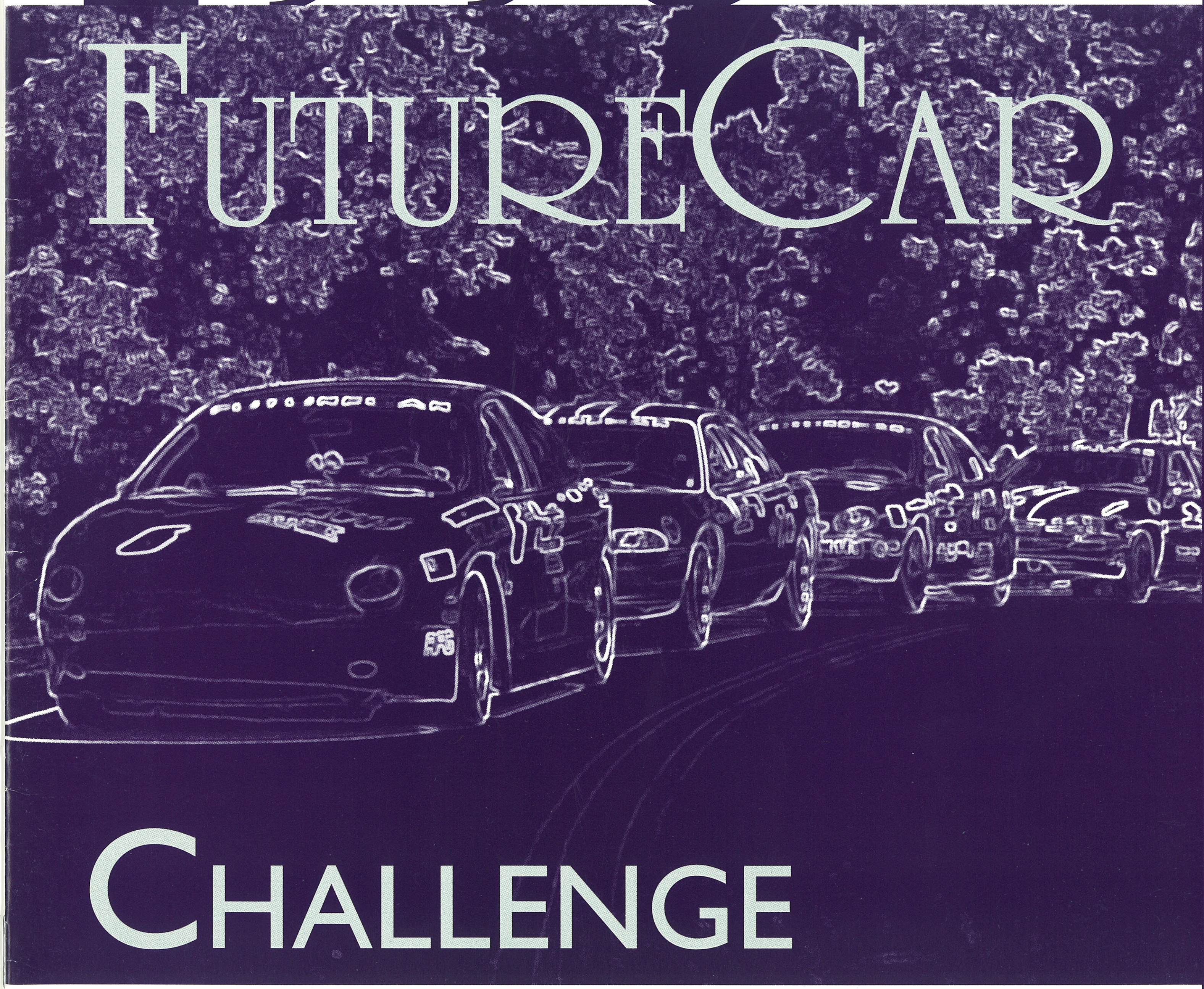
1998 FutureCar Challenge



1998 FutureCar challenge

Program

What Is The FutureCar Challenge?

The 1998 FutureCar Challenge is a student engineering competition designed to provide students with hands-on experience addressing real-world issues and advancing state-of-the-art technology. FutureCar is cosponsored by the U.S. Department of Energy (DOE) and the United States Council for Automotive Research (USCAR), a joint research effort among Chrysler Corporation, Ford Motor Company, and General Motors Corporation. The sponsors have invited 13 North American universities to use the most advanced vehicle technologies to modify a mid-size sedan to reach 80 miles per gallon (mpg) while still offering the same comfort, safety, and affordability that consumers expect from conventional vehicles.

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

Students will apply cutting-edge technology to meet the tough guidelines of the competition, including advanced propulsion systems, space-age materials, and alternative fuels like natural gas, ethanol, and hydrogen. 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.

The third annual FutureCar Challenge runs June 3 through 10, 1998, and begins with a series of technical evaluations at Oakland Community College in Auburn Hills, Michigan. Industry and government engineers will measure fuel efficiency, exhaust emissions, range, acceleration, braking, handling, and driveability. 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.

Highlights of this year's competition include design judging and a display at the Detroit Grand Prix; on-track testing at the Chrysler Technology Center in Auburn Hills; emissions and efficiency testing at the U.S. Environmental Protection Agency's National Vehicle and Fuel Emissions Laboratory in Ann Arbor; and a vehicle display and competition closing at Greenfield Village in Dearborn.

What Is The Partnership For A New Generation Of Vehicles?

PARTNERSHIP FOR A NEW GENERATION OF VEHICLES

Announced in September 1993 by President Clinton, Vice President Gore, and the CEOs of Chrysler, Ford, and General Motors, PNGV is a partnership between the federal government and the nation's major automobile manufacturers. This historic government-industry partnership also includes research support from scientists and engineers at universities, automotive suppliers, and small businesses to achieve important national goals:

- Significantly improve U.S. competitiveness in manufacturing
- Apply commercially viable innovations to conventional vehicles
- Develop technologies for vehicles that will achieve up to 80 mpg while maintaining performance, safety, and affordability

There are many ways to achieve an 80-mpg vehicle, but each requires a delicate balance among vehicle fuel economy, power efficiency, and characteristics such as vehicle mass, aerodynamic drag, braking recovery efficiency, and accessory load.

Key Sponsors

U.S. Department of Energy

The U.S. Department of Energy has an aggressive research and development (R&D) program in advanced vehicle technologies. DOE and its network of national laboratories support work in fuel cells, energy storage, hybrid systems, advanced materials, alternative fuels, and heat engines. As a corollary, DOE has sponsored student vehicle competition since 1989. These competitions are an effective way to demonstrate and test the technologies developed in the laboratory. More than 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 1998 FutureCar Challenge. 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

The United States Council for Automotive Research (USCAR) was formed by Chrysler, Ford, and General Motors to strengthen the technology base of the domestic auto industry through cooperative precompetitive research. Collaborative R&D work among the three auto companies has been under way since 1988. USCAR was founded 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.

FutureCar Supporters

OAKLAND COMMUNITY COLLEGE

Detroit Edison

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NATIONAL SCIENCE FOUNDATION

American Iron and Steel Institute

The Aluminum Association

GOODYEAR

Managed by Argonne National Laboratory and the American Society for Engineering Education

ARGONNE NATIONAL LABORATORY OPERATED BY THE UNIVERSITY OF CHICAGO

AMERICAN SOCIETY FOR ENGINEERING EDUCATION ASEE

FutureCar Challenge Schedule

Wednesday, June 3		
Registration	8:00 – 11:00 a.m.	OCC – Garage Area
Vehicle Inspection	9:00 a.m. – 5:30 p.m.	OCC – Garage Area
Refueling	9:00 a.m. – 5:00 p.m.	OCC – Outside Garage Area
Qualifying	2:00 – 5:30 p.m.	OCC – Lot F/Mott Road
Safety Meeting/Skit Night	5:30 – 8:00 p.m.	OCC – Gym, Bldg. J
Charging	8:00 – 10:00 p.m.	OCC – Charging Tent, Garage Area
Qualifying	8:00 – 9:30 p.m.	OCC – Lot F/Mott Road
Thursday, June 4		
Opportunity Charging	8:00 a.m. – 10:00 p.m.	OCC – Charging Tent, Garage Area
Vehicle Inspection	8:00 – 11:00 a.m./12:30 – 5:30 p.m.	OCC – Outside Garage Area
Refueling	8:00 – 11:00 a.m./12:30 – 5:30 p.m.	OCC – Garage Area
Qualifying	8:00 – 11:00 a.m./12:30 – 9:30 p.m.	OCC – Lot F/Mott Road
Opening Ceremony	11:00 a.m. – noon	OCC – Garden Area
Team Meeting	6:00 – 7:00 p.m.	OCC – Garage Area
Friday, June 5		
Caravan to CTC	7:30 – 8:00 a.m.	OCC to CTC
Acceleration	8:00 – 9:00 a.m.	CTC – Track
Oral Design Review	9:00 a.m. – noon/1:00 – 5:00 p.m.	OCC – T1
Coast Down Testing	9:00 a.m. – 6:00 p.m.	CTC – Track
Caravan to OCC	6:00 – 6:30 p.m.	CTC to OCC
Team Meeting	6:30 – 7:30 p.m.	OCC – Cafeteria
Saturday, June 6		
Trailer to Hamtramck	6:00 – 7:00 a.m.	OCC to Hamtramck
Shuttle to Belle Isle	7:00 – 7:30 a.m.	Hamtramck to Belle Isle
Shuttle to Hamtramck	5:00 – 5:30 p.m.	Belle Isle to Hamtramck
Design Review, Display	9:00 – 5:00 p.m.	Detroit Grand Prix at Belle Isle
Trailer to Auburn Hills	5:30 – 6:30 p.m.	Hamtramck to OCC
Faculty Dinner	8:00 – 10:00 p.m.	Mountain Jacks
Sunday, June 7		
Vehicles to EPA, CTC	5:30 – 6:30 a.m.	EPA, CTC
Emissions Testing	6:30 a.m. – 9:00 p.m.	EPA, CTC
Vehicles to OCC	9:00 – 10:00 p.m.	EPA, CTC
Monday, June 8		
Emissions Testing	7:00 a.m. – 9:00 p.m.	EPA, CTC
Tours	8:00 a.m. – noon	CTC
Refueling	2:00 – 9:00 p.m.	OCC – Outside Garage Area
Charging	2:00 – 9:00 p.m.	OCC – Charging Tent, Garage Area
Team Meeting	6:00 – 7:00 p.m.	OCC – Garage Area
Tuesday, June 9		
Trailer to CTC	7:00 – 8:30 a.m.	OCC to CTC
Endurance	8:30 – 11:30 a.m.	CTC – Track
Caravan to OCC	11:30 a.m. – 12:30 p.m.	CTC to OCC
Refueling	11:30 a.m. – 1:00 p.m.	OCC – Outside Garage Area
Charging	noon – 1:00 p.m.	OCC – Charging Tent, Garage Area
Dynamic, Static Consumer Acceptability	1:30 – 6:00 p.m.	OCC – Lot F
Solo	6:00 – 8:00 p.m.	OCC – Lot F
Charging	7:00 – 10:00 p.m.	OCC – Charging Tent
Team Meeting	8:30 – 9:30 p.m.	OCC – Cafeteria
Wednesday, June 10		
Caravan to HFM	6:30 – 7:30 a.m.	HFM
Vehicle Display Setup	7:30 – 8:30 a.m.	HFM – Entrance
Vehicle Display	9:00 a.m. – 1:00 p.m.	HFM – Entrance
Awards Ceremony	1:00 – 3:00 p.m.	HFM – Lovett Hall

OCC = Oakland Community College
EPA = Environmental Protection Agency
CTC = Chrysler Tech Center
HFM = Henry Ford Museum

Concordia University

Faculty Advisor: *Henry Hong*
Team Leaders: *Douglas Monahan, Federico Polidori, Luciano Martin*

Vehicle Number 2

The Concordia University Dodge Intrepid is a parallel hybrid electric vehicle (HEV) with zero-emission-vehicle (ZEV) capabilities. The Concordia FutureCar uses two power plants: the main plant is a Volkswagen turbo direct-injection (TDI) diesel engine, and the second is a Solectria Permanent Magnet electric motor. A Motorola microcontroller manages battery-pack state of charge (SOC) and controls the engagement and disengagement of the clutch that connects the diesel engine to the drivetrain. The Solectria motor has regenerative capability, which is used to recapture some of the energy lost as heat dissipated when braking. The recaptured braking energy is then sent back to the battery pack. A driving cycle with a combination of city and highway driving will keep the battery pack at an 80% SOC, making it a charge-sustainable HEV. Lightweight materials have been used to replace steel door skins and all four door glasses.

Lawrence Technological University

Faculty Advisors: *Craig Hoff, Nick Brancik*
Team Leader: *Becky Steketee*

Vehicle Number 4

Lawrence Technological University is a team to watch in 1998. Their parallel hybrid Ford Taurus was a strong contender in the 1996 FutureCar Challenge, but a major change last year – automatic, hydraulic shifting of the manual transmission – ran into mechanical problems, leaving them with a disappointing finish in 1997. But Becky Steketee, team leader, claims that is all behind them now. She reports that thousands of bench-test shifts prove the system is now dependable. The special transmission is paired with a modified 1.9-L, direct-injected Volkswagen turbo-diesel engine. Electric propulsion adds thrust under acceleration, and the diesel runs by itself under cruising conditions.

Michigan Technological University

Faculty Advisor: *John Beard*
Team Leader: *Matt Hortop*

Vehicle Number 7

The 1998 Michigan Technical University (MTU) FutureCar, the Northwind, is a series HEV conversion of a Dodge Intrepid. The car is propelled from 0 to 60 mph in under 12 seconds by a Unique Mobility 75-kW DC permanent magnet motor and single-speed transaxle. The motor's power comes from either the 330-V traction battery pack (26 Hawker Genesis 16-amp-hour lead acid batteries) or the auxiliary power unit (APU). The APU consists of a 32-kW DC permanent magnet alternator engine, directly coupled to a 1.5-L Peugeot diesel engine. The power demands on the engine are controlled via a true load leveling strategy using the alternator's power electronics.

Ohio State University

Faculty Advisors: *Gregory Washington, Giorgio Rizzoni*
Team Leader: *Alan Holmes*

Vehicle Number 13

The Ohio State FutureCar Team offers a practical family car with low manufacturing cost and a practical, durable combination of a direct-injection compression-ignition engine, parallel hybrid electric drivetrain, and a low-mass battery pack. Its electric system sustains its charge, so the Lucky 13 requires only fuel, which can be normal diesel fuel, 100% farm-grown or recycled soy oil, or any combination. Aerodynamics and mass are improved with composite parts from an investigation of advanced manufacturing.

Texas Tech

Faculty Advisor: *Tim Maxwell*
Team Leader: *Chris Larson*

Vehicle Number 8

The Texas Tech FutureCar, Black Magic, is a platform for demonstrating the latest fuel cell and automotive technology. The vehicle features a proton-exchange-membrane fuel cell, flat-transformer-based power converters, and a custom-built, dual-motor powertrain. With consumer satisfaction in mind, an emphasis was placed on comfort, driver-friendly operation, and performance. Offering 210 ft-lbs of neck-wrenching torque and a stout 195 hp, modest acceleration was the last thing on the minds of Texas Tech engineers.

University of California, Davis

Faculty Advisor: *Andy Frank*
Team Leaders: *Marcus Alexander, Chris Van Wert*

Vehicle Number 6

UC-Davis will be using a parallel, charge-depletion hybrid control strategy. A large, efficient Ovonics nickel metal hydride battery pack will be combined with a custom-designed 75-kW Unique Mobility electric motor. This combination will provide a significant all-electric range and allow acceleration equivalent to a standard V-6 sedan. A small-displacement Subaru gasoline engine is implemented to extend the range of the vehicle at steady-state operation and low states of battery charge. The engine and motor will operate through a computer-controlled Nissan continuously variable transmission (CVT). The CVT will allow the driver to control the vehicle as a conventional automatic transmission, while allowing the engine to operate at its best efficiency. This powertrain and control strategy will be mated to an aluminum-intensive Mercury Sable, in an effort to reduce the vehicle weight to below 2,800 lbs. The reduced weight will allow for increased performance while decreasing consumption and emissions. Peripheral systems, such as power steering and climate control, will be optimized for efficiency and consumer acceptability.

University of Illinois at Urbana – Champaign

Faculty Advisor: *Robert A. White*
Team Leader: *Jeremy Cellarius*

Vehicle Number 14

The University of Illinois at Urbana-Champaign FutureCar runs a series HEV. The control of the auxiliary power unit (APU) tracks power use of the motor and optimizes the amount of power generated for the best possible engine, generator, and battery storage efficiency. The APU is powered by a small diesel engine that runs on B20 biodiesel fuel. To further increase vehicle efficiency, the coefficient of drag was reduced by smoothing the front and rear shapes and adding a belly pan to decrease the amount of turbulence under the car.

University of Maryland

Faculty Advisor: *David Holloway*
Team Leaders: *David Higdon, George Konstantakopolus*

Vehicle Number 11

The University of Maryland has developed a passive-controlled, charge-sustaining, series HEV out of a 1995 Dodge Intrepid. The powertrain consists of two Northrup Grumman motors and controllers, an E85 three-cylinder Suzuki engine, 16-amp-hour Hawker Genesis batteries (324 V), and a New Venture Gear 11.5:1 single-speed transmission. During city use, the vehicle will operate thermostatically, running the engine around its most efficient point, which will provide power for the traction motor and charge the batteries. On the highway, it will use a load-leveling strategy in which the engine will provide the nominal power to the traction motor, and the batteries will only be used for those short demands of high power. The vehicle also has regenerative braking. Other optimized features include the fuel tank, battery-pack cooling system, composite hood and trunk, aluminum subframe, Sanden high-voltage AC system, custom-made Walker exhaust system, exhaust gas recirculation, three-way controlled catalyst, heat battery, and additional lightweight components.

University of Michigan, Ann Arbor

Faculty Advisor: *Valdis Liepa*
Team Leader: *Alex Sammut*

Vehicle Number 5

The University of Michigan has developed a parallel HEV, the Dark Horse, with a 30-kW Fisher motor and the new updated 1.9-L Volkswagen TDI engine. The team has continued work from previous years to reduce the weight of the vehicle. Additionally, an aggressive strategy to reduce NO_x and particulate emissions has been developed to improve the overall design of the car. Further, a new electronic brake system has been developed to improve regenerative braking strategy.

University of Tennessee

Faculty Advisors: *Jeffrey Hodgson, Bill Hamel*
Team Leader: *CeCedric Bobo*

Vehicle Number 15

The University of Tennessee entry into the 1998 FutureCar Challenge is designed to operate as a dual hybrid vehicle. In this configuration, the vehicle is capable of operating as either a parallel or series hybrid vehicle. The vehicle uses a compressed natural gas (CNG)-fueled Saturn 1.9-L engine with a Miller combustion cycle as an auxiliary power unit. The battery pack consists of 28 Hawker Genesis 13-amp-hour lead acid batteries (336 V nominal). The primary tractive power is provided by a Unique Mobility permanent magnet brushless DC motor with a smaller motor of similar design acting as a generator. The controls system intelligently selects the vehicle mode of operation and controls the driving components appropriately. It can operate as a charge-sustaining vehicle. Low-rolling resistance tires are utilized to decrease the force opposing vehicle motion, thus increasing fuel efficiency. The most significant mechanical feature of the vehicle is the implementation of a power-split-gear reduction device that allows a fixed ratio of traction motor to wheel speed while allowing the engine to operate at a constant speed with a continuous variable ratio to the wheel.

University of Wisconsin – Madison

Faculty Advisor: *Glen Bower*
Team Leaders: *Ethan Brodsky, Jon Butcher, Jon Ertmer, Mark Metoki, Matt Peterson, Jamie Pitterle, Tim Robeke, Matt Thiel, Neel Vasvada*

Vehicle Number 10

For the 1998 FutureCar Challenge, the University of Wisconsin's Ford Taurus, the Aluminum Cow, will be a parallel HEV. The vehicle's primary power source will be a 65-kW Ford TDI engine, assisted by a 32-kW Unique Mobility Drive System. The electric drive will receive power from a 7.5-kW amp-hr, 240-V nickel-cadmium battery pack and is capable of regenerative braking. A 586-PC-104 computer will manage the controls.

Virginia Tech

Faculty Advisor: *Doug Nelson*
Team Leaders: *Andy Pogany (EE), Mike Ogburn (ME)*

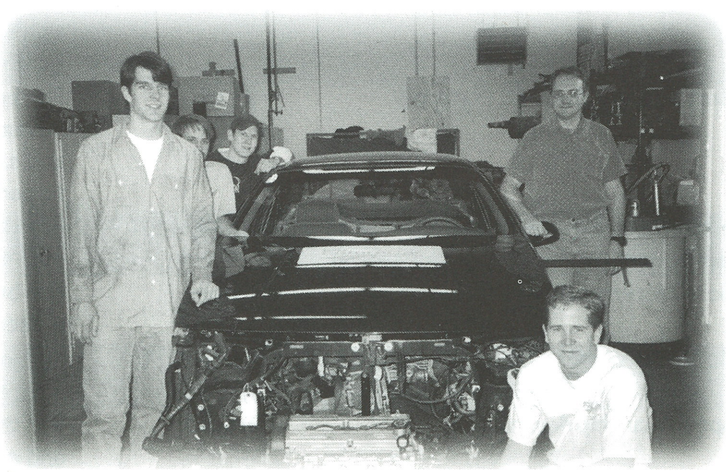
VEHICLE NUMBER **1**

The Virginia Tech Animul H2, a converted Chevrolet Lumina, is a series HEV. An AC induction motor and IGBT inverter provide traction and regenerative braking. A relatively small, sealed, lead acid battery pack provides transient power for the electric drivetrain. The average power demand of the vehicle is met by a 20-kW proton-exchange membrane fuel cell stack fueled by pure hydrogen stored as a compressed gas. Other fuel cell subsystems include air compression and humidification, stack cooling water loop, output power processing, and controls. The vehicle is charge-sustaining with the fuel cell system operated in a load-following strategy for high efficiency and zero emissions.

West Virginia University

Faculty Advisor: *Chris Atkinson*
Team Leader: *Steve Burke*

VEHICLE NUMBER **3**



The West Virginia University team is in the process of converting its 1994 Mercury Sable aluminum-intensive vehicle into a CNG/electric parallel HEV, with a view of achieving even lower exhaust emissions, better fuel efficiency, and better performance than their previous generation sub-ULEV Chevrolet Lumina series HEV. The engine used in the vehicle is a conversion of a Ford 1.6-L DOHC Zetec engine to CNG operation, coupled with a 75-kW Unique Mobility permanent magnet motor, to an Acura Integra 5-speed transmission. The control strategy is to use the electric drive motor for initial acceleration, regenerative braking energy recovery, and reducing the peak load and transients seen by the engine. A relatively small pack of advanced lead acid batteries used for energy storage is situated in and below the trunk. Exhaust emissions reduction measures include the use of CNG-specific catalysts and EGR.

AWARDS

Awards	Amount	Description
First Place	$6,000	Based on combined scores from all events
Second Place	$5,000	Based on combined scores from all events
Third Place	$4,000	Based on combined scores from all events
Fourth Place	$3,000	Based on combined scores from all events
Fifth Place	$2,000	Based on combined scores from all events
Sixth Place	$1,000	Based on combined scores from all events
Most Energy Efficient Vehicle	$3,000	For highest energy economy from the Energy Economy Event, based on EPA combined city and highway cycle fuel-economy method
Best Overall Engineering Design	$3,000	Based on combined scores from the technical report, oral presentation, and vehicle design inspection
Best Acceleration	$1,000	For fastest acceleration time
Best Dynamic Handling	$ 500	For highest combined Slalom, Skidpad, and Braking scores
Best Over-the-Road Fuel Efficiency	$1,000	Based on energy efficiency from the Endurance Event
Lowest Emissions	$1,500	For top score in the Emissions Event
Best Technical Report	$1,500	For top-scoring technical report
Best Vehicle Design Inspection	$1,500	For highest score in the Vehicle Design Inspection
Best Oral Design Presentation	$1,500	For highest score in the Oral Design Presentation; application of advanced technology is stressed
Best Consumer Acceptability	$1,000	For top combined static and dynamic scores
Best Appearance	$ 500	Based on GM design team evaluation
Lowest Vehicle Driving Losses	$1,000	For lowest total amount of energy lost during city and highway cycles due to vehicle losses (rolling friction and aerodynamic), calculated from coastdown testing data
Best Safety	$ 500	For the extent to which safety considerations are incorporated into the vehicle; determined by Vehicle Design Inspection
Best Application of Advanced Technology	$1,000	For highest combined scores of Emissions, Fuel Economy, and Vehicle Design Inspection events; open to alternative-fuel vehicles (E85, CNG, LPG, H_2, or DME)
Best Use of Advanced Materials	$1,000	For best application of materials that may lead to increased energy efficiency, lower production costs, and safer vehicles; determined by Vehicle Design Inspection
Innovations in Aluminum (sponsored by the Aluminum Association)	$ 500	For the best application of aluminum; determined by the Vehicle Design Inspection
Best Workmanship	Trophy	For best combined interior and exterior vehicle presentation in the Vehicle Design Inspection
Best Teamwork	Trophy	For exceptional team effort to get the vehicle ready for events throughout the competition
Sportsmanship Award	Trophy	For the highest level of assistance to other teams and organizers despite the team's own circumstances
Spirit of the Challenge Award	Trophy	For showing perseverance in the face of adversity and maintaining a positive attitude throughout the competition
Best Skit	Trophy	For receiving the most votes for the best skit
Best Solo	Trophy	For the lowest time in the optional Solo Event

PARTICIPATING SCHOOLS

- 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