diesel passenger vehicles haven't gained widespread U.S. acceptance. "We wanted to demonstrate a technology with a race car that was applicable to a large number of U.S. consumers," he says. "We just couldn't do that with diesel."

Zadig is quick to point out, however, that diesel-powered race cars are gaining considerable attention in the world of motor sports. For example, diesel-powered vehicles (some running on synthetic diesel and/or biodiesel) are now competing in sanctioned Le Mans events. Unfortunately, Europe's excitement over diesel power continues to get lost in translation with Americans. Meanwhile, the American Le Mans series switched to E10 in 2007 and at the sametime the IRL made a full leap to pure denatured ethanol. The answer was clear. If Zadig wanted to use a fuel Americans could relate to, ethanol was the way to go. He discovered that corn ethanol had about 20 percent fewer lifecycle GHG emissions than gasoline and that cellulosic

Iogen's Cellulosic Ethanol Deliveries

April 2004
First cellulosic ethanol shipment sent to Petro-Canada refinery in Montreal, Quebec, Canada

Summer 2004
Mission Green: 8,700-mile cross-Canada cellulosic ethanol road test. Fueled GMC Yukon with cellulose-based E85

July 2005
G8 Summit in Gleneagles, Scotland: Fueled leaders' vehicles with cellulose-based E5

December 2005
United Nations COP 11 Conference in Montreal, Quebec, Canada: Fueled 12 flex-fuel Chevy Impalas with cellulose-based E85

2004-'06
Fueled fleet of 24 flexible fuel vehicles with cellulose-based E85 for Natural Resources Canada

2004-present
Fueling Iogen's fleet of flexible-fuel vehicles with cellulose-based E85

ethanol—if he could get it—had about 80 percent less GHG emissions than gas. He could run straight denatured ethanol (E98) like Indy was doing, but that lacked the "demonstration" effect he sought because consumers can't get pure ethanol at the pump. What he really needed was cellulose-based E85. "We saw a connection between what consumers could get at the pump, particularly in the Midwest, and what we could use in competition," Zadig says.

Until recently, San Diego, Calif., had the only E85 pump in the state. Now, according to the National Ethanol Vehicle Coalition, California has four public E85 pumps. For Zadig, coupling the consumer applicability of E85 with the environmental benefits of cellulosic ethanol was a win-win prospect. It was no longer if, but how he'd make it happen.

Getting at the Source

Once he decided to use cellulose-based E85, Zadig set out to find it and was swiftly disappointed. "It just wasn't available," he says. "I learned about all of these wonderful things, all of this activity and all of these people proposing to start biorefineries. Then, to my disappointment, I discovered that only one company in all of North America made any amount of cellulosic fuel that a person could even propose to acquire. That's Iogen."

Iogen Corp., one of Canada's leading biotechnology firms and perhaps one of the most well-known players in the global race to commercialize cellulosic ethanol, has operated a demonstration/research and demonstration facility in Ottawa for years. Once in a territory all its own, Iogen is now competing against a hoard of aggressive new entrants to the cellulosic ethanol game. Established corn ethanol giants like Poet LLC, Abengoa BioEnergy and VeraSun Energy Corp. all have ambitious cellulosic ethanol programs, while new players like Range Fuels, BlueFire Ethanol Fuels Inc. and Colusa Biomass Energy Corp. have also entered the fray. Still, Iogen stands as the only company that is able to produce and occasionally deliver significant quantities of ethanol produced from biomass. The company primarily uses wheat and barley straw, but has also experimented with corn stover and other ag residues.

As it were, fortuitous association would eventually connect Zadig with Iogen. One of Zadig's fellow company board members is close friends with the Foody family, which owns Iogen. That allowed Zadig to create a dialogue in the summer of 2007 with Iogen Executive Vice President Jeff Passmore. "I met Jeff and he quickly agreed that Iogen would seriously look at this," Zadig says. "Everything started to fall into place from there."

Passmore was excited about the idea from the get go. "Our reaction was, 'Absolutely. We would be thrilled to provide you with the fuel,'" Passmore says. "Of course, we needed to know the volume. He told us 850 gallons and we said, 'Yes. We can provide that.' Up until then, he had been unable to procure a single gallon from anyone else." With a handshake, the delivery arrangement was set. Iogen would supply what ended up to be 845 gallons of cel-

lulosic ethanol to GAM in time for the 25 Hours of Thunderhill.

For Iogen, supplying the fuel was simple. "We've got that in stock," Passmore says. Transporting the fuel, however, wasn't easy for a company that's not in the distribution business. "When somebody wants to procure fuel from Iogen, we don't have a fleet of trucks to deliver it all over North America," Passmore explains. Zadig called a friend and fellow "car nut" who owns an international shipping and logistics company, JSI Shipping, which helped get the fuel from Ontario to California in accordance with all federal and state regulations. The E99—all fuel ethanol is denatured with 1 percent low-sulfur natural gasoline in Canada—arrived a few weeks before the race with a certificate of analysis that gave GAM the detailed fuel specs it needed for accurate blending. The fuel was made from either wheat and/or barley straw, according to Passmore.

In the months leading up to the 25 Hours of Thunderhill, Zadig was intent on running E85 in its two new imported race cars, identical Le Mans prototypes. Aside from the 845-gallon shipment coming from Iogen for the December race, sourcing cellulose-based fuel for warm-up events was next to impossible. Corn-based E85 would have to suffice.

Zadig could have purchased E85 at the pump, but he wanted to control the blend ratio. He knew that deviations in the blend could potentially change the engine performance. "We wanted to get pure, denatured ethanol and mix our own gas with it," he says. Getting E85 at the pump, even in California, is relatively easy. Sourcing pure, denatured ethanol for custom blending with race-grade gasoline is more challenging. "It never occurred to me that ethanol would be so difficult to get, but it really was," Zadig says. "Finding it was not the problem—it was handling it, meeting all federal and state regulations, management of the fuel vapors … that was the challenge."

Ultimately, Zadig was able get InterState Oil Co., a full-service, multi-line wholesale fuel distributor, to deliver the ethanol he needed. "It took a lot of work, but today I can make a phone call and have any amount of fuel delivered to our shop the next day," he says. With denatured ethanol in hand, Zadig was able to precisely blend the alternative fuel with Sonoco GT-plus racing gas to exacting specifications.

Modifying the Cars

Most racing leagues are governed by sanctioning bodies that endorse and organize events. Whether it's NASCAR or the International Motorsports Association, these groups establish racing venues, write the rules, maintain legal and insurance requirements and essentially govern every aspect of each race. The 25 Hours of Thunderhill is run by the National Auto Sport Association, or NASA (not to be confused with the U.S.

space program). NASA has a series called the Western Endurance Racing Championship—a seven race series with a number of different classes, and the only sanctioned endurance race series on the West Coast. This is the type of race where you'll see modified Mazdas and Hondas running alongside Le Mans prototypes. The endurance sports racing (ESR) class has very few rules related to alternative fuels and drive train capabilities. "You can basically race just about anything you want as long as it meets the safety, sound and maximum fuel load requirements," Zadig says. "Those lax rules tend to attract the fastest vehicles out there."

With financial backing from some of GAM's other drivers, Zadig purchased two $120,000 cars from Norma Auto Concept, a boutique European chassis builder. Both cars are built around an M20 F chassis, a style that has dominated the European amateur endurance racing world for the past half decade. The Norma M20 F normally comes with a 20-gallon fuel tank. "We reconfigured that for E85, which requires about 40 percent more fuel by volume," Zadig says.

PHOTO: JIM PARKS
Each of GAM's race cars were modified for E85, including the installation of slightly larger fuel tanks.

In endurance auto racing, cars are typically designed to carry enough fuel to make fuel stops only every two hours. "The ES and ESR classes are allowed to carry as much as 44 gallons of fuel, so if you're running a big block V8 with 500 to 600 horsepower to carry it around the track, you'll want that much fuel capacity," Zadig says.

On the other hand, the Honda 2.0 liter VTEC engines Zadig's new cars are equipped with (the K-20R motors in these cars are a slightly different version of what's in regular Honda Civics and Accords in the

United States) don't require the maximum fuel tank size. They come standard with 20-gallon tanks. "In a car like ours, where weight is a huge issue, you really want to carry a minimum amount of fuel. So you calculate the smallest possible tank size." However, because E85 has less energy content than gas, it's necessary to carry more fuel to go the same distance volumetrically. So GAM's technicians added larger 28-gallon fuel tanks to the vehicles. "The cars actually lend themselves to adding additional tank capacity," Zadig says. "These are technically two-seater cars, so we were able to fill that passenger area with some additional tank space."

The team also "mapped" the cars' fuel systems and engines to optimize operating ranges for E85. "We went from burning about 9 gallons per hour with the stock setup to a little less than 12 gallons per hour with E85, which gave us more headroom than we expected."

Because the stock engines and components in GAM's cars were basically set up for straight gas or E10, specialists at the Irvine, Calif.-based Automotive Technology Group Inc. made sure everything was E85 compatible. In addition to changing out the fuel tank, they swapped out filters, pumps, and fuel injection rails and injectors. One technician had extensive engine tuning experience and was familiar with ethanol. "That allowed us to plan for and order the proper parts and components so that when the cars arrived from Europe in the middle of September, we pretty much had everything ready to go," Zadig says.

The conversion process was completed at a cost of about $10,000 per car, which included a day of tuning on a chassis dynamometer, a machine primarily used to measure torque, power and emissions characteristics. The conversion from gasoline to ethanol was "flawless," Zadig says. "It went totally perfect. Almost everything else we did to get these cars prepared for racing seemed to have been tormented by issues—vendors sending the wrong pieces and that sort of thing—but the conversion to E85 went perfectly smooth. In fact, we derived about a 12 percent horsepower gain (they expected only a 7 percent gain) and about an 11 percent gain in torque. In racing, any time you get added, unexpected horsepower it puts a smile on your face."

In the run up to Thunderhill, GAM ran one or both cars in three different endurance races, with mixed results. The team ran both cars on E85 in competition for the first time at an event in Monterey, Calif., and led the race before springing a leak and falling back to second overall. A subsequent event in Sonoma, Calif., was less successful but was still valuable preparation for Thunderhill. "None of the problems we had in those races were in any way related to E85 or the motors, but rather getting to know these new cars," Zadig says.

Race Day

When the big day finally arrived, the battle-scarred and tested GAM team was as prepared as they could be. GAM's team, including drivers, mechanics and support crew, was nearly 30 people strong. "You plan and plan and plan … and then you just have to let go when it all starts," says Zadig, a self-confessed control freak.

Zadig says the team came to the 25-hour event with a "degree of trepidation." The favorite going into the race was a team running an expensive Daytona Prototype race car, a world-class vehicle that would normally run in the Rolex Grand-Am series. Setting their nerves aside, the team's managed to turn No. 27 car the second and third fastest laps in qualifying. "We were

The Drivers

Car No. 28:	
1.	Steve Zadig
2.	Richard Hatfield
3.	Dave Allen
4.	Umberto Milletti
Car No. 87:	
1.	Dennis Pavlina
2.	Michael Kantor
3.	Mark Gillies
4.	Nik Johnson

PHOTO: GREEN ALTERNATIVE MOTORSPORTS

More than 70 cars of various styles and classes competed in the 2007 25 Hours of Thunderhill.

pretty pleased about those qualifying times," Zadig says.

The race started at 11 a.m. on Dec. 1 and ended at noon the next day. The No. 87 car managed to stay in second place for almost the entire race, even jumping into the lead for bit. That car eventually "limped" across the finish line in the runner-up position (behind the Daytona Prototype), running the last 50 laps without a nose. "We learned that these cars are really built for smooth European tracks," Zadig says. "Next year, we'll have the cars reengineered for that."

Zadig's No. 27 car also fared well, running third for a while but later encountering electrical problems unrelated to the fuel or the motor. That kept the car sidelined in the pits for more than three hours. The crew got the car back on the track at about 10 p.m. and it performed flawlessly over the next 14 hours. "The motors performed tremendously," Zadig says. "I can't say enough about the E85 and how it performed. The engines were strong from the moment we started to the last lap, and indeed, our lap times [barely increased throughout the race]. That's a testament to E85—not only its power but how good it is on motors."

For drivers like Zadig, endurance races like the 25 Hours of Thunderhill are their Super Bowl. "We all get pretty excited about this," he says. "I was amazed in June of this year when I started communicating with some other teams just how much effort was going into the preparation for this race. Of the 70 teams that entered this year, I would wager that 30 or so are already scheming about next year."

GAM will return to the 25 Hours of Thunderhill in 2008, but it's uncertain if they'll be using cellulose-based fuel. "We'll see," Zadig says, explaining that he's already been in communications with cellulosic players like Georgia-based Range Fuels, which broke ground on a cellulosic ethanol plant in November. However, Zadig would prefer to acquire cellulosic fuel closer to home. California-based BlueFire Ethanol and Colusa Biomass, two promising celluosic ethanol startups, might one day provide him with that option.

In the meantime, GAM will likely burn corn-based E85 and look for ways to promote its mission. "The team is already talking about next year," Zadig says. "We hope we have the opportunity to run cellulose-based E85 because that's where our hearts are, but we'll run corn."

Ultimately, these guys just want to win races without harming the environment. "We took third place in 2006 and second place in 2007. So you know what's next? We've gotta win, right." EP

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