FutureDrive

Volume 5, Number 1 DOE/Industry Competitions Advancing Automotive Technology Spring 1999

TECHNICAL FEATURE

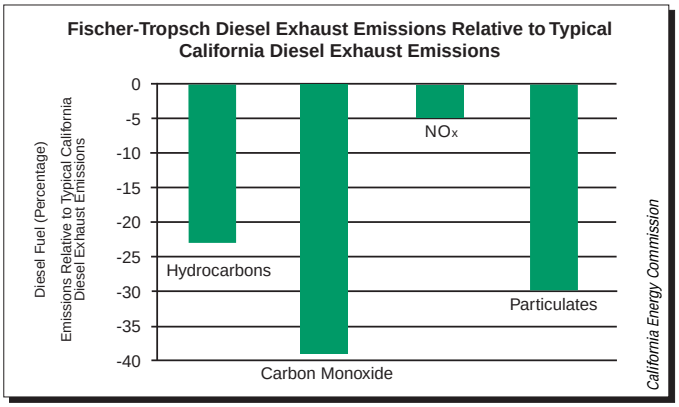
Real Success with Synthetic Diesel Fuels

Two FutureCar 1999 competitors are set to show the feasibility of running diesel engines on low-emission liquid fuels synthesized from natural gas.

Because synthetic diesel fuels are simpler in composition (having only straight-chain hydrocarbons) and contain no sulfur, they burn much more cleanly than conventional diesel. More importantly, they produce far less particulates, a major diesel pollutant recently identified as carcinogenic.

Concordia University in Montreal will be using dimethyl ether(DME), most often used as an industrial solvent, in the Dodge Intrepid they've modified to house a 1.9-L Volkswagen turbo direct-injection engine. The University of Wisconsin-Madison will be running its Mercury Sable on "Fischer-Tropsch" diesel in a 1.8-L Lynx turbo direct-injection engine from Ford. This engine went into production in January 1999 for sale in Europe.

Dimethyl ether (CH_3-O-CH_3) is capable of lowering emissions from diesel engines to the California ULEV (ultra-low emission vehicle) standard. Smoke is almost eliminated, and emissions of nitrogen oxides are very low. DME behaves much like propane and requires a pressure of 5 bars to remain liquid at room temperature. The cetane number of DME (a measure of ignitability) is 55–60, or up to 20% better than modern diesel fuels. This property makes DME a good fuel for direct-injection engines.



Because DME must be pressurized, the Concordia team must design a whole new fuel delivery system, from the storage tanks to pumps to a radical new injector system. "It was a big problem to find pumps and valves that wouldn't heat up or leak," says team advisor Henry Hong, "because DME's viscosity is 10 times less than diesel's." They located appropriate, though expensive, equipment through the aircraft industry.

Concordia's main innovation is the injector system. Instead of the injector needle opening due to a pressure differential, as in a conventional injector system, it is opened by the electromagnetic force from a solenoid. Because DME is a vapor at atmospheric conditions, high pressure is not required for fuel atomization and vaporization. Thus, the liquid DME can be injected at a pressure of about 200 bars, rather than the 2,000 bars needed for conventional diesel fuel, and it will still vaporize adequately. The resulting lower injection temperatures limit the formation of nitrogen oxides.

In addition to fabricating the injectors, the team is developing the complex electronic switching circuitry and microprocessors to link the cycling of the solenoids to the demands for power. For example, to open the injector needle as quickly as possible (to be comparable to conventional diesel opening speeds), a new electronic solenoid driving circuit had to be designed.

"ULEV is what we're shooting for. I don't think we're that far off."

Glenn Bower, University of Wisconsin-Madison Team Advisor

"Nobody's ever done this," Hong claims. "We might be the first in North America to have a working DME vehicle."

The Wisconsin team hasn't ventured quite as far out on the fuel technology limb. Fischer-Tropsch fuel behaves very much like diesel,

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FUTUREDRIVE (ISSN 1523-2727)
Volume 5, Number 1, Spring 1999

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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New Competitions for a New Millenium

FutureCar 2000 and EcoCar 2000

1999 marks the fourth and final year of the FutureCar Challenge. The FutureCar Challenge was conceived to parallel the technology development path of the Partnership for a New Generation of Vehicles (PNGV). Since then, many advances in propulsion technologies have occurred, and PNGV has made its technology down-selects. The path to ultra-efficient vehicles is much clearer now, yet great challenges remain. New "super-ultra-low" emissions standards loom as formidable barriers to implementing new engine and fuel technologies. At the same time, advances in energy storage and fuel cells hold much promise for the future.

FutureCar 2000 is the DOE-sponsored successor to the FutureCar Challenge. No longer linked to PNGV, FutureCar 2000 is a completely new competition that wipes the slate clean and introduces new vehicle platforms. FutureCar 2000 is founded to parallel another new competition, EcoCar 2000. The top-finishing schools from FutureCar 2000 will earn invitations and financial support to participate in EcoCar 2000, representing North America in the first running of this major new international high-efficiency, low-emissions vehicle competition. FutureCars that compete in the EcoCar Challenge, however, must operate on gasoline or diesel; if they are hybrids, they must be charge sustaining.

Organized and managed by the Society of Automotive Engineers International, EcoCar 2000 is a biennial competition that rotates between North America, Europe, and Asia. Teams of college-level engineering students compete against their vehicles' own baselines, seeking the greatest percentage improvement as their measure of success.

FutureCar 2000 is a worthy successor to the FutureCar Challenge and opens a new chapter in advanced vehicle technology competitions. More information about submitting a proposal for acceptance into FutureCar 2000 can be found in the Request for Proposal, available through the contact given at the bottom of this page. I encourage every eligible school with an interest in participating in FutureCar 2000 to submit a proposal by April 2. For more information on EcoCar 2000, contact Bob Sechler at sechlr@sae.org.

With these new competitions leading the way, the new millennium will bring better and even more challenging vehicle competitions—something we can all look forward to!

Bob Larsen

Robert L. Larsen
Manager of Fuels and Vehicle Systems
Argonne National Laboratory

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 FutureCar 2000 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.

Formula Teams Show M85 Can Go Wheel-to-Wheel with Gasoline—And Win

The University of Akron began fueling its Formula SAE entries with M85 in 1990 for the extra prize money. Since then, Akron has supplemented its competition budget with a good portion of these special funds provided by the U.S. Department of Energy.

For the University of Texas at Arlington, it was the vision that an 85% methanol fuel could actually boost the performance of a formula-style race car. Besides, after winning or placing in nearly every Formula SAE since the competition began in 1981, the perennial powerhouse (along with the Rochester Institute of Technology and Cornell University) was ready for a new challenge.

These schools are two of the 14 entrants that ran their cars on M85 in the 1998 Formula SAE, a popular competition sponsored by USCAR, DOE, and many private companies.

"M85 lets us get more power out of a smaller engine than gasoline does," says UTA faculty advisor Bob Woods. UTA began using a 400-cc engine fueled with M85 in the 1995 Formula SAE and took first place with it. Most schools use a 600-cc engine.

The University of Texas at Arlington's past Formula SAE vehicles gather for a reunion

"Because M85 absorbs a lot of heat when it vaporizes, it cools the air around it," Woods explains. We can turbocharge without the need for an intercooler, which makes our car cheaper and lighter and better-performing over short distances because we're not losing air pressure to the engine."

Given the competition's intake restriction (20 mm for gasoline-fueled cars and 18 mm for M85-fueled cars), UTA knew that it could achieve almost the same power with a 400-cc engine as the gasoline schools would with a 600-cc engine, while gaining points in the fuel economy, weight, and cost categories. Turbocharging easily made up the power difference, to the point where UTA entered an even smaller engine (250 cc) in the 1998 competition and came in second overall.

In 1997 UTA placed first in both endurance and fuel economy among M85-fueled cars. "Usually the two are at odds because the winner of the endurance tends to burn a lot of fuel," Woods notes. "Our smaller engine was the reason we could do both."

But don't think you can simply copy its engine size and fuel type and get the same results that UTA does, warns team manager Steve Gillespie. "We know the reasons behind what we do," Gillespie says. "Our technical specifications are public information, but our engineering strategy isn't always."

Both UTA and Akron say they rely on solid engineering principles, eschewing the gee whiz. "The Formula SAE is meant to be training for the real world, for the marketplace," says Gillespie. "We want our cars clean, simple, and well built," echoes Akron team captain Andy Vrenko. "If there's too much technical wizardry, the car won't be easy to maintain for the weekend autocross racer."

The relative newcomer, the University of Akron has adopted a strategy of simplicity that has paid off. Akron placed third overall in 1998 without turbocharging. Faculty advisor Richard Gross says he encourages his team to concentrate on reliability first.

"It would probably take a couple of years for us to develop and implement a reliable turbocharging system," Gross says. "A couple of more horsepower is not worth the loss of reliability we might face if we prematurely added turbocharging to the mix. Turbocharging gives better acceleration, but we can make it up with adjustments to our suspension, car weight, and driver control."

(continued on page 6)

Formula SAE Winners Since 1995
M85 Vehicles in Green

		Total Points
1998	1 Cornell University	924.62
	2 University of Texas, Arlington	887.02
	3 University of Akron	804.45
	4 University of Missouri, Rolla	768.04
	5 Rochester Institute of Technology	757.16
1997	1 Cornell University	847.38
	2 University of Texas, Arlington	829.66
	3 Rochester Institute of Technology	799.19
	4 University of Cincinnati	795.42
	5 University of Akron	757.21
1996	1 University of Texas, Arlington	887.51
	2 Rochester Institute of Technology	787.40
	3 Ecole de technologie superieure	764.90
	4 Cornell University	707.33
	5 Virginia Tech	705.61
1995	1 University of Texas, Arlington	859.37
	2 Rochester Institute of Technology	855.81
	3 Cornell University	845.05
	4 Western Washington University	818.94
	5 University of Michigan, Ann Arbor	807.08

Formula SAE Scoring

75	Presentation
150	Engineering Design
100	Cost Analysis
75	Acceleration
50	Skid-Pad Event
150	Autocross Event
50	Fuel Economy
350	Endurance Track Event
1,000	Total Points

From the Corn Field to the Fuel Tank

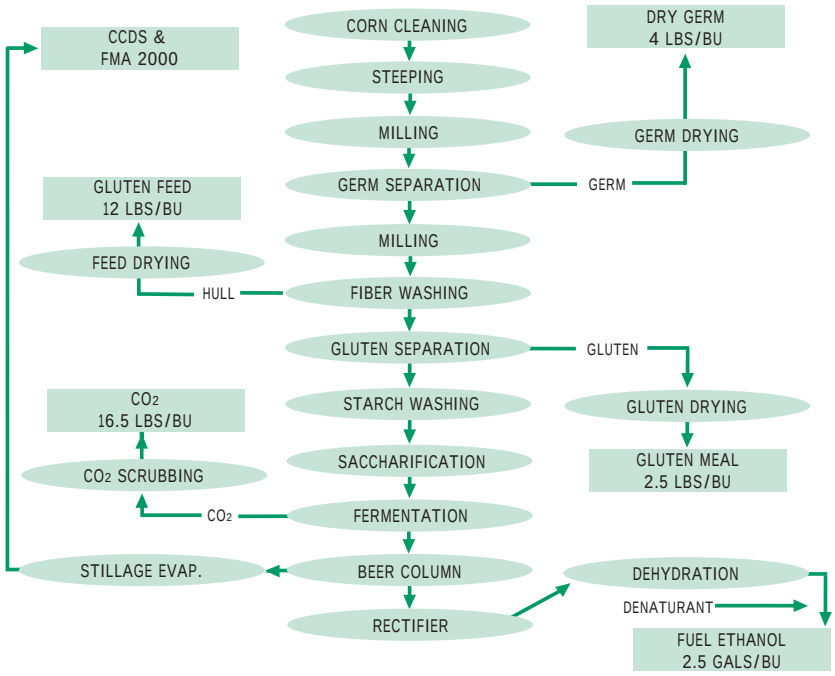
Williams Ethanol Services, Inc., has donated 5,000 gallons of E85 fuel for student teams to use as they prepare for and compete in the 1999 Ethanol Vehicle Challenge this May. The 85% ethanol content of the fuel was produced in Williams' ethanol plant at Pekin, Illinois, which annually produces about 100 million gallons of ethanol from 38 million bushels of field corn, according to Jim Redding, Director of Ethanol Marketing for Williams.

Williams uses a wet milling process to produce ethanol. Batches of corn kernels are steeped in warm water, then go through a series of steps to separate the germ, gluten, and hulls from the starch (the only part of the corn used to make ethanol). The starch is converted into a sugar, which undergoes fermentation to produce a beer containing about 10% ethanol. The beer is distilled, leaving less than 0.8% water in the final ethanol product. Each bushel of corn processed this way yields about 2.5 gallons of ethanol, 4 pounds of corn germ, 2.5 pounds of gluten meal, and 12 pounds of gluten feed for livestock.

A little over half of the ethanol that Williams produces is mixed into commercially sold gasoline/ethanol blends containing 10% ethanol. The rest is sold to industry to be made into industrial solvents, cough syrup, mouth wash, antiseptics, disinfectants, or vodka and other alcoholic beverages—and donated for research projects like the Ethanol Vehicle Challenge.

Much of the fuel now sold in the United States contains small amounts of ethanol. The blend lessens harmful emissions from cars and trucks, considered the main sources of hydrocarbon and carbon monoxide pollution in U.S. cities. A 1998 EPA study found hydrocarbon emissions from vehicles run on a 90% gasoline/10% ethanol blend were an average of 6 to 24% lower, and as much as 50% less (in a 1987 Chevrolet Blazer tested at 75°F).

Typical Corn Wet Milling/Ethanol Production Process



Producing ethanol from corn and using E85 to fuel a mid-size car creates 24–26% less greenhouse gas emissions than gasoline.

Carbon monoxide reductions averaged 10 to 30%.

Most proponents of ethanol, though, consider its greatest potential to be in fuel with high ethanol content, such as E85. Redding and other experts believe that high-ethanol fuels will become increasingly competitive with gasoline as automotive engineering advances enhance the performance of vehicles designed specifically for ethanol, and ethanol production becomes more efficient, lowering consumer cost.

An Argonne National Laboratory study to be published this spring finds that on a full fuel-cycle basis, producing ethanol from corn and using E85 to fuel a mid-size car creates 24 to 26% less greenhouse gas emissions than recovering and refining petroleum into gasoline and using it to fuel the same car. At the same time, Redding points out, many of the cars competing in the 1998 Ethanol Vehicle Challenge achieved better fuel efficiencies than comparable gasoline-powered models, even though ethanol contains only about two-thirds the Btu's.

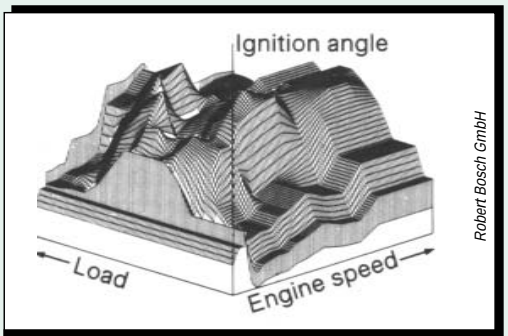
Past concerns that more energy is spent to produce ethanol than is contained in the ethanol product have been put to rest. Studies now show that across the industry, the average net energy benefit per gallon of ethanol produced is 20,000 to 25,000 Btu. Redding notes that recent process improvements at the Pekin plant have increased the annual production of ethanol from 60 million to 100 million gallons without a significant increase in process energy consumption.

John DePue

Students Can Reprogram Silverado's Powertrain Control Module for 1999 Ethanol Vehicle Challenge

For the second year in a row, General Motors will provide the vehicles for the Ethanol Vehicle Challenge at its proving ground in Milford, Michigan. This year, though, the competition will be different in several ways.

Instead of the Malibu passenger cars that students converted to ethanol use in last year's competition, teams will convert full-size pickup trucks. Because trucks are used by different kinds of drivers and for different purposes than passenger cars, organizers will add two new events and modify one of last year's events to test how students address the different performance requirements for full-size pickups. According to Mark Farone of GM's Truck Group, last year's autocross will be replaced with an off-road course that the students will complete, rally style, against a clock.



Interrelational model showing how ignition timing is programmed to respond to varying engine speeds and loads in a typical powertrain control module

"The change will provide a more complete picture of the students' mindsets and capabilities and the direction that the competition will be taking in the future."

Mark Farone, GM Truck Group

The competition will also feature a new hill-climb event in which the vehicles will tow a trailer uphill to test vehicle acceleration under conditions encountered by trucks. And the fuel economy portion of the competition will include testing the vehicles with and without a fixed load, again to reflect real-world conditions for full-size trucks.

The biggest change, though, is the result of a request made by students after the 1998 Ethanol Vehicle Challenge. For the first time, students will have the opportunity to alter, indirectly, the vehicle's powertrain control module (PCM).

In a fuel-injection engine, the PCM controls when and how much fuel flows to the engine, when the spark plugs spark, when the transmission shifts—virtually every aspect of engine and powertrain operation. For any combination of information received from the vehicle sensors (e.g., speed, manifold air pressure), the PCM checks the "calibration tables" that have been programmed into its memory to determine the values that will provide the best response to a given situation. These values are established for each vehicle model by extensive dynamometer and real-world testing. Engineers calculate the optimal settings for fuel efficiency, performance, emissions, and drivability, and these values are "burned in" to the chip in the PCM. The values in the Silverado PCM are optimum values for a *gasoline-powered* full-size pickup.

For this year's competition, GM will provide students with blank calibration tables for certain engine functions. The students will conduct testing to calculate a value for each cell of the tables to provide optimal performance for their ethanol-fueled engines. The students will send the tables to GM, and GM will recalibrate (or "reflash") the PCMs on the basis of the values calculated by the students. The students can modify the PCM any way they want—within certain safety and durability thresholds (nothing will be input that would compromise the students' safety or engine integrity). GM will then send the PCMs back to the schools, and the students will conduct more tests to determine whether the PCM provides optimal performance for their converted vehicles.

This change offers significant benefits to the students. In the past, the PCM was a sealed system, a "black box" that the students had to work around in converting their vehicles to run on ethanol. According to engineering student Seth Valentine of Cedarville College, "We spent more time fighting the PCM than fighting the fuel. Now we can really get into the details of ethanol performance, rather than focusing on other 'nonethanol' issues such as sensor calibrations, startup sequence, and fuel curves. The teams will get better results, and we will be able to see what ethanol is capable of."

Michael Svestka of the University of Illinois-Chicago agrees. "The results of last year's competition were extremely tight; six teams placed within a point or two of one another in both emissions and fuel economy events, mainly because the stock PCM limited what the students could do. This will really open things up and make the competition more of a design challenge."

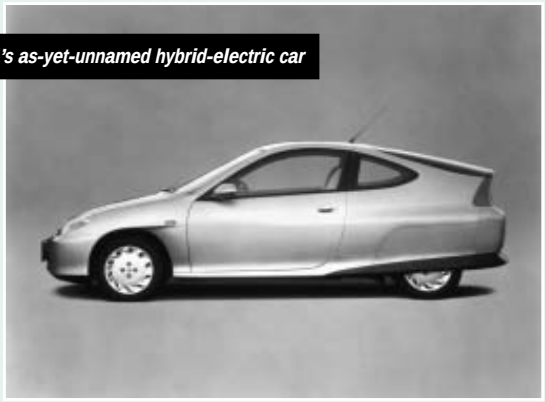
Says GM's Farone, "The change, although it means additional work for GM engineers, will provide a more complete picture of the students' mindsets and capabilities and the direction that the competition will be taking in the future."

Mary Fitzpatrick

HEVs for Sale This Fall

Honda dealerships will be the first to offer hybrid-electric vehicles to American consumers, beginning this fall. In addition to nearly doubling the fuel economy of the leading gasoline-powered cars on the market, Honda says, its HEV is engineered to meet California's ultra-low emission vehicle (ULEV) standard, currently the most stringent in the world.

Honda unveiled its as-yet-unnamed HEV at the North American International Auto Show in Detroit in January. The sleek and aerodynamic two-passenger sport coupe combines the strengths of gasoline engines and battery-driven electric motors to average an expected 70 mpg in combined city/highway driving. An extremely lightweight aluminum and plastic construction—at 1,740 pounds it weighs 800 pounds less than a Civic subcompact—is a big factor in its over-the-top fuel economy.



Honda's as-yet-unnamed hybrid-electric car

The new Honda's cruising power is supplied by its 1-liter, three-cylinder, lean-burn VTEC (variable valve timing and electronic lift control) engine. The electric motor, fed by a nickel metal-hydride battery, comes into play mainly during acceleration. The battery is recharged by a generator that recovers energy from braking.

"This vehicle is a major technological achievement for Honda, incorporating a wide range of technologies developed over the past two decades of Honda research and development into cleaner automobiles," said Tom Elliot, executive vice president of American Honda Motor Co., Inc.

Real Success....

(continued from page 1)

can be stored and transported in the same infrastructure, and has already been distributed in California in blends with conventional diesel. The fuel has a cetane value in the 70s, even higher than that of DME, and it contains no aromatics or sulfur to contribute to emissions.

Other than emissions, Wisconsin faculty advisor Glenn Bower doesn't expect engine operation to change much. One crucial factor will be getting an additive to replace the sulfur of conventional diesel fuels, which lubricates the injectors. In addition, "With the higher cetane number and shorter ignition delay, we might get a little combustion advance," Bower says. The team might need to retard the timing, but its schedule may not allow the time needed to reprogram the fuel injector controls.

Bower expects that the in-cylinder temperature will stay about the same as that for conventional diesel, so the NO_x emissions will need some aftertreatment. "We'll have the standard catalyst that's supplied with this engine," Bower explains. "It's designed to take care of hydrocarbons and carbon monoxide, but it also gives a 15 to 20% reduction in particulates and 7 to 10% reduction in NO_x." The team is also talking with a catalyst manufacturer about getting an additional NO_x trap. "ULEV is what we're shooting for. I don't think we're that far off if we get the NO_x taken care of," Bower predicts.

Jane Andrew

Formula Teams....

(continued from page 3)

Akron's Andy Vrenko notes that his team seeks to improve performance in many ways, even by selecting bearings that will minimize friction. But the team's choice of elastomer for its suspension system may be equal parts competition strategy and civic pride: Akron, Ohio, is the home of the Goodyear Tire & Rubber Company, whose test track is used frequently by the Akron team. "Goodyear has been very generous. We couldn't have done it without them," says Faculty Advisor Gross, whose Formula SAE students have been hired not only by Goodyear, but by Bridgestone/Firestone Inc., Penske Motorsports, and Tilton Engineering, as well.

Akron continues to run its formula vehicles on M85 for the added engineering challenges the fuel poses. For example, engineering for M85 fuel has required students to test different fuel/air ratios for engine intake design. "Many things can be done to optimize the fuel efficiency and power output of M85," Vrenko explains. "We do a lot of good computer modeling and dynanometer work with our engine, testing the air/fuel mixture for each rpm."

Tony Androsky, Formula SAE series manager for the Society of Automotive Engineering, calls it "Real Life 101." "Students with Formula experience go to the top of the heap because industry is looking for workers who can pitch design, work creatively under costing constraints, work well in a team, and lead others," he says.

Bob Woods agrees: "It used to be that recruiters would ask me about students with top grades. Then they began asking me about memberships in professional societies. Now they just say, 'give me your formula team members.'"

Cathy Kaicher

Ethanol Vehicle Challenge

GM Milford Proving Ground, MI
May 19-26

Teams of college students from the U.S. and Canada will convert 1999 Chevrolet Silverados to run on E85 fuel. Their goals are to improve fuel economy, lower exhaust emissions, and provide excellent cold-startability while maintaining performance and drivability. Sponsored by DOE, GM, and Natural Resources Canada.

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FutureCar Challenge

Oakland Community College
Auburn Hills, MI
June 2-10

Annual competition sponsored by DOE, DaimlerChrysler, Ford, and GM has university students convert a Dodge Intrepid, Chevrolet Lumina, or 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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Sunrayce 99

Washington, DC to Orlando, FL
June 20-29

Teams from 40 colleges design, build, and race solar-powered cars in this road rally sponsored by GM, DOE, and EDS. Key factors include driver safety, vehicle weight and durability, efficiency of components, aerodynamics, rolling resistance, and energy recovery/storage systems.

- *Contact:*
  Sunrayce Headquarters
  730 Peachtree St. NE, Suite 876
  Atlanta, GA 30308
  Phone: (800) 606-8881
  E-mail: headqtr@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. Contestants participate in publicity stops in communities along the way. Open to manufacturers, students, and hobbyists. Principal sponsors are NESEA and DOE.

- *Contact:*
  Nancy Hazard
  Northeast Sustainable Energy Association
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  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-m, wire-guided race. Regional competitions are held in 26 states and Washington, DC.

- *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 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, while competing in two classes: gasoline and methanol. Sponsored by the Society for Automotive Engineers, USCAR, and DOE.

- *Contact:*
  Shanin Hart
  SAE Collegiate Design Series
  SAE International
  400 Commonwealth Dr.
  Warrendale, PA 15096
  Phone: (724) 772-4046
  E-mail: hart@sae.org
- Web site: www.SAE.org/STUDENTS/formula.htm

(continued)

(continued from page 7)

SAE Supermileage

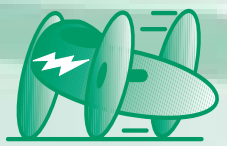
Eaton Proving Grounds, Marshall, MI
June 11-12

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
  136 E. Michigan Ave.
  Kalamazoo, MI 49007
  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. The following national event is also held.



1999 Pentad U.S. National Electrathon Championship

Los Angeles, CA
April 30-May 2

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

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

EVTC Events

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

- *Contact:*
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  Phoenix, AZ 85003
  Phone: (602) 256-2599
  E-mail: info@evrace.com
- Web site: www.evrace.com

Solar BikeRayce USA

Topeka, KS
May 28-30

Bicycles and other human-powered vehicles to which an electric motor, battery, and solar panel have been added compete in a 200-m sprint and 100-km distance event. Sponsors include the Kansas Corporation Commission, New Resources Group, and Crowder College. The event emphasizes high school students but has categories for adults and seniors as well.

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- *Web site:* www.sunrayce.com/sea/bike_raycing/

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.

DOE/Industry Competitions
Advancing Automotive Technology

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