Ford Motor Company

June 9, 2004

Dear FutureTruck Team Members:

Welcome to FutureTruck 2004!

Ford Motor Company is pleased to co-sponsor this final year of the FutureTruck competition at the Ford Michigan Proving Grounds in Romeo. We are pleased to once again support you in this year's effort to refine the technologies in your hybrid-electric Explorers.

As Ford continues to design and build vehicles with the features and functionality that our customers desire, we are also continually striving to incorporate new technologies in vehicles like the Explorer to improve their energy efficiency, safety, performance, and function and reduce emissions. The FutureTruck competition allows us to partner with you in exploring not only the latest technologies, but also the customer's perception of those technologies as applied in various designs.

In the past year, you have had the opportunity to refine the technologies implemented in your vehicles. We hope that this year has been rewarding for each of you, as you progressed from planning through development to implementation. We are confident that this hands-on experience has been invaluable in teaching you communication and teamwork skills that will be with you for the remainder of your professional lives.

When you began FutureTruck, you committed yourselves to a long program of hard work and personal sacrifice. You are to be commended for the dedication you have demonstrated to your team and its goals. We at Ford Motor Company, as well as our co-sponsor — the United States Department of Energy — and all the other corporate and governmental sponsors, look forward to interacting with you and acknowledging your achievements during the competition.

We at Ford believe that the cooperation between industry, the U.S. and Canadian governments, and your universities is an important part of the FutureTruck program. We encourage you to promote similar cooperation as you pursue your individual careers. Fostering positive relationships and communication is critical as our society faces the future's challenges.

Ford Motor Company welcomes you to the 2004 FutureTruck Competition and wishes you all, the greatest possible success!

Randal Visintainer
Engineering Director –
SUV's & Body-on-Frame Products

Allan Kammerer
Executive Director -
North American Product Development

Phil Martens
Group Vice President –
Product Creation

Welcome to the Future

FUTURETRUCK IS A UNIQUE FIVE-YEAR ENGINEERING PROGRAM THAT BRINGS TOGETHER THE RESOURCES OF INDUSTRY, GOVERNMENT, AND ACADEMIA IN A COOPERATIVE EFFORT TO ADDRESS IMPORTANT ENVIRONMENTAL AND ENERGY-RELATED ISSUES POSED BY THE GROWING DEMAND FOR SPORT UTILITY VEHICLES (SUVS).

FutureTruck 2004 challenges teams of students from 15 top North American universities to reengineer a conventional, mid-size 2002 Ford Explorer into a lower-emissions vehicle with at least 25% higher fuel economy, without sacrificing the performance, utility, and safety consumers want. To meet these challenges, students employ cutting-edge automotive technologies, including advanced propulsion systems, lightweight materials, and alternative fuels such as hydrogen, ethanol, and biodiesel. All of the teams in FutureTruck 2004 are implementing hybrid electric design strategies, which have an internal combustion engine with a battery and an electric motor.

Where Is FutureTruck?

After months of preparation, teams will participate in eight days of intense testing, scheduled for June 9-16, 2004. First, vehicles will undergo a comprehensive safety evaluation, followed by dynamic testing and static design events at Ford's Michigan Proving Ground (MPG) in Romeo. The tailpipe and greenhouse gas (GHG) emissions of the FutureTruck vehicles will be evaluated at Ford's Allen Park Testing Laboratory. The competition will culminate in a road rally to various sponsoring companies around Detroit and a finish line ceremony at Ford World Headquarters on June 17.

Who Is Involved?

The U.S. Department of Energy (DOE) has partnered with Ford Motor Company as the headline sponsors of FutureTruck 2002, 2003, and 2004. Ford provides the Explorer SUVs that the teams are modifying, almost $315,000 in seed and prize money, engineering mentoring for each team, competition facilities, and operational support. Argonne National Laboratory, a DOE research facility, provides competition management, team evaluation, and technical and logistical support. More than 300 participants from 15 top North American universities participate in the program. Fifteen private and public organizations also joined with DOE and Ford to support this innovative engineering program.

Why Is FutureTruck Important?

Today, more than 50% of all new vehicles sold in the United States are SUVs, light-duty trucks, and vans, which have historically been less fuel efficient than passenger cars. Increasing the fuel efficiency of vehicles, including SUVs, will help reduce petroleum usage, decrease our dependence on foreign oil, and boost our economy. FutureTruck shows that the cooperation of industry, government, and academia is the best approach to developing more energy-efficient and "greener" automotive technologies, improving our economy and our environment, and keeping North American technology competitive on a global basis. The competition also helps develop hundreds of highly skilled engineers with a greater awareness of clean, fuel-efficient technologies—preparing them to lead the automotive industry in the 21st century.

FUTURETRUCK '04 Technologies

Team	Configuration	Strategy	Engine	Transmission	E-Motor	Batteries	Fuel
California Polytechnic State University, San Luis Obispo	Series	Charge Sustaining	1.9L TDI VW	GM 4L60E Automatic, 4-Speed	NetGain WarP 11", DC Series, 336kW Peak	Hawker Genesis PbA - 288V	B35
Cornell University	Through-the-Road Split Parallel — Electric on Front Axle	Charge Sustaining	2.0L Nissan SR20DET	Nissan RER01A Automatic, 4-Speed	AC Propulsion AC-150, AC induction, 150kW Peak	Hawker Genesis PbA - 336V	RFG
Georgia Institute of Technology	Through-the-Road Parallel — Electric on Front Axle	Charge Sustaining	3.0L Lincoln V6 (LS)	Ford 5R55N Automatic, 5-Speed	AC Propulsion AC-150, AC Induction, 150kW Peak	Hawker Odyssey PbA - 336V	RFG
Michigan Technological University	Through-the-Road Parallel — Electric on Rear Axle	Charge Sustaining	2.0L Ford Zetec I-4	Ford XS4P Automatic, 4-Speed	UQM SR218 Perm. Magnet, 75kW Peak	Hawker Genesis PbA - 312V	RFG
Ohio State University	Pre-Transmission Parallel	Charge Sustaining	2.5L Detroit Diesel	Ford M50D-R4 Manual, 5-Speed	Siemens/Ecostar, AC Induction, 32kW Peak	Hawker E-Cell PbA - 300V	B35
Pennsylvania State University	Post-Transmission Parallel	Charge Sustaining	2.5L Detroit Diesel	Ford M50D-R4 Manual, 5-Speed	Solectria, AC Induction, 37kW Peak	Lithium Tech, Li ion - 180V	B35
Texas Tech University	Post-Transmission Parallel	Charge Sustaining	2.3L Ford SVO	Ford A4LD, Automatic, 4-Speed	Solectria, AC Induction, 75kW Peak	Panasonic NiMH - 273.6V	H_2
University of Alberta	Pre-Transmission Parallel	Charge Sustaining	1.8L Ford Lynx Diesel	GM 4L60E Automatic, 4-Speed	UQM SR120, DC Brushless, 60kW Peak	Panasonic NiMH - 200V	B35
University of California, Davis	Post-Transmission Parallel	Charge Sustaining/ Charge Depleting	1.9L Saturn I-4	NVG Manual, 5-Speed	(2) UQM SR218N, Perm. Magnet 82kW Peak	Ovonic NiMH - 317V	E85
University of Idaho	Post-Transmission, Soft Parallel	Charge Sustaining	3.0L Lincoln V6 (LS)	Ford 5R55N Automatic, 5-Speed	Leeson SR218, AC Induction, 13.5kW Peak	Maxwell Ultra Capacitors - 48.6V	RFG
University of Maryland	Pre-Transmission Parallel	Charge Sustaining	3.0L Lincoln V6 (LS)	Ford 5R55N Automatic, 5-Speed	Honda MF2, 10kW Perm. Magnet	Panasonic NiMH - 276V	E85
University of Tennessee	Pre-Transmission Parallel	Charge Sustaining	2.3L Ford	Ford M50D-R1 Manual, 5-Speed	UQM SR218H Perm. Magnet, 75kW Peak	Hawker Genesis PbA - 300V	E85
University of Wisconsin — Madison	Post-Transmission Parallel	Charge Sustaining	1.8L Ford Lynx Diesel	Borg Warner Manual, 5-Speed	Delphi UW-EV1-1, AC Induction, 108kW Peak	Panasonic NiMH - 273.6V	B35
Virginia Tech	Series	Charge Sustaining	2.0L Ford Zetec	Single-Speed 3.73:1	GE EV2000, AC Induction, 85kW Peak	Hawker Genesis PbA - 336V	H_2
West Virginia University	Post-Transmission Parallel	Charge Sustaining	2.5L Detroit Diesel	New Venture Gear Manual, 5-Speed	Leeson SR218, AC Induction, 13.5kW Peak	Panasonic NiMH - 48V	B35

The teams in the FutureTruck competition are employing many novel ideas, approaches, and technologies that provide near-term and long-term solutions to increasing the efficiency and reducing the overall environmental impact of SUVs. Various hybrid electric vehicle designs—many of which are either in production or are being considered by original equipment manufacturers—are demonstrated in the student-modified vehicles, including series and parallel hybrids.

Engines modified to run on biobased fuels, such as ethanol and biodiesel, represent a near-term approach; more advanced engines, such as homogeneous-charge compression-ignition engines and hydrogen internal combustion engines, represent more long-term approaches. Exemplifying the long-term approach to reducing onboard energy consumption, one team has chosen a "charge-from-the-wall" philosophy to extend the short electric-vehicle range of its hybrid.

The teams are combining advanced power units with emerging exhaust gas aftertreatment technologies to reduce emissions and total GHG production. Other systems, such as selective catalytic reduction to control oxides of nitrogen emissions, are being used with high-efficiency diesel engines. Advanced electric drive systems enable hybrid features— such as regenerative breaking, high-load electric assist, and engine transient smoothing—to further improve vehicle-level efficiency.

These student-designed and -modified vehicles truly represent the future of automotive powertrains.

FUTURETRUCK '04

PRE-COMPETITION REPORTS (30 POINTS)

***Event Captain: Stephen Gurski**, Argonne National Laboratory*

FutureTruck teams are required to submit two design description reports during the competition year to update FutureTruck organizers about the fuels and technologies that they will be implementing. Each report is worth 15 points. In addition, teams are required to submit two project updates that detail the team's organization and include timelines, organizational charts, and schedules for the project.

VEHICLE INSPECTIONS AND DYNAMIC READINESS (75 POINTS)

***Event Co-Captains: Stephen Gurski** and **Justin Kern**, Argonne National Laboratory*

Vehicles are inspected several weeks before the competition to ensure that they are operational and that all the main systems are functional. Up to 40 points are available for the pre-event inspection. Up to 35 dynamic readiness points are also available to the teams. These points are given to the teams for completing the Safety/Technical Inspection and the qualifying events within a certain number of days; the Dynamic Readiness evaluation focuses on vehicle reliability and robustness for various dynamic events. At the competition, vehicles are evaluated for safety, and their compliance with all competition rules for chassis, mechanical, electrical, and fuel systems is verified.

BRAKING, HANDLING, AND OFF-ROAD (55 POINTS)

***Event Co-Captains:** (Braking and Handling) **Tim Carritte**, **Kevin Halsted**, and **Matt Konarski**, **Dennis Stange**, Ford Motor Company*

***Event Co-Captain:** (Off-Road) **Gary Frederick**, Ford Motor Company*

After the Safety/Technical Inspection, teams must pass certain qualifying events to be eligible for participation in the FutureTruck competition. The Braking and Handling events are designed to test dynamic vehicle safety and verify compliance with competition requirements. They are worth 15 points. To remain true to the heritage of SUVs, FutureTruck vehicles must demonstrate a high degree of off-road mobility, defined as a vehicle's ability to successfully negotiate off-road obstacles and routes. Four-wheel-drive capability is critical to successfully negotiate all obstacles without damage or loss of function. The team's Off-Road score is based on the sum of points for each obstacle a team passes; this event is worth 40 points.

*The **Best Dynamic Handling Award** ($500) is presented to the team with the best Handling time.*

TRAILER TOW (50 POINTS)

***Event Captain: Vickie Jaje**, Ford Motor Company*

The goal of this event is to demonstrate that the vehicle can tow a 2,000-lb trailer over a designated route at a reasonable speed; this is the highest load condition that will be placed on the vehicle at the competition. To receive full points, teams must stop halfway up and then continue to the top of the 7% grade, complete the laps within a specified time, and complete the following three stages in order. Stage 1 consists of a 1.25-mile loop starting with a .5-mile 7% grade. Stage 2 consists of a 2.5-mile loop with a variety of grades, including a short distance with a grade at 17%. Stage 3 consists of three additional laps that combine the Stage 1 and the Stage 2 loops.

Events & Awards

REGULATED TAILPIPE EMISSIONS (100 POINTS)

***Event Co-Captains: Mike Duoba** and **Justin Kern**, Argonne National Laboratory, and **Mike Martin**, Allen Park Test Laboratory*

Reducing emissions from on-road consumer vehicles is very important to future air quality. Manufacturers must design new SUVs to comply with more stringent regulatory limits on emissions levels. To earn points in this event, FutureTruck vehicles must meet real-world requirements by simultaneously controlling pollutants and meeting minimum federal Tier 0 emissions standards. The goal of the event is to meet California's Super Ultra Low Emissions Vehicles (SULEV) standard. To be eligible for full points, teams must achieve Ultra Low Emissions Vehicles (ULEV) standard or lower emissions levels.

*The **ArvinMeritor Lowest Regulated Tailpipe Emissions Award** ($2,000) is presented to the team with the highest bracket in the Regulated Tailpipe Emissions event.*

GREENHOUSE GAS IMPACT (100 POINTS)

***Event Co-Captains: Mike Duoba** and **Justin Kern**, Argonne National Laboratory*

The objective of the Greenhouse Gas Impact event is a reduction in GHG emissions compared to the stock model year 2002 Explorer. The GHG emissions of each vehicle consist of two measured components: (1) upstream fuel-cycle emissions, and (2) dynamometer emissions measurements. The GHGs measured and used in scoring this event are carbon dioxide, methane, and nitrous oxide. Upstream fuel-cycle emissions are those that result from a fuel's production and distribution cycle. These include GHG emissions from primary energy recovery, transportation, and storage; fuel production process; and fuel transportation, storage, and distribution. Each vehicle will be assigned upstream GHG emissions based on the type of fuel used, according to a peer-reviewed analysis of GHG emissions contained in the Greenhouse gas, Regulated Emissions and Energy use in Transportation (GREET) model. The amount of energy consumed in the combined city and highway dynamometer tests will be used to calculate the amount of upstream GHG emissions attributable to each vehicle's operation. The dynamometer emissions are determined by measuring tailpipe emissions produced from combined city and highway dynamometer tests. The upstream fuel-cycle emissions and the dynamometer emissions for each vehicle are then combined to obtain the GHG impact number.

*The **Lowest Greenhouse Gas Emissions Award** ($2,000) is presented to the team with the lowest GHG impact number (score) determined from this event*

ON-ROAD FUEL ECONOMY (100 POINTS)

***Event Co-Captains: John Morris, Dennis Stange**, and **Tim Carritte**, Ford Motor Company*

***Fueling Captain: Tom Hoppinthal**, Ford Motor Company*

This event demonstrates the robustness and on-road fuel economy of each vehicle. The total distance traveled (within prescribed speed limits) divided by the amount of energy used determines the fuel economy, and thus, the score. The event includes stop-and-go, urban, and highway driving segments. To be eligible for full points, teams must complete all laps with a fuel economy 25% above that of the stock Explorer.

*The **BP Best On-Road Fuel Efficiency Award** ($2,000) is presented to the team with the highest fuel efficiency in the On-Road Fuel Economy event.*

ACCELERATION (90 POINTS)

***Event Co-Captains: Sal Gusmano** and **Don Stange**, Ford Motor Company*

Passing and freeway merging performance remain key customer satisfaction criteria. To evaluate acceleration, the vehicles accelerate from a standard start on each lap of the On-Road Fuel Economy event and run a 1/8-mile section on a straight course. Elapsed times are measured by using photocell-based timing equipment, and trap speeds at the end of the run are recorded by radar (for reference only). Scores are calculated by using the average elapsed time of the best five out of six runs. To be eligible for full points, teams must meet or beat the stock Explorer's average time.

*The **Best Acceleration Award** ($1,000) is presented to the team with the fastest average acceleration time.*

FutureTruck '04 Events & Awards

VEHICLE DESIGN INSPECTION (75 POINTS)

***Event Captain: Duane Hartsell**, Ford Motor Company*

Teams give a presentation on the vehicle's design in its entirety and answer questions from a team of industry and government judges. Judges evaluate the vehicles in the following areas: engineering concept, component selection and assembly, weight reduction, cost minimization, material selection, serviceability, systems integration, and overall execution of the vehicle design and its components. This is not an evaluation of one technology over another, but an evaluation of the implementation of each team's design strategy.

*The **Best Vehicle Design Inspection Award** ($1,500) is presented to the team with the highest score in the Vehicle Design Inspection event.*

ORAL PRESENTATION (100 POINTS)

***Event Captain: Shelley Launey**, U.S. Department of Energy*

Up to two members of each team make an oral presentation then answer questions from a panel of government and industry experts. The presentation addresses how the team attempted to meet the competition goals, such as increased fuel economy and decreased emissions, without sacrificing the safety, performance, or utility of the stock vehicle. Teams validate or justify any modeling or performance prediction methods they used for their design. Judges evaluate the teams on the basis of presentation style and technical content. Presentation style is worth 30 points, technical content is worth 60 points, and an additional 10 points can be awarded at the judges' discretion.

*The **Best Oral Presentation Award** ($1,500) is presented to the team with the highest score in the Oral Presentation event.*

CONSUMER ACCEPTABILITY (125 POINTS)

***Event Captain (Inspection): Dave Shimcoski**, Argonne National Laboratory*

***Event Captain (Drive): Randy Weston**, Ford Motor Company*

The Consumer Acceptability event compares the FutureTruck vehicles to the stock Explorer from a prospective buyer's point of view. This event consists of a vehicle inspection worth 30 points and consumer drive evaluation worth 65 points. An additional 10 points can be awarded for each of the following three items retained in the vehicle: stock luggage capacity, third row seat, and spare tire. During the inspection, judges evaluate the vehicle in three distinct sections: the driver area, general vehicle interior, and vehicle exterior. In the consumer drive evaluation, judges evaluate the ride and handling of the vehicle from a consumer's point of view on a set road course.

*The **Best Consumer Acceptability Award** ($1,000) is presented to the team with the highest combined scores from the vehicle inspection and drive evaluation in the Consumer Acceptability event.*

WRITTEN TECHNICAL REPORT (100 POINTS)

***Event Captain: Stephen Gurski**, Argonne National Laboratory*

To demonstrate communication skills, each team submits a written technical report documenting its approach for meeting the FutureTruck goals. The report includes information on the concept, design elements, engineering analysis, and development of the vehicle. These reports are judged by a group of industry and government experts on content and mechanics.

*The **Best Technical Report Award** ($1,500) is presented to the team with the highest score for the Written Technical Report.*

BEST WORKMANSHIP AWARD

This award is presented to the team with the best combined interior and exterior vehicle presentation, based on the scores and input from the judges in the Vehicle Design Inspection event.

BEST APPEARING VEHICLE AWARD

***Event Captain: Kathleen Smith**, Natural Resources Canada*

The Best Appearing Vehicle Award ($1,000) is presented to the team with the highest score in the Vehicle Appearance event. Each vehicle must provide a visual impression that displays quality, value, and the professional pride of the team. The interior and exterior appearance of the competition vehicles will be judged for overall harmony of appearance, visual impact, graphics organization, color aerodynamic enhancements, fit and finish, and visual appeal.

DR. DONALD STREIT SPORTSMANSHIP AWARD

This award is presented to the team that offers the highest level of assistance and support to other teams and organizers despite their own circumstances. This award is presented in honor of Dr. Donald Streit, who served as a dedicated faculty advisor to the Pennsylvania State University FutureTruck team and embodied the true meaning of sportsmanship. Although Dr. Streit's life ended prematurely, his memory and his example are carried on by the students who have and will continue to participate in FutureTruck.

SPIRIT OF THE CHALLENGE AWARD

This award, presented by the competition organizers, is given to a team that exhibits the following characteristics: exceptional perseverance in the face of adversity, maintaining a positive attitude throughout the competition despite significant challenges and obstacles, and pursuing exceptionally high technical standards for their team that best represent the spirit of the FutureTruck competition.

MOST IMPROVED TEAM AWARD

This award is presented to the team that demonstrates the most improved overall performance over previous FutureTruck competitions. Improvement may be determined by performance in individual events or the overall competition.

TOP PLACE AWARDS

Top competition finishers are determined by the best combined scores from all the scored events.

First Place	**$6,000**
Second Place	**$5,000**
Third Place	**$4,000**
Fourth Place	**$3,000**
Fifth Place	**$2,000**
Sixth Place	**$1,000**

FUTURETRUCK '04

Sponsored Awards

National Science Foundation Outstanding Faculty Advisor Award

***Event Co-Captains: Delcie Durham**, National Science Foundation, and **Shelley Launey**, U.S. Department of Energy*

It takes an enormous amount of time and energy for a faculty advisor to pull together a team of students and professors who may be reluctant to undertake a time-consuming project such as FutureTruck. Yet most participating students claim that FutureTruck is one of the highlights of their university experience. Since 1997, this National Science Foundation (NSF)-sponsored faculty award has provided recognition to the faculty advisors who, through their leadership and research, are advancing the frontiers of science and engineering while passing on a legacy to their students that extends throughout the automotive industry. This award is presented to the faculty advisor who best incorporates Advanced Vehicle Technology Competition (AVTC) activities into the classroom and who has had the most significant impact on the engineering education of his students or has used AVTCs to enhance the engineering education experience. These funds are placed into a university account to be used to enhance the integration of the AVTC experience into the undergraduate curriculum for the benefit of the students.

$20,000

Delphi Advanced Powertrain Controls Award

***Event Captain: Harry Husted**, Delphi*

This award recognizes the important role that powertrain controls play in hybrid vehicles and the need to implement a well-integrated control system in the overall vehicle framework. This award focuses on technologies that are expected to lead to improvements in one or more of these areas: fuel efficiency, reduced tailpipe emissions, or vehicle performance. Underscoring its commitment to advanced hybrid technologies, Delphi is sponsoring the Advanced Powertrain Controls Award to recognize three teams for excellence in the control aspects of their advanced powertrains.

First Place–$1,000, Second Place–$750, Third Place–$500

The MathWorks Modeling Award

***Event Captain: Paul Smith**, The MathWorks*

This award recognizes FutureTruck teams that exhibit the most creative application of The MathWorks software products, MATLAB and Simulink, to the design of system models and/or control systems. Teams will be evaluated on how well they applied MATLAB and Simulink to help achieve the overall competition objectives in the areas of fuel economy, performance, and emissions; their preparation of a summary relating modeling and simulation activities directly to a list of the competition objectives; how well the team related the overall competition objectives to specific model-based design activities; the overall development process followed; techniques used for data analysis and visualization; quality of presentation; and lessons learned.

First Place–$1,000, Second Place–$750, Third Place–$500

National Instruments Most Innovative Use of Virtual Instrumentation Award

***Event Captain: Michael Zeller**, National Instruments*

Virtual instrumentation is the combination of industry-standard computer technology equipped with powerful application software and cost-effective hardware to perform the functions of traditional control or measurement devices. It focuses on software-centered systems that exploit the computing power, productivity, display, and connectivity capabilities of commercially available computing technology. This award encourages FutureTruck teams to use PC-based technology in designing and controlling a cost-effective FutureTruck. Teams will be scored on innovation, implementation, overall quality of workmanship, and judges' discretion.

First Place–$1,000, Second Place–$750, Third Place–$500

Visteon Innovative Use of Electronics Award

***Event Captain: Tom Gioia**, Visteon*

The personality of a vehicle is increasingly determined by its electrical and electronic systems. This award recognizes the contribution of the electrical and electronic systems to the consumer value of the vehicle. In determining the winners, Visteon will examine market relevance, originality, human-machine interface, consumer value (cost/improved fuel economy), appropriate data bus structures, optimal partitioning of modules and minimum number of wires, optimal partitioning between mechanical and electrical subsystems, power generation and distribution systems, and diagnostic ability.

First Place–$1,000, Second Place–$750, Third Place–$500

FUTURETRUCK '04 Judges

CONSUMER ACCEPTABILITY

Deanna Carroll is the Manager of Dana's Electronic Systems – Diversified Products NA Innovation Center, developing intelligent actuators for underhood and undervehicle. Deanna received her Ph.D. in Electrical Engineering from Texas A&M University and has worked in the areas of by-wire systems, fault detection/management, and systems engineering since graduation.

Ricardo Martinez, Fuels Product Specialist, manages the Specialty Fuels Team within BP's Global Fuels Technology group. He holds a B.S. in Chemistry from the University of Illinois – Chicago. This is his first year participating in the FutureTruck competition.

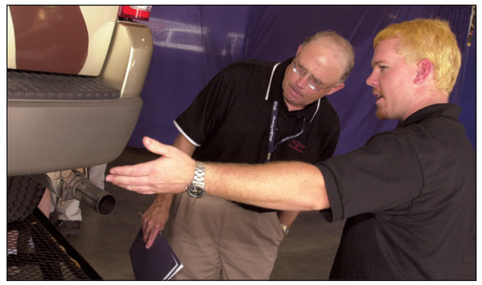
Cleve Moler is chairman and chief scientist at The MathWorks. Cleve was one of the original authors of Matlab and was previously a professor of math and computer science for almost 20 years at the University of Michigan, Stanford University, and the University of New Mexico.

Salim Momin is director of the Virtual Garage Lab for Freescale Semiconductor's Transportation & Standard Product Group. Salim has been involved in the Automotive Electronics Industry for over 25 years and with Freescale Semiconductor for 20 years. His current interests are in Modeling and Simulation of Automotive Control Systems. Salim holds a B.S.E. in Bio-engineering from Purdue University.

Sabine Nakouzi earned her B.S. and M.S. in Chemical Engineering from Michigan State University and the University of Michigan respectively and her Master's and Doctorate degrees in Bio-Chemical Engineering from the University of Michigan. She has worked at Ford since 1995 and is currently Manager of Interior IP/Console/ Trim for SUVs at Ford.

Chuck Risch is currently on a special term appointment with Argonne National Laboratory's Center for Transportation. Previously, Chuck worked in the automotive industry for more than 35 years, including Ford Motor Company and DaimlerChrysler, working in the areas of alternative fuels, emissions and fuel economy. He holds a B.S. and M.S. in Mechanical Engineering from Rose-Hulman and the University of Michigan respectively. This is Chuck's second year as a FutureTruck judge.

John Sakioka was named Director of Ford Motor Company's FreedomCAR office in 2003, and is responsible for leading Ford's pre-competitive research activities with GM, Daimler-Chrysler, and U.S. Department of Energy. He has been with Ford for over 25 years and has held several senior-level management positions in Product Development. He has a B.S. in Mechanical Engineering from UCLA and an M.S. in Electrical and Electronic Computer Control Systems from Wayne State University.



Rogelio Sullivan is Team Leader for the Materials Technologies Program in the FreedomCAR and Vehicle Technologies Office at the U.S. Department of Energy. For the last 10 years, he has worked on development of hybrid propulsion systems, engine combustion and emissions research, power electronics/electric drive systems, and lightweight materials. Mr. Sullivan received a B.S. degree in Mechanical Engineering and a Master's degree in Business Administration from the University of Maryland.

ORAL PRESENTATIONS

Fawzan Al Sharif is a business development manager with Ricardo, Inc. For the last 7 years, Fawzan has worked on the design, application, support, and sales and marketingof CAE software for the powertrain engineering industry. Currently, he is responsible for the sales and marketing of the engine performance analysis program, WAVE. He is a graduate of the Mechanical and Aerospace Engineering program at the Illinois Institute of Technology in Chicago, Illinois.

Chris Atkinson is owner of Atkinson LLC, a company specializing in software-based tools for advanced engine control development and calibration. He was involved in advanced student vehicle competitions as a faculty advisor from 1991 to 2000. He holds a Sc.D. degree from MIT in Mechanical Engineering.

Connie Bezanson manages the U.S. Department of Energy's Advanced Vehicle Competition activities within the FreedomCAR and Vehicle Technologies Program Office. Ms. Bezanson received a B.S. in Mechanical Engineering from The Catholic University of America.

Walt Clark is Director of Advanced Electronic Systems for Visteon, where he has worked since its formation in June 2000. Previously, he held various positions with Ford Product Development, Planning, and Powertrain Engineering. Walt has a B.S. in Computer Systems Engineering from the University of California at Los Angeles and has worked in the field of vehicle engineering for over 35 years.

Andrew Dame graduated from the University of Michigan with a B.S. in Mechanical Engineering and from Wayne State's Engineering Management Master's Program. While at Ford, Andrew has worked in Powertrain Diagnostics for five years and the V6 Mustang Powertrain Calibration for seven years. Recently, he assumed a position as Calibration Technical Expert for 4-cylinder and Small V6 Commodity Calibration.

Neil Krohn has worked in Motorola's semiconductor section, now called Freescale Semiconductor, for 27 years. He has held a variety of positions, including work on board-level factory automation computers to powertrain microprocessors. Andrew also has two years aerospace electronics experience and six years of experience designing automotive assembly line test equipment.

A. J. Lasley is Chief Engineer of the Energenix Center for Delphi Corporation. Delphi's Energenix Center is responsible for developing next-generation energy systems, power electronics, energy storage solutions, and powertrain controls.

Mike Lowry is the supervisor of the Advanced Energy Conversion Group for the Energenix Center of Delphi Corporation. For the past 13 years, he has been involved in designing, building, testing, and integration of electric drive systems for electric and hybrid vehicles. Mike currently is working on the development of solid oxide fuel cells. He served as a vehicle design inspection judge in 2000 and 2001.

Mike Schwarz recently retired after 31 years with Ford, where he was Director of Sustainable Mobility Technologies, the activity within Ford that is responsible for Hybrid and Fuel Cell electric vehicle research and systems engineering. Mike also served as Ford's Director of the Partnership for a New Generation of Vehicles (PNGV), now called FreedomCAR. He graduated from the University of Michigan with a B.S. in Mechanical Engineering.

Gayathri Seenumani is a Technical Consultant for The MathWorks, primarily working with customers in the automotive/aerospace area. She has an Electrical Engineering degree from the University of Madras and a Master's in Electrical Engineering from the University of Akron and is currently enrolled in the Ph.D. program in Mechanical Engineering at the University of Michigan at Ann Arbor.

Winnie Torres-Ordonez is the Senior Research Engineer in BP's Fuel Product Development group. Her projects include supporting BP's Clean Cities program and relaunching ultimate premium gasoline in selected U.S. markets. She received her Chemical Engineering degrees from MIT (Ph.D. and M.S.) and from the University of the Philippines (B.S.).

VEHICLE DESIGN INSPECTION

Barbara Goodrich, Staff Engineer in BP's Fuel Product Development group, is a FutureTruck judge for the third year. Her research areas are combustion and compression ignition engine fuels. She holds a B.S. in Mechanical Engineering and an M.S. in Chemical Engineering, both from Michigan State University.

John Hickey is the Director of Advanced Engineering for the Automotive Systems Group of Dana Corporation. John's current assignment involves the development of products and processes that deal with technologies that are non-traditional to Dana. He has been with Dana for 34 years and has experience in engineering, manufacturing, and IAM.

Don Hillebrand has over 20 years of experience in automotive engineering, research management, and government affairs and was a senior policy advisor to the Executive Office of the President, White House Office of Science and Technology. Don holds a Ph.D. in Mechanical Engineering from Oakland University and is currently the Vehicle Systems section leader at Argonne National Laboratory's Center for Transportation Research.

Arun Jaura is the Technical Leader for Hybrid Vehicle Development in Ford's Research and Advanced Engineering. Prior to joining Ford, he worked with Defense Research for 10 years. He joined Ford after completing his Ph.D. in 1996. He led the successful demonstration of the industry's first hydrogen-engine-propelled HEV, known as the H2R, and is a technical consultant to US AID on advanced propulsion and sustainable mobility.

Jeff Kainz is Delphi Corporation's Ford Powertrain Engineering Customer Manager, with responsibility to provide Delphi components and design solutions for the Ford family of vehicles. While at Delphi, Jeff has worked on PC-based automated powertrain calibration tools for engine calibrators, and developing and validating transmission control and fuel control algorithms. Jeff was responsible for engine calibration on the 1996 F150 & F250 trucks.

Pete Maloney works as a consultant for The MathWorks, primarily in the areas of engine calibration optimization for automotive customers and automatic code generation for aerospace customers. Previously, Pete worked for 4 years at Ford's Advanced Powertrain division and 6 years at Delphi Automotive Engine Management Systems. During that time, he designed and developed powertrain control algorithms and associated calibration processes. Pete has served as a FutureTruck judge for the past 3 years.

Mike Tamor received his B.S. in Physics from UCLA and his Ph.D. in Physics from the University of Illinois at Urbana-Champaign. Mike has been with Ford's Scientific Research Laboratory for more than 20 years. In 1994, he joined the Alternative Power Source Technology Department to work on hybrid electric vehicle system analysis and optimization and is currently the Manager of Propulsion System Engineering for the Department of Research and Advanced Engineering at Ford.

Ed Wall is Program Manager of the FreedomCAR and Vehicle Technologies program office of the Energy Efficiency and Renewable Energy Division of the U.S. Department of Energy. Ed received a B.S. in Physics from Muhlenberg College and a Master's in Geology from the Johns Hopkins University.

Jim Winkelman obtained his Ph.D. from the University of Wisconsin. After 10 years at General Electric working on the application of singular perturbation methods and adaptive control techniques and 10 years at Ford in the development of electronic vehicle controls, Jim came to work for Visteon, where he is now manager of Advanced Powertrain Systems. His group is currently working to reduce CO_2 emissions through the development of base internal combustion engine and hybrid powertrain technologies.

Pete Zogas is Senior Vice President of Sales and Marketing for National Instruments (NI). Before coming to NI, Pete worked as a design engineer for Texas Instruments and worked in the bipolar semiconductor sector at AT&T. He received his B.S. in Electrical Engineering from Drexel University.

Continued

FUTURETRUCK '04 Judges (cont'd)

DELPHI ADVANCED POWERTRAIN CONROLS AWARD
Philip Guys, Ford Motor Company
Paul Niessen, Ford Motor Company
Karl Schten, Delphi
T.V. Sriram , Delphi
Jim Walters, Delphi

THE MATHWORKS MODELLING AWARD
Jarvis Davis, The MathWorks
Peter Maloney, The MathWorks
Sameer Prabhu, The MathWorks
Paul Smith, The MathWorks

NATIONAL INSTRUMENTS MOST INNOVATIVE USE OF VIRTUAL INSTRUMENTATION AWARD
Joe DiGiovanni, National Instruments
John Limroth, National Instruments
Todd Mory, Ford Motor Company
Chaitnaraine Phagoo, Ford Motor Company
Dave Tourner, Ford Motor Company
Michael Zeller, National Instruments

NATIONAL SCIENCE FOUNDATION OUTSTANDING FACULTY ADVISOR AWARD
Delcie Durham, National Science Foundation
Pat Ford, Ford Motor Company
David Holloway, University of Maryland Retired
Robert Larsen, Argonne National Laboratory
Shelley Launey, U.S. Department of Energy

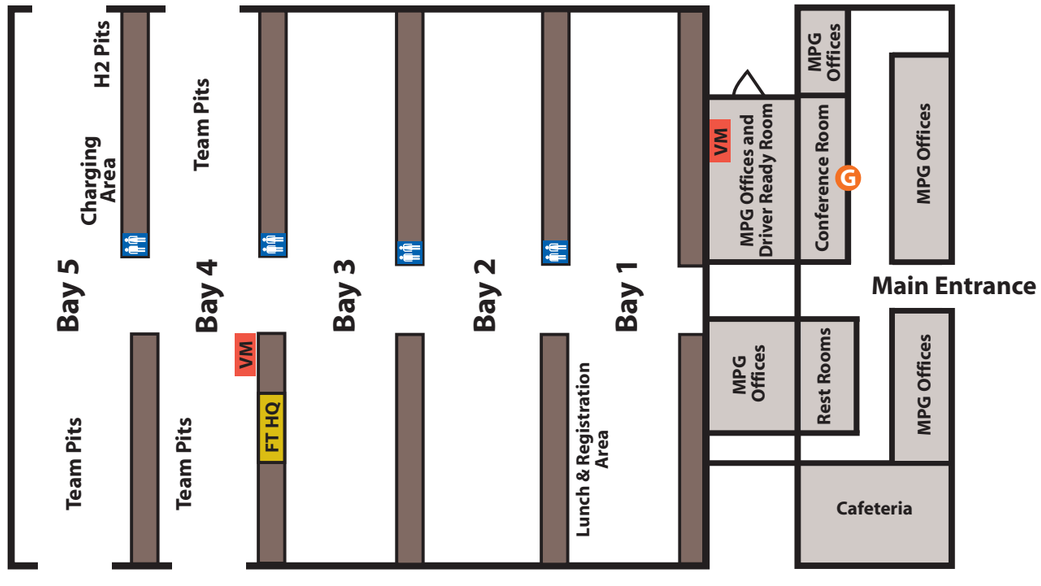
VEHICLE APPEARANCE
Liz Callanan, The MathWorks
John Firment, Consultant
Kathleen Smith, Natural Resources Canada
Jim Smithbauer, Ford Motor Company

VISTEON INNOVATIVE USE OF ELECTRONICS AWARD
Tom Gioia, Visteon
Gregg Gumkowski, Visteon
Prasad Prasad, Ford Motor Company
John Quingley, Visteon
Randy Visintainer, Ford Motor Company

WRITTEN TECHNICAL REPORT
Gary Baker, Natural Resources Canada
Gordon Cheever, Delphi
Roger Feller, Visteon Corporation
David Hamilton, U.S. Department of Energy
Duane Hartsell, Ford Motor Company
Steve McConnell, Argonne National Laboratory
Chuck Risch, Argonne National Laboratory

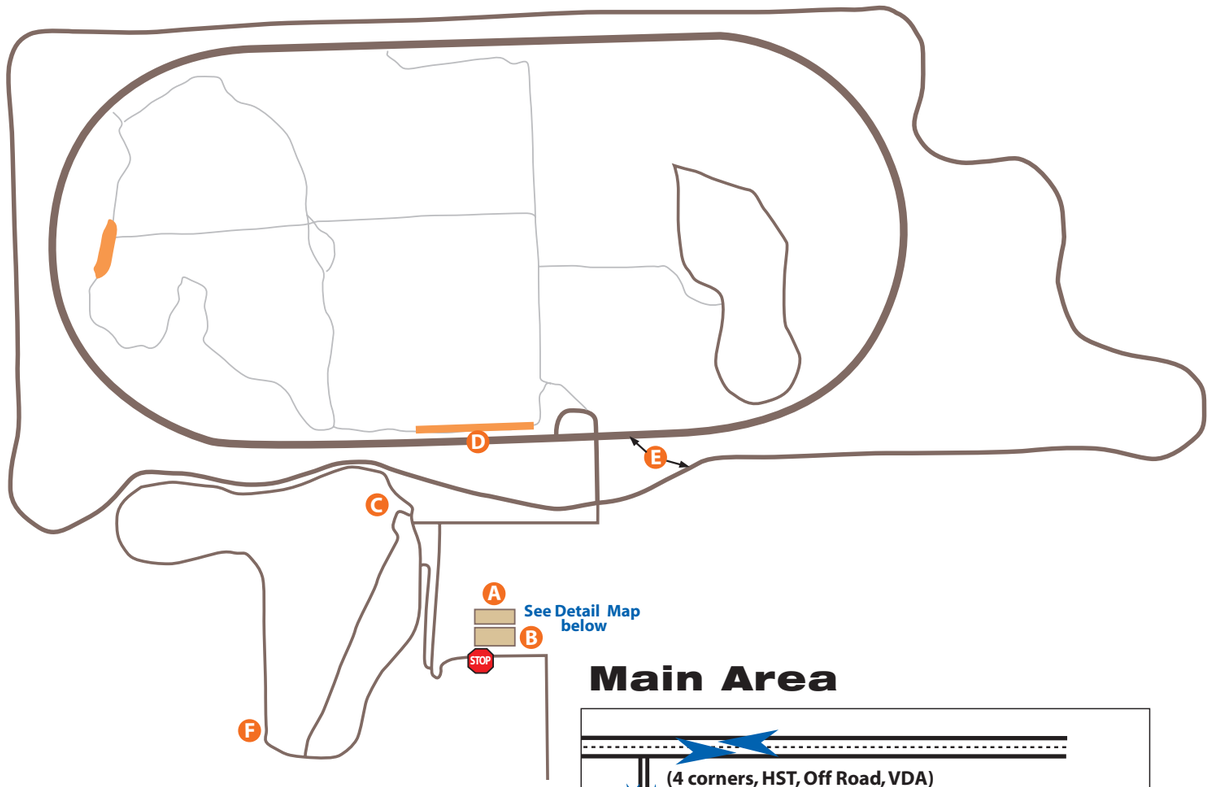
FUTURETRUCK '04 Maps

Main Garage



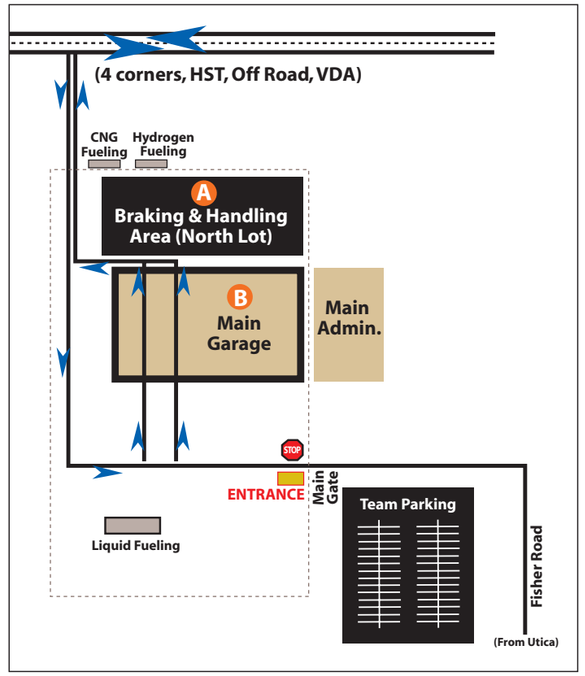
Restrooms
VM Vending Machines

Michigan Proving Ground



- A BRAKING & HANDLING
- B PITS
- C TRAILER TOW
- D ACCELERATION
- E FUEL ECONOMY
- F OFF ROAD
- G ORAL PRESENTATIONS

Main Area



FUTURETRUCK '04

Competition Schedule

Wednesday, June 9	EVENT	TIME	LOCATION	MAP KEY
	Registration/Safety/Security	7:00 a.m.-12:00 p.m.	B1, MPG	B
	Safety/Tech. Inspections	10:00 a.m.-12:00 p.m.	B3, MPG	B
	Fueling	10:00 a.m.-12:00 p.m.	Fuel Station, North Lot, MPG	A
	Lunch, NO EVENTS	12:00 p.m.-1:00 p.m.	B1, MPG	B
	Safety/Tech. Inspections	1:00 p.m.-5:00 p.m.	B3, MPG	B
	Braking, Handling, Off-Road	1:00 p.m.-5:00 p.m.	North Lot and Off-Road Course, MPG	A & F
	Fueling	1:00 p.m.-5:00 p.m.	Fuel Station, North Lot, MPG	A
	Skit Night	6:30 p.m.-9:30 p.m.	Club Monte Carlo, Utica	1

Thursday, June 10	EVENT	TIME	LOCATION	MAP KEY
	Safety/Tech. Inspections	7:00 a.m.-11:00 a.m.	B3, MPG	B
	Braking, Handling, Off-Road	7:00 a.m.-11:00 a.m.	North Lot and Off-Road Course, MPG	A & F
	Trailer Tow	7:00 a.m.-11:00 a.m.	Trailer Tow Course, MPG	C
	Fueling	7:00 a.m.-11:00 a.m.	Fuel Station, North Lot, MPG	A
	Lunch, NO EVENTS	11:00 a.m.-1:00 p.m.	B1, MPG	B
	Safety/Tech. Inspections	1:00 p.m.-5:00 p.m.	B3, MPG	B
	Braking, Handling, Off-Road	1:00 p.m.-5:00 p.m.	North Lot and Off-Road Course, MPG	A & F
	Trailer Tow	1:00 p.m.-5:00 p.m.	Trailer Tow Course, MPG	C
	Fueling	1:00 p.m.-5:00 p.m.	Fuel Station, North Lot, MPG	A
	Team Leader Meeting	6:00 p.m.-6:30 p.m.	B1, MPG	B

Friday, June 11	EVENT	TIME	LOCATION	MAP KEY
	Safety/Tech. Inspections	7:00 a.m.-11:00 a.m.	B3, MPG	B
	Braking, Handling, Off-Road	7:00 a.m.-11:00 a.m.	North Lot and Off-Road Course, MPG	A & F
	Trailer Tow	7:00 a.m.-11:00 a.m.	Trailer Tow Course, MPG	C
	Fueling	7:00 a.m.-11:00 a.m.	Fuel Station, North Lot, MPG	A
	Emissions Testing	7:00 a.m.-5:30 p.m.	APTL	7
	Lunch, NO EVENTS	11:00 a.m.-1:00 p.m.	B1, MPG	B
	Braking, Handling, Off-Road	1:00 p.m.-5:00 p.m.	North Lot and Off-Road Course, MPG	A & F
	Trailer Tow	1:00 p.m.-5:00 p.m.	Trailer Tow Course, MPG	C
	Fueling	1:00 p.m.-5:00 p.m.	Fuel Station, North Lot, MPG	A
	Team Leader Meeting	6:00 p.m.-6:30 p.m.	B1, MPG	B

Saturday, June 12	EVENT	TIME	LOCATION	MAP KEY
	Emissions Testing	7:00 a.m.-5:30 p.m.	APTL	7
	Braking, Handling, Off-Road	7:00 a.m.-4:30 p.m.	North Lot and Off-Road Course, MPG	A & F
	Team Leader Meeting	6:00 p.m.-6:30 p.m.	B1, MPG	B

Sunday, June 13	EVENT	TIME	LOCATION	MAP KEY
	Emissions Testing	7:00 a.m.-5:30 p.m.	APTL	7
	Fueling	1:00 p.m.-6:00 p.m.	Fuel Station, North Lot, MPG	A

Monday, June 14	EVENT	TIME	LOCATION	MAP KEY
	On-Road Fuel Economy/ Acceleration	9:00 a.m.-12:30 p.m.	High Speed Track, MPG	E & D
	Fueling	10:00 a.m.-3:30 p.m.	Fuel Station, North Lot, MPG	A
	Lunch	12:30 p.m.-1:30 p.m.	B1, MPG	B
	Panoramic Photo	4:00 p.m.-5:00 p.m.	TBD	
	Team Leader Meeting	6:00 p.m.-6:30 p.m.	B1, MPG	B

Tuesday, June 15	EVENT	TIME	LOCATION	MAP KEY
	Media Day	9:30 a.m.-11:30 a.m.	B1, MPG	B
	Education Center	11:00 a.m.-1:00 p.m.	B1, MPG	B
	Lunch	11:00 a.m.-1:00 p.m.	B1, MPG	B
	Vehicle Display	11:30 a.m.-1:00 p.m.	B1, MPG	B
	Sponsored Awards Delphi Advanced Powertrain Controls Award,The MathWorks Modeling Award, National Instruments Most Innovative Use of Virtual Instrumentation Award, Visteon Most Innovative Use of Electronics Award	1:30 p.m.-6:00 p.m.	B4 & B5, MPG	B
	Static Design Events Vehicle Design Inspection, Consumer Acceptability, Oral Presentations	1:30 p.m.-6:00 p.m.	B4 & B5, MPG Oral will be held in a conference room shown on Main Garage Map	B G
	Consumer Drive Evaluation	1:00 p.m.-6:00 p.m.	North Lot, Drive Course, MPG	A & C
	Vehicle Appearance	1:00 p.m.-6:00 p.m.	B4 & B5, MPG	B

Wednesday, June 16	EVENT	TIME	LOCATION	MAP KEY
	Sponsored Awards Resume	8:00 a.m.-12:00 p.m.	B4 & B5, MPG	B
	Static Design Events Resume	8:00 a.m.-12:00 p.m.	B4 & B5, MPG Note that oral presentation is in conference room	B G
	Consumer Drive Evaluation Resumes	8:00 a.m.-12:00 p.m.	North Lot, Drive Course, MPG	A & C
	Lunch & Ford Presentation	12:00 p.m.-2:00 p.m.	B1, MPG	B
	Dinner and Awards Ceremony	7:00 p.m.-10:30 p.m.	San Marino Club	5

Thursday, June 17	EVENT	TIME	LOCATION	MAP KEY
	Road Rally	7:00 a.m.-12:00 p.m.	Various Sponsors	
	Finish Line Ceremony	12:00 p.m.-1:30 p.m.	Ford World Headquarters	6

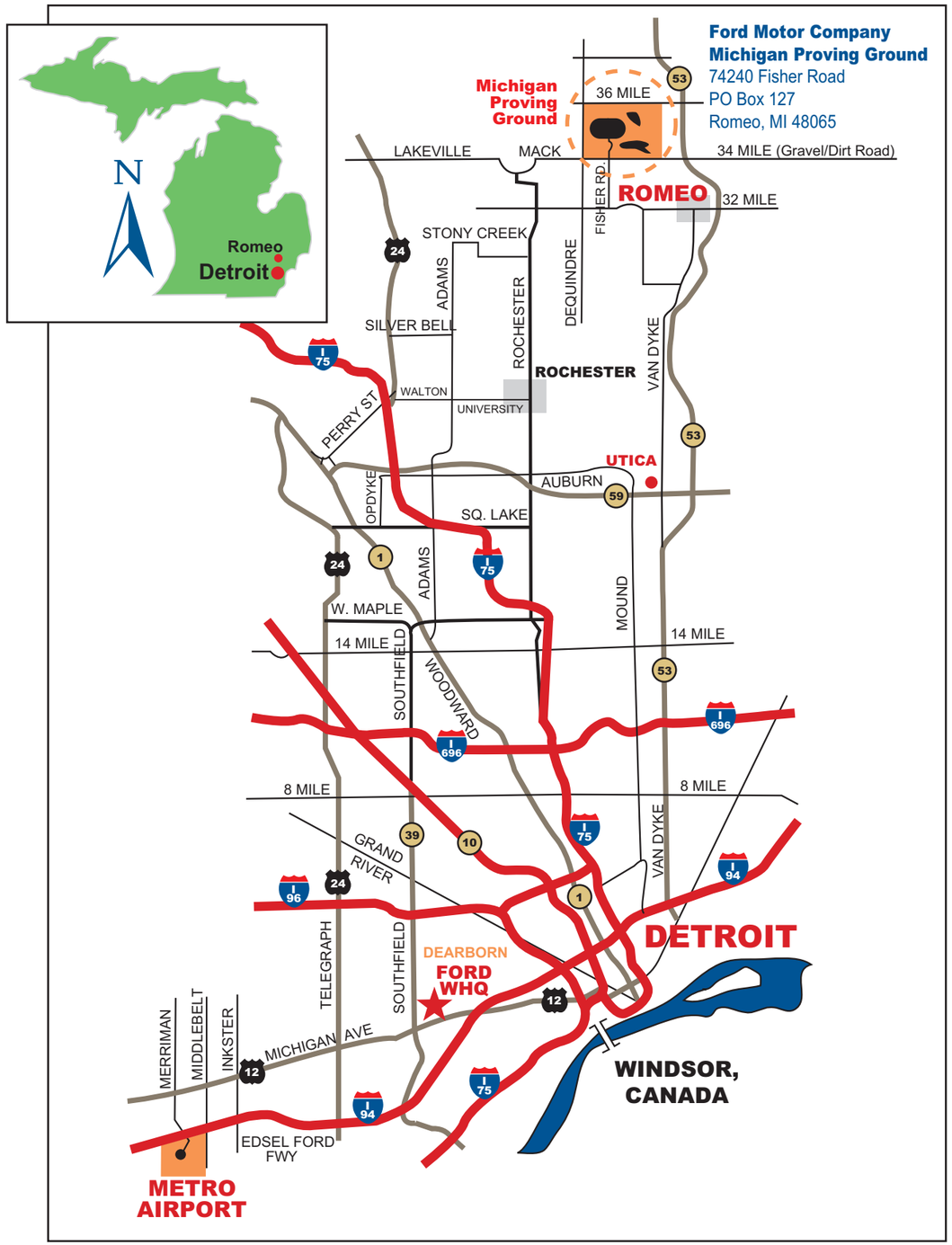
Location Key

MPG – Michigan Proving Ground
B1 – Bay One, Garage
B3 – Bay Three, Garage
B4 – Bay Four, Garage
B5 – Bay Five, Garage
APTL– Allen Park Test Laboratory

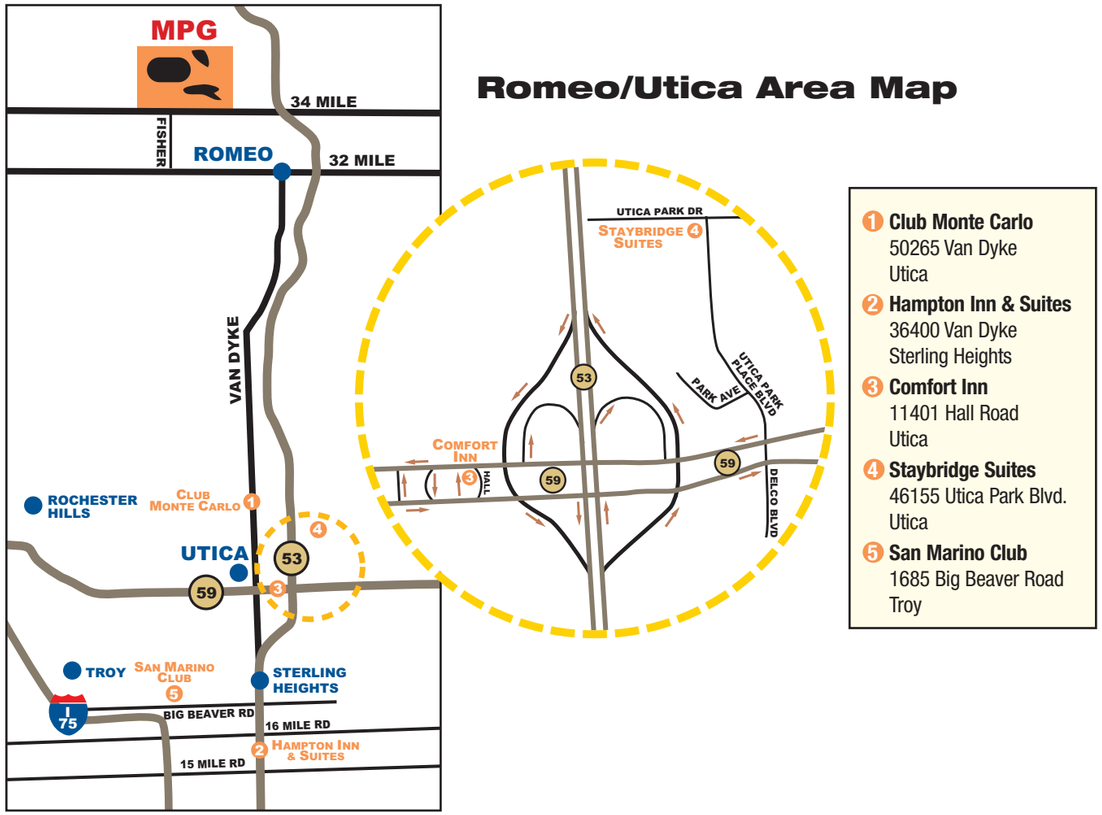
PULL-OUT SECTION

FUTURETRUCK '04 Maps

Detroit Area Map



Romeo/Utica Area Map



1. **Club Monte Carlo**
   50265 Van Dyke
   Utica
2. **Hampton Inn & Suites**
   36400 Van Dyke
   Sterling Heights
3. **Comfort Inn**
   11401 Hall Road
   Utica
4. **Staybridge Suites**
   46155 Utica Park Blvd.
   Utica
5. **San Marino Club**
   1685 Big Beaver Road
   Troy

Dearborn/Allen Park Area Map

6. **Ford World Headquarters**
   One American Road
   Dearborn
7. **Allen Park Test Laboratory**
   1500 Enterprise Drive
   Allen Park

FUTURETRUCK '04 Team Summaries

California Polytechnic State University, San Luis Obispo

Faculty Advisors: Christopher Pascual and George Delagrammatikas

Team Leaders: Andreas Baer and Zoltan Laszlo

Approach to Hybrid Design

The Cal Poly Hybrid Vehicle Design Team developed a traditional series hybrid electric vehicle with a unique control and power management strategy. This strategy blurs the lines between real-time generation and thermostatic control strategies to facilitate the optimal use of a number of reliable, off-the-shelf components. Each component operates at its peak efficiency to meet the goals of the competition. Our approach provides a drivetrain with equivalent performance, reduced fuel consumption, and lower greenhouse gas emissions than a stock Ford Explorer. The series design results in impressive improvements using today's technology. However, the Cal Poly FutureTruck's unique modularity allows for simple integration of future technologies such as fuel cells, advanced engine technology, improved generators, and batteries.

Team Accomplishments

In addition to meeting the competition's goals, the Cal Poly team has two main goals: (1) offering students a chance for hands-on engineering experience, while (2) striving to implement a high standard of engineering and fabrication, such that the finished product is indistinguishable from a stock Ford Explorer in terms of performance, utility, and comfort.

Cornell University

Faculty Advisor: John Callister

Team Leader: Brian Schimpf

Approach to Hybrid Design

The Cornell HEV team is using a split-parallel design in which the electric motor drives the front wheels and the internal combustion engine drives the rear. We are using the AC Propulsion 150, a 200-hp AC induction motor driven by a lead-acid battery pack. To reduce the more speed and increase torque, we employed a fixed-ratio 3:1 gear box and 3:1 front differential. The engine is a Nissan SR20DET—a turbocharged 2.0L, four-cylinder spark ignition unit. The engine runs on RFG and was chosen for its excellent power density and appropriate power characteristics.

Team Accomplishments

For the past 13 years of the Cornell HEV team's existence, we have been providing opportunities for engineering students to hone their skills and apply their knowledge in a real-world setting. The students leaving our program are always better prepared for the working world and have consistently found that their experiences on the HEV teams gave them an advantage over their peers. The students graduate with a love of automobiles and a familiarity with environmentally friendly technology.

Georgia Institute of Technology

Faculty Advisor: Jerome Meisel

Team Leader: Paul Mandeltort

Approach to Hybrid Design

The Georgia Tech Model GT employs a split-parallel through-the-road strong hybrid powertrain. A 200-peak-hp AC induction electric motor drives the front wheels of the vehicle, and a 210-peak-hp six-cylinder engine drives the rear wheels. The vehicle is designed to deliver impressive performance, ultra-low emissions, and improved fuel economy while retaining stock functionality and customer acceptability.

Team Accomplishments

The Model GT team has accomplished many of its goals during the 3 years of working with the Explorer. Manufacturing modifications to the stock vehicle have been minimized. The design allows the hybrid-electric powertrain to be a factory option, in the same way that six- and eight-cylinder engines and automatic and manual transmissions are options. We have maintained a fun-to-drive vehicle with a strong parallel hybrid design that out-performs standard powertrain configurations with respect to acceleration and handling. In the 2003 competition, the Model GT took first place in the acceleration event, beating the stock vehicle by over a half second in the 1/8-mile. The vehicle also took second place in the handling event. The Model GT team also made improvements in two core competition goals: emissions and fuel economy. The Model GT captured first place in emissions as the only vehicle demonstrating ULEV levels of emissions. With improved performance and emissions over the stock vehicle, the Model GT still improved fuel economy by 9% while maintaining state-of-charge in the vehicle's batteries. In 2004, the Model GT team enters a refinement year. The team hopes to optimize its current design in order to improve fuel economy by 25%, increase performance, and reduce emissions even further.

Michigan Technological University

Faculty Advisor: John Beard

Team Leaders: Brigham Erickson and Laura Merkel

Approach to Hybrid Design

The MTU FutureTruck will be a through-the-road parallel hybrid electric vehicle again this year. This will be a similar configuration to that of the last two competitions with the Explorer.

Team Accomplishments

Over the last three years, the team has had many accomplishments. Most importantly, the team members have learned what is required to build a successful vehicle of the future. Most team members are studying engineering, and the additional skills they learn on the team will help make them better engineers. The team's significant engineering accomplishments include designing a new suspension, a new frame, a new powertrain, and a Controller Area Network (CAN), and writing hybrid vehicle controls. Also, during the first year with the Explorer, the team designed and built a power-split transmission. Although the power-split never made it to competition, its design was a significant feat in itself. Finally, MSU's second and third place finishes at the first two competitions are accomplishments that can only be topped by a first this year.

Ohio State University

Faculty Advisors: Giorgio Rizzoni, Yann Guezennec, Lino Guzzella, and Frank Ohlemacher

Team Leader: Larry Slone

Approach to Hybrid Design

The Mighty Bucks continue to employ a charge-sustaining, parallel hybrid architecture. The system comprises an advanced compression-ignition direct-injection (CIDI) engine and AC induction electric motor. The two are belt-coupled in a pre-transmission configuration, providing both additional power and regenerative braking.

Team Accomplishments

The team has many accomplishments to be proud of during the last three years. While the team has struggled to run hybrid during the competition, our vehicle has completed every dynamic event in the previous two competitions. In fact, in 2002, the BuckHybrid produced the third best results for both fuel economy and GHG emissions. The BuckHybrid improved both of these performances in 2003, yielding the second best fuel economy and GHG results. Behind the technical successes of the BuckHybrid lie the triumphs of the Mighty Bucks themselves. The team has not only successfully recruited new members and sponsors, but has also added new public relations events to the annual calendar. Many new partnerships have been formed, both within the university and with companies nationwide. FutureTruck has brought together graduate and undergraduate students from across the university and around the world. In the end, these students of various disciplines and languages all learn the same valuable lessons in real-world problem solving and teamwork.

Pennsylvania State University

Faculty Advisor: Daniel Haworth

Team Leaders: Paul Minear and Jim Schmalzried

Approach to Hybrid Design

Beginning in 2002, Penn State chose to pursue a multi-year development strategy. Initially, we focused on developing a robust and reliable hybrid electric vehicle platform; subsequent years have been used primarily to implement improved emissions treatment systems and refine powertrain control strategies. Underlying goals included maximizing fuel economy and minimizing tailpipe emissions while maintaining stock driveability and appearance.

Team Accomplishments

Penn State has successfully converted a 2002 Ford Explorer into a hybrid electric vehicle. Utilizing a 2.5L common-rail diesel engine and an AC induction electric motor, Penn State achieved nearly 25% fuel economy improvement over the base Explorer while maintaining near-stock look and feel. Penn State implemented advanced technologies to significantly reduce diesel emissions, including a urea selective catalytic reduction system, a diesel particulate filter, and a diesel oxidation catalyst. Prototype lithium ion batteries were installed to provide efficient energy storage for the electric motor. Custom titanium and aluminum brake rotors were fabricated, each saving approximately 13 pounds of rotating mass. An air suspension was implemented to provide active ride height adjustment and improved handling. Penn State received the inaugural “Build Ford Tough” award in 2003 and placed 5th overall in both 2002 and 2003.

Texas Tech University

Faculty Advisors: Tim Maxwell and Michael Parten

Team Leader: Andrew Leslie

Approach to Hybrid Design

Texas Tech University’s hybrid design is considered a post-transmission parallel. The Ford Explorer’s mechanical powertrain is a hydrogen-powered 2.3L Ford internal combustion engine. The electrical powertrain is a Solectria 75kW electric motor with a 300VDC nickel-metal hydride (NiMH) battery pack. This design was chosen to investigate how well a hydrogen internal combustion engine (H^2ICE) would provide power to the wheels and to the ground.

Team Accomplishments

In 2002, Texas Tech University was the only FutureTruck team ever to run solely on fuel cell power, and the team won second place for The Most Innovative Use of LabVIEW Real-Time. During FutureTruck 2003, Texas Tech continued its use of hydrogen as a transportation fuel using a traditional internal combustion engine. Texas Tech University was the first FutureTruck team to compete in the On-Road Fuel Economy, Acceleration, and Off-Road events under hydrogen power. Through the FutureTruck competitions, our teams have had worthwhile experiences in developing and using cutting-edge technologies and have raised the bar for future hybrid electric vehicle competitions.

University of Alberta

Faculty Advisor: David Checkel

Team Leader: Clayton Bond

Approach to Hybrid Design

The University of Alberta has designed a pre-transmission parallel hybrid. This design places a Ford 2.0L TDCi engine, running on a biodiesel blend (B35), in parallel with a brushless DC motor. Electrical energy is stored in a NiMH battery pack.

Team Accomplishments

The University of Alberta has continued to work hard every year to improve our hybrid design. Our initial design included a 2.0L Zetec engine and lithium ion batteries for electrical storage, but the hybrid configuration was changed to utilize the high-efficiency, direct-injection turbo-diesel engine, as well as the more robust battery pack of NiMH cells. In addition, the team is integrating an automatic 8-speed transmission into its pre-transmission parallel hybrid design. These changes, as well as modifications to the control strategy, ensure that the University of Alberta FutureTruck will exceed the competitions goals of increasing fuel economy and reducing environmental impact. The team has consistently improved its performance over the past three years and plans to be a top contender at the 2004 competition.

University of California, Davis

***Faculty Advisor:** Andrew Frank*

***Team Leaders:** Aashish Dalal and Aaron Singer-Englar*

Approach to Hybrid Design

Through the use of lightweight components, aerodynamic improvements, custom powertrain elements, embedded electronics, and an advanced control system, our vehicle is capable of achieving double the fuel economy of the stock vehicle, while having a minimal GHG impact on the environment. A large battery pack and electric motor allow our plug-in hybrid to take full advantage of the high energy efficiency of electricity and provide a 50-mile, all-electric zero-emissions driving range.

Team Accomplishments

The UCD team strives to accomplish three goals. First, provide practical engineering experience to students, integrating theoretical classroom learning and practical application. Second, to develop and expand new technologies, prove that they are a viable automotive resource, and continue to strengthen the bond between industry and academia. Finally, to keep the public informed about new vehicle technologies and what societal and environmental impacts they may have. Our team consists of about 20 undergraduate and 3 graduate students from a broad spectrum of engineering disciplines, primarily mechanical and electrical. Students involved in the project expand upon existing technologies using a creative approach to enhance driver comfort, safety, and efficiency. Over the past three years, the team has designed and built a vehicle that surpasses the expectations of what an SUV can be—a vehicle with increased performance, high fuel economy, and low emissions.

University of Idaho

***Faculty Advisors:** Frank Albrecht and Don Blackketter*

***Team Leaders:** Richard Statler, Jeremy Forbes, and Jeremy Boles*

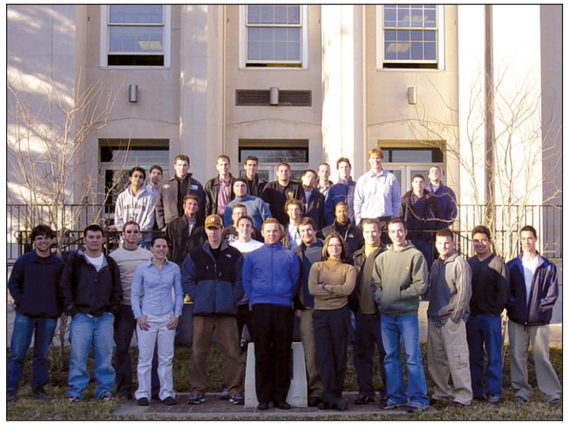
Approach to Hybrid Design

The 2004 hybrid is a mild-electric parallel configuration. The powertrain is a 3.0L engine running on RFG and an 18-hp AC induction machine with ultracapacitors as the low-voltage energy storage system. The hybrid system is tied together through the custom-designed transfer case that repackages 50% of the stock system for transparent operation in 4WD/all-wheel drive (AWD).

Team Accomplishments

University of Idaho has created the world's first Tri-brid, combining hydraulic, ultracapacitors, and a combustion engine in one vehicle. Research continues with these technologies on two vehicles in 2004. The ultracapacitor system has been optimized and enlarged for use again on the Ford Explorer, while the hydraulic technology has been enlarged and installed on a Ford F-350 to be used as a tow truck for transporting the competition vehicle. Chemically preheated catalytic converters, passive cooling, and thermoelectric generators are all used to reduce emissions and increase fuel economy.

University of Maryland



***Faculty Advisors:** Gregory Schultz and David Holloway*

***Team Leaders:** Corey Merdler, Mike Welch, Vincent Nguyen, and Elizabeth Goldwasser*

Approach to Hybrid Design

In approaching the FutureTruck design problem, our goal was to modify a Ford Explorer to increase fuel economy, reduce emissions, and create a design feasible for production. Keeping our design as a mild hybrid increases production feasibility.

Team Accomplishments

For the 2004 FutureTruck competition, the University of Maryland will build upon the progress made in past competitions. Our team converted a Lincoln 3.0L, six-cylinder engine to dedicated E85. We designed adapter plates to mate an electric motor to our internal combustion engine and transmission. Throttle-by-wire technology has been implemented to overcome the constraints presented by manual throttle control. Wind tunnel testing helped us to implement a front air dam and a rear spoiler to improve the Excite's coefficient of drag. Using Labview, we have written a hybrid control strategy that controls our hybrid powertrain. An infotainment system with an in-dash touch screen has been implemented to allow the driver to monitor vehicle status.

University of Tennessee

***Faculty Advisor:** Dr. David (Butch) Irick*

***Team Leaders:** Gary Holder, John Miller, and David Smith*

Approach to Hybrid Design

Team Tennessee has designed a parallel, pre-transmission hybrid powertrain for our Ford Explorer, nicknamed Evolution, with a charge-sustaining control strategy, employing limited zero-emissions vehicle (ZEV) operation. A 2.3L, four-cylinder Ford engine optimized for E85 and a 53kW Unique Mobility electric motor power this system. Our design will allow us to shut down the engine when the vehicle is stopped, launch and restart using the electric motor, and operate as a ZEV during some phases of driving.

Team Accomplishments

Over the past 3 years, approximately 80 undergraduate and 5 graduate engineering students have participated in the FutureTruck program at the University of Tennessee. These students have received academic credit for their senior capstone design experience through participation in FutureTruck and have benefited greatly from the interdisciplinary format of this project. Highlights of their accomplishments include development of award-winning control systems and telematics systems. Team Tennessee is using this third year of the competition to concentrate on calibration, tuning, and testing of Evolution.

University of Wisconsin — Madison

Faculty Advisor: Glenn Bower

Team Leaders: Jason Peto and Daniel Bocci

Approach to Hybrid Design

To minimize the GHG impact of our vehicle, Wisconsin developed a parallel hybrid utilizing a compression-ignition engine with an advanced catalyst system capable of achieving SULEV emissions. Once a suitable engine was selected, the traction (electric) drive components were sized to maintain vehicle acceleration, while also being able to capture all available regenerative energy.

Team Accomplishments

Wisconsin utilized a Ford Lynx 1.8L compression-ignition engine in conjunction with a modified Delphi EV1 AC induction motor in a post-transmission parallel hybrid. Engelhard supplied a selective catalytic reduction (SCR) catalyst and a particulate filter to help Wisconsin strive for SULEV emissions. The engine is coupled to a Borg-Warner T5 transmission and maintains the vehicle's 4-wheel-drive capability with a Borg Warner 13-54 transfer case. Throughout FutureTruck 2003, the Moolander achieved 35 mpg on biodiesel while surpassing ULEV emissions. Using a Ballard planetary gear reduction, students modified the motor to a through-shaft design. The EV1 motor is a copper rotor-bar design that is very compact and typically over 90% efficient. The electric motor is powered using two Panasonic prismatic battery packs from the Toyota Prius and a Solectria motor controller using CAN controls. Wisconsin incorporated the new Delphi E-Steer system to minimize parasitic losses. A belt-driven starter/alternator replaced the engine's original starter and alternator to increase the efficiency of the 12V charging system from 40% to 75%. In addition, an electric vacuum pump supplies power-assist brakes at all times so the engine can be shut off during deceleration, increasing fuel economy by 2%.

Virginia Tech

Faculty Advisor: Doug Nelson

Team Leader: Henning Lohse-Busch

Approach to Hybrid Design

The Hybrid Electric Vehicle Team (HEVT) of Virginia Tech is using a hydrogen-fueled engine-generator set to power its vehicle, called Magellan. Magellan is an ultra-low-emissions series hybrid Ford Explorer that maintains the performance and consumer acceptability of the stock vehicle while increasing fuel economy.

Team Accomplishments

HEVT engineered and implemented a clean and efficient engine-generator set composed of a 2L engine running on clean-burning hydrogen and an AC induction generator that efficiently produces electric power for the vehicle. This power, along with extra power from a battery pack, allows an electric motor to deliver high torque to the wheels. Magellan, with its internal combustion engine, is a cost-effective transitional solution for hydrogen vehicles. This true "laboratory on wheels" only requires the driver to turn the key and put the car in drive. Last, but not least, many generations of HEVT students have gained valuable engineering knowledge, hands-on experiences, as well as teamwork and leadership skills that they will take with them into industry.

West Virginia University

Faculty Advisor: Nigel Clark

Team Leader: Mark Jacobs

Approach to Hybrid Design

WVU's approach to the hybrid design included downsizing the stock motor and implementing an electric propulsion system in order to conserve fuel and capture lost braking energy. WVU has chosen to do this by incorporating a 2.5L diesel engine and a post-transmission, post-transfer-case parallel electric propulsion system.

Team Accomplishments

WVU's FutureTruck team converted a stock 2002 Ford Explorer into a diesel-electric hybrid vehicle. The team uses a post-transmission, post-transfer-case parallel mild hybrid assist configuration in which the electric motor and drive shaft are tied together through a hybrid gearbox attached to the transfer case. The engine, fueled by biodiesel (B35: 35% soy-based diesel, 65% crude oil diesel), is a 4-cylinder, turbo-charged, 142-hp Detriot Diesel with exhaust gas recirculation. The electric motor is an 18-hp, brushless, three-phase AC induction motor. A 48V battery pack, recharged by regenerative braking, powers the motor. A National Instruments Compact FieldPoint (cFP) system controls the electric motor and diesel engine by interfacing with an electric motor controller and controlling the signals sent to the electric control unit (ECU), which is responsible for diesel operations. The emissions resulting from the use of a diesel engine are reduced by using a three-stage exhaust after-treatment system. The exhaust is routed in sequence to the particulate matter (PM) trap, SCR device, and a clean-up catalyst. Urea injection is performed upstream of the SCR catalyst to further reduce oxides of nitrogen (NO_x) emissions.

FUTURETRUCK '04 Mentors

A Ford Motor Company engineer was assigned to each team to provide technical mentoring. The mentors helped guide the teams through the vehicle design process and provided an industry perspective on their design approach. Ford mentors also helped the teams explore the benefits of their chosen technologies, to help them produce the most efficient, consumer-acceptable vehicle possible.

Name	Assignment	School
Scott Bodjack	Escape/Tribute Vehicle Integration Supervisor	University of Tennessee
Vijay Iyer	Suspension Design Engineer	Cornell University
Brian Licht	Piston & Rod Assembly	University of Alberta
Scott Low	Product Planning Analyst	University of Wisconsin - Madison
Brandon Masterson	Vehicle Development Engineer	Michigan Technological University
John Nalevanko	NVH Engineer–Wind Noise	Georgia Institute of Technology
Tony Palumbo	Manufacturing Leadership -RVT	California Polytechnic State University, San Luis Obispo
James Potter	Control Strategy Design–Transmission	Ohio State University
Tom Schramski	Axle/Driveline/4x4/AWD Systems Supervisor	University of California, Davis
Jack Szpytman	EcoStar Electric Drive Systems Manager	West Virginia University
Hoang Truong	Ranger Program Management	Texas Tech University
Bill Weidenaar	Truck Vehicle Engineering Supervisor	University of Idaho
Russ Worosz	E-Series Powertrain Program Management	University of Maryland
Peter Worrel	Regenerative Braking Product Design Supervisor	Pennsylvania State University
Min Zhu	Manual Transmission & Clutch Engineer	Virginia Tech

FutureTruck '04 Sponsors

Major Sponsors

The National Science Foundation (NSF) has been a long-time supporter of DOE's advanced vehicle technology competitions. In addition to providing financial support to FutureTruck, each year the NSF has provided a $20,000 award for faculty members who have made significant contributions to the goals of the FutureTruck program and to engineering education. This year's award will be the seventh outstanding faculty advisor award sponsored by NSF.

The NSF is an independent agency of the U.S. government responsible for investing more than $4.4 billion annually in almost 20,000 research and education projects. These projects cover nearly every field of science and engineering. The NSF also encourages high-quality education at all levels and heavily supports graduate education in the sciences and engineering. Known for promoting science, the NSF has funded numerous scientific activities. Grant recipients have been recognized with several Nobel prizes and other prestigious awards.

On the web at **www.nsf.gov**

Delphi, a world leader in mobile electronics and transportation components and systems technology, is returning for its fifth year as a major sponsor of the FutureTruck competition. Delphi engineers and staff will be involved in judging and coordinating competitive events for the program. The company is also sponsoring the Delphi Advanced Powertrain Controls Award.

Multi-national Delphi conducts its business operations through various subsidiaries and has headquarters in Troy, Michigan, USA; Paris, France; Tokyo, Japan; and São Paulo, Brazil. Delphi's two business sectors—a Dynamics, Propulsion, Thermal & Interior Sector and an Electrical, Electronics & Safety Sector—provide comprehensive product solutions to meet complex customer needs. Delphi, with approximately 187,000 employees in 41 countries, is committed to reducing the environmental impact of automobiles and has a history of innovative solutions that improve fuel economy, help reduce emissions, decrease vehicle mass, and increase recyclability.

On the web at **www.delphi.com**

The MathWorks is the leading developer and supplier of technical computing software in the world. Employing more than 1,000 people, the MathWorks was founded in 1984 and is headquartered in Natick, Massachusetts, with offices and representatives throughout the world. The MathWorks customers are over 500,000 of the world's leading technical people, in over 100 countries, on all seven continents. These technical people work at the world's most innovative technology companies, government research labs, financial institutions, and at more than 3,500 universities. They rely on us because MATLAB and Simulink have become the fundamental tools for their engineering and scientific work. Today for example, automotive engineers responsible for powertrain, chassis, body, and other systems must reduce development time while continuing to satisfy market demands for safe, high-performance, fuel-efficient cars and trucks. This requires the development of new technology and systems, particularly electronics and software, in the vehicle. It also requires improved collaboration among carmakers and their suppliers to produce clearer specifications, faster design iterations, and verifiable implementations. Automotive companies are meeting these challenges by using development and testing processes based on model-based design, technical computing, and test-and-verification tools from the MathWorks.

On the web at **www.mathworks.com**

ArvinMeritor, a global supplier of integrated automotive systems and modules, is returning to sponsor FutureTruck for the fourth year and present the ArvinMeritor Lowest Regulated Tailpipe Emissions Award. For this event, FutureTruck vehicles must meet real-world requirements by simultaneously controlling pollutants and meeting minimum Federal Tier 0 emissions standards; the ultimate goal is to meet California's Super Ultra Low Emissions Vehicles standard.

An $8-billion global supplier of integrated systems, modules, and components for the automotive industry, ArvinMeritor is headquartered in Troy, Michigan, and employs 32,000 people at more than 150 manufacturing facilities in 27 countries. The company serves light vehicle, commercial truck, trailer, and specialty original equipment manufacturers and related aftermarkets. The Light Vehicle Systems' Air and Emissions Technologies Division is a premier supplier of emissions management solutions.

On the web at **www.arvinmeritor.com**

National Instruments (NI) is a technology pioneer and leader in virtual instrumentation—a revolutionary concept that has changed the way engineers and scientists approach measurement and automation. Leveraging the PC and its related technologies, virtual instrumentation increases productivity and lowers costs for customers worldwide through easy-to-integrate software, such as the NI LabVIEW graphical development environment, and modular hardware, such as PXI modules for data acquisition, instrument control, and machine vision. Headquartered in Austin, Texas, NI has more than 3,000 employees and direct operations in 40 countries. For the past 5 consecutive years, FORTUNE magazine has named NI one of the 100 best companies to work for in America.

In addition to providing an NI Application Engineer advisor to each team for product support and expertise through all phases of the competition, NI also donated more than $750,000 in software and hardware products to participating teams.

Through its support of the FutureTruck competition, NI continues its commitment to education by providing tomorrow's engineering leaders with tools to be successful today and in the future.

On the web at **www.ni.com**

Visteon Corp., a leading global supplier of automotive systems, takes pride in the range of systems and technologies that are making trucks cleaner and more fuel efficient without sacrificing performance or comfort. Visteon, the largest Tier 1 content provider for light trucks globally, is proud to be a major sponsor of the 2004 FutureTruck competition.

We are developing solutions that provide our customers with safety-conscious products that improve the environment. From using lighter-weight materials in the drive train to fuel tanks that reduce evaporative emissions, Visteon is collaborating with its customers to bring innovative technology to market.

At Visteon, our systems engineering capability allows us to integrate multiple components into single systems that reduce weight while improving quality and reliability. Our engine induction systems integrate functions traditionally performed by over 50 components into 15. Our slip-in-tube propshaft is a revolutionary driveline technology that is up to 30% lighter than conventional designs, which, in turn, reduces vehicle noise, vibration, and harshness.

Visteon Corporation delivers consumer-driven technology solutions to automotive manufacturers worldwide and through multiple channels within the global automotive aftermarket. Spun off from Ford Motor Company in 2000, Visteon has 75,000 employees and a global delivery system of more than 180 technical, manufacturing, sales, and service facilities located in 25 countries.

On the web at **www.visteon.com**

Natural Resources Canada (NRCan) has been a long-time supporter of DOE's advanced vehicle technology competition program, providing technical and program support for more than 20 competitions over 15 years. FutureTruck underscores NRCan's commitment to addressing the global issue of climate change and supporting sustainable energy policies and advanced automotive technologies.

NRCan provides knowledge, expertise, and program activities for the sustainable development and use of Canada's natural resources and to support the global competitiveness of its resource and related sectors. This includes energy activities that encompasses policy development; market development programs; and international activities in energy efficiency, renewables, transportation technologies, alternative fuels, and conventional fuels.

On the web at **www.nrcan.gc.ca**

BP is focused on finding, producing, and marketing the natural energy resources on which the modern world depends. In addition, the company is committed to making a positive contribution and taking a leadership role toward a cleaner environment. BP delivers cleaner-burning and lower-emissions fuels to more than 115 cities worldwide that have serious air quality problems. As vehicle technology continues to advance, fuels and lubricants must also change to keep pace with the new technology. Several years ago, BP introduced ECD®, an emissions control (ultra-low-sulfur) diesel fuel that helps sulfur-sensitive control systems operate effectively.

BP is supplying a variety of fuels to many of the Future Truck participants. In support of technological advancement, BP is sponsoring the BP On-Road Fuel Economy Award. Evaluation criteria are demonstration of the robustness and on-road fuel economy for stop-and-go, urban, and highway driving segments.

On the web at **www.bp.com**

Michigan Proving Ground runs 24 hours per day, five days a week, and offers customer support facilities and services, extensive mechanical services, full-vehicle evaluation, a variety of road surfaces, and 22 vehicle chassis dynamometers. With the exception of emissions testing, all of the scored FutureTruck events will be hosted at this world-class facility in Romeo.

Allen Park Test Laboratory provides a wide range of testing capabilities including the following: Advanced Powertrain Engineering Test Site, OBDII & Clean Air Act Phases I and II, Dynamic Systems Optimization, FFV-NMOG, Vehicle Prep & Parasitic Loss, Non-Regulated Emissions Testing, Cold CO Certification, Fuel Systems Testing & Development, Gas Standards Laboratory, Powertrain Systems Analysis, and other testing. This facility will host the FutureTruck Emissions Testing and Greenhouse Gas Impact events.

Competition Supporters

Dana Corporation is a global leader in the design, engineering, and manufacture of value-added products and systems for automotive, commercial, and off-highway vehicles. Delivering on a century of innovation, the company's continuing operations employ approximately 45,000 people worldwide dedicated to advancing the science of mobility. Founded in 1904 and based in Toledo, Ohio, Dana operates technology, manufacturing, and customer-service facilities in 30 countries. Sales from continuing operations totaled $7.9 billion in 2003.

On the web at **www.dana.com**

Freescale Semiconductor, formerly known as Motorola's Semiconductor Product Sector (SPS), is one of the oldest and most diverse makers of microchips in the world. Since Motorola's introduction of the MPC555 in 1998, the MPC500 family has rapidly gained acceptance throughout North America, Europe, and Japan as an industry standard MCU architecture for high-speed automotive applications. Each device in the growing family features a 32-bit RISC core that is compliant with the PowerPC instruction set architecture. With up to 1 megabyte of embedded Flash, the MPC500 family is suitable for complex real-time control, requiring computationally complex algorithms including dual-precision, floating-point arithmetic. Code compatibility among family members helps eliminate migration worries and ensures software reuse between family members.

On the web **www.freescale.com**, **www.mot-sps.com**

The Aluminum Association has been a sponsor of DOE's advanced vehicle technology competitions for more than 5 years, encouraging teams to explore aluminum to help boost environmental, safety, and handling performance and for special emphasis on weight reduction for increased fuel efficiency.

One of the original FutureTruck partners, the Aluminum Association, based in Washington D.C., with offices in Detroit, Michigan, is the trade association for U.S. primary aluminum producers, recyclers, and manufacturers of semifabricated aluminum products. Member companies operate nearly 200 plants in 37 states. The Association's Automotive and Light Truck Group promotes the use of aluminum in automotive structures and components by demonstrating the reasons why it is the material of choice for high-value, safe, environmentally friendly, and superior-performing vehicles. The FutureTruck competitions help teach students how to use aluminum, which had doubled in use in cars and light trucks during the last 10 years.

On the web at **www.autoaluminum.org**

In-Kind Supporters

Ricardo, Inc., the U.S. division of UK-based Ricardo plc, is a leading engineering technology and services provider, undertaking advanced product engineering, design, and development services for the world's automotive, truck, and off-highway vehicle manufacturers. Ricardo focuses on engines, transmissions, drivelines, chassis systems, electronics and electrical systems, and integration of these systems in complete vehicle engineering programs. In addition, Ricardo markets, develops, and supports a wide range of design and analysis software products, including WAVE, which are designed specifically for application during the powertrain development and vehicle integration process. In addition to providing competition support, Ricardo is donating WAVE software to each of the FutureTruck teams.

On the web at **www.ricardo.com**

Founded in 1916, **AAA Michigan** is a nonprofit membership organization offering automotive, travel, insurance, and financial services to more than 47 million members in Michigan. It is part of The Auto Club Group (ACG), the largest affiliation of AAA clubs in the Midwest, with 4.1 million members in eight states. ACG clubs belong to the national AAA federation, with more than 46 million members in the United States and Canada. AAA has a long history of public service and offers advocacy on important safety, consumer, automotive, and environmental issues.

AAA Michigan has been providing roadside assistance to AAA members since 1922. The club's Emergency Road Service network annually responds to almost 900,000 calls.

On the web **www.aaapublicaffairs.com**