FUTURE CAR

CHALLENGE

1999

1999 FutureCar challenge

FUTURECAR, THE NATION'S PREMIER, COLLEGE-LEVEL
AUTOMOTIVE ENGINEERING COMPETITION

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Participating Schools and Universities

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University of Maryland

University of Michigan

University of Tennessee

University of Wisconsin — Madison

Virginia Tech

The 1999 FutureCar Challenge is a student engineering competition that is designed to provide students with hands-on experience solving real-world problems and advancing state-of-the-art technology. FutureCar is co-sponsored by the United States Department of Energy (DOE) and the United States Council for Automotive Research (USCAR), a joint research effort among Chrysler, Ford, and General Motors. The sponsors have invited 13 North American universities to modify, by using the most advanced vehicle technologies, a mid-sized sedan that can reach 80 miles per gallon (mpg) and yet still offer the same comfort, safety, and affordability that consumers expect from conventional vehicles.

Each team received either a Taurus (or a prototype aluminum Sable) from Ford Motor Company, a Chevrolet Lumina from General Motors Corporation, or a Dodge Intrepid from Chrysler Corporation to serve as its platform. The three auto manufacturers also awarded each team $10,000 in seed money.

Students have been applying cutting-edge technologies — including advanced propulsion systems and space-age materials — and alternative fuels (like natural gas, ethanol, and hydrogen) to meet the tough guidelines of the competition. DOE has also purchased two fuel-cell stacks for use in the competition. Two teams are working to adapt this technology to their competition vehicles.

This year's FutureCar Challenge — the fourth — takes place June 2 through June 10, 1999, and begins with a series of technical evaluations at Oakland Community College in Auburn Hills, Michigan. Industry and government engineers will measure fuel efficiency, range, acceleration, braking, handling, and driveability. Emissions testing will be performed at the U.S. Environmental Protection Agency's National Vehicle and Fuel Emissions Laboratory in Ann Arbor. The vehicles will also be judged on design, manufacturability, cost, and consumer acceptability. Awards will be given in 25 categories, and winners will share about $60,000 in prize money.

The conclusion to the 1999 Challenge will be a two-day trip to Washington, D.C. Along the way, the FutureCars will make stops at West Virginia University in Morgantown and at the University of Maryland in College Park. The finale of the event will include a finish-line ceremony at DOE Headquarters, a vehicle display on Capitol Hill, and an awards ceremony in the Cannon Caucus Room.

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COMPETITION SCHEDULE

Tuesday, June 1

Registration and Impound	5:00 - 7:00 p.m.	R/F Tent/Pit Area

Wednesday, June 2

Tech Inspections	8:00 a.m. - 7:00 p.m.	Body Shop - Building A
Qualifying	8:00 a.m. - 7:00 p.m.	Parking Lot 10
Lunch	Noon - 1:00 p.m.	

Thursday, June 3

Tech Inspections	8:00 a.m. - 7:00 p.m.	Body Shop - Building A
Qualifying	8:00 a.m. - 7:00 p.m.	Parking Lot 10
Oral Presentations	8:00 a.m. - 7:00 p.m.	T-Building
Coastdown Testing	8:00 a.m. - 7:00 p.m.	
Lunch	Noon - 1:00 p.m.	R/F Tent

Friday, June 4

Emissions Testing	8:00 a.m. - 6:00 p.m.	EPA - Ann Arbor, MI
Emissions Testing	8:00 a.m. - 6:00 p.m.	Ford - Dearborn, MI (Fuel Cell Vehicles)

Saturday, June 5

Emissions Testing	8:00 a.m. - 6:00 p.m.	EPA - Ann Arbor, MI

Sunday, June 6

On-Road Fuel Economy Testing	8:00 a.m. - 2:00 p.m.	Auburn Hills, MI
Precise Refueling	2:00 - 4:00 p.m.	
Acceleration	4:00 - 6:00 p.m.	
Skit Night	7:30 -9:30 p.m.	

Monday, June 7

Design Review, Consumer Acceptability, Aluminum, and Appearance Judging	8:00 a.m. - 4:00 p.m.	Parking Lot 10
Lunch	Noon - 1:00 p.m.	Parking Lot 10
Solo	4:00 - 7:00 p.m.	Parking Lot 10

Tuesday, June 8

Road Trip: Auburn Hills, MI, to Morgantown, WV (400 mi)	5:30 a.m. - 5:00 p.m.	
Lunch and Refueling	11:00 a.m. - Noon	
Dinner at West Virginia University	6:00 - 8:00 p.m.	Morgantown, WV

Wednesday, June 9

Road Trip: Morgantown, WV, to College Park, MD (200 mi)	8:00 a.m. - Noon	
Lunch and Refueling/Recharging at University of Maryland	Noon - 4:00 p.m.	College Park, MD
Road Trip: College Park, MD, to Arlington, VA	4:00 - 6:00 p.m.	

Thursday, June 10

Stage FutureCars	8:00 - 9:00 a.m.	Arlington National Cemetery
Finish Line Ceremony	9:00 a.m. - Noon	DOE Forrestal Building
Stage FutureCars	Noon - 1:00 p.m.	Capitol Hill
Awards Banquet	1:00 - 3:00 p.m.	
Capitol Hill Display	3:00 - 5:00 p.m.	

SAFETY INSPECTIONS Pass/Fail

Occupant and vehicle safety are paramount to the FutureCar Challenge. The vehicle inspections have been designed to evaluate vehicle safety and to verify compliance with all vehicle requirements and safety specifications. The inspections must be completed successfully before vehicles will be allowed to compete in dynamic events.

QUALIFYING EVENTS 50 Points

Again, occupant and vehicle safety are a major concern of the FutureCar Challenge. Qualifying events have been designed to test vehicle safety and to verify compliance with the vehicle requirements. Teams must pass all qualifying and handling events with their vehicles in "normal mode" in order to compete in any dynamic events. These events include (1) Tilt Test, (2) Braking, (3) Slalom, and (4) Skid Pad.

ENERGY ECONOMY 230 Points

Energy Economy testing is completed for each vehicle on a chassis dynamometer. Testing, which is held at the U.S. EPA's Ann Arbor facility, will include both city and highway cycles. The objective of the Vehicle Energy Economy Events is to determine the energy economy of each vehicle in the FutureCar Challenge. The energy economy is based on the hydrocarbon fuel energy consumed and any off-board electrical energy used during a virtual trip of 250 mi each in urban and highway drive cycles. This provides a distance/energy ratio that can be used to compare the FCC vehicles with conventional vehicles.

City 130 Points

The City portion of the Energy Economy event involves running the Urban Dynamometer Driving Schedule (UDDS), which is the first 1,370 s of the Federal Test Procedure (FTP), which consists of the cold transient (bag 1) and the stabilized (bag 2) phases.

Highway 100 Points

The Highway portion of the Energy Economy event involves running the Highway Fuel Economy Dynamometer Schedule (HFEDS). The HFEDS is a highway-speed cycle that is 16.4 km (10.2 mi) long and 12 min 44 s in duration. The test using this cycle is referred to as the highway fuel economy test, or HWFET.

EMISSIONS 100 Points

Emissions reduction from on-road consumer vehicles is very important to future air quality. Manufacturers must design the new generation of vehicles with increasing constraints on emissions levels. This effort must be reflected in the development of FutureCar Challenge vehicles. Vehicles not meeting 1968 federal levels do not receive points beyond those given for participation (20% of total). The emissions are based upon the UDDS portion of the dynamometer testing. If off-board energy is used in the 250-mi urban cycle trip, the power plant emissions are included in the vehicle emissions calculation.

ACCELERATION 60 Points

Each vehicle will make a 1/8-mi run from a standing start to test the vehicle's acceleration performance. The fastest of four runs will be used for scoring.

ENDURANCE 60 Points

The objective of the Endurance Event is to demonstrate the robustness of the vehicle and on-road fuel economy. Each vehicle will be refueled to capacity (fuel tanks filled until the automatic shut-off valve engages and battery packs charged to stated capacity) and run for a specified number of laps around a predetermined road course until (1) the laps are completed or (2) the vehicle breaks down. Vehicle on-road energy economy will be calculated on the basis of the amount of electricity and fuel used.

WRITTEN DESIGN REPORT 100 Points

Before the start of the competition, each team is required to submit a 15-page written report describing its vehicle's design. Key aspects of the report include information on powertrain configuration, component selection, control strategy, fuel and electrical power considerations, emissions control strategies, vehicle structure modifications, suspension modifications, materials usage, manufacturability, expected vehicle operation and market usage, and performance projections accompanied by appropriate test results. Reports are to be formatted according to current Society of Automotive Engineers standards and are judged on content and quality.

VEHICLE DESIGN INSPECTION 130 Points

This review, lasting approximately 25 min, is conducted by a panel of judges and involves a presentation of the actual vehicle. Up to three members of each team make a 15-min presentation around the vehicle, and the remaining 10 min are for judges' questions. The purpose of this event is to assess the engineering concept, design elements, systems integration, and execution of the vehicle and its components. The judging for special awards for Best Workmanship, Innovations in Aluminum, and Best Appearing Vehicle will be made during this event.

ORAL DESIGN PRESENTATION 150 Points

Up to three members of each team will make a 20-min oral presentation to a group of industry experts, then answer questions for 10 min. During their presentations, teams will describe the methods they used to improve fuel economy, the modifications they made to the vehicle's major components, the stand-alone experimental components or systems they designed to enhance the vehicle, and the developmental testing and results that demonstrate the potential of their vehicle design. Judges will evaluate the teams on the basis of the above information and the overall quality of the presentation.

CONSUMER ACCEPTABILITY 120 Points

This event evaluates the vehicle from a prospective buyer's point of view, focusing on the quality of the finish, aesthetics, utility, and general driveability. The event includes a static and dynamic review of the vehicle. The static portion of the event evaluates comfort/roominess, usable interior storage, instrument panel and cluster, controls, audio system, alarms, dome light, cargo space, and customer maintenance labels. The dynamic portion of the evaluation considers handling, directional stability, maneuvering/parking, brake feel/effectiveness, road noise, driver control position, performance feel/responsiveness, transaxle operation, powertrain noise, ease of starting, idle noise/roughness, hesitation/sag, shutdown characteristics, and response to full steering turn. The vehicle's Heating, Ventilation, and Air Conditioning (HVAC) system will also be evaluated during the dynamic portion of this event.

AWARDS

Awards	Amount	Description
First Place	$6,000	Based on the combined scores from all events.
Second Place	$5,000	Based on the combined scores from all events.
Third Place	$4,000	Based on the combined scores from all events.
Fourth Place	$3,000	Based on the combined scores from all events.
Fifth Place	$2,000	Based on the combined scores from all events.
Sixth Place	$1,000	Based on the combined scores from all events.
Most Energy Efficient Vehicle	$3,000	Highest energy economy determined from the Energy Economy Event using EPA combined city and highway cycle fuel economy method.
Best Acceleration	$1,000	Fastest Acceleration Time.
Best Dynamic Handling	$500	Awarded to the team with the highest combined Slalom, Skid Pad, and Breaking scores.
Best Over-the-Road Fuel Efficiency	$1,000	Based on the energy efficiency of the Endurance event.
Lowest Emissions	$1,500	Top-scoring performer in the Emissions event.
Best Technical Report	$1,500	Awarded for the top-scoring Technical Report.
Best Vehicle Design Inspection	$1,500	Awarded for the highest score in the Vehicle Design Inspection.
Best Oral Design Presentation	$1,500	Awarded for the highest score in the Oral Design Presentation. The application of advanced technology is stressed.
Best Consumer Acceptability	$1,000	Based on the top combined static and dynamic scores.
Best Appearing Vehicle	$1,000	Based on the scores of vehicle designers at the Consumer Acceptability Event.
Lowest Vehicle Driving Losses	$1,000	Based on the lowest total amount of energy lost during the city and highway cycles due to vehicle losses (rolling friction & aerodynamic). Losses calculated on the basis of each vehicle's coast-down testing data.
Best Safety	$500	Determined during the Vehicle Design Inspection Event, this award is based on the extent to which safety considerations are incorporated into the vehicle.
Best Use of Advanced Technologies	$1,000	Determined during the Vehicle Design Inspection Event, this award is given to the school that incorporates the best mix of advanced technologies. Equal weight is given to their number, application, level of development, and degree of integration in the overall vehicle design.
Best Use of Alternative Fuels	$500	Open to alternative-fueled vehicles (E-85, CNG, H_2, and DME), it is based on the sum of the scores of Emissions, Energy Economy, and Vehicle Design Inspection.
Innovations in Aluminum	$1000	Determined during the Vehicle Design Inspection Event, this award is based on the best application of aluminum.
Best Workmanship	Trophy	Best combined interior and exterior vehicle presentation based on the scores and input from the judges in the Vehicle Design Inspection Event.
Best Teamwork	Trophy	Awarded by the Organizers. Based on exceptional level of team performance throughout the competition to get the vehicle ready for events.
Sportsmanship Award	Trophy	Awarded by the Organizers to the team putting forth the highest level of assistance to other teams and organizers despite its own circumstances.
Spirit of the Challenge Award	Trophy	Awarded by the Organizers to the team showing perseverance in the face of adversity and maintaining a positive attitude throughout the competition.
Best Solo	Trophy	Awarded to the team with the lowest time in the optional Solo Event.

TEAMS

Pierre Sambour, J.P. Delebelis, Zorhab Lamy, Eric Lambert, Gilles Huard, Sam Graceffa, Dr. Henry Hong (Advisor), Saeed Moshirian. ***Not pictured:*** *Tony Tremonte, Jason Engler, Sho Fu Yeh, Mark Obulio, Taro Dicks, Hitan Patel, Patrick Mattei.*

School name:
Concordia University

Vehicle name:
RECHARGER

Faculty advisor:
DR. HENRY HONG

Team captain:
SAM GRACEFFA

The 1999 Concordia University FutureCar's team consists of 15 people, including 2 graduate students (both pursuing a Master's of Applied Science degree with a major in Mechanical Engineering) and 13 undergraduate students (6 in Electrical Engineering and 7 in Mechanical Engineering). For us, the FutureCar project is an extra-curricular activity.

Our major goal is to have a running HEV that uses DME as the fuel medium, which should reduce exhaust emissions. Another goal is to apply an innovative injector and fuel delivery system design. To achieve this goal, we developed a parallel charge-sustaining hybrid electric vehicle. For Recharger, our Dodge Intrepid, we chose to use a 4-cylinder, 1.9-L TDI Volkswagen engine that has been converted to use dimethyl ether (DME) as a fuel. We modified the fuel injectors, as well as the entire fuel delivery system, to be able to inject the DME in a liquid state. Because of the chemical composition of DME, using DME as the fuel medium in internal combustion (IC) engines (like our Volkswagen engine) will significantly reduce the harmful exhaust emissions associated with conventional IC engines that use diesel or gasoline. A Siemans Simatic Step-7 200 series PLC will be used to control the injection timing, as well as the operational sequences.

We're excited about the opportunity to combine practical experience with academics, as well as the chance to develop the teamwork and interpersonal skills needed in industry. Concordia will benefit from Challenge-related media exposure and will have the opportunity to showcase its engineering projects for potential and present sponsors—and recruit potential students. Another important benefit is school spirit, because the entire student body is rallying behind the FutureCar project.

School name:
Lawrence Technological University

Team name:
LTU = TOTAL POWER

Vehicle name:
E.D. (ELECTRIC DIESEL)

Faculty advisors:
NICK BRANCIK
DR. RICHARD STANLEY
DR. ROBERT FARRAH

Team captains:
BERNADETTE CLETO
NICOLE HALBACH
BRAD LARKIN

Front row: *David Ahomed, Rob Silvi, Nicole Halbach, Noel Plentos, Mike Tunney, Kevin Kasa, Michelle Covelle, Tom Cutsinger, An Vu.* ***Left side of car, row 1 L to R****: Brian Wilt, Delano Farmer.* ***Row 2, L to R:*** *Percey Ramsey, Kurtis Powers, Steve Wieland.* ***Row 3:*** *Dr. Robert Farrah.* ***Row 4:*** *Marty Brozowski.* ***Row 5, leaning on roof:*** *Nick Brancik.* ***Right side of car: Row 1, L to R:*** *John Swain, Dave Morse, Derek Szamanski.* ***Row 2, L to R:*** *Brad Larkin, Dennis DeDonatis, Matt McGlynn.* ***Row 3:*** *Jennifer Patrias.* ***Row 4:*** *Steve Jones.* ***Row 5, leaning on roof:*** *Tom McBride.*

The LTU team consists of 34 members (not including advisors) who are majoring in either mechanical engineering or electrical engineering. All team members are seniors.

Our FutureCar Team has converted a 1996 Ford Taurus into a charge-depleting parallel hybrid vehicle. Our car — E.D. (or Electric Diesel) — uses a 43-kW Unique Mobility brushless DC motor, a Volkswagen 1.9-L TDI diesel engine, and a Volkswagen 5-speed transmission. The E.D. has a 172-V nickel-metal hydride battery pack. Features such as low-profile prismatic side mirrors, lightweight carbon fiber and aluminum body panels, and an aerotail improve E.D.'s efficiency by reducing aerodynamic drag and weight. E.D. also boasts an advanced-technology Ker® clutch and HEV batteries produced by Ovonic. E.D. also has an advanced thermal management system to provide proper cabin atmosphere and other benefits. An air suspension and an overall control system help to improve E.D.'s performance and efficiency.

First and foremost, our team would like to place first in the competition. The benefits of being a member on this team are many. First, we have gained knowledge and experience in working as a team. Second, we will be learning about new concepts and technologies from the other universities that are involved in the FutureCar Challenge. Third, we will learn valuable skills that we will be able to apply to our engineering careers after graduation.

School name:
Michigan Technological University (MTU)

Team name:
MICHIGAN TECH FUTURECAR TEAM

Vehicle name:
NORTHWIND

Faculty advisor:
DR. JOHN BEARD

Team captain:
CLYDE BULLOCH

Dan Haapala, Karl Haapala, Dave Cummings, Brian Medema, Brandon Bloss, Loren DeVries, Aaron Thul, Clyde Bulloch, Christian Muehlfeld, Kenneth Haapala, Brian Couchene, Brian Peck.

Our team has 25 undergraduates representing several academic disciplines. We also have one EE graduate student, who is focusing on controls. The undergraduates involved in the program are all volunteers.

The MTU team will once again compete with a load-leveling series hybrid. This involves operating the engine-alternator combination at about 25 different power outputs, depending on the average amount of power that the vehicle requires to operate over finite time intervals (which are continuously re-evaluated). For 1999, we focused on developing a vehicle that met manufacturability, cost-effectiveness, and reliability goals while achieving 55 mpg and meeting Federal Tier II emissions. All of the major components in the 1999 vehicle are or have substitutes that are in mass production. The goal of meeting Federal Tier II emissions is being approached through the use of Fisher Tropsch Diesel, engine tuning, and catalyst development with the DaimlerChrysler Corporation.

Our team approaches the FutureCar competition not only with the spirit of competitiveness, but also with the spirit of cooperation as we work with everyone involved in the competition to produce the ultimate vehicle for the future. The FutureCar Challenge benefits the participating schools and their students in many ways. The students who participate in the Challenge not only become experts in hybrid electric vehicles, but also great assets to industry. Students who have participated in the Challenge have learned how to look at the "big picture" while working in an interdisciplinary team environment.

School name:
Ohio State University

Vehicle name:
LUMINATOR

Faculty advisors:
GIORGIO RIZZONI
GREG WASHINGTON

Team captain:
ALAN HOLMES

Alan Holmes, Dr. Giorgio Rizzoni (Advisor), Michael Nation, Ai Linh Hua, Andy Wingerter, Stephen England, Aaron Hampton, Troy Miller, Avra Brahma, Adam Orosz, Han Sung Kim, Fredrick Lust, Marc Crockett, Paul Zahniser, Betty Jo Collier, Mike Hopka. ***Not pictured:*** *Mark Sorna (grad), Ben Bakenhaster, Brad Glen, Ben Hatcher (senior), Joe Dombroski (freshman), Desmond Fong (sophomore), Pui Sai Pansy Lee, Andrea Mazzone, Devesh Upadhyay.*

Our team has 24 members; all of the participants are volunteers. Two-thirds are undergraduates, with 60% majoring in mechanical engineering and 30% majoring in electrical engineering.

Our team has been working on the two most promising configurations for HEVs. One is an electrically variable transmission, or EVT, which is similar to that used in the Toyota Prius in basic concept, but with a variety of operating modes for better performance and economy. The other is a parallel hybrid with a simplified mechanical transmission, which draws the maximum benefit from a single electric motor.

Our goals are both educational and technical. Students and the public learn about advances in automotive technology and efficiency in an interesting context that relates to their coursework and their daily transportation. Students and faculty also test the performance and practical value of their ideas for improving an important part of our daily lives.

School name:
Texas Tech University

Vehicle name:
BLACK MAGIC

Faculty advisor:
DR. TIMOTHY MAXWELL

Team captain:
ERLE RAWLINS

Chris Machuca, Chris Larson, Ryan Montgomery, Greg Lawford, Jason Harris, Mark Shuck, Erle Rawlins, Wallace Turner, Richard Howlett. ***Not pictured:*** *Bora Akgerman, M.D. Alam, Arif Amin, Todd Bell, William Decker, Brian D'Souza, Shailendra Dungar, Eduardo Favela, Bill Georgen, Justin Holcomb, Chad Kroecker, Paul Leonard, Michael Luce, John Manning, Manoj Maskey, David Mizar, Nichol Monagham, Miten Nagda, Manuel Olivas, Gabriel Ramirez, Michael Romero, Philip Scott, Brian Shaffer, Nabin Shrestha, Jonathan Teague, Casey Welch, Damon Williams, Yinglin Yang.*

Our 1999 FutureCar Challenge team consists of 14 undergraduate students (7 ME and 7 EE majors), 4 of whom are volunteers, and 14 graduate students (5 Advanced Vehicle Engineering students, 2 ME students, and 7 EE students).

We've chosen to implement a fuel cell in a mid-sized sedan, which is a series hybrid design. Black Magic uses our own form of a hydrogen recirculation pump that uses stored pressure to operate. Instead of charging our batteries in parallel, we're charging them in series, and each battery has its own charger.

We're excited about our work for the FutureCar Challenge. Since our program is multi-disciplinary, we have engineers from different disciplines who are learning to work together. We're also learning what it's like to work on a big project and meet deadlines.

School name:
University of California, Davis

Team name:
TEAM FATE

Vehicle name:
COULOMB

Faculty advisors:
DR. ANDY FRANK
DR. ANDY BURKE

Team captain:
BRIAN JOHNSTON

Back row, left to right: *Prof. Andrew Frank, Mark Duvall, Ben Mazet, David Ochoa, Rob Kamisky, Tom Bradley, Rafael Jimenez, Nicholas Struven, Iwan Kurniawan, Brian Huff, Julien Chevallier, James Vaughn, Ryan Laity, David Funston, Robert Balch, Bruce Momsen, Kevin Stump, Steven Khau, Courtney Waters, Tyler Garrard* ***Front row****, left to right: Mike Baxley, Charnjiv Bangar, Roberto Garcia, Samantha McMahon, Elaine Maes, Marjorie Anne Lester, Laurence Mayer, Chris Nitta, Nat Meyr, Peter Hutchison, John Hayes, Shing Wong, Jerome Cousin, Marcus Alexander, Richard Carlson, Brian Johnston, Brian Moran, Eric Chattot.* ***Not pictured:*** *Prof. Andrew Burke, Alexandre Dufour, Samuel Kao, Colleen Lindsey, Stacey Jo Ross, Aaron Rowden.*

Team Fate consists of 40 students: 6 grads and 34 undergrads (27 students are juniors or seniors). Thirty students are majoring in mechanical engineering, 8 are majoring in computer science or electrical engineering, one is majoring in aeronautical engineering, and one is majoring in design. Most of the students work as volunteers, and a few receive independent research or design units.

We've focused on all aspects of a vehicle's design — weight, aerodynamics, rolling resistance, fuel economy, emissions, and creature comforts. Our goal is to produce a car that is fun to drive, yet has high fuel economy, low emissions, and good performance. For Coulomb, we've used an in-line parallel powertrain consisting of a Nissan 2.0-L continuously variable transmission (CVT), a Unique Mobility custom 75-kW electric motor, and a 660-cc Subaru engine running on reformulated gasoline (RFG). The CVT uses a custom computer-controlled, servo-hydraulic shifting system developed at UC Davis. This system is mechanically very simple and minimizes parasitic hydraulic losses. The CVT allows the electric motor and engine to be operated near their highest efficiencies at all times. Electric motor and engine use are managed by a charge-depletion control strategy. In practice, this strategy requires a large battery pack (18-kWh high-power NiMH from Ovonic Battery Co.) to ensure long all-electric range and minimize fleet emissions. The UC Davis hybrid should qualify for at least 0.8 ZEV credits under the California LEVII mandate.

Thanks to the competition, we've been gaining practical engineering, leadership, and communication skills. We've also learned the importance of teamwork, budgets, time management, and deadlines. The competition setting encourages outside (corporate, government, and private) sponsorship, which supports UC Davis research.

School name:
University of Illinois at Urbana — Champaign

Team name:
ELECTRIC ILLINI

Vehicle name:
EMF2

Faculty advisors:
ROBERT A. WHITE
PHILIP T. KREIN

Team captain:
JEREMY A. CELLARIUS

Sean West (Electrical Systems Team Leader), Lian Cai, Johnny Douglas, Edward Polzin, Chad Gross, Dave Johns, Ryan Murphy, Eugene Pascaul, Eric Borrowman, Aaron Ickes, Richard O'Brien, Nate Schomp, Mark Meinhart, Erik Wise, Jeremy Cellarius (Team Captain & Mechanical Systems Team Leader), Matt Atsinger, Bill Pray, Mike Perry, Andy Krier, Bob Siller, Joe Mucha, Daliah Saper, Donald Chen, Alex Soto, Greg Laudermilch, Ricky Mat. ***Not pictured:*** *Prof. Robert A. White (ME), Prof. Philip T. Krein (EE).*

Our team consists of 40 members, who are split evenly between mechanical and electrical disciplines (although we have nearly every engineering discipline represented). We have two grad students (1 ME and 1 EE, who is our electrical systems team leader). Half of our team participates through a new course, Electric and Hybrid Automotive Systems. The others volunteer their time.

We are working to further develop our load-leveling series HEV design from 1998. A UIUC-patented switching capacitor network will equalize the charge between two adjacent batteries in the pack. Our generator controller is a student-modified 3-phase SCR firing-board-controlled rectifier. This is the first time the full control has been implemented (we've been developing the control circuit for these boards since the 1993 HEV Challenge).

As in all large-scale projects, we really benefit by participating in the Challenge. We are required to apply the technology in a practical setting — in some cases, we have to go beyond that and learn new technologies or techniques. We believe that the experience is an invaluable asset to our education and personal growth.

School name:
University of Maryland

Team name:
TERRAPINS

Vehicle name:
InTERPid

Faculty advisor:
DR. DAVID HOLLOWAY

Team captain:
JOSHUA GOLDMAN

Our team consists of 35 students: 30 Mechanical and 5 Engineering majors (all undergraduates, except for 1graduate), who are all involved in the project as a 3-credit technical elective.

Our car is a series hybrid electric vehicle (single speed following power generation). Our main goals in the Challenge are to explore new options in hybrid-electric vehicle design, as well as to learn about automotive design. By participating in the competition, we hope that the university will gain national recognition as a center for excellence in automotive design.

School name:
University of Michigan

Vehicle name:
WOLVERINE

Faculty advisor:
DR. VALDIS LIEPA

Team captains:
DANIEL T. HERRERA
LARRY A. MERCIER, JR.
MAYUR VALANJU

Front row: *Khaled Taleb-Agha, Daniel T. Herrera, Larry A. Mercier Jr., Jim Kane, Mayur Valanju.* ***Back row:*** *Brock Partee, Duane C. Wilder, Darren Losey, Parag Desai, Valdis Liepa (Advisor).*

Our team consists of volunteers and individuals who are getting credit for their work on the car. People from all disciplines of engineering are involved: Chemical Engineers, Electrical Engineers, Mechanical Engineers, and Material Science Engineers. Our group is made up of 15 undergraduate and 3 graduate members.

We are using a parallel configuration to power our car. We have quickly removed the torque converter and added an external pump to pressurize the transmission at the start, and then we shift back to the regular internal pump after a few seconds. We have a vacuum heat battery that stores hot coolant, and we recirculate that through the engine initially to reduce cold-start emissions and to heat up the passenger cabin quicker. Also, we have a regenerative braking system that captures the energy during braking and puts it back into the batteries. We are using a kevlar/carbon fiber composite hood to lower the hood weight to a mere 8 lb and are adding a pearl coat to the paint to increase consumer acceptance.

By participating in the Challenge, we are developing the ability to apply the theories that we learn in class to solve real-world problems. Also, we have developed key time-management skills that can be applied to the real world. More important, though, we believe that we have developed people skills during this project that we could not have developed in the classroom.

School name:
University of Tennessee

Team name:
UNIVERSITY OF TENNESSEE FUTURECAR TEAM

Faculty advisor:
DR. JEFF HODGSON

Team captain:
DOUG FERGUSON

Front row: *Nik Gresshoff, Hans Swift, Larry King, Fred Mottley, Mary Webb, Paul McCown, Craig Rutherford (graduate student), Doug Ferguson (team captain), Issac Freeman, and Geoff Howley.* ***Back row:*** *Jason Shaw, Jack Frens, Dr. Jeff Hodgson (Advisor), Steve Borgman.* ***Not pictured:*** *Mary Carville Webb, Veronika Gospodareva, Nik Gresshoff, Claudell Hatmaker, Stephen Jesse, Larry King, Paul McCown, Fred Mottley, Matt Smith, Hans Swift.*

Our team of 17 includes 12 undergraduate and 5 graduate students. We are all Mechanical Engineering majors, and this is a credit program.

We have a duel-hybrid electric vehicle. The ICE is a 1.9-L Saturn engine, which we have converted to run on compressed natural gas (CNG). The primary drive is a Unique Mobility electric motor. Our vehicle's generator is a Unique Mobility SR180 SR brushless DC permanent magnet motor. Power storage is electrochemical; we are using 27 lead acid Hawker Genesis 13-Ah 12-V batteries. The power split device is a planetary gear set.

We're looking forward to the competition. Our objectives in competing in the 1999 FutureCar Challenge have been to learn more about hybrid electric vehicles and their systems, improve our engineering skills, and add to the University of Tennessee's engineering curriculum. We hope to improve our skills in the areas of teamwork, leadership, communications, scheduling, and economics. By accomplishing our objectives, we will meet our goal of having a competitive entrant in the 1999 FutureCar Challenge.

School name:
University of Wisconsin — Madison

Team name:
UW-MADISON FUTURECAR TEAM

Vehicle name:
ALUMINUM COW

Faculty advisor:
DR. GLENN BOWER

Team captain:
MIKE KOPLIN

Front row: *Bich Ty Lee, Jon Ertmer, Ethan Brodsky, Anton Kozlovsky, Mike Koplin, John Norquist, Herman Wiegman, Ted Bohn, Chris DeSalvo.* ***Back row:*** *Dr. Glenn Bower (Advisor), Brian Swenson, Jon Butcher, Joel VanEss, Neel Vasavada.*

Our team consists of undergraduate students pursuing diverse majors: Mechanical Engineering, Industrial Engineering, Electrical Engineering, Chemical Engineering, Material Science, Computer Science, and Business. We have about 50 members, who are mostly volunteers, but some (~20) are also credit students.

We've employed a number of innovative approaches to our vehicle, the Aluminum Cow. For example, we're using a small, lightweight battery pack. In addition, the Aluminum Cow would be easy to manufacture because the drivetrain fits between framerails, and the HV system is integrated into the battery box (except the inverter and motor).

We're excited about the competition because it gives us an opportunity to have hands-on experience building a high-tech car. That experience really builds upon classroom theory. We're also excited about our real-world experience working with suppliers and meeting deadlines.

School name:
Virginia Tech

Team name:
HEVT (HYBRID ELECTRIC VEHICLE TEAM OF VIRGINIA TECH)

Vehicle name:
ANIMUL H2

Faculty advisor:
DR. DOUGLAS NELSON

Team captain:
MIKE OGBURN (GRADUATE STUDENT)

Front row: *William Luttrell, Michael Johnston, Craig Van Tine, Mark Schmale, Rick Pabst, Shea Fitzgibbons, Lally Singh, Tobe Greider, Paul Bryan, Scott Mattison, John Bird, Dr. Douglas Nelson (Advisor), Aaron Gooding, Alex Boligitz, Eric Hossenlopp, Andrew Scanlon, Mike Ogburn, David O'Neal, Paul Atwood, Brian King, Ryan Leisey.* ***Not pictured:*** *Kevin Alexander, Michael Angiolillo, Joe Barretta, Charles Bell, Jeff Berry, Carl Craddock, Robert Dickerson, David Donofrio, Robert Fahrenkrog, Stephen Gurski, J.P. Hansen, Andi Hartman, Daren Herring, An Huynh, Rob Lindstrom, Eric Marth, Daria Michael, Brian Murphy, Neil Placer, Andy Pogany, Anthony Poo, Scott Postle, Levi Quelland, Greg Settle, Gregg Sherman, Rich Silva, Bryant Sims, Chris Smith, Michael Stewart, Megan Welpe.*

Our team consists of 49 people. Most of the participants are senior ME majors who are earning credit for the project, although a number of us are volunteering our time.

Virginia Tech's ANIMUL H2 is a fuel-cell hybrid-electric vehicle with a 100-kW drive and a 20-kW fuel cell APU. We've employed regenerative braking and off-board inductive charging technologies, as well as thermostatic state-of-charge control with load following control of the fuel cell APU. Onboard vehicle systems include compressed hydrogen fuel storage, a 3-kWh lead acid battery pack, air supply, and humidification. ANIMUL H2 also has a DI thermal control system and a Pentium-based control system with an LCD-touch driver interface.

In the 1999 FutureCar Challenge, we hope to be competitive and yet demonstrate the potential of applying fuel cells in current vehicles. We also hope to promote the application of advanced technologies in today's automotive marketplace.

School name:
West Virginia University

Faculty advisor:
DR. CHRIS ATKINSON

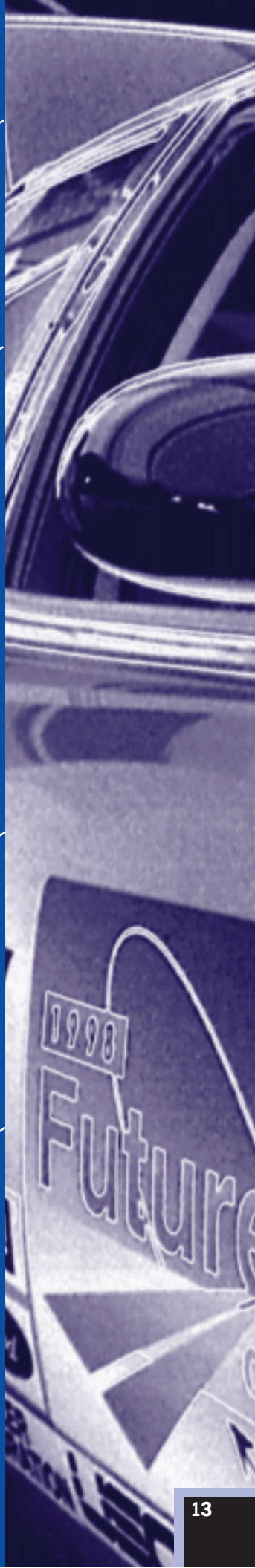
Team captains:
STEVE BURKE
JOHN ANDERSON

Back row, from left: *Mei-Ling Wu, Zazli Zabidi, Nick Rossi, Jason Conley, Steve Burke, Csaba Toth-Nagy, John Long, Sam Taylor.* ***Front row, from left:*** *Richard Kariuki, John Anderson and Emmanuel Malenya.*

This year, our team consists of 18 participants: 3 grad students, 12 undergrads, and 3 volunteers.

Our hybrid is based on a parallel hybrid drivetrain, with a 75-kW Unique Mobility electric motor assisting a CNG-fueled, 60-kW Ford 1.6-L SI engine. The strengths of this design are excellent performance, extremely low emissions, and a sophisticated control strategy that allows for significant gains in fuel economy. This strategy requires the engine to operate at or near maximum torque whenever it is running, with excess power being returned to the batteries through a charging-while-driving mode for use during ZEV operation.

For our team, the most important part of FutureCar is having fun while learning. We've acquired more practical knowledge in our first week in the shop than at any other time in our academic lives, and we have fun doing it. As a result, we have gained an enviable reputation in HEV design, which helps FutureCar alumni get jobs they enjoy upon graduation.



1997 FutureCar challenge

COMPETITION HOST SITE

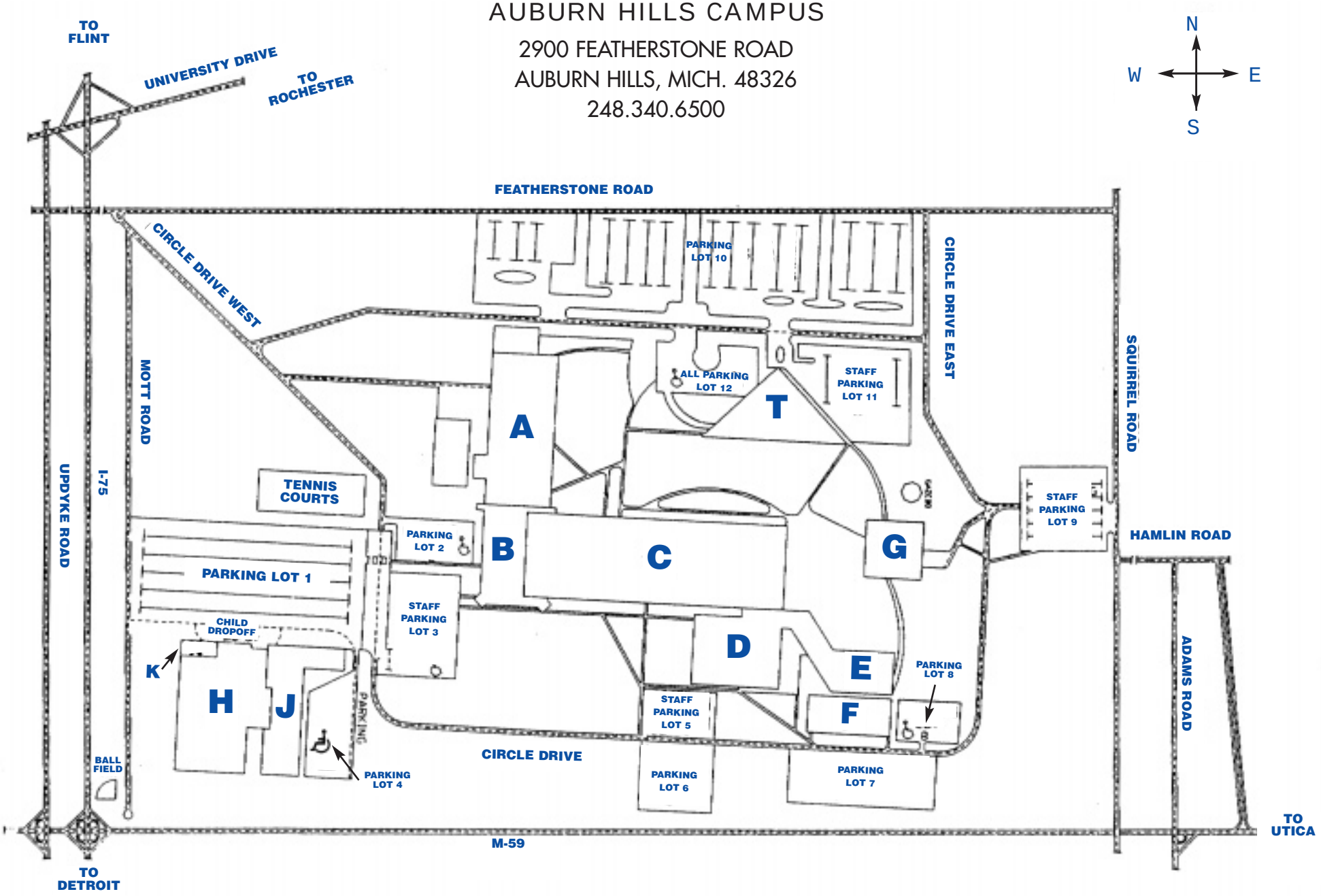
KEY TO MAP

Academic Support.....D
Administration .....B-2nd Floor
Admissions B-242
Bookstore.....G
Business Dept.....C
Business Office.....B-214
CAD Lab.....A
Cafeteria.....G
Cashier's Office .....B-2nd Floor
Child Care Center .....K
Counseling.....B-238
Educational Services .....D
English Dept. .....D
Financial Aid B-227
Gymnasium .....H
Humanities Dept. .....D
I.I.C.....D
Job Placement.....B-112
Library .....D
L.R.C. .....D
Mac Lab.....D
Math Dept. C
Natural Science Dept. C
Police Academy .....J
Public Safety .....G
Registration.....B-242
Social Science Dept.....D
Technology Dept. .....B
Welcome Center .....B-2nd Floor
Handicap Parking.....

Oakland County Community College

AUBURN HILLS CAMPUS

2900 FEATHERSTONE ROAD
AUBURN HILLS, MICH. 48326
248.340.6500



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B20

1999 FUTURECAR CHALLENGE HEADLINE SPONSORS

U.S. Department of Energy

The Department of Energy (DOE) has an aggressive R&D program in advanced vehicle technologies . The DOE — and its network of national laboratories — supports work in fuel cells, energy storage, hybrid systems, advanced materials, alternative fuels, and heat engines. As a corollary, the DOE has been sponsoring student vehicle competitions since 1989. These competitions are an effective way to demonstrate and test the technologies developed in the laboratory. Over 15,000 students have received hands-on engineering experience in these competitions. Many of them move on to take jobs in the automotive industry, bringing with them an understanding of and enthusiasm for these technologies.

Natural Resources Canada

Natural Resources Canada, through its research and technology development arm, CANMET Energy Technology Centre, is a proud sponsor of the 1999 FutureCar Challenge. NRCan, in partnership with the U.S. Department of Energy, has been a sponsor of these student vehicle challenges since they first began in 1989. By combining the next generation of technical innovators with some of North America's emerging alternative transportation technologies, the FutureCar Challenge is helping to ensure a sustainable, environmentally responsible transportation future.

United States Council for Automotive Research (USCAR)

USCAR is an organization formed by Chrysler, Ford, and General Motors to strengthen the technology base of the domestic auto industry through cooperative pre-competitive research. Collaborative research and development work among the three auto companies has been under way since 1988. USCAR was formed in 1992 to help coordinate administrative and informative services for the companies' existing and future research consortia devoted to tackling shared technological and environmental concerns. In late 1993, USCAR formed the Partnership for a New Generation of Vehicles (PNGV) with the federal government to develop technologies that get up to 80 mpg with fewer emissions. USCAR's website — www.uscar.org — contains a wealth of information on these advanced technologies.

1999 FUTURECAR CHALLENGE HOST SPONSOR PROFILE

OAKLAND COMMUNITY COLLEGE

OCC was established in 1964 by a vote of the Oakland County electorate. Since its community college record-opening enrollment of 3,860 in the fall of 1965, OCC enrollment has grown to 25,000 credit students attending five campuses and several extension centers. The college offers university transfer associate degrees in Business Administration, Pre-International Commerce, Science, Liberal Arts, Liberal Arts/Fine Arts (Visual), and Science Pre-Engineering. Additionally, OCC offers career associate degrees in more than 90 technical and semi-professional occupations. Over 800 full-time employees strive to actualize the OCC mission of being a student-centered institution that provides quality learning opportunities for individuals, communities, and organizations on an accessible, affordable basis.

Oakland Community College is very encouraged to again serve as the host site for the FutureCar Challenge. Its Automotive Servicing Associate Degree and Certification Program is greatly enhanced through faculty and staff participation in the FutureCar Challenge. Unique, innovative programs such as the FutureCar Challenge help to ensure that OCC will be the comprehensive community college citizens of the third millennium will demand. The lessons the FutureCar Challenge will teach in partnerships and teamwork as new automotive technologies are developed during the competition will positively impact participants for years to come.

1999 FUTURECAR CHALLENGE SPONSOR PROFILES

FutureCar Challenge sponsors lend financial, in-kind, and material support to the university teams. They do so because their missions are complementary to those of the FutureCar Challenge: develop and use technologies that promote efficiency, safety, and environmental protection. Their support is much needed and highly valued.

The Aluminum Association, Inc.

The Aluminum Association is the trade association for U.S. producers of primary aluminum, recyclers, and semi-fabricated aluminum products. Its Automotive and Light Truck Group works to accelerate the use of aluminum in automotive structures and components by demonstrating and promoting that it is the material of choice for high-value, safe, environmentally friendly, and superior performing vehicles. Member companies operate more than 200 plants in 35 states.

Detroit Edison

Detroit Edison, a DTE Energy Company, is the nation's seventh-largest electric utility. As the energy supplier to America's industrial heartland, Detroit Edison serves more than five million people in Southeastern Michigan. Detroit Edison is no longer just a traditional electric utility, but a company providing its customers with solutions to their energy needs with a broad range of products and energy-management services. More than one million miles of electric vehicle operation and maintenance experience helps us to provide power and technical expertise to the FutureCar Challenge.

The United States Environmental Protection Agency

The EPA is committed to protecting people from significant harm to their health and environment and reducing human health and environmental risks based on the best available scientific information. Reducing air pollution is a high priority. Through cooperation among researchers and the automobile industry, the average car today emits 60-90% less pollution over its lifetime than cars 20 years ago.

The United States Department of Commerce

The Department of Commerce plays a vital national role of promoting job creation, economic growth, sustainable development, and improved living standards through partnerships with business, universities, communities, and workers. One of the most successful partnerships led by the Department of Commerce is the Partnership for a New Generation of Vehicles, a historic alliance between the government and the American automotive industry to develop highly fuel efficient, very low emission cars for the 21st century. The Department of Commerce is determined to maintain American competitiveness in the world market by developing the types of cutting-edge technologies showcased in the FutureCar Challenge.

The National Science Foundation

The NSF is an independent agency of the U.S. federal government responsible for investing over $3.3 billion annually in almost 20,000 research and education projects covering nearly all fields of science and engineering. The Foundation encourages high quality in education at all levels and heavily supports graduate education in the sciences and engineering. It is well known for its promotion of science, the numerous advances it has funded, and the recognition that its grantees have achieved, including several Nobel prizes and other highly prestigious awards.

FutureCar 1999 Participating Schools and Universities

Concordia University

Lawrence Technological University

Michigan Technological University

Ohio State University

Texas Tech University

University of California, Davis

University of Illinois — Urbana

University of Maryland

University of Michigan

University of Tennessee

University of Wisconsin — Madison

Virginia Tech

West Virginia University

FutureCar 1999 Sponsors

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Oakland Community College (OCC)

U.S. Department of Energy

U. S. Council for Automotive Research (USCAR)

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