FutureDrive

Volume 4, Number 4 **DOE/Industry Competitions Advancing Automotive Technology** Fall 1998

COMPETITION HIGHLIGHT

FutureCar Challenge Not for Faint of Heart

The Partnership for a New Generation of Vehicles, a 1993 White House initiative, asks commercial automakers to create lean and green "Supercars." These magical machines must get the equivalent of 80 miles per gallon and meet extremely low emissions limits, while remaining comfortable and pleasing to a driver and four passengers.

The FutureCar Challenge asks university students to scale the same heights.

Of course, commercial automakers also have to find ways to mass produce the vehicles and keep them affordable for consumers, something the FutureCar Challenge doesn't expect of its would-be miracle workers. Still, Challenge organizers ask for a lot, and this year they nearly got it.

Lawrence Technological University, which placed third overall in the 1998 FutureCar Challenge, came close to attaining the ambitious fuel-efficiency and emissions goals of the PNGV. Lawrence Tech's parallel-hybrid electric/diesel sedan reached 75 mpg-equivalent, a near miss of the PNGV goal. The University of Wisconsin-Madison, which tied with Virginia Tech for first place overall, tied Lawrence Tech in its fuel economy achievement but didn't fare as well in emissions.

Lawrence Tech's biodiesel fuel (20% soybean derived) yielded emissions so low they almost matched the U.S. Environmental Protection Agency's proposed Tier 2 limits specified by PNGV. But another important feature of Lawrence Tech's technologically superior vehicle suffered: it fell flat in consumer acceptability.

Sometimes you just can't schedule innovation. That's one of many valuable lessons the FutureCar Challenge can teach students, teachers, and sponsors alike each year.

Lawrence Tech team advisor Craig Hoff agreed that the car's supereffficient gear train, a hydraulically actuated manual transmission that shifts automatically, is not yet user-friendly. (A shift in gears can take as long as 10 seconds.) Fortunately, Hoff received some expert ideas for fixing this problem when he presented the concept to the 1998 Global Powertrain Congress in October.

Many believe the FutureCar Challenge is the nation's most difficult student vehicle competition. Hoff recounts that a chief engineer for Ford who recently joined the Lawrence Tech engineering faculty was amazed at the scope of what the students had attempted and, more importantly, what they accomplished.

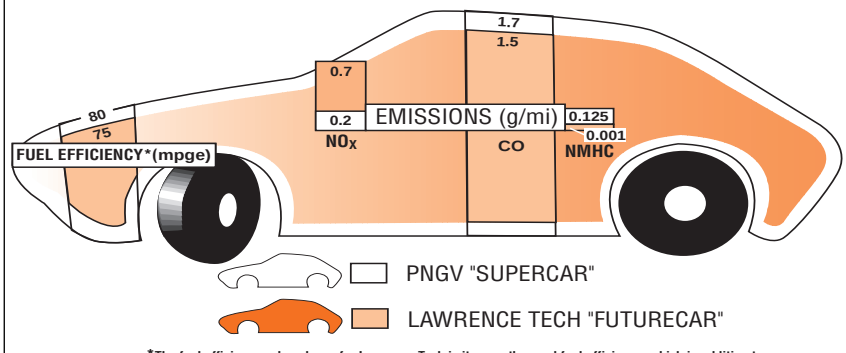
"We're asking these kids to knock on the door of the PNGV goals," said Challenge Director Bob Larsen. "That's a lot to do in one year."

Texas Tech, which entered the FutureCar Challenge for the first time this year, pronounced it the most challenging vehicle contest in its experience. "The emphasis on fuel economy really changes the way you approach the problem," said faculty advisor Michael Parten.

The first task of a newly formed student team is to select the powertrain, engine, and fuel combination that it believes can win. 1998 saw seven parallel hybrid powertrains, five series hybrid, and a unique

(continued on page 4)

The 1998 FutureCar Challenge saw Lawrence Technological University close in on the emissions and fuel efficiency goals of the Partnership for a New Generation of Vehicles.



*The fuel efficiency value shown for Lawrence Tech is its over-the-road fuel efficiency, which in addition to nearly reaching the PNGV dynamometer-based goal, is more than twice the over-the-road fuel efficiency recorded by the gasoline-powered Lumina that served as a control vehicle for this year's FutureCar Challenge.

IN THIS ISSUE

FUTUREDRIVE
Volume 4, Number 4, Fall 1998

Purpose
To inform sponsors, participants, organizers, volunteers, and others interested in DOE-sponsored student vehicle competitions of the plans for and results of the competitions.

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Printed on Recycled Paper

Announcing 1999-2000 GATE Winners

Student vehicle competitions like the FutureCar Challenge and the Ethanol Vehicle Challenge have served as springboards for several new U.S. Department of Energy initiatives. GATE—the Graduate Automotive Technology Education program—is the latest such initiative.

GATE helps universities establish graduate programs in one of five critical multidisciplinary automotive technology areas. These areas are fuel cells, direct-injection engines, lightweight materials, hybrid electric vehicle drivetrains and control systems, and advanced energy storage.

The universities we've selected to establish GATE Centers in the 1999-2000 academic year are:

Fuel cells:	University of California, Davis Virginia Tech
Direct-injection engines:	Michigan Technological University
Lightweight materials:	University of Michigan-Dearborn
Hybrid electric vehicle drivetrains and control systems:	University of Maryland University of Tennessee West Virginia University Ohio State University University of California, Davis
Advanced energy storage:	The Pennsylvania State University

DOE awards grants of $200,000 to establish a focused graduate program with a series of courses and laboratory work at each selected university. Another $100,000 per year is available to each school for fellowships. Participating universities are expected to have already established a successful track record in advanced automotive technology. They must also show industry participation, because the automotive industry is the ultimate beneficiary of GATE.

For more information on GATE, visit our web site at: www.ipd.anl.gov:80/gate/.

Shelley Launey

Manager, Small Business and University Programs, DOE Office of Transportation Technologies

CORRECTION

In the list of 1998 FutureCar Challenge winners on page 6 of the Summer 1998 issue of FutureDrive, we erroneously showed the University of Wisconsin-Madison as placing second overall. In fact, UW-Madison tied for first place. The correct FutureCar results are:

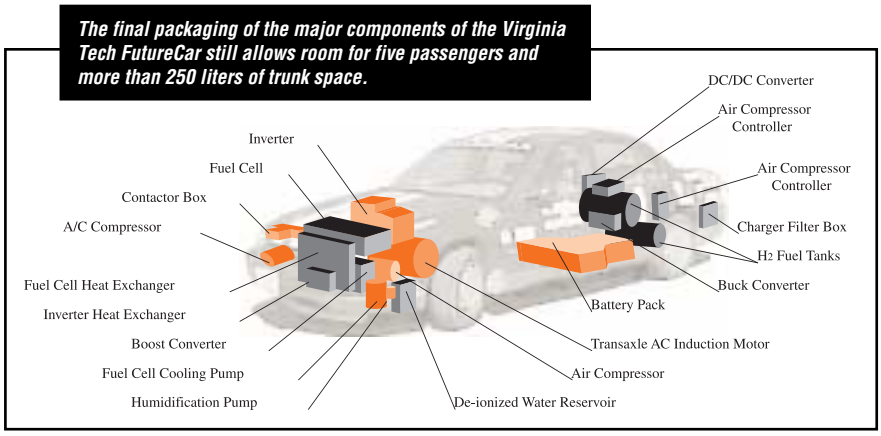
1st Place (Tie)	Virginia Tech
	Univ. of Wisconsin-Madison
3rd Place	Lawrence Tech
4th Place	Michigan Tech
5th Place	Univ. of Maryland
6th Place	Concordia Univ.

FutureDrive regrets the error.

Fuel Cells at FutureCar: Well Begun Is Half Done

Two teams left the 1998 FutureCar Challenge with "unfinished business." These two teams, Texas Tech University and Virginia Tech, built cars that were ready for fuel cells.

But in April—with the competition less than 2 months away—they learned the fuel cells wouldn't be ready (the schools have since received them). The two prototype proton-exchange membrane (PEM) fuel cells were the first of their kind, and the company making them, Energy Partners, Inc., needed to thoroughly test them.



The final packaging of the major components of the Virginia Tech FutureCar still allows room for five passengers and more than 250 liters of trunk space.

The teams committed to build a fuel cell vehicle in a year. Although they suspected the year would stretch to two, everyone adopted a very aggressive schedule, shooting for the 1998 competition.

It was an especially bold challenge because it meant firsts for everyone involved. For instance, Energy Partners had built fuel stacks for small utility vehicles, but nothing approaching the 20-kW units it was building for the FutureCars.

The company faced two lengthy tasks: building the stack, and testing it. A "short stack" of 10 cells was built first for endurance testing. To pass, the test stack had to operate for 200 hours. That took a large chunk of testing time because durability tests had to be alternated with other performance tests. To get some continuous testing time, the research staff put in many all-nighters. (They've since upgraded to automatic, continuous testing.)

The stack was also tested for operating pressure. "This parameter is particularly important for fuel cell cars," explains Mike Ogburn, team leader for Virginia Tech. "The standard air pressure for PEM stacks is 30 psig, but to get 30 psig consumes most of the fuel cell energy output to run the onboard air compressor," Ogburn said. "The parasitic loss factor is very high." At 20 psig the losses are lower. Energy Partners found that the stack was still within its rated performance at 20 psig, so the students will be able to run their cars at the lower pressure and still have good net power.

An Energy Partners' PEM short stack with this design has now run for 1,200 hours at 75% power, a marathon in the world of fuel cells. The test stack also provides a current density of 0.63 W/cm^2, possibly the highest of any prototype PEM stack today.

In the meantime, faced with empty space instead of a fuel cell, Texas Tech scrambled to cope with its own first. The Chevy Lumina it converted was its first electric vehicle. Despite the beginner's bumps (such as wiring problems that forced them to compete with one instead of two electric motors), team advisor Michael Parten is glad the team decided to go the fuel-cell route. "Fuel cells definitely have real possibilities for the future," he says. "Even though we knew it was going to be difficult, we'd do it again."

For Virginia Tech, first was foremost: remarkably, the school tied for first place with a team whose members were all new to the FutureCar Challenge, and a car built around a fuel cell that wasn't there. "We went with a drivetrain we were familiar with," Ogburn said. "Just about the only thing missing was the fuel cell itself, and a little plumbing."

Ogburn believes that this year's FutureCar Challenge wasn't a full test of the new technologies: "A lot of the teams started with new cars and didn't have things quite together yet. The competition next year is going to be a lot more fierce."

Jane Andrew

Secretary of Energy Bill Richardson drove the University of Wisconsin's 1998 FutureCar to the dedication of Argonne National Laboratory's Transportation Technology R&D Center.

(continued from page 1)

dual-series/parallel-hybrid configuration from the University of Tennessee. Battery operation was augmented with fuels that included diesel, biodiesel, compressed natural gas, reformulated gasoline, and ethanol.

The teams must then convince a DOE selection committee with an articulate and technically sound project proposal. The reward is $10,000 in seed money and a family-sized sedan with which to work.

Rigorous project control during subsequent months of design and production is imperative to success, learned Jeff Hodgson, advisor to the University of Tennessee team (also first-time participants). "We weren't aware of how far behind some of our groups were," he said. "We're adding some project controls for 1999."

David Hickel of Western Washington University, a veteran of student competitions who worked for Argonne National Laboratory at the 1998 FutureCar Challenge, urged teams to "play smart" with their limited preparation time. Hickel recalled his 1997 Propane Challenge experience, when his team had to choose between spending time on improving range or lowering emissions. Emissions was worth double the points that range was, so the team focused on emissions.

Strategic planning joins engineering design, project management, and proposal writing as an important skill that competitions like the FutureCar Challenge help students to learn. And like many lessons in life, they don't always come easy.

Cathy Kaicher

FUTURECAR 2000 NOTICE OF INTEREST

To be considered for participation in FutureCar 2000, schools must submit written proposals to a DOE selection committee by April 2, 1999. Proposals must follow the format stipulated in the FutureCar2000 Request for Proposal. To obtain a Request for Proposal, contact Argonne National Laboratory at (630)252-3175 or visit the Student Vehicle Competitions web site via www.transportation.anl.gov/ttrdc/research.

SPONSOR PROFILE

GM's Role in Student Competitions to "Pick Up" in 1999

The 1999 Chevrolet Silverado

Once again next spring, General Motors will be a primary sponsor of the Ethanol Vehicle Challenge. In addition to making available its Milford Proving Ground for competition testing, the GM Truck Group is donating 14 of its newest full-sized pickup truck, the 1999 Chevrolet Silverado.

About 200 students from 14 colleges and universities in the U.S. and Canada will convert the trucks to run on E85, a blend of 85% denatured ethanol and 15% gasoline-like hydrocarbon primer. The goal is to improve fuel economy and lower emissions while maintaining performance and consumer acceptability. According to Tom Stephens, GM vice president and group director of engineering for the GM Truck Group, the pickups "will offer challenges to the student teams and an exciting platform on which to highlight their technological skills."

The Silverado, created to replace the Chevy C/K pickup, is bigger than its predecessor, with a larger cab, more storage room, and a more functional cargo box. It also offers improved fuel economy, lower emissions, and more horsepower and torque for faster acceleration. All models come standard with a four-wheel disc/four-wheel antilock braking system.

GM is no newcomer to alternative-fuel vehicle competitions. The company has been a main sponsor of the Sunrayces and supplied the vehicles for DOE's earlier Methanol and Natural Gas Challenges. With Ford and Chrysler, it has supplied cars and seed money for the FutureCar Challenges. In 1997, GM provided 14 Chevrolet Malibus for the first Ethanol Vehicle Challenge, which was also held at Milford Proving Ground. And plans are in the works for GM to host a new international student competition—the 2000 SAE International EcoCar Competition—at Milford as well.

Sometimes the information gathered at these competitions is used to upgrade equipment and bring cutting-edge technologies closer to consumers' driveways. During testing at the 1998 Ethanol Vehicle Challenge in May, GM evaluated a real-time diagnostic instrument that could reduce the cost of emissions testing for alcohol-fueled vehicles. (Currently emissions are collected over time in a bubbler and analyzed later.)

However, a main benefit of the competitions is that they support GM's ongoing alternative-fuel vehicle research, design, and development. "It is GM's quest to improve the environmental performance of practical vehicles that appeal to our customers' needs and expectations," Stephens said.

GM received the latest Clean Cities "National Partner" award from DOE in recognition of its leadership in developing and marketing advanced-technology vehicles. Over the past 10 years, GM has offered vehicles fueled by ethanol, methanol, electricity, natural gas, and propane. The company is also involved in R&D on hybrid vehicles, fuel cells, advanced battery technology, and direct-injection turbo diesel engines.

Marita Moniger

Win-Win at WEC: FutureCar Gets International Exposure at World Energy Congress

Attendees at the 17th Congress of the World Energy Council (WEC) in Houston this September were treated to a vision of the future in transportation at an exhibit hosted by the U.S. Department of Energy. WEC delegates inspected the top three cars from DOE's 1998 FutureCar Challenge and talked to student members of the winning teams. The students—from the University of Wisconsin at Madison, Virginia Tech, and Lawrence Tech in Michigan—were able to polish their presentation skills by discussing their vehicles with delegates from as far away as Russia and the Far East, some of whom found a hybrid-electric vehicle a totally new concept.

Most of the WEC delegates were not from the transportation industry and were very curious about the FutureCar vehicles. They were able to see the cars in acceleration runs and a 150-meter drag race, designed to show that the cars of the future could be energy efficient without sacrificing acceleration, performance, or speed.

Members of the University of Wisconsin team wearing the Texas cowboy hats they were given for winning a drag race at the WEC in Houston. Their modified prototype aluminum Mercury Sable weighed just 2,976 pounds; a stock Sable weighs more than 3,300 pounds.

"Where else would an Arabian prince jokingly ask, 'Is this the car that's going to put me out of business?'"

Nick Brancik, an advisor of the Lawrence Tech team (represented at WEC by students Tony Grabowski, Gary Madar, and John Michelini, faculty member Craig Hoff, and "ED," a hybrid-electric/diesel car), was exuberant about the team's experience at the event. "With 47 heads of state in attendance, a keynote address by former President George Bush, and a spectacular 3-hour opening ceremony, we felt honored to be a part of it all," he said.

Michael Koplin, student leader of the UW team (joined by Neel Vasavada, Jonathan Butcher, Bich Ty-Le, Michael Christophersen, faculty advisor Glenn Bower, and the hybrid-electric/diesel vehicle "Aluminum Cow"), also found the WEC to be "a great opportunity, especially culturally." He enjoyed talking to a distinguished audience of ambassadors and policymakers and was delighted to have the chance to take Shell's vice president of product development out for a spin. Koplin said that the DOE exhibit seemed to be one of the more popular ones at WEC, perhaps because it "actually had something tangible, not just conceptual, to offer."

UW team advisor Bower commented that "everyone was interested in acceleration." He noted that the response of the Europeans in attendance contrasted with that of Americans, because about half of the German, French, and British populations own diesel vehicles. These drivers wondered whether a hybrid vehicle would offer them any advantages and spent their time comparing information on engine size and fuel economy.

"Animul," the series hybrid-electric vehicle designed by the Virginia Tech team (represented at WEC by students Mike Ogburn, Andy Pogany, Steve Gurski, and Jason Hutchinson and team advisor Doug Nelson), attracted a lot of attention, being a slightly different beast than the other two cars. The converted Lumina can be powered by batteries or a fuel cell.

Team leader Ogburn found WEC to be "one of the most amazing trade shows we ever attended, and the exposure it afforded our vehicle was one-of-a-kind—like nothing we could have duplicated on our own." He was struck by the number of "older" CEOs and business leaders who actively sought out students because they wanted the opinions of the "new generation, not the old guard, on what the future of energy would be."

And where else, Ogburn pointed out, would a member of the Belgian consulate ask a student to speak at a cocktail reception, or an Arabian prince jokingly ask, "Is this the car that's going to put me out of business?"

Marita Moniger

FUTUREDRIVE IS ON THE WEB

Current and back issues of FutureDrive are available on the World Wide Web at www.ipd.anl.gov:80/ttrdc/publications/futuredrive/futuredrive.html.

Alternative Fuel Competitions Give Students an Edge in Job Market

The experience gained by engineering graduates who participated in the FutureCar Challenge and other vehicle competitions in college gives them an edge in the job market, according to one midwestern job recruiter. His observations were echoed by a recent graduate now working for the nation's largest auto manufacturer.

"Students coming out of the FutureCar competitions and similar 'hands-on' alternative fuels programs are the best. Companies grab them up," said John Rockenstein, a recruiter with Management Recruiters of Cincinnati, Ohio.

Rockenstein works nationally placing professionals in the capital equipment industry. He specializes in filling job searches in the industrial engine business. "The graduates with FutureCar experience are a step above those coming out of traditional college engineering programs," he said.

"Whether it's because these competitions attract better students, or develop them, I am not sure. I have seen significant evidence of both," the recruiter said.

Rockenstein observed that during his nearly 10 years as a recruiter to the engine industry, "My client companies have recognized one common college activity as significant on a candidate resume—participation in a vehicle challenge."

Recent statistics from a U.S. Department of Energy survey seem to bear him out. That survey found that 64% of the graduating students who participated in the 1998 Ethanol Vehicle Challenge accepted jobs in the auto industry.

The experience of William Spencer Wheat, a spring graduate of the Advanced Vehicle Engineering master's program at Texas Tech University and a vehicle competitions veteran, also confirms Rockenstein's observations. In Wheat's last year of school, a General Motors official sought him out because of his competition experience and offered to interview him for a job. For about 6 months Wheat has been working at GM's Global Alternative Propulsion Center in Rochester, New York. Wheat said there will soon be three people working at the center who were involved in vehicle competitions while in college.

Recent statistics from DOE show that 64% of the graduating students who participated in the 1998 Ethanol Vehicle Challenge accepted jobs in the auto industry.

According to Rockenstein, competitions such as those sponsored by DOE's Office of Transportation Technologies in partnership with the vehicle industry help students in many ways.

"Students who have participated in these competitions are more organized, better communicators, and excellent team players. They present themselves more confidently when interviewing, and in general have a better fundamental and technical understanding of vehicle powerplants," Rockenstein explained. He added that these competitions help develop maturity and teach discipline, team cooperation, planning, innovation and problem solving, skills needed for success in the real world.

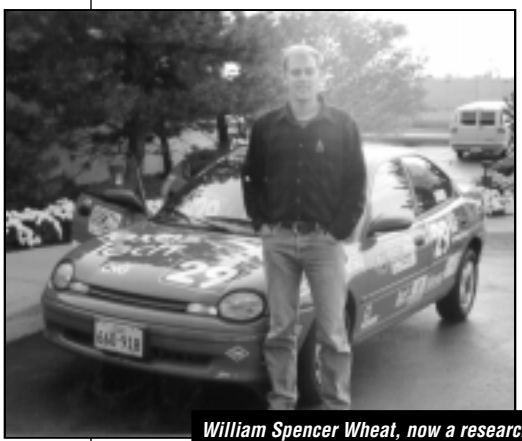
Wheat said that his experiences with college auto competitions taught him teamwork that has been invaluable in his job with GM. And he finds the contacts he made are still useful to him in his job. "It was not only what I was learning, but who I was meeting at the competitions that I have found to be of tremendous importance," Wheat said.

Rockenstein believes that by participating in vehicle challenges, students are forced to begin looking not only at their own special interests, but also at the "big picture."

"At first, they may be interested in only one aspect of the job, but they cannot do their work in a vacuum," he said. In order to solve a single problem, the student finds that it is necessary to understand what other members of the team are doing and figure out how the various components are interrelated in order for the whole project to be successful.

And that is a lesson that can help students later in work—and in life.

John DePue



William Spencer Wheat, now a researcher with GM, still relies on contacts he made while a student at vehicle competitions.

Ethanol Vehicle Challenge
GM Milford Proving Ground, MI
May 18-26

Sponsored by DOE, GM, and Natural Resources Canada. Fourteen teams of college students from the U.S. and Canada will convert 1999 Chevrolet Silverados to run on E-85 fuel. The goal is to improve fuel economy, lower exhaust emissions, and provide excellent cold-startability while maintaining performance and drivability.

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  E-mail: cmcfadden@anl.gov
- Web site: www.transportation.anl.gov/ttrdc/research

FutureCar Challenge
Oakland Community College
Auburn Hills, MI
June 2-10

Annual competition sponsored by DOE and USCAR (representing DaimlerChrysler, Ford, and GM) gives students from more than a dozen universities the opportunity to convert a Dodge Intrepid, Chevrolet Lumina, or aluminum-bodied Ford Taurus into a "future car" with up to three times the fuel efficiency and the same performance, utility, safety, and affordability as today's vehicles. Students select advanced technologies and varying fuels for meeting the goals of 80-mpg-equivalent and low emissions.

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- Web site: www.transportation.anl.gov/ttrdc/research

Sunrayce 99
Washington, DC to Orlando, FL
June 20-29

Teams from 40 colleges design, build, and race solar-powered cars in this event sponsored by GM, DOE, and EDS. The goal is to develop highly efficient, electrically powered vehicles that are fueled by the sun—and to travel a 1,340-mile route in the shortest time. Key factors include driver safety, vehicle weight and durability, efficiency of components, aerodynamics, rolling resistance, and energy recovery and storage systems.

- *Contact:*
  Sunrayce Headquarters
  730 Peachtree St. NE, Suite 876
  Atlanta, GA 30308
  Phone: (800) 606-8881
  E-mail: headqter@Sunrayce.gmr.com
- Web site: www.sunrayce.com

11th Annual NESEA American Tour de Sol
Waterbury, CT to Lake George, NY
May 22-28

Road rally for electric, hybrid electric, or solar-assisted electric sedans, utility vehicles, mass transit vehicles, and motorcycles. Free public events featured in communities along the way. Open to a fixed number of manufacturers, students, or hobbyists. Principal sponsors are NESEA and DOE.

- *Contact:*
  Nancy Hazard
  Northeast Sustainable Energy Assoc.
  50 Miles St.
  Greenfield, MA 01301
  Phone: (413) 774-6051, ext. 18
  E-mail: NHazard@nesea.org
- Web site: www.nesea.org

Junior Solar Sprints

DOE program open to 6th, 7th, and 8th graders. Participants obtain a photovoltaic panel and motor and must design and build a model vehicle that will compete in a 20-meter, wire-guided race. Regional competitions are held in 26 states and Washington, DC. Start your own regional competition!

- *Contact:*
  Linda Lung
  Manager of Education Programs
  National Renewable Energy Lab.
  1617 Cole Blvd.
  Golden, CO 80401
  Phone: (800) 639-3649
  E-mail: linda_lung@nrel.gov
- Web site: www.nrel.gov/business/education/SprintWeb/

Formula SAE
Silverdome, Pontiac, MI
May 19-23

College students design and build formula-style racing cars. Restrictions are placed on the car frame

(continued)

(continued from page 7)

and engine to test participants' creativity. Four-cycle engines up to 610 cc can be turbocharged or supercharged. Cars are judged on static inspection and engineering design, solo performance trials, and track endurance and compete in two classes: gasoline and methanol. Sponsored by the Society for Automotive Engineers, USCAR, and DOE.

- *Contact:*
  Anthony Androsky
  SAE Collegiate Design Series
  SAE International
  400 Commonwealth Dr.
  Warrendale, PA 15096
  Phone: (724) 772-8535
  E-mail: androsky@sae.org
- Web site: www.SAE.org/STUDENTS/formula.htm

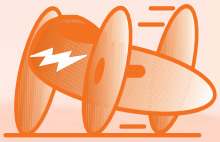
SAE Supermileage

Eaton Proving Grounds, Marshall, MI
June 11-12

University teams develop and build a single-person vehicle with the goal of setting a world fuel economy record. Sponsored by the Society for Automotive Engineers and Briggs & Stratton.

- *Contact:*
  Fred Kinney
  Transmission Division
  Eaton Corporation
  Kalamazoo, MI
  Phone: (616) 342-3314
  E-mail: fredriclkinney@eaton.com
- Web site: www.SAE.org/STUDENTS/supermw.htm

Electrathon Competitions



High school students build lightweight vehicles powered by lead-acid batteries. The winner travels the farthest in 1 hour. Sponsored by various regional and local organizations, Electrathon rallies are held throughout the U.S. A national event is also held:

1999 Pentad U.S. National Electrathon Championship
Southern California
April 16-18

- *Contacts for all events:*
  Gary Raymond
  Box 1722
  Thousand Oaks, CA 91358
  Phone: (805) 492-5858
  glraymond@earthlink.net

  Electrathon America
  1251 W. Sepulveda Blvd.
  Torrance, CA 90502
  electra@aol.com
- Web site: electrathonamerica.org/

EVTC

EVTC Events

Electric Vehicle Technology Competitions, Ltd., sponsors various electric vehicle competitions for high school and university students each year, including the ABB University Spec Series and Formula E.

- *Contact:*
  Mike Shaw
  Electric Vehicle Technology
  401 S. 2nd Ave.
  Phoenix, AZ 85003
  Phone: (602) 256-2599
  E-mail: info@evrace.com
- Web site: www.evrace.com

To learn more about these and other student vehicle competitions, visit the DOE Office of Transportation Technologies web site at www.ott.doe.gov/student.html.

FutureDrive
DOE/Industry Competitions
Advancing Automotive Technology

98 Silver Award
ANNUAL AWARDS COMPETITION
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