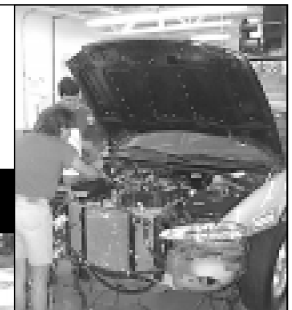
FutureDrive

Volume 5, Number 2 **DOE/Industry Competitions Advancing Automotive Technology** Summer 1999

COMPETITION PREVIEW

Seasoned Student Engineers in High Gear for 1999 FutureCar Challenge



University of Tennessee students prepare for this year's FutureCar Challenge

During the FutureCar Challenge's four-year history, student teams have refined, tested, and demonstrated nearly every trend in advanced automotive technology—direct-injection diesels, fuel cells, hybrid electric vehicles of novel designs, continuously variable transmissions, automatically shifting manual transmissions, and alternative fuels. Expect more refinements on the refinements this year.

"For many of the schools, this year's competition is their third or fourth FutureCar Challenge," says Mike Ogburn of the Virginia Tech team. "With that technological base and cumulative experience, the teams will be driving some pretty sophisticated machinery."

Alan Holmes, a member of the Ohio State team, agrees. "This year's FutureCar Challenge offers a fantastic opportunity to see working fuel cells, hybrid electric powertrains, and other exciting technologies in popular real-world cars," he says.

The 1999 FutureCar Challenge will conclude a series in which top engineering students converted conventional midsized sedans into cars of the future, cars that approached 80 mpg-equivalent fuel efficiency and super-low emissions.

Although by all accounts the competition this year will be tougher than ever, students like Mike Ogburn and Alan Holmes are optimistic about how their high-tech cars will perform. Ogburn is partial to the over-the-road portion of the event—from Auburn Hills, Mich., to Washington, D.C. —which is meant to test fuel economy and reliability and to showcase the FutureCars. "Such a trip is commonplace for many cars and drivers today, but it is an amazing way of finding the smallest bugs in a prototype design," he observes.

The Ohio State University team is working very hard to design, build, and compare two hybrid powertrains: a parallel hybrid electric vehicle (HEV) with an automatically shifted manual transaxle and a "hybrid" HEV with an electric variable transmission. The team is also working to build a safe, low-voltage motor designed specifically for HEV use. "We've learned that in the HEV, control is more important than power," says Holmes.

Virginia Tech and Texas Tech will be competing with fuel-cell-powered cars—a highly innovative technology that's tough to implement, even by major automakers. The teams have not had much time to work out the bugs, but even if they are not perfected, fuel-cell-powered vehicles will certainly attract attention this year. More common technologies, like diesels, will also be closely followed because they are becoming quicker, cleaner, and more fuel efficient.

The University of California-Davis has developed a powertrain incorporating a continuously variable transmission that allows the prime mover (either an electric motor or an internal combustion engine) to operate at the best possible efficiency for the power demanded at each instant in time. "This concept allows the gasoline engine to operate at an efficiency close to that of a fuel cell on hydrogen," team faculty advisor Andy Frank says. The UC-Davis' concept is completely automatic; the driver cannot control the gasoline engine or electric motor except through the accelerator and brake pedals.

Frank says his team is in a continuous development process. "Each year the concepts explored are more advanced and sophisticated," he says. "Even so, our powertrain has fewer moving parts than that of 1926 Model T Ford, and only 15% of the parts of a 1996 V-6 engine and automatic transmission of equal performance."

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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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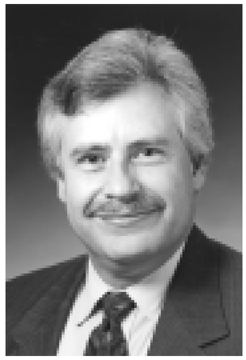
Competitions Yield Collaborations



The U.S. Department of Energy's student vehicle competitions are helping to build a foundation of trust and good experiences among the automotive industry, government, and engineering schools. Fruitful collaborations in advanced automotive engineering are continuing to result.

In this issue we profile Goodyear Tire and Rubber Company, a sponsor of DOE advanced technology vehicle competitions for nearly a decade. Goodyear sees its sponsorship as a two-way street: "Our participation not only helps the student competitors, but also enables us to advance our tire designs in parallel with the advances in hybrid electric vehicle design," William Egan, chief engineer of advanced tire design, says in the article (see p. 6).

In the Spring issue of FutureDrive we wrote about how long-time sponsor General Motors, donor of 14 Silverado pickup trucks for this year's Ethanol Vehicle Challenge, is helping student competitors recalibrate the trucks' gasoline-optimized powertrain control modules to make them more suitable for E85 fuel. GM is giving students an opportunity to engage in an important type of real-world engineering.

We have also been following the progress of Virginia Tech and Texas Tech University in recent issues. These schools will enter fuel cell vehicles (converted Luminas) in the 1999 FutureCar Challenge. If they run at competition—and both teams are confident they will—these fuel cell cars will be among the first demonstrated in the United States. Energy Partners built the fuel cells that Virginia Tech and Texas Tech are using and has provided technical support to the teams for more than a year now. DOE purchased the fuel cells for the teams in support of its goal to further research that will help make fuel cells practical for family vehicles.

The technological advancements the students are pursuing are moving the auto industry one step closer toward improving fuel efficiency and consumer acceptability and increasing the use of domestic renewable fuels. One subscriber, an engineer, may have put it best: "FutureDrive demonstrates a powerful application of education to a practical end use. It just might help save our planet."

Robert P. Larsen
Director of Competition Programs
Manager of Fuels and Vehicle Systems
Argonne National Laboratory

CLARIFICATION

In the Spring issue of FutureDrive ("Real Success with Synthetic Diesel Fuels") we reported that the synthetic fuel dimethyl ether (DME) is attractive for diesels because it vaporizes instantly under atmospheric pressure. The article said that this property results in lower injection temperatures, which is incorrect. Rather, the instant vaporization of DME in the cylinder means that the fuel is distributed and burned evenly; therefore, complete combustion can be achieved at a lower combustion gas temperature, and, as a result, the potential to form nitrogen oxides is reduced.

Vehicle Challenges Keep UTEP in Step

Texas may be a big presence on the map, but the engineering department at the University of Texas at El Paso (UTEP) has only recently been gaining attention—thanks largely to its participation in vehicle competitions. UTEP, which borders Mexico in westernmost Texas, entered its first alternative fuel vehicle challenge in 1992 and, since 1995, has had a team run each year in a DOE-sponsored event. The school placed third overall in the 1996 Propane Vehicle Challenge.

Some of the benefits of these competitions to students are well-known: they learn to work on a team and apply their knowledge in the real world. Ryan Wicker, advisor to UTEP teams since 1995, claims even more. "The competitions probably provide students with a more valuable and rewarding experience than any other they will have in college," he says. "They give students the chance to enhance the skills they've developed at solving close-ended problems in the classroom by meeting open-ended vehicle design challenges."

UTEP's 1999 Ethanol Vehicle Challenge Team

Wicker is also impressed with the interdisciplinary learning that goes on as a result of competitions. Designing automobiles involves all engineering disciplines, he says—electrical, computer, metallurgical, materials, and civil as well as mechanical and industrial. What's more, students improve their communication skills as they make presentations, answer questions, solicit sponsors, write papers, and even design their own Web pages (check out "research" and "EAFRL" at http://www.utep.edu/meandie).

Oscar Moguel, a student member of UTEP's current Ethanol Vehicle Challenge team, agrees. "Every time I go to an interview, they're not just looking for people who know the technology. They want people who can communicate—who can write effectively, who can talk to other people, who can lead. They want people who know how to make schedules and meet deadlines." Team members who have learned these management and organizational skills have a jump start in the job market.

And that's not the only job-hunting advantage the competitions provide. Fernando Jasso, 1999 team captain, feels that "the opportunities I've had to make contacts in the automotive industry should really pay off after graduation." A junior in Mechanical Engineering, he's already compiled a long list for his job search of the people he's met and talked to and the companies he's dealt with for the Challenge.

As a direct result of its involvement in the competitions, UTEP's Mechanical and Industrial Engineering Department has received grants from the university and local industries. The funds have gone to create an Engines and Alternative Fuels Research Laboratory (EAFRL), which currently employs 5 graduate and 12 undergraduate research assistants. EAFRL's cold room facility is currently being used to test the engine the school plans to enter in the 1999 Ethanol Vehicle Challenge.

Several students work part-time at EAFRL during the school year and at a local automotive manufacturing plant in the summer. Cooperative endeavors like these help cement the school's ties with the automotive industry, perhaps opening the door to even more opportunities for collaborative research.

UTEP has been able to leverage its investment in EAFRL to expand its Mechanical and Industrial Engineering Program and recruit and maintain talented faculty and students. A case in point is Javier Perez. One of two students now in the graduate program, he was inspired to continue his studies because of his experience in the competitions and at EAFRL. His work spawned his thesis on developing a constant emissions monitoring system, a technology that will be used in future competitions.

Other research at EAFRL is comparing standard engine performance measurements using gasoline, liquefied petroleum gas (LPG) carburetion, and LPG liquid-phase port fuel injection. A NASA grant is funding development of a direct imaging technique for particle laden diesel fuel spray.

Marita Moniger

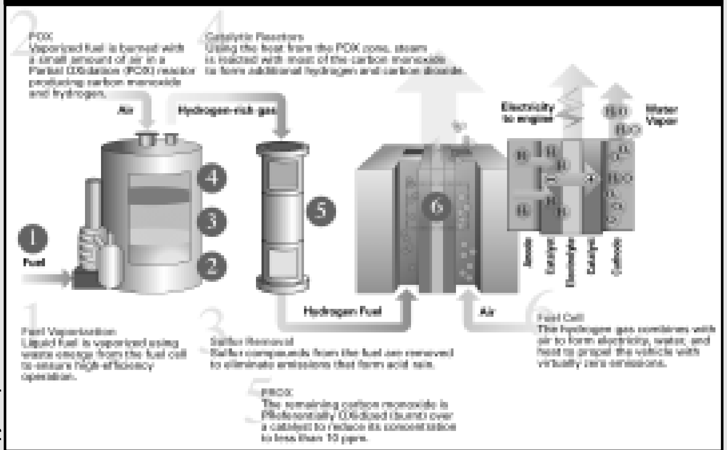
"The competitions probably provide students with a more valuable and rewarding experience than any other they will have in college"
Ryan Wicker, UTEP Team Advisor

The Fuel Cell: Building Block of the 21st-Century Car?

It won't be long before Americans will be driving fuel-cell-powered cars. The "Big Three" along with Toyota and Mercedes-Benz target 2004, and Honda's shooting for 2003.

The rapid pace of automotive fuel cell development in the past few years has surprised skeptics and supporters alike. Even Mobil, Shell, ARCO, and Exxon are no longer squeaking "expensive" and "a long way off," like they were in 1995. Mobil ran an advertorial in the *Wall Street Journal* last year that said, in part: "Imagine owning an automobile that runs on fuel cells. Need to fill up? You can still drive into a Mobil station." That's change.

The Epyx Multi-Fuel Processor



Epyx Corporation

U.S. car manufacturers are spending close to $1 billion to develop fuel cell cars according to Rhett Ross, U.S. Fuel Cell Council President. "When automotive companies start to spend this much money, you know they see profits down the road," says Ross. Why the optimism?

For one, researchers have overcome the need for bulky on-board hydrogen storage, suddenly making the fuel cell car practical and giving oil companies a reason to change heart. The cars can run on liquid fuels like methanol, ethanol, or gasoline, which the vehicle itself will reformulate (through partial oxidation) into hydrogen gas. Our ubiquitous fuel supply infrastructure can remain intact with only minor changes to accommodate the alcohol fuels.

Argonne National Laboratory, Hydrogen Burner Technologies, and Epyx Corporation, a wholly owned subsidiary of Arthur D. Little International, all have been developing fuel reformers for fuel cell vehicles. The reformers contain a fuel vaporizer in which the fuel is heated with waste heat from the fuel cell, a partial oxidation reactor that yields hydrogen and carbon monoxide, and a catalyzer that converts the carbon monoxide to less harmful carbon dioxide. The reformer adds weight and bulk, but these are countered by the lack of a hydrogen tank on board and the dramatically reduced size of the fuel cell in recent years—the direct result of its power output jumping sevenfold since 1991. Less than a decade ago a fuel cell with enough power for a car would have been larger than the car itself.

A General Motors prototype fuel cell car

With refinement, the reformer will almost certainly shrink as well. Or it may not be needed at all. A direct methanol liquid feed fuel cell under development adds 50% ruthenium to the anode's catalytic coating, creating a chemically active "filter" that pushes methanol to split into carbon and hydrogen and lets only the resulting hydrogen ions pass through to the cathode.

The direct methanol liquid feed fuel cell would allow the engine to run at lower temperatures because fuel vaporization and partial oxidation would not be needed. Already lightened and made more compact by removing the reformer, the fuel cell powertrain wouldn't need the bulk and weight of thermal insulators either. "We think this new technology will bring the fuel cell down to earth for good," Dr. Surya Prakash of the University of Southern California said as the joint NASA-funded version was introduced in 1997. Some other experts consider the direct methanol liquid feed fuel cell a mere scientific curiosity. Certainly it is farther in the future than today's proton exchange membrane fuel cells.

The power output of fuel cells has shot up largely because thinner and better-conducting materials have been developed for the membrane between the fuel cell's anode and cathode. When fuel cells were used in the Gemini space program, these membranes were polystyrene; the latest are elastomer gels.

Materials research has also helped to dramatically reduce the cost of fuel cells to about one-tenth what they were a decade ago. As recently as five years ago the amount of platinum in a fuel cell big enough to power a car cost a whopping $30,000. Since then, the fuel cell has shrunk, reducing the amount of catalyst needed. Just as importantly, researchers at Rennselaer Polytechnic Institute and Los Alamos National Laboratory have developed membrane materials with more conductivity and as much as 95% less platinum. One method involves curing a liquid film of platinum on a separate surface and hot pressing it to the fuel cell electrodes.

Many prototype fuel cell cars contain small battery packs to help power the vehicle in the five minutes or so that it takes for the fuel cell to reach full operating temperature. (Energy released during braking and deceleration charges the battery.) Ford's battery-augmented fuel cell concept car goes from 0 to 60 mph in 12 seconds and puts out 90 horsepower during computer simulations. DaimlerChrysler is confident that 0 to 60 in 6 seconds is on the horizon. The powertrain in these hybrids needs to seamlessly shift from fuel cell to battery power. "The driver needs to not know what's happening," says Tim Maxwell, a Texas Tech educator whose students are building a prototype fuel cell vehicle for the 1999 FutureCar Challenge.

That fuel cell cars can't currently operate in temperatures below freezing (for the simple reason that the water inside them turns to ice) will keep them out of Northern driveways for a while. Carmakers expect to solve this glitch by rollout time. Among the other areas in need of refinement are catalyst and membrane materials, methods to protect against carbon monoxide poisoning of the fuel cell, low-cost carbon monoxide and hydrogen sensors, and less parasitic vehicle auxiliaries, especially air compressors. More complex and comprehensive computer models, such as Argonne National Laboratory's "GCtool"-based model, are essential for studying the effects of operating conditions, cell materials, and system design on fuel cell efficiency and performance.

Rhett Ross believes there's a sense among automotive executives that consumers are becoming more open and are eager for something different. "People might be willing to pay a couple of thousand more for a vehicle that runs clean and gets more mileage," he says. Another bonus for consumers: the fuel cell powertrain has far fewer moving or heat-stressed parts than the internal combustion engine, which should translate into reduced maintenance and a longer-lasting car.

Cathy Kaicher

EVOLUTION OF THE FUEL CELL CAR

1839	Sir Walter Grove invents the fuel cell (FC)
1960s	FCs begin being used in U.S. space program
1980s	Los Alamos National Laboratory (LANL) begins research to reduce platinum catalyst needed in FCs by 90%
1990	DOE and General Motors begin light-duty FC vehicle R&D program at LANL
1993	Energy Partners demonstrates a FC/battery hybrid fueled with compressed H_2
1994	DOE teams up with each of the Big Three for separate R&D collaborations on proton exchange membrane (PEM) FC cars and battery/PEM hybrid cars
1994	Daimler-Benz demonstrates FC cargo van: FC and compressed H_2 fills cargo area
1995	Argonne National Laboratory develops on-board methanol reformer
1996	Chrysler begins on-board gasoline reformer R&D
1996	Daimler-Benz demonstrates FC passenger van: two 25-kW fuel cells under rear seats; compressed H_2 stored on top
1996	Toyota demonstrates FC sport utility vehicle augmented with battery power: metal hydride H_2 storage
1997	California Institute of Technology/University of Southern California patent "aqueous liquid feed organic fuel cell using solid polymer electrolyte membrane": no on-board reformer needed
1997	DOE/Ford/International Fuel Cells demonstrate H_2-fueled PEM FC that needs no air compressor
1997	Mazda demonstrates FC car with metal hydride H_2 storage: 15 x 8.5 x 8.5-in. FC in rear
1997	Toyota demonstrates FC sport utility vehicle fueled by methanol, augmented with battery: FC beneath floor
1997	Daimler-Benz demonstrates compact FC car: methanol reformer in rear; FCs beneath passenger compartment
1997	Ballard begins 2-year test run of 3 FC buses in Chicago, 3 in British Columbia: H_2 stored on top
1997	Arthur D. Little demonstrates gasoline reformer for use in PEM FC cars
1998	Rensselaer Polytechnic Institute/Dais Corp. introduce higher-conductivity (+15%), lower-cost (-40%) PEM FC membrane material
1998	Mobil Oil Company joins Ford in fuel reformer R&D
1998	General Motors demonstrates FC compact van fueled by methanol at Paris auto show
1999	DaimlerChrysler demonstrates FC 5-passenger compact car fueled by liquid hydrogen
1999	Two university teams demonstrate Energy Partners FCs in DOE-sponsored FutureCar Challenge

TECHNEWS

Read All About Them!

Detailed technical information about the vehicles that have competed in the FutureCar and Ethanol Vehicle Challenges is available to interested parties from the Society of Automotive Engineers. All documents can be ordered through the SAE web page at http://www.sae.org. Technical papers since February 1998 can also be downloaded directly from the Internet after first paying for the publication with a credit card.

The design papers that teams prepare for the competitions are compiled by SAE into Special Publications. In addition, each year competition organizers select several of the papers to be presented at the SAE Annual Congress. These papers are sold individually. For the 1999 SAE Congress, three teams from the 1998 Ethanol Vehicle Challenge and two from the 1998 FutureCar Challenge presented their outstanding design papers:

- Cedarville College
  Cedarville College Ethanol Vehicle Challenge Testing Results
- Kettering University
  The Effect of Multiple Spark Discharge on the Cold-Startability of an E85 Fueled Vehicle
- Texas Tech University
  1998 Future Car Challenge Technical Report
- The University of California, Riverside
  Development of a Low-Emission, Dedicated Ethanol-Fuel Vehicle with Cold-Start Distillation System
- University of Wisconsin-Madison
  The Development of the University of Wisconsin's Parallel Hybrid-Electric Aluminum Intensive Vehicle

Goodyear Treads Far for FutureCar

Tires are key factors in a vehicle's ease of handling, braking, and comfort of ride. Tires even play a role in fuel efficiency.

Although it looks deceptively simple, the tire is a complex piece of equipment. A typical radial tire consists of alternating layers of liners, plies, steel belts, and overlays covered with rubber treads. Goodyear's most popular tire contains 30 different synthetic rubbers, 8 types of natural rubber, 8 types of carbon black, steel cord, steel bead wire (to hold the tire to the wheel), polyester and nylon, and 40 different chemicals, waxes, oils, pigments, and similar compounds.

In 1999, the nation's largest tire manufacturer is again providing FutureCar Challenge competitors with hi-tech tires that feature low roll resistance and improved handling. Goodyear has donated the tires for the FutureCar Challenge and its predecessor advanced-technology vehicle competitions since DOE began them in the early 1990s.

"We feel that a lot of the vehicle development work that is going on for these competitions has the capability to be on the forefront of technology," says William Egan, Goodyear's chief engineer of advanced tire design. "We are confident that there will soon be a place in the market for hybrid electric vehicles, and the students who are participating in these competitions are going to be the automotive engineers and designers who will help make it happen."

As advances have been made in engine and fuel system components for FutureCar Challenge vehicles over the years, so have advances been made in Goodyear's design and manufacture of the tires provided for those vehicles. The tires this year feature a rolling resistance coefficient of 0.0052, compared with 0.0064 for the tires supplied by Goodyear for the 1996 competition.

Egan explains that a tire's running surface is flattened by the load on a wheel. "This forced deformation of tire material and the friction of the tread elements on the roadway cause rolling resistance," he says. Roll resistance is a function of a tire's energy-absorptive qualities. If the tire transfers the energy to the road instead, less engine power will be needed to overcome the resistance. To create a tire with less roll resistance, Goodyear engineers reduce the stress within the tire by constructing it with lightweight materials and rubber that absorbs less heat than standard tires.

According to Egan, the number of factors that must be taken into account just to lower tire rolling resistance for the FutureCar Challenge vehicles is typical of the complexity of tire design and manufacture today. Factors that must be taken into account include tire profile, shape and construction, weight, rubber compounds, tread design, and tire inflation pressures. Since these factors also affect other aspects of tire performance, the entire design process represents a complex balancing of features to produce a tire that achieves the optimal mix of performance characteristics for the tire's intended use.

"Goodyear wants to be part of DOE's effort," Egan says, "and our participation not only helps the student competitors, but also enables us to advance our tire designs in parallel with the advances in hybrid electric vehicle design."

John DePue

...Student Engineers...

(continued from page 1)

Undaunted by their overwhelming first year in FutureCar (1998), in which their vehicle was still incomplete at competition time, the University of Tennessee expects to complete and re-enter its Dual-HEV. UT's Dual-HEV can operate in both series and parallel modes.

The students are excited, but cautious, about their on-the-edge automotive engineering. Nobody is willing to predict what mix of technology, performance, and design will end up being this year's ultimate FutureCar. Mike Ogburn's thoughts echo those of many of his peers: "I think that one of the most respectable achievements at FutureCar Challenge is to have a design that just works—but if it works and works well, you can bet someone will notice!"

Kevin Brown

1999 FutureCar Team	Powertrain	Fuel
Concordia University	parallel HEV	dimethyl ether
Lawrence Technological University	parallel HEV	Fischer-Tropsch diesel
Michigan Technological University	series HEV	California Phase 2 gasoline
Ohio State University	parallel HEV	Fischer-Tropsch diesel
Texas Tech University	series HEV	hydrogen
University of California	parallel HEV	reformulated gasoline
University of Illinois	series HEV	Fischer-Tropsch diesel
University of Maryland	series HEV	ethanol (E85)
University of Michigan	parallel HEV	Fischer-Tropsch diesel
University of Tennessee	series & parallel HEV	compressed natural gas
University of Wisconsin	parallel HEV	Fischer-Tropsch diesel
Virginia Tech	series HEV	hydrogen
West Virginia University	parallel HEV	compressed natural gas

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:*
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  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-m, wire-guided race. Regional competitions are held in 26 states and Washington, DC.

- *Contact:*
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  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

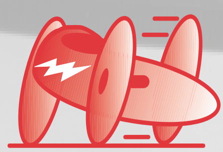
Eaton Proving Grounds, Marshall, MI
June 11-12

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.



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

EVTC

EVTC Events

Electric Vehicle Technology Competitions, Ltd., sponsors electric vehicle competitions for high school and university students each year.

- *Contact:*
  Mike Shaw
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  401 S. 2nd Ave.
  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

High school students race human-powered vehicles to which an electric motor, battery, and solar panel have been added. Sponsored by the Kansas Corporation Commission, New Resources Group, and Crowder College.

- *Contact:*
  Art Boyt
  Crowder College
  601 Laclede Ave.
  Neosho, MO 64850
  Phone: (417) 451-4700
  E-mail: aboyt@crowdercollege.net
- *Web site:* www.sunrayce.com/sea/bike_raycing/

Winston Solar Challenge

Dallas to Los Angeles
July 19-26

Solar race for high school teams from around the country. Sponsored by the Winston Solar Education Program, which also hosts free workshops to teach students the physics and technology of roadworthy solar cars.

- *Contact:*
  Lehman Marks
  The Winston School
  5707 Royal Lane
  Dallas, TX 75229
  Phone: (214) 691-6950 ext. 238
  E-mail: LehmanM743@aol.com
- Web site: www.winstonsolar.org

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
Newsletter Clearinghouse

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