Challenge X 2006
Final Media Coverage Report

July 24, 2006

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SECTION 1

Overview, Observations & Recommendations

2005 - 2006 Media Review

The media strategy for the second year of Challenge X included the following elements: opportunistic media pitching throughout the year; reaching out to national, trade, specialty publication and Phoenix-area media around the time of the competition; and continued efforts to expand the Outreach Program to reach audiences at the local level in the 17 team home markets.

The following report represents a comprehensive look at the public relations effort for the second year of Challenge X, which focused on the June competition in Mesa, Arizona. As with Year One, media outreach efforts for this academic year-end event included team pitching on the local level as part of the Outreach Program; sponsor pitching to promote their own involvement in the Challenge X competition; publicizing a Media Day event at GM's Desert Proving Ground; conducting a radio tour with the 17 teams; and posting a video news release (VNR) at the end of the competition to reach local broadcast and electronic outlets.

Our estimate for total print and broadcast audience reach for Year Two of Challenge X is a minimum of 22 million impressions. This is a very conservative estimate, as audience figures for some of the team clips, radio interviews and online coverage are unavailable. Audience reach and a summary of coverage are listed in detail later in this report; print and online clips are attached in the appendix.

Local Outreach Programs

The Outreach Program continues to be a successful addition to our overall PR strategy, as it is an effective way to garner localized community interest and media coverage of individual teams and their collective efforts as part of the Challenge X program. As in Year One, thirteen of the 17 teams officially made presentations to compete for outreach program awards at the 2006 competition. Further, all 17 teams assigned Outreach Coordinators had made a concerted effort to participate in the program on some level.

As evidenced in the teams' final Outreach Program written reports, there was a sizeable increase in community awareness and local media coverage in many markets during Year Two, as most of the teams made significant efforts to further develop the outreach strategies they initiated in Year One of the program.

The total estimated audience reach as a result of the team efforts in the Outreach Program *that we are able to measure* is more than 14 million – this is an extremely conservative measure, however, as we are not able to track audience figures for all of the local coverage reported by the teams in their official outreach reports. Team Outreach Program coverage is included in the charts below with the Audience Size column marked "not available."

The Outreach Program continues to grow in strength and momentum. Many of the teams are establishing true relationships with local reporters who have a keen interest in following the team through the entire Challenge X program. Clearly, we recommend continuing or even further enhancing the team Outreach Program in Year Three of Challenge X.

Year Two Competition Media Event

Given that this year's event was in Arizona rather than Michigan, where much of the automotive trade press is located, Challenge X organizers decided to offer to host key trade media contacts for the media event at the end of the competition. Even with this obstacle, however, we were very pleased with the media turnout at the competition Media Day and Ride & Drive, and with the resulting broadcast, print and online media coverage we received from the competition.

This year's radio tour was a home run with 90 total radio interviews – confirming that radio is an excellent medium for promoting Challenge X, due to the ability to localize each story. Each of the 17 teams participated in as many as 13 interviews over the course of the week surrounding the competition, and the three top-placing teams did additional interviews once results were announced. We strongly suggest continuing the radio tour effort for the next year of Challenge X.

Since planning for the Media Day initially included the participation of a celebrity figure (Jay Leno or Chip Foose), the competition organizers decided to pursue a Year Two VNR package to distribute to team markets. Unfortunately, the celebrities had last-minute scheduling conflicts and were unable to participate in the Media Day or VNR. Even so, pitching resulted in at least a dozen television stories about the Challenge X competition.

As we look down the road toward the final year of the Challenge X competition series, our strategy will broaden to include pitching the top-tier national outlets that we have been holding off on contacting until we have hard news to report (i.e., the winner of the entire multi-year competition series). When that time comes, we suggest coordinating an all-out media blitz to those outlets, and considering hosting key national media as we did at this year's competition for trade media.

SECTION 2

U.S. and Canada Media Tracking Report

2005-2006 CHALLENGE X STUDENT COMPETITION
U.S. and Canada Media Coverage Report

Total Coverage and Estimated Audience for Year Two:

Print: **101** hits; more than **15.5 million readers** (approximately 65 hits generated by the Outreach Program)
Television: **39** local impressions; 400,000 known viewers – however, since ratings were only available for a fraction of the TV clips; estimated audience reach should be closer to **1 million viewers** (approximately 27 hits generated by the Outreach Program)
Radio: **95** discrete stories (including 9 state news networks and 8 metro network and regional news outlets); nearly **5.6 million listeners** (5 stories generated by the Outreach Program)
Online: **55** hits; audience figures not available

TOTAL MINIMUM AUDIENCE: **22,147,557**

U.S. and Canada Media Placements

PRINT:

Publication	Audience Size	Date	Market
Electric & Hybrid Vehicle Tech. International*	Not Available	2005 Edition	Global
Workforce Diversity for Engineering & IT	15,031	August 2005	Melville, NY
The Republic	21,938	August 2, 2005	Columbus, IN
Automotive Engineering International	87,260	August 17, 2005	Warrendale, PA
Tulsa Business Journal	5,000	August 19, 2005	Tulsa, OK
Daily Oklahoman	283,679	August 21, 2005	Oklahoma City, OK
The Collegian	19,300	August 23, 2006	State College, PA
Design Engineering	19, 208	August/September 2005	Toronto, ON
Akron: Magazine for Alumni*	Not Available	Fall 2005	U.S. National
PEO Engineering Dimensions Journal*	66,592	September/October 2005	Provincial (Canada)
New York Times Magazine*	1,680,583	September 25, 2005	New York, NY
Popular Mechanics	1,210,126	October 2006	U.S. National
The Times-Tribune	73,598	October 2, 2005	Scranton, PA
Centre Daily Times	24,751	October 3, 2005	State College, PA
Waste News Magazine	51,516	October 10, 2005	Akron, OH
The Altoona Mirror	34,137	October 20, 2005	Altoona, PA
San Diego Reader	170,000	October 20, 2005	San Diego, CA
Cleveland Plain Dealer	476,424	October 23, 2005	Cleveland, OH
Minority Engineer	14,506	November 2005	Melville, NY
Daily Oklahoman	190,655	November 8, 2005	Shattuck, OK
Market Wire	Not Available	November 14, 2005	U.S. National
The Lantern	28,000	November 21, 2005	Columbus, OH
Daily Aztec	15,000	November 21, 2005	San Diego, CA
USA Today	2,272,815	November 21, 2005	U.S. National
VDI Nachrichten*	600	November 25, 2005	Chicago, IL

Engineers' Forum	Not Available	December 2005	New York, NY
MRI Bulletin (Penn State Newsletter)	Not Available	December 2005	Not Available
Alternatives Journal	5,000	December 2005	Waterloo, ON
Pittsburgh Post Gazette	232,584	December 1, 2005	Pittsburgh, PA
Davis Enterprise	8,937	December 2, 2005	Davis, CA
The Rose Thorn*	Not Available	December 9, 20005	Terre Haute, IN
Suburban Life	8,517	January 18, 2006	Loveland, OH
Wall Street Journal	2,083,660	January 25, 2006	U.S. National
Terre Haute Tribune Star*	25,920	January 25, 2006	Terre Haute, IN
Comstock Magazine	21,500	February 2006	Sacramento, CA
Washington Technology	119,580	February 13, 2006	Washington, DC
The Daily Mining Gazette	11,020	February 15, 2006	Houghton, Keweenaw, Baraga & Ontonagon Counties, Michigan
Lubbock Avalanche Journal	54,634	February 16, 2006	Lubbock, TX
The Buchtelite*	15,000	February 21, 2006	Cleveland, OH
Milwaukee Journal Sentinel	242,819	February 23, 2006	Milwaukee, WI
Globe and Mail	318,351	February 23, 2006	National (Canada)
The Digital Collegian (Penn State Campus Paper)	Not Available	February 24, 2006	Penn State Campus
The Daily Texan	30,000	February 24, 2006	Austin, TX
City News Service	Not Available	February 27, 2006	San Diego, CA
North County Times	89,835	February 27, 2006	San Diego, CA
Milwaukee Journal Sentinel	242,819	February 28, 2006	Milwaukee, WI
Daily Aztec*	15,000	March 1, 2006	San Diego, CA
The Commercial Dispatch	14,804	March 5, 2006	Columbus, OH
University of Waterloo Imprint*	12,000	March 17, 2006	Waterloo, Ontario
Akron Beacon Journal	184,825	March 19, 2006	Akron & Cleveland, OH
University of Waterloo Annual Report*	Not Available	Mach 21, 2006	National (Canada)
Business Wire	Not Available	March 28, 2006	U.S. National
The Digital Collegian (Penn State Campus Paper)	Not Available	March 31, 2006	Penn State Campus
Scientific American	582,768	April 2006	U.S. National
PR Newswire	Not Available	April 19, 2006	U.S. National
West Side Ledger	43,600	April 20, 2006	Akron, OH
The Columbus Dispatch	244,280	May 5, 2006	Columbus, OH
San Diego Union-Tribune	314,279	May 8, 2006	San Diego, CA
City News Service	Not Available	May 8, 2006	U.S. National
Waterloo Record	Not Available	May 13, 2006	Ontario, Canada
Norman Transcript	40,405	May 17, 2006	Norman, OK
Indianapolis Star	252,862	May 18, 2006	Indianapolis, IN
Starkville Daily News	5,824	May 18, 2006	Starkville, MS
Tribune Star	25,920	May 18, 2006	Terre Haute, IN
University Wire	Not Available	May 19, 2006	U.S. National
Daily Democrat	9,782	May 19, 2006	Woodland, CA
The Davis Enterprise	8,937	May 19, 2006	Davis, CA
Jackson Clarion Ledger	98,986	May 24, 2006	Jackson, MS
U Weekly	20,000	May 24, 2006	Columbus, OH
Cleveland Plain Dealer	356,286	May 27, 2006	Cleveland, OH

East Valley Tribune	109,637	May 31, 2006	Mesa, AZ
The Penn Stater (magazine)	Not Available	May/June 2006	Not Available
Collegiate Times (VA Tech)	14,000	June 1, 2006	Blacksburg, VA
University Wire	Not Available	June 2, 2006	U.S. National
The Noblesville Ledger	25,794	June 6, 2006	Indianapolis, IN
Business Wire	Not Available	June 8, 2006	U.S. National
EurekaAlert!	Not Available	June 8, 2006	U.S. National
East Valley Tribune	109,637	June 9, 2006	Mesa, AZ
The Roanoke Times	97,344	June 10, 2006	Roanoke, VA
The Capital Times	21,612	June 10, 2006	Madison, WI
Richmond Times Dispatch	188,893	June 10, 2006	Richmond, VA
Cleveland Plain Dealer	476,424	June 11, 2006	Cleveland, OH
Akron Beacon Journal	184,825	June 11, 2006	Akron & Cleveland, OH
East Valley Tribune	109,637	June 11, 2006	Mesa, AZ
Wisconsin State Journal	148,292	June 11, 2006	Madison, WI
Business Wire	Not Available	June 12, 2006	U.S. National
Arizona Republic	452,016	June 12, 2006	Phoenix, AZ
Daily Oklahoman	190,655	June 12, 2006	Oklahoma City, OK
PR Newswire	Not Available	June 13, 2006	U.S. National
Jackson Clarion Ledger	98,986	June 15, 2006	Jackson, MS
PR Leap	Not Available	June 18, 2006	U.S. National
Electronic Engineering Times (EE Times)	150,000	June 19, 2006	U.S. National
The Virginia Pilot	198,273	June 23, 2006	Norfolk, VA
Green Car Journal	30,000	July 2006	U.S. National
Motor Magazine	143,831	July 2006	U.S. National
Material Handling Product News	81,466	July 2006	U.S. National
Advanced Battery Technology	1.000	July 2006	U.S. National
Design News	169,885	July 17, 2006	U.S. National
Auto Week	12,000	July 17, 2006	U.S. National
Automotive Design & Production	60,105	July 26, 2006	U.S. National
Biodiesel Magazine	2,200	August 2006	U.S. National
Minimum Total Audience	**15,558,757**		

* These stories were reported by the teams in their final Outreach Program reports. However, the teams did not include a clip for this coverage, and current news searches yield no results.

TELEVISION:

Station	Audience Size	Date	Market
KTUL-TV	Not Available	August 19, 2005	Tulsa, OK
KJRH-TV	Not Available	August 24, 2005	Tulsa, OK
KOTV-TV	Not Available	August 24, 2005	Tulsa, OK
FOX-23	Not Available	August 24, 2005	Tulsa, OK
WSYX-TV	Not Available	August 24, 2005	Columbus, Ohio
WJAC-TV	Not Available	September 1, 2005	Columbus, Ohio
CKCO-CTV	Not Available	September 22, 2005	Southwestern Ontario
Rogers Television	Not Available	Sept 27, 2005	Kitchener-Waterloo
WISC-TV	Not Available	October 21, 2005	Madison, WI
KVUE-TV	39,644	November 23, 2005	Austin, Texas
WSLS-TV (NBC)	Not Available	February 6, 2006	Roanoke/Lynchburg, VA
WLUC-TV	Not Available	February 13, 2006	Upper Michigan
WLUC-TV	Not Available	February 14, 2006	Upper Michigan
WTWO-TV	Not Available	February 18, 2006	Farmersburg, IN
WTWO-TV	Not Available	February 18, 2006	Farmersburg, IN
XETV-TV (FOX)	Not Available	February 27, 2006	San Diego, CA
NASA Sci Files	Not Available	March 15, 2006	Not Available
WDBJ-TV (CBS)	Not Available	April 6, 2006	Roanoke, VA
WSLS-TV (NBC)	Not Available	April 6, 2006	Roanoke, VA
WSET-TV (ABC)	Not Available	April 6, 2006	Lynchburg, VA
Daily Planet (Discovery Channel Canada)	Not Available	April 26, 2006	Scarborough, Ontario
WTOK-TV	Not Available	May 16, 2006	Meridian,MS
CKCO-CTV	Not Available	May 16, 2006	Southwestern Ontario
WTHI-TV	Not Available	May 18, 2006	Terre Haute,IN
KTXL-TV	Not Available	May 18, 2006	Sacramento, CA
CBC National	Not Available	May 22, 2006	National (Canada)
WTTE-TV	Not Available	May 24, 2006	Columbus, OH
KPNX-TV	11,160	June 1, 2006	Phoenix, AZ
KPNX-TV	35,856	June 1, 2006	Phoenix, AZ
KPNX-TV	121,116	June 8, 2006	Phoenix, AZ
WSLS-TV	21,284	June 8, 2006	Roanoke/Lynchburg, VA
WCBI-TV	29,780	June 8, 2006	Columbus, OH
WAPT-TV	20,000	June 8, 2006	Jackson, MS
WAPT-TV	12,000	June 8, 2006	Jackson, MS
WAPT-TV	1,000	June 9, 2006	Jackson, MS
WCBI-TV	17,918	June 9, 2006	Columbus, OH
WSLS-TV	22,683	June 9, 2006	Roanoke/Lynchburg, VA
WDBJ-TV	29,436	June 10, 2006	Roanoke/Lynchburg, VA
WDBJ-T	44,137	June 11, 2006	Roanoke/Lynchburg, VA
Minimum Total Audience	**406,014****		

***Television audience figures based on Nielsen ratings. Ratings only available for a fraction of the TV clips; estimated audience reach should be closer to **1 million**. Please note that San Diego State indicated that interviews were held with local CBS, ABC affiliates and KUSI in their final Outreach Program report, however no coverage was noted.*

RADIO:

The following summarizes the individual team interviews as part of the competition Radio Tour:

University	Number of Interviews Scheduled	AQH Numbers
Michigan Tech	10	366,800
Mississippi State University	4 + 3 as winners = 7	302,600
Ohio State University	4	233,700
Penn State University	3	136,900
Rose-Hulman Institute of Technology	4	105,800 + 1 NPR station
San Diego State University	4	181,700
Texas Tech	3 + 1 mention	91,200 + 1 NPR station
University of Akron	4	112,300 + 1 NPR network
UC Davis "Team Fate"	6	326,200
University of Michigan	9	414,400 + 2 NPR stations
University of Tennessee-Knoxville	3	229,200
University of Texas Austin	5	241,000
University of Tulsa	5	265,400
University of Waterloo	3	150,000
University of Wisconsin-Madison	4 + 4 as winners = 8	234,800 + 1 NPR station
Virginia Tech	7 + 5 as winners = 12 + 3 mentions	1,929,800 + 2 NPR stations
West Virginia University	5	268,000
TOTAL:	**94**	**5,588,800**

Total Radio Tour Interviews: 90 + 4 on-air mentions
Total Average Quarter Hour: 5,588,800 *(not including NPR reach)*

The following summarizes the nationally syndicated show, nine state news networks, seven metro news networks and one regional outlet that aired interviews as part of the competition Radio Tour:

Nationally Syndicated Show	Talk Radio America	132 Affiliates
State News Networks	Jackson, MS	35 Affiliates
	Ohio State News Net.	61 Affiliates
	Penn State News Net.	71 Affiliates
	Ohio NPR News Net.	35 Affiliates
	Michigan News Net.	84 Affiliates
	Tennessee News Net.	80 Affiliates
	Oklahoma News Net.	44 Affiliates
	Wisconsin News Net.	50 Affiliates (2 interviews)
	Virginia News Net.	45 Affiliates (2 interviews)
Metro Network News Outlets	Indianapolis, IN	28 Affiliates
	San Diego, CA	15 Affiliates
	Cleveland, OH	15 Affiliates
	Detroit, MI	65 Affiliates
	Nashville, TN	15 Affiliates
	Oklahoma City, OK	10 Affiliates

	Silver Springs, MD	30 Affiliates
Regional News Outlet	Kalamazoo, MI	9 Affiliates

The following summarizes the radio interviews OUTSIDE the competition Radio Tour that teams conducted as part of the Outreach Program during Year Two:

Station	Audience Size	Date	Market
WIBA-AM/FM (Wisconsin)	Not Available	September 27, 2005	Madison, WI
94.5 FM (Canada)	Not Available	October 17, 2005	Southwestern Ontario
Clear Channel News Radio (California)	Not Available	October 20, 2005	San Diego, CA
CBC –Radio One (Canada)	Not Available	May 17, 2006	National (Canada)
KFBK Radio	Not Available	May 18, 2006	Sacramento, CA

ONLINE[T]:

Outlet	Date
University of Tulsa*	August 9, 2005
Popular Mechanics (Blog Section)	October 2005
MS State Engineering School Website*	October 2005
AutoChannel**	November 21, 2005
CNEWS**	November 21, 2005
The Auto Channel	January 24, 2006
EV World	January 24, 2006
University of Akron	February 4, 2006
Engineering E-News*	February 7, 2006
HEVT (VA Tech) *	February 8, 2006
Science Coalition *	February 8, 2006
Inside Indiana Business	February 15, 2006
Open Source Energy Network*	February 28, 2006
WVU News and Information Services*	February 28, 2006
Rose-Hulman	March 2, 2006
Renewable Energy Access	March 3, 2006
SDSUniverse	March 20, 2006
Suburban News Publication*	March 22, 2006
Autoblog	April 17, 2006
CNETNews.com	April 25, 2006
Inside Indiana Business	May 17, 2006
University of Texas Engineering School*	May 1, 2006
Somethingawful.com*	May 16, 2006
Enewscourier.com (The News Courier)	May 17, 2006
Cushingdaily.com (Cushing Daily Citizen)	May 17, 2006

Sapulpadailyherald.com (Sapulpa Daily Herald)	May 17, 2006
Panews.com (The News)	May 17, 2006
The Daily Times (Pryor Daily Times)	May 17, 2006
UC Davis News & Information	May 18, 2006
Physorg.com	May 18, 2006
Fuel Cell Works	May 19, 2006
YubaNet.com	May 19, 2006
Penn State Live (PSU Live)	May 25, 2006
EV World	May 27, 2006
TechnologyNewsDaily.com	June 3, 2006
University of Wisconsin-Madison University Communications	June 8, 2006
The Auto Channel	June 8, 2006
The Auto Channel	June 8, 2006
TMCnet	June 8, 2006
CCNews.com (CCN Magazine)	June 9, 2006
ZDNet.com	June 9, 2006
TG Daily	June 9, 2006
Jalopnik	June 9, 2006
WorldCarFans.com	June 9, 2006
YubaNet.com	June 9, 2006
Penn State Live (PSU Live)*	June 12, 2006
HoustonChronicle.com	June 12, 2006
TechnologyNewsDaily.com	June 9, 2006
MCADCafe.com	June 12, 2006
The Auto Channel	June 12, 2006
DBusinessNews.com	June 13, 2006
TMCnet	June 13, 2006
EV World	June 21, 2006
IEEE Spectrum	July 2006
Ferret.com.au (Australia)	July 20, 2006

[r]Audience estimates are not available for this medium.

* Coverage reported by the teams resulting from Outreach Program efforts. However, the team did not include a clip for this coverage, and current news searches yield no results.

** Online sites that carried the Associated Press article by Tim Malloy, as indicated by San Diego State Outreach Report.

SECTION 3

Selected Quotes

"Solutions to chipping away at the nation's, if not the world's, dependency on oil were on display at General Motors Desert Proving Grounds in Mesa last week."

Arizona Republic
June 12, 2006

"Talking to dozens of young engineers in the competition was both impressive and informative. All were members of university teams who designed and built passenger vehicles using advanced powertrain technology to reduce fuel usage and emissions. The project vehicles had been lovingly crafted by electrical, mechanical, and chemical engineering students and computer scientists, supplemented by the odd nuclear or industrial engineer."

IEEE Spectrum (Online)
July 2006

"I can't say I was surprised Thursday when I arrived at the GM Desert Proving Ground in Mesa to find that my alma mater, Mississippi State, had finished near the top in an automotive engineering contest. School pride aside, Thursday's program, which marked the end of year two of the Challenge X competition, is encouraging for any motorist who gets sticker shock each time they fill up."

East Valley Tribune
June 11, 2006

"University of Akron engineering students have established themselves as members of the creative front in the struggle to develop and perfect a high performing, fuel efficient car that is also environmentally friendly….'This competition gives our students hands-on design and engineering experience,' said Dr. Iqbal Husain, lead faculty advisor for the UA team."

West Akron Sun
July 21, 2006

"Burns reflects for only one or two beats when he's asked what difference it will make if the San Diego State team wins or loses the Challenge X competition. 'There are people who won't buy a hybrid until an American car company makes one,' he says. 'There are people who will not buy a hybrid until it meets their power requirements. There are people who won't buy a hybrid because they've never seen one that they would be caught dead in.' Winning the contest would work towards eliminating all three hurdles to hybrids winning wider acceptance."

San Diego Reader
October 20, 2005

"The first formal inspection of their biodiesel-and electric powered hybrid vehicle for the 2006 Challenge X competition is minutes away, and the students are running final checks. The contest pits a Penn State crew against 16 other teams from universities across the country to see who can come up with the best alternative-fuel vehicle: lowest emissions, most fuel efficient, still able to do 0-to-60 in less than 10 seconds."

The Penn Stater
May/June 2006

SECTION 4

Selective Print and Online Clips

(does not include hard copy clips)

Penn State students ready for Arizona hybrid vehicle competition
Penn State Live (Online)
May 26, 2006

Penn State's entry in the Challenge X competition departed May 24 for the General Motors proving ground in Mesa, Ariz. A 75-foot trailer was on hand to carry the vehicle and the team's equipment, spare parts and tools from the garage at the Pennsylvania Transportation Institute's Hybrid and Hydrogen Vehicle Research Center. Though the silver Chevrolet Equinox looked unchanged as it was driven onto the car transport -- except for a plethora of sponsor decals adorning the sides -- there is little under the skin that has remained the same since the vehicle, donated by General Motors, arrived at Penn State last summer. Since that time, engineering students have been working to transform the small "crossover" SUV into a hybrid electric vehicle that meets the goals of the competition, a three-year initiative known as Challenge X: Crossover to Sustainable Mobility.

Last June the Penn State team placed fifth overall at the competition, the result of a year's work entailing extensive modeling and design, report writing, presentations, and the design and fabrication of a trade show booth. This year the competition ramps up from the conceptual phase to hardware implementation.

This year's Challenge X, a Department of Energy and corporate-sponsored advanced vehicle technology competition, pushes university teams to re-engineer their Equinox into a vehicle that is more fuel efficient and cleaner running while maintaining the utility for which the vehicle was originally designed. To meet these goals, the Penn State team has replaced the gasoline V6 engine with a very compact, common rail turbo-diesel engine, according to Matthew Shirk, a graduate student in mechanical engineering and Penn State Challenge X student team leader for this year's competition. The engine is mated to a continuously variable automatic transmission. The engine and transmission are computer controlled, and work together with a powerful electric motor that is powered by a 300-volt lithium ion battery pack. The vehicle is a parallel diesel-electric hybrid with an all-wheel-drive system that works similarly to that found in the stock Equinox. The small engine allows for greater fuel efficiency, while the electric drive components aid the small, less-powerful engine when more power is required.

The competition will begin on Tuesday, May 30, and wrap up on June 7. Dynamic events to test the vehicle's performance will include an autocross-style handling event, a trailer towing event up a dynamometer-simulated "Baker Grade," a low-friction traction event, a fuel economy on-the-road event, an emissions event and more. The students also will make technical presentations to cover in detail the design of the vehicle and its control systems. Eight members of the Penn State team will leave State College on May 30 and will meet their Equinox in Mesa to check over all systems and finish the final touches before competition begins.

Seventeen university teams are scheduled to participate in this year's competition. They are: Michigan Technological University, Mississippi State University, Ohio State University, Penn State, Rose-Hulman Institute of Technology, San Diego State University, Texas Tech University, University of Akron, University of California-Davis, University of Michigan, University of Tennessee, University of Texas at Austin, University of Tulsa, University of Waterloo, University of Wisconsin-Madison, Virginia Tech and West Virginia University. For more information, contact the Penn State team's adviser, Dan Haworth, at (814) 863-6269.

A fuel-efficient SUV?; U. of Akron team works on alternative energy source
The Plain Dealer (Cleveland)
By: Christopher Jensen
May 27, 2006

Unhappy with your fuel economy? Like the idea of converting your sport-utility vehicle to an "advanced propulsion system" with better fuel economy, lower emissions and no loss of day-to-day driveability? That's what a group of students from the University of Akron is trying.

Surrounded by tools, wires, components and empty cans of Mountain Dew (you can't be too careful about your health), the students are converting a 2005 Chevrolet Equinox into a car of the future.

Akron is one of 17 universities in the Challenge X: Crossover to Sustainable Mobility competition, of which the primary sponsors are General Motors Corp. and the U.S. Department of Energy.

The "crossover to sustainable mobility" only begins to hint at the hubris involved in the complex job facing the Challenge X-men and -women.

The idea is to take the Equinox, a small, car-based sport utility, and come up with a design to change its 3.4 liter V-6 powertrain to an alternative energy source.

That source must offer higher mileage and lower emissions, yet drive like an everyday vehicle.

Akron's plan is to offer a performance hybrid that does all those good, environmental things, yet has enough power that it is still fun to drive, said Chuck Van Horn of Willowick, who is finishing his master's degree in mechanical engineering.

"It has to have some get up and go," he said.

It is the kind of project that would take a lot of time and effort by a team of veteran engineers from a major automaker, much less students.

"It is a very significant task for any engineering organization to take a traditional internal combustion engine and convert it to advanced propulsion," said Micky Bly, GM's co-leader of Challenge X and director of GM's Hybrid Vehicle Integration program.

This is the second year of the three-year competition. Last year the task was to design the alternative-energy system for the Equinox. Akron placed second and Ohio State University, the only other team from Ohio, placed third. First was the University of Waterloo in Canada.

This year the team had to carry out its design, moving from paper to pavement. The final exam starts Wednesday at the GM proving grounds outside Phoenix, where it will be make-or-break time. There, in the 100-plus degree heat, the vehicles will undergo tests including handling, emissions, fuel economy and a generally dreaded towing exercise that could put a fatal strain on less-robust designs.

Challenge X develops large talent pool

Overall, it is certain to be a high-stress situation for all the competitors, since, if something breaks, the students have to figure out what went wrong and how to fix it in time to continue.

Failure in Phoenix means no chance of being the overall, three-year winner. But a team that fails would still be allowed to continue next year, when the goal is to refine the vehicle to the point where a consumer would accept it.

GM and the Energy Department have somewhat related reasons for supporting the program.

"We see this as an investment in the future," said Ed Wall, the Energy Department executive in charge of Challenge X, as well as several other DOE alternative-energy programs. "We are helping build the scientists and engineers who will help design the cars of the future."

One of the big reasons GM has been involved in such competitions, which go back about 15 years, is to nurture and recruit young but experienced engineers. As part of the competition, the students follow GM's worldwide vehicle development procedures.

"There is no better talent pool than these students. When they come out of school, they know our process and have been living with how we design and develop cars," Bly said. "They are miles ahead of students coming cold out of college. It works great."

One of those engineers is Cynthia Svestka, a GM hybrid integration performance engineer, who participated in a propane-vehicle project at Cedarville University in Cedarville, Ohio, starting late in 1995 and ending in the spring of 1997.

That competition taught her how to find an alternative when things don't go as planned. "That is very important and is something the students do on a daily basis," she said. "Having that ability has definitely served me well."

About 50 Akron students, including undergraduates and graduates from classes including engineering and business, have worked on the team, said Cincinnati native Don Whitmore, who is finishing his master's degree in mechanical engineering.

Rushing to get the vehicle finished in the last few weeks, many students worked 20 hours a day in an electro-mechanical blur.

Whitmore has been spending a large part of his life beneath the Equinox while making a graduation vow to never eat another double cheeseburger. Despite the personal discomfort, the students say it is worth it.

"I'm getting marketable experience," said Michael Barton of Akron, a mechanical engineering student who will be a junior next fall.

It is up to the teams whether to be conservative or hope for more credit by taking a more adventurous engineering approach.

Those who play it safe have a good chance their vehicles will run reliably, said the Energy Department's Wall. "Others have kind of thrown the dice and bet the farm. There is more risk involved with the more exotic approaches."

The Akron students have taken the more exotic approach. The team has selected a 1.9 liter, four-cylinder Volkswagen diesel engine, transplanted from a Volkswagen New Beetle, that runs on B20 bio-diesel fuel.

Electricity added with ultracapacitors

That engine will be boosted by a 64-kilowatt Ballard electric drive motor. The bold move is deciding to get bursts of power released from Maxwell Technologies' ultracapacitors, instead of relying entirely on batteries like the hybrids sold today.

Ultracapacitors are high-tech energy storage devices that are intriguing some researchers because of the potential to be more durable than batteries. Like batteries, the ultracapacitors will be recharged automatically as the vehicle brakes or coasts.

Neither Honda nor Toyota uses ultracapacitors yet in its hybrids. "It is a technology that we are studying that has a lot of potential in high-performance applications," a Toyota spokesman said.

Since it is an experimental vehicle, one concern next week in Phoenix is durability, particularly during the towing event, said Nathan Picot of Massillon, who is working on his master's degree in electrical engineering.

"Everything will be stressed to the max. There is definitely the possibility of overheating those systems," Picot said.

On a recent afternoon, the students were learning, just as Svestka said, to deal with things gone wrong. One challenge was finding an electrical ground fault that was keeping the ultracapacitors from getting a full charge.

"It is a medium-duty worry, but not a show-stopper," said Whitmore, standing near a cardboard sign taped to a window that notes, "Batman says: Danger High Voltage."

Program offers practical experience

One of the most valuable things about the Challenge X is that students are getting real-world experience at designing and then making the various systems work together, said Bob Veillette, a professor of electrical engineering.

"They get a lot of technical, practical experience. They face real-world problems; they learn what the automotive industry is all about, not just doing a design on paper but installing things in a vehicle," Veillette said.

Students quickly discovered that some electrical systems, such as brakes and power steering, wouldn't work properly when the Volkswagen engine was installed. The problem was that the systems didn't recognize the electronic signals from the new diesel engine.

There is no question that engineering an advanced propulsion source has been a huge project, but for the students, there is a lot to be gained, said Picot.

"You have to make lots of compromises. It gives you great, practical experience. It is what happens in the industry . . . horse trading," he said.

Also, there is value to working as a team and understanding the responsibilities of being a team member. "If you fail, everyone fails," Picot said.

Despite the long days and nights, the team is looking forward to the vehicle-to-vehicle competition.

"We haven't run into an obstacle we haven't been able to overcome," Van Horn said.

Penn State Team Participates in Challenge X Hybrid-electric Competition
EVWorld.com
May 27, 2006

SYNOPSIS: Challenge X, a Department of Energy and corporate-sponsored advanced vehicle technology competition, pushes university teams to re-engineer their Equinox into a vehicle that is more fuel efficient and cleaner running while maintaining the utility for which the vehicle was originally designed.
Penn State's entry in the Challenge X competition departed May 24 for the General Motors proving ground in Mesa, Ariz. A 75-foot trailer was on hand to carry the vehicle and the team's equipment, spare parts and tools from the garage at the Pennsylvania Transportation Institute's Hybrid and Hydrogen Vehicle Research Center. Though the silver Chevrolet Equinox looked unchanged as it was driven onto the car transport -- except for a plethora of sponsor decals adorning the sides -- there is little under the skin that has remained the same since the vehicle, donated by General Motors, arrived at Penn State last summer. Since that time, engineering students have been working to transform the small "crossover" SUV into a hybrid electric vehicle that meets the goals of the competition, a three-year initiative known as Challenge X: Crossover to Sustainable Mobility.

Last June the Penn State team placed fifth overall at the competition, the result of a year's work entailing extensive modeling and design, report writing, presentations, and the design and fabrication of a trade show booth. This year the competition ramps up from the conceptual phase to hardware implementation.

This year's Challenge X, a Department of Energy and corporate-sponsored advanced vehicle technology competition, pushes university teams to re-engineer their Equinox into a vehicle that is more fuel efficient and cleaner running while maintaining the utility for which the vehicle was originally designed. To meet these goals, the Penn State team has replaced the gasoline V6 engine with a very compact, common rail turbo-diesel engine, according to Matthew Shirk, a graduate student in mechanical engineering and Penn State Challenge X student team leader for this year's competition. The engine is mated to a continuously variable automatic transmission. The engine and transmission are computer controlled, and work together with a powerful electric motor that is powered by a 300-volt lithium ion battery pack. The vehicle is a parallel diesel-electric hybrid with an all-wheel-drive system that works similarly to that found in the stock Equinox. The small engine allows for greater fuel efficiency, while the electric drive components aid the small, less-powerful engine when more power is required.

The competition will begin on Tuesday, May 30, and wrap up on June 7. Dynamic events to test the vehicle's performance will include an autocross-style handling event, a trailer towing event up a dynamometer-simulated "Baker Grade," a low-friction traction event, a fuel economy on-the-road event, an emissions event and more.The students also will make technical presentations to cover in detail the design of the vehicle and its control systems. Eight members of the Penn State team will leave State College on May 30 and will meet their Equinox in Mesa to check over all systems and finish the final touches before competition begins.

Seventeen university teams are scheduled to participate in this year's competition. They are: Michigan Technological University, Mississippi State University, Ohio State University, Penn State, Rose-Hulman Institute of Technology, San Diego State University, Texas Tech University, University of Akron, University of California-Davis, University of Michigan, University of Tennessee, University of Texas at Austin, University of Tulsa, University of Waterloo, University of Wisconsin-Madison, Virginia Tech and West Virginia University. For more information, contact the Penn State team's adviser, Dan Haworth, at (814) 863-6269.

GM looks for alt-fuel ideas
East Valley Tribune
By: Ed Taylor
May 31, 2006

In its quest to develop alternative-fuel vehicles, General Motors is turning to college students for help.

The GM Desert Proving Ground in east Mesa will be the testing site for alternative-fuel vehicles developed by 17 university teams from across North America as part of a three-year competition sponsored by GM and the U.S. Department of Energy.

Called Challenge X: Crossover to Sustainable Mobility, the contest is designed to help train future GM engineers and perfect new technologies that could help relieve the nation's dependence on foreign oil.

The experimental vehicles were delivered to the proving ground Monday, and testing will begin on Friday and continue through the middle of next week. The winners will be announced on June 8.

"These teams have done a phenomenal job," said Micky Bly, GM's director of engineering for hybrid vehicles and coexecutive lead for the Challenge X competition. "We are learning from these students, they are learning from us and we hope eventually we can get some of them to work for us."

The competition, which is nearing the end of its second year, is designed to mimic GM's vehicle development process.

During the first year, the teams designed the technology systems they wanted to use in their vehicles using the same design tools and software used by GM engineers.

In the second year, each team was issued a Chevrolet Equinox, a small SUV that they modified to run on the alternative fuels they selected. Those are the vehicles that will be put through their paces at the desert proving ground.

In the final year, the teams will make modifications and perfect their systems to have the vehicles ready for theoretical mass production.

Second-year awards will be given in a variety of categories from sportsmanship to top adviser to overall best performer judged on emission, performance and fuel economy. Winners will receive trophies and cash prizes.

Twelve teams have decided to run their vehicles on diesel fuel; two on hydrogen; two on E85, a blend of 85 percent ethanol and 15 percent gasoline; and one on a combination of E85 and hydrogen.

All of the entries also use some form of hybrid technology that incorporates an electric system to enhance mileage and performance, Bly said.

Each of the technologies has its advantages and disadvantages, requiring the teams to determine which offered the optimum combination of performance and emissions, he said.

"Hydrogen is hard to do, but it does offer the lowest emissions," Bly said. "Diesel has the best mileage, but there is an emission penalty. So these teams had to make some great decisions."

Because of GM's increased development work with hydrogen, a mobile system will be installed in the next few weeks at the desert proving ground to store and pump hydrogen fuel, said GM spokesman Jerry Wilson.

The company had hoped to have the permanent system ready for the Challenge X testing, but that schedule can't be met, he said. Instead, a smaller portable unit will be used to fuel the Challenge X hydrogen vehicles, Wilson said.

Virginia Tech HEVT set to compete in Challenge X competition
The Collegiate Times
By: Reid Doughten
June 2, 2006

With many Americans reeling in the face of high prices at the gas pump, the search for alternative fuel sources has become more lucrative than ever. Last Thursday, several Virginia Tech students unveiled their own innovative solution to this problem: a bio-fueled hybrid electric SUV set to be shipped halfway across the country for evaluation by the experts of General Motors. Destination: Mesa, Arizona.

These students, roughly 40 in all, make up the Hybrid Electric Vehicle Team (HEVT) and have been working since spring 2004 to develop an environmentally and economically friendly vehicle for entry in the Challenge X competition -- a joint venture of General Motors and the United States Department of Energy. Over the course of the next two weeks, their modified Chevrolet Equinox will be subjected to a gauntlet of tests and competitions designed to test their vehicle's handling, acceleration, fuel economy, emissions and towing capabilities.

Now competing in the second year of the three-year Challenge X program, the Virginia Tech HEVT formed in spring 2004 as one of 45 interested teams that submitted proposals to competition organizers. Of those, 17 teams, representing American and Canadian universities, were selected to develop and integrate alternative propulsion systems built and designed by students and professors into a donated Chevrolet Equinox.

Sponsored by General Motors and the United States Department of Energy, the program aims to accelerate the shift to better, more sustainable fuel sources -- better in both fuel economy and the amount of greenhouse gas emissions -- without sacrificing current standards of vehicle performance. During the 2005 competition, teams were required to develop computer models for their proposed propulsion systems -- everything from hydrogen fuel cells to ethanol/electrically powered hybrids -- and to then present reports on the estimated viability of those systems. According to Steven Boyd, the leader of the Virginia Tech HEVT student team, each team was essentially "pitching their idea to GM," as if proposing a new technology for eventual production.

The second year of the competition, which began in fall 2005, opened with each team receiving a new Equinox SUV and getting to work, integrating their own components into GM's design. HEVT's system? A Saab BioPower 2.0L engine compatible with E85 ethanol fuel and aided by a 52 kilowatt rear traction motor.

"The design strives to reduce petroleum use," Boyd said, adding that the team is "aiming for an 80 percent reduction (in gasoline use)." He emphasized that their use of E85 fuel -- a liquid combination of 85 percent ethanol and 15 percent gasoline already available at many gas pumps in the Midwest -- was key to achieving efficiency and reducing gasoline use.

The main ingredient of E85, ethanol, can be produced from ordinary plant matter like corn or sugar cane, both of which are grown domestically and are 100 percent environmentally friendly. Moreover, ethanol, when compared to burning gasoline, produces fewer greenhouse gases and can boost engine performance.

The downside? For students living in southwest Virginia, the chances of seeing E85 offered at the campus Exxon anytime soon are slim. With only 600 E85-equipped filling stations nationwide, most Americans will still have to rely on normal gasoline for the foreseeable future.

As is the case in engineering design, the Challenge X teams have to account for every effect of their added components. Said Doug Nelson, professor of mechanical engineering and HEVT's faculty advisor, the unique design of Tech's vehicle needs to be implemented "all while maintaining the performance, utility and safety of the vehicle."

Tech has had success doing just that. During the 2005 competition, HEVT placed second in the design report competition and fourth overall, earning a total of $5,000 in prize money. In addition, Doug Nelson received the National Science Foundation Outstanding Long-Term Faculty advisor award. Other successful teams included those from the University of

Waterloo (Ontario, Canada) and the University of Akron, who are competing this year with a fuel cell hybrid and a Volkswagen biodiesel engine, respectively.

The third and final competition, scheduled for 2007, will likely take place at GM's proving grounds in Milford, Michigan and will involve further performance validation and evaluation.

When asked about the real world applications of some of the technologies seen at Challenge X, Susan Garavaglia of General Motors said, "GM is already pursuing most of the technologies the students are using," citing electric hybrids and E85-compatible vehicles as specific examples. "We also have to ensure that these technologies are cost-effective for the consumer," Garavaglia added.

In addition to the economic possibilities is the potential educational value of projects like HEVT. With participation on HEVT comes "a lot of learning from a hands-on project with real problems and solutions, real budget and time constraints and real competition from other schools," said Nelson.

Speaking on what the students are hoping to accomplish through Challenge X and HEVT, Boyd said, "For the students, it's a great learning experience, a true team project. On top of that, we're helping to raise awareness for alternative fuels and show that there's a demand for this."

Energy battle fuels contest
Rose-Hulman engineer, WHS grad helps make SUV into biodiesel hybrid
The Noblesville Ledger (Indiana)
By: Katie Robbins
June 6, 2006

Students says he'd like to work on cars, hybrids after graduation

TERRE HAUTE, Ind. -- Clint Hammes loves engineering and cars, and he's taken his knowledge of both to the next level with a chance to make fuel efficiency history.

Hammes, a 2003 graduate of Westfield High School, is one of about 50 undergraduates at Rose-Hulman Institute of Technology that is participating in Challenge X, a competition sponsored by General Motors, the U.S. Department of Energy and other government and industry leaders.

"I love it," Hammes, a junior mechanical engineering student, said about working on the project. "This is the best real-world experience you can have at school."

The Rose-Hulman group, representing one of 17 engineering schools in the United States and Canada participating in the challenge, has been working to transform a gasoline-dependent Chevrolet Equinox, a sport utility vehicle, into a more eco-friendly, biodiesel-powered hybrid. The Equinox gets 19 miles per gallon in the city, 25 mpg on the highway, according to the federal government's fuel economy Web site.

Challenge W is intended "to provide an opportunity for students to work with the U.S. Department of Energy and also mentor students in engineering," said Susan Garavaglia, manager of advanced technology communications for General Motors and the Challenge X competition.

Hammes is the leader for the vehicle's fabrication team, which works on the vehicle's components and transmission design.

The Rose-Hulman team is spending two weeks this month in Phoenix in the second round of the competition, where a group of Challenge X officials will test the SUV on acceleration and other components and also on the team's presentations.

"I hope we beat the pants off the other schools," Hammes said, adding that Rose-Hulman is the only private school competing. "We want to prove that we can compete with the big guys."

If the Rose-Hulman team wins Challenge X, Hammes said that along with bragging rights, the school will receive monetary awards for future competition and the chance to put the win on a resume for graduate job searches following graduation.

Hammes said after he graduates in 2007, he would like to continue working on cars and hopefully continue to work on hybrid vehicles.

Hybrid-vehicle team places second nationally
University of Wisconsin-Madison University Communications
June 8, 2006

Tired of high gas costs and poor sport utility vehicle (SUV) fuel efficiency?

A group of engineering students at the University of Wisconsin-Madison has spent the last three years building one of the cleanest and most fuel-efficient SUVs in North America. The principles behind the vehicle, appropriately named the "Moovada," could one day be incorporated into mass-production hybrid SUVs.

The effort is part of a contest, "Challenge X: Crossover to Sustainable Mobility," sponsored by General Motors and U.S. Department of Energy.

Today (Thursday, June 8), in Mesa, Ariz., the UW-Madison team was awarded second place in the competition, coming in just behind a team from Virginia Tech University. Third place went to a team from Mississippi State University.

"We wanted to place in the top three, and we did that," says Glenn Bower, the team's adviser and a faculty associate in the College of Engineering. The UW-Madison team will bring home $6,000 in prize money and 10 individual awards.

For the past week, UW-Madison engineering students put their vehicle to the test at a proving ground in Mesa during the final round of the competition.

The competition challenged students to revamp a Chevrolet Equinox, maintaining the SUV's performance while enhancing its fuel efficiency by 50 percent and decreasing tail-pipe emissions. UW-Madison is one of 17 colleges from the United States and Canada competing in the challenge to make the best hybrid SUV.

According to Liz Casson, team leader and UW-Madison student, the Moovada is unique because of the vehicle's power train, the design that transmits power to the vehicle.

"The power train is a through-the-road, parallel diesel-electric hybrid design," Casson explains. "It basically means that the electric motor powers the rear wheels while the engine powers the front wheels."

It is a design that maintains the Equinox's handling and performance, but improves its fuel efficiency and emissions. Casson says the Moovada gets approximately 35 miles per gallon (mpg) - 20 mpg better than the 15 mpg that a regular SUV averages.

In addition to fuel economy, events tested the vehicle's brakes and handling, its ability to tow a trailer and its emissions.

UW-Madison has competed in events similar to Challenge X since 1992, winning five first-place finishes.

In the future, the principles of the Moovada and other participating vehicles could one day be incorporated into regular SUVs. Bower explains that if gas prices were greater than $4 per gallon, the Moovada would pay for itself.

"The Moovada is a highly hybridized vehicle," says Bower. "It would be a $3,000 to $5,000 cost premium to add this to a stock vehicle. Fuel prices would need to be around $4 per gallon for consumers to recapture their investment."

Challenge X is good for the future of the SUV - and for the future of the student participants. Bower explains that the event trains students in hybrid automotive concepts, skills that make graduating students extremely attractive to recruiters from the automotive industry.

As for the students, although they admit the competition has been time-consuming, it has also been rewarding.

"I've probably spent too much time on this project," says Casson. "[But] for me, it was a place for me to do something constructive, do something with my hands, learn something new - all while being with my friends. It was just where I wanted to be."

Virginia Tech team prevails in GM alt-energy vehicle contest
East Valley Tribune
By: Ed Taylor
June 9, 2006

An electric hybrid vehicle running on E85 fuel proved to be the right technological combination for a team from Virginia Polytechnic Institute and State University, which won top honors Thursday in a General Motors sponsored competition to demonstrate alternative energy vehicles. The team from Blacksburg, Va., beat 16 other university groups by producing a vehicle that was tops in fuel economy, emissions and performance during a week of testing at GM's Desert Proving Ground in Mesa. The U.S. Department of Energy joined GM to co-sponsor the Challenge X contest, which was designed to test new ideas to reduce America's dependence on imported energy while giving engineering students across North America real-world experience in advanced engine design.

The E85-electric combination, which reduced the vehicle's petroleum consumption by 75 percent, could be a major contributor to relieving the nation's energy problems, said Steven Boyd, a graduate student and leader of the Virginia Tech team, which won a $7,000 prize. “We pushed the technology envelope the furthest by using a hydrogen fuel cell, but the team was not able to get the SUV running by the contest deadline and thus was eliminated from consideration for an award. Still, the technology may have the best long term promise,” said Matt Stevens, the team's cocaptain.

"Once we got it going, it worked," he said. "The fact that a group of students could make it work - that is a major leap."

GM engineers believe that hybrid and E85 systems provide the best short-term solutions leading to hydrogen vehicles in the future, said Daniel Hancock, vice president, GM engineering operations.

"I don't have a crystal ball, but it is a good way to do it - combining a hybrid with a domestic fuel source," he said.

The team re-engineered a 2005 Chevrolet Equinox SUV as a split-parallel hybrid that uses two electric motors to improve mileage and performance and an engine that runs on E85 - a blend of 85 percent ethanol produced from domestically grown corn and 15 percent gasoline.

A team from the University of Wisconsin, Madison took second place with a hybridbiodiesel combination, while Mississippi State finished third, also with a hybridbiodiesel design.

Many of the vehicles suffered operational glitches during the test-driving.

An Equinox modified by a team from the University of Waterloo in Canada pushed consumers, and more models are being brought onto the market. "We will need a diversity of power-train solutions," he said. Hancock was impressed with the quality of the work done by the students, saying, "this is not simple stuff they are doing."

The three-year contest has one more year to go.

During the next 12 months, the teams will refine their designs to make them easier to drive in real-world conditions. They will be tested again next year at a GM proving ground in Michigan. The long-term goal is "to remove vehicles from the energy debate," Hancock said.

HOKIES TAKE TOP PRIZE IN NATIONAL AUTO CONTEST
The Roanoke Times (Virginia)
By: Greg Esposito
June 10, 2006

A team of Virginia Tech students won the second round in a competition to produce fuel-efficient vehicles with low emissions.

The Tech team was announced as the winner Thursday evening among a field of teams from 17 universities in North America. Competitors included the University of Michigan, the University of Texas at Austin and Penn State.

The competition, dubbed "Challenge X: Crossover to Sustainable Mobility," is a three-year event sponsored by General Motors and the U.S. Department of Energy.

Tech finished fourth in the first year of the competition -- the design phase. The University of Waterloo won last year's competition.

This year's event involved each team applying those designs to a 2005 Chevrolet Equinox, a compact SUV.

Tech's vehicle uses two electric motors in addition to a regular engine and runs on an ethanol/gas blend. It reduced the petroleum use by 74 percent, getting 19.7 miles per gallon of the hybrid fuel.

Steve Boyd, a mechanical engineering graduate student and leader of Tech's 40-person team, said the technology the team used is not much different than what's on the market.

The challenge was integrating the motors and a battery pack into the original vehicle while maintaining its integrity and ease of operation.

The fact that it runs on domestic fuel makes it a practical design, he said.

"I think it represents a very here-and-now kind of solution to what to do about increasing gas prices," he said.

The changes they made could be done by a car manufacturer and only add the standard increase in cost for a hybrid -- about $3,000 or $4,000.

The scoring system was on a 1,000-point scale and included tests for acceleration, towing capacity, comfort, safety as well as fuel efficiency and emissions.

With 901.9 points, Tech edged out the University of Wisconsin at Madison team, which scored 887.7 points in the weeklong competition in Mesa, Ariz.

The organizers kept the standings a mystery until the end of the contest, but Boyd said the team expected to finish in the top three.

"We've had the vehicle running in one form or another since the first week of February," he said. "I think we knew going into it that we would have a reliable vehicle."

In addition to winning lowest emissions and lowest petroleum consumption, the Tech team also won in the category of best-written technical report and best braking and handling.

The team received a $7,000 reward for its finish. It will use that money toward improvements for next year's competition.

In the upcoming year the teams will refine their vehicles for the final round. Boyd said they'll work on things like getting the vehicle to run on only electric motors when stopped in traffic.

Boyd is cautiously optimistic.

"Certainly, we'll have some confidence but the other schools do such a great job," he said.

Va. Tech team energized
Richmond Times Dispatch (Virginia)
By: Greg Edwards
June 10, 2006

Jun. 10--A team of Virginia Tech engineering students has won the second year of a competition sponsored by the government and industry to develop fuel-efficient and low-emission vehicles.

The Tech Hybrid Electric Vehicle team was one of 17 teams chosen by the U.S. Department of Energy and General Motors Corp. to participate in the three-year "Challenge X: Crossover to Sustainable Mobility" competition. It was held this year at GM's Mesa Desert Proving Grounds in Arizona.

The Energy Department and U.S. automakers have been sponsoring similar multiyear competitions for several years.

The Tech team took particular pleasure in besting perennial competition favorite, the University of Wisconsin-Madison, which finished second this year, said Steven Boyd, the mechanical engineering graduate student who is the Tech team's leader. A Mississippi State University team finished third.

Boyd, 25, is a 1999 graduate of Chesterfield County's L.C. Bird High School. Other Richmond-area students on the team are Jacob Morrison, Brandon Gibson, Jason Cunningham and Justin Dixon.

The federal agency and GM gave each team a Chevrolet Equinox crossover sport utility vehicle, $10,000 in expense money and up to $25,000 in auto parts. The Hokie team replaced the standard Equinox engine with two hybrid electric motors and with a four-cylinder turbo-charged Saab engine that runs on an 85 percent ethanol-to-gasoline mixture. The second- and third-place finishers coupled biodiesel engines with hybrid-electric motors.

Using the ethanol fuel, the team reduced the vehicle's petroleum consumption by 75 percent and improved its fuel economy from 24 to 28 miles per gallon, Boyd said. Besides winning the overall points title, the Hokies captured firsts in the lowest petroleum consumption, lowest exhaust emissions and written technical report categories. They finished fourth overall last year.

All vehicles underwent similar fuel-economy and emissions testing in the 105-degree Southwest U.S. heat. They even towed a 2,500-pound load as the objective of the competition is to improve the vehicle without reducing its performance.

Seniors on the team get two semesters of class credit for participating, and Boyd is using the project for his master's thesis. All participants get good exposure to potential employers, and Boyd said he is headed to a job at the Energy Department.

In the third and final year of the competition next year, Boyd said the team wants to improve the vehicle's hybrid electric drive and its fuel economy to 30 miles per gallon.

Driven by challenges; U. of Akron engineering students offer up cutting- edge design in alternative- energy competition

The Plain Dealer (Cleveland)
By: Christopher Jensen
June 11, 2006

Mesa, Ariz. - If universities awarded doctorates in adversity, persistence and an oddly ravenous appetite for technical challenges, several University of Akron engineering students would be showing off their new degrees and calling each other "doctor."

But there was no evidence anybody was thinking about that as the 21 Akron students competing in an alternative-energy competition struggled to meet a crucial deadline.

The Akron team was one of 17 from the United States and Canada competing in "Challenge X: Cross-over to Sustainable Mobility," which was sponsored by General Motors Corp. and the U.S. Department of Energy.

The goal was to do the best job of converting a 2005 Chevrolet Equinox into a more environmentally friendly creation, one that would have better fuel economy and lower emissions.

The logical solution would be some form of a hybrid design. That means that, like the Ford Escape Hybrid, Toyota Prius or Honda Civic Hybrid, it would use a conventional gas or diesel engine boosted or temporarily replaced by an electric motor powered by some electrical storage device, usually batteries.

For GM and the Department of Energy, the goal was to encourage engineering students to develop an interest in alternative energy sources and gain experience in developing them.

Just after Memorial Day, the teams gathered here at GM's Desert Proving Ground near Phoenix for an eight-day test of their planning and theories and the vehicle's performance.

But early last weekend, the members of the Akron team were facing a deadline for completing several tests to show that their Equinox was roadworthy and safe enough to continue. Unfortunately, they couldn't get it to run properly, and some team members acknowledged they were worried.

After a year's work, they were hoping - for the first time - to see their Equinox move under its own alternative-energy power. That would validate their intellectual, mechanical, electrical and computer-engineering skills.

But failing to meet the deadline meant they wouldn't be allowed to continue with the all-important driving portions of the competition, including tests for fuel economy, emissions, towing and driveability.

Bessie the cow

There's no denying Akron was the cause of its own misfortune. An inflatable cow provides a good example of the different approaches taken by the teams in the competition.

While the Akron team was worried and hard at work, the University of Wisconsin team was relatively serene. It had almost finished its competition. Things went so well because the Wisconsin students converted their Equinox to what was essentially a conventional hybrid.

"It is pretty straightforward, basically. It is better to be drivable and not have a lot of bells and whistles," said Liz Casson from Potomac, Md., the team leader and a recent electrical engineering graduate.

The team members' biggest problem would turn out to be figuring out who stole "Bessie," their inflatable cow mascot. "She was here, then she was gone," said Casson, seeming strangely unmoved by the loss of the bovine.

The Wisconsin team's effort - converting a conventional vehicle to a conventional hybrid - was no small challenge, but it didn't compare with the far more complex hybrid project the Akron students chose.

Akron replaced the Equinox's V-6 with a turbocharged, 1.9-liter four-cylinder Volkswagen diesel and a six-speed transmission. That would be boosted or temporarily replaced with an electric motor.

So far so good. It was the audacity of what came next that impressed some event officials.

First, the Akron vehicle's electric motor would get its power from two sources. One would be nickel-metal hydride batteries of the kind typically used in hybrids on sale now. The second would be ultracapacitors, an advanced technology that stores energy.

Ultracapacitors have intrigued automakers, one reason being it seems likely they would last longer than batteries. But so far no automaker has had the nerve to use them in a passenger hybrid sold to the public.

In addition, the Akron team was going for a sophisticated hybrid design that could operate in two ways. Team members wanted the ideal hybrid, offering the best performance in the city with a so-called series mode and on the highway with a so-called parallel mode.

Akron's team was trying to go all the way on fuel economy and top what Toyota, Honda, Ford and GM are trying to do, said David Friedman, research director of the Clean Vehicles Project at the Union of Concerned Scientists.

In addition, rather than buy some key components, including those needed to control some important functions, the team decided to make its own, a risky decision.

"I went for it because that is how you learn," said Iqbal Husain, a professor of electrical and computer engineering at the University of Akron, who worked with the team.

What Akron is trying to do is solve the energy-storage issue that is a major limitation for hybrids and all-electric-drive vehicles, said Robert Larsen, senior technical adviser for the Center for Transportation Research at the U.S. Department of Energy's Argonne National Laboratory.

"Their approach of using a combination of advanced batteries and ultracapacitors is absolutely at the cutting edge of where the technology is at a professional level," Larsen said. "It is a very daunting challenge to meld these two energy-storage devices together. It has been impressive what they have been able to do so far."

'Engineering opportunities'

In the first few days, it was too soon to say the Akron team had bitten off more than it could chew. But there was no doubt the team's mouth was indelicately full.

"We took a technological risk. We knew that when we started," said Nathan Picot, an Akron graduate student in electrical engineering.

But there wasn't a lot of debate about that approach. From the beginning, the team wanted to do something challenging and innovative, said Don Whitmore, who just finished his master's degree in mechanical engineering.

Such a daring approach also meant there was the greatest chance of an educational win, regardless of where the team placed, said team adviser Richard Gross, an assistant professor of mechanical engineering.

"High risk . . . and high reward is what it is," he said.

The team tried to deal with what would turn out to be a conga line of problems that came dancing along with a near-rhythmic regularity. There were naps next to tires, gulps of energy drinks and long, long days.

A major and ongoing problem was some elusive weirdness in the computer software that suddenly kept the hybrid system from working.

"It is a bit mysterious," said Bob Veillette, an adviser and associate professor of electrical and computer engineering.

For hour after hour, students like Picot tapped away at laptops working on the software, writing new programs, frowning, trying something new, hoping to make it all work.

"This was a setback, but we're going to work through it," said Whitmore.

With a deadline disaster approaching for Akron and several other teams, the organizers finally extended the cutoff until Saturday afternoon. The teams had been working hard, making progress and deserved a break, organizers said.

As problems continued, Akron - worried about missing the deadline - finally sent its vehicle out running on the diesel engine alone. Since those tests were basically to make sure it would still handle safely, relying on the diesel was OK.

Three minutes before the deadline, with temperatures around 112 degrees, an official radioed back to headquarters: "Akron has completed the event."

While the casual observer might see the difficulties faced by Akron as "problems," Micky Bly was sort of a malfunction Pollyanna.

The students' problems were really "engineering opportunities," said Bly, the co-leader of Challenge X and director of GM's Hybrid Vehicle Integration program.

While looking tired after a series of 13-hour days - the maximum allowed by the organizers - the Akron students acknowledged they were learning a lot. They were getting invaluable experience in getting electrical and mechanical systems - as well as people - to work together.

If there were any regrets about the team's ambitious design, they weren't being voiced publicly.

"You have to put your neck out there and do something nobody else has done before," said Joe Bisbing, a University of Akron electrical engineering undergraduate student from Pittston, Pa.

Akron was not alone in having so many "engineering opportunities." Several teams fared far worse. The University of Michigan and the University of California at Davis were essentially nonstarters.

Only one other team, the University of Waterloo, in Ontario, took on a technological challenge that matched or exceeded Akron's. Waterloo went for a hydrogen fuel cell, which would use a chemical reaction to produce power.

The Canadian team also faced a series of problems, including incredibly tiny hydrogen leaks, said Raydon Fraser, the faculty adviser and a professor in the college's department of mechanical engineering.

The leaks were fixed, and eventually the Waterloo vehicle was driven around, but so many deadlines had been missed that the team was no longer an official competitor.

Akron's problems continued into Monday, with the hybrid system never being operational and the team failing to complete the fuel-economy run or finish the 17-mile trailer-towing exercise in the maximum of 20 minutes.

Virginia Polytechnic Institute and State University won the event, with the University of Wisconsin taking second. Teams were not ranked below second place.

Some students, like Akron's Whitmore - who got his master's and is graduating - will never see the vehicle on which they worked so long operate as a hybrid.

But for other students this was only the second year of a three-year event. That means Akron has almost a year to perfect its system before heading back to Arizona in 2007. The requirement next year is to present the vehicle in a form that would be acceptable to consumers.

"We were overly ambitious, but we learned a lot," said Rob Paciotti of Avon Lake, who is working on his master's degree in mechanical engineering. "It is not like we're going to give up."

UW team second
Wisconsin State Journal (Madison, Wisconsin)
By: Ron Seely
June 11, 2006

An innovative powertrain invented by student engineers at UW-Madison allowed the team of students to place second in a national competition aimed at demonstrating practical advances in fuel efficiency.

The contest, called "Challenge X: Crossover to Sustainable Mobility," is sponsored by General Motors and the U.S. Department of Energy. Thursday, the UW-Madison team was awarded second place in the competition in Mesa, Ariz., coming in just behind a team from Virginia Tech University.

The SUV built by the team was named "Moovada."

The students revamped a Chevrolet Equinox, maintaining the SUV's performance while boosting its fuel efficiency by 50 percent and decreasing tail-pipe emissions.

The unique drivetrain created by the students allowed the hybrid's electric motor to power the rear wheels while the engine powered the front wheels. The design maintained the Equinox's handling and performance but improved its fuel efficiency and emissions. The Moovada gets about 35 miles per gallon, 20 mpg better than the 15 mpg that a regular SUV averages.

Commentary: Miss. State shows how to save fuel
East Valley Tribune
By: Slim Smith
June 11, 2006

I can't say I was surprised Thursday when I arrived at the GM Desert Proving Grounds in Mesa to find that my alma mater, Mississippi State, had finished near the top in an automotive engineering contest.

I mean, it's increasingly hard to find something MSU isn't good at, you know?

School pride aside, Thursday's program, which marked the end of year two of the Challenge X competition, is encouraging for any motorist who gets sticker shock each time they fill up.

The official name of the competition is Challenge X: Crossover to Sustainable Mobility. As you might suspect, that's the sort of title you get when engineers are in charge.

In layman's terms, Challenge X is a competition that allows college engineering students to apply their skills in pursuit of making future autos more efficient, more environmentally friendly and less dependent on oil.

Seventeen universities in the U.S. and Canada are competing in the project, which began in 2005 and will end next summer. Virginia Tech finished first, followed by Wisconsin and Mississippi State.

Each school was given a 2005 Chevrolet Equinox, which the students have been tinkering with for the past 24 months.

Virginia Tech students replaced the standard engine with an ethanol/hydrogen engine while Wisconsin and Mississippi State went with bio-diesel engines.

Personal bias aside, I'm not clear why Mississippi State isn't sitting in first place. The MSU students said their entry was the fastest and could pull the heaviest payload.

There's no disputing the latter claim. Through a mixup, the MSU entry pulled 10,000 pounds, four times the competition's required weight.

"We had a miscommunication on the weight,'' drawled MSU team leader David Oglesby, a graduate student from Columbus, Miss. "So we're very proud of the way we performed.''

Pulling a big payload is of particular importance down South, where at any moment you might discover a perfectly good refrigerator left at the dump. Speed means something in that part of the world, too, where it is not uncommon to find Dale Earnhardt "3" stickers on hearses.

There is another year of competition — and, not unlike any coach, team leader Oglesby assessed MSU's chances to move up from third place.

"There are a lot of things we want to do to the car,'' he said. "And we only lose a couple of people off our team, so we feel really good about next year.''

It gives me comfort knowing that good old Mississippi ingenuity is playing a role in this important field.

I figure the car of tomorrow will be a pickup truck.

Students Test Prototypes of Hybrid SUVs
The Arizona Republic
By: Lars Jacoby
June 12, 2006

Solutions to chipping away at the nation's, if not the world's, dependency on oil were on display at General Motors Desert Proving Grounds in Mesa last week.

Teams of students from 17 universities across the country have been at the vehicle testing site since May 30 showcasing their views on the hybrid technology to judges in the Challenge X competition, sponsored by GM and the U.S. Department of Energy.

The competition is touted as a way to promote a "crossover to sustainable mobility," which would in turn help in the fight to decrease dependence on oil. "What's so great about this competition is that we have 17 ways to solve the problem," said Judge Bob Larsen of Argonne National Laboratory, a Department of Energy research center.

Larsen said he and his colleagues have been working on the hybrid solution since 1989, and there is no one "silver bullet" that will cure the run on oil. However, he said that many of the solutions the students presented last week may become part of the solution.

"There is no simple answer, rather a whole menu of options," Larsen said.

"We're never going to get to zero oil use, but if we can reduce our consumption by 1 to 2 million barrels of oil a day, that's huge."

The students in the competition are on their way to becoming part of the solution, Larsen said. Many of them, he said, will continue in this field and "will be years ahead of others that haven't been in this type of competition."

Challenge X is a three-year competition with the first year focusing on computer modeling of a "virtual vehicle." This year is the second, and teams had to have their prototypes, or "mule vehicles," operational. In the third year, all vehicles will need to be refined and appear as if they just rolled off the assembly line.

Each team of engineers was given a 2005 Chevrolet Equinox SUV by GM and tasked with converting it to a hybrid vehicle that runs on the fuel of their choice. The finished vehicles ran on everything from reformulated gasoline to biodiesel, hydrogen and E85.

The team from Virginia Tech took home first place and $7,000 for their split parallel hybrid SUV that runs on E85, an ethanol blend of gas that reduces petroleum use from well to wheels by nearly 75 percent, as well as two electric motors that kick in when enough of a charge is stored up.

"I think it's a testament to the mechanical engineering program that we have here at Virginia Tech," said Nick Phucas, of his team's win.

Phucas said about 30 team members, most of them mechanical engineers, have had their vehicle running since February and have had its hybrid capabilities online since mid-March.

"To finish well in this competition you should have already done lots of testing," Phucas said. "We try to do as much testing beforehand so if there are any problems, we know how to fix it."

And they had their share. The team had to overcome a couple of problems throughout the competition, including a cooling loop problem that Phucas said was a direct result of the desert heat, but they overcame them to finish first this year.

Because their vehicle is a prototype, it has about $200,000 of equipment in it, but VT team leader Stephen Boyd said that if it were ever mass-produced, that cost would drop dramatically.

To overcome the vehicle's reliance on petroleum, Boyd said the team decided to fuel the vehicle with E85, a product of corn ethanol, because its use means "energy security" for the country.

"Ethanol is produced here in the U.S. and we control it; it's not like oil where we have no control over its production," Boyd said.

In addition, he said the team's HEV, Hybrid Electric Vehicle, currently gets about 25 miles to the gallon, but one of the missions of next year's team is to get that up to 30 mpg.

"But (the vehicle) is faster than stock, and has lower emissions, too ... for the most part people don't buy hybrid to save money on gas, they drive them because they're concerned about the environment."

TU team takes eighth in auto design contest
The Daily Oklahoman
By: Jim Stafford
June 13, 2006

Jun. 13--A team of engineering students from the University of Tulsa placed eighth overall in the recently concluded Challenge X national collegiate contest to create an environmentally friendly vehicle.

Competing in Mesa, Ariz., the Tulsa team was one of 17 selected for the contest from more than 150 universities that applied, said Christi Patton, associate professor of chemical engineering.

"They donated a Chevy Equinox, and our job was to take out that power train with one of our own design that would improve fuel economy and emissions," Patton said.

The TU team of about 40 students participated in the yearlong project. They designed a hybrid vehicle that relied on a combination of diesel power and electric motor drive.

A team from Virginia Tech University was the overall contest winner. TU also placed third in a category sponsored by National Instruments for the use of its LabVIEW simulation software.

"These are really the most elite of the people who are doing automotive design work," Patton said. "We feel like being in the top half of the best in the country plus Canada is quite an amazing accomplishment."

The design by students from the University of Wisconsin-Madison placed second.

Other teams participating on Challenge X included Michigan Technological University; Pennsylvania State University; Rose-Hulman Institute of Technology; San Diego State University; Texas Tech University; Ohio State University; University of Akron; University of California, Davis; University of Michigan; University of Tennessee; University of Texas at Austin; University of Waterloo; and West Virginia University.

Sponsors were the Department of Energy and General Motors.

Mississippi briefs
The Clarion Ledger
June 15, 2006

STARKVILLE

Team finishes 3rd in engineering competition

A team of Mississippi State University engineering students finished third in a national engineering competition.

The nine-member team was one of 17 competing in the Challenge X competition to re-engineer a 2005 Chevrolet Equinox sport utility vehicle to make it more environmentally friendly without affecting performance.

The MSU team developed a diesel-electric hybrid capable of getting 35 miles per gallon.

MSU finished behind Virginia Polytechnic Institute and State University and the University of Wisconsin-Madison.

What If You Had to Build a Socially Responsible SUV?
IEEE Spectrum (Online)
By: John Voelcker
July 2006

Car fanatic or not, few 20-year-olds can knowledgeably discuss the pros and cons of hydrogen fuel cells, ultracapacitors, and batteries for automotive energy storage—perhaps even fewer in scorching desert heat.

The scene was General Motors' Mesa Proving Grounds in Arizona. It is one of GM's two main North American test facilities, with 75 miles (121 kilometers [km]) of roads and a high-speed test track over 5000 acres (20 km2). The heat—up to 120 degrees Fahrenheit (49 degrees Celsius)—makes it ideal for testing vehicles and their air-conditioning under intense conditions. Half a century ago, the area was empty and remote, visited only by a few cattle. Now, this top-secret facility is rapidly being engulfed by hundreds of beige stucco houses in walled subdivisions.

The event was the second-year finals of the three-year Challenge X competition among teams from 17 North American universities. Sponsored by the U.S. Department of Energy, GM, and several equipment manufacturers, it's the latest in a series of university auto-design contests that date back to 1987.

Talking to dozens of young engineers in the competition was both impressive and informative. All were members of university teams who designed and built passenger vehicles using advanced powertrain technology to reduce fuel usage and emissions. The project vehicles had been lovingly crafted by electrical, mechanical, and chemical engineering students and computer scientists, supplemented by the odd nuclear or industrial engineer.

The actual car? Oh, that's not till Year Two.

Challenge X follows a real-world corporate vehicle design process—in this case, GM's—over three full years. The students' first year was largely devoted to computer modeling, simulation, and design testing. Only then was each team given a 2005 Chevrolet Equinox, which in the U.S. is a “compact” sport-utility—4.8 meters long, weighing 1724 kilograms (kg) with all-wheel-drive—fitted with a 185-horsepower (138 kilowatt [kW]), 3.4-liter V6 gasoline engine. Teams also got access to engines, battery packs, motors, electronic controllers, software, and other equipment from 28 corporate sponsors.

Year Two was all about implementation: Students had to turn their design files into a modified, running vehicle, which was trucked to the Desert Proving Grounds in May and put through an exhaustive series of tests. The driving event for invited press closed the second year of the competition, after prizes were awarded for overall scoring on a variety of factors—everything from emissions, fuel consumption, and on-road performance to technical writing, electronic control strategy, and community outreach.

During the third year, teams will refine their vehicles to provide a “showroom” auto that meets consumer requirements—a new and challenging element in such competitions. This may include the ability to tow a trailer weighing 453 kg (1000 pounds) or more up a 5 percent grade for many miles in 110 degree F (43 degrees C) heat, or instant starting in temperatures well below 0 degree F (-18 degrees C). It means air-conditioning that works flawlessly, comfortable seats, the storage space that buyers expect in an SUV—and enough acceleration to merge comfortably into freeway traffic with a full load of people and luggage while towing that same trailer.
AWD hybrid turbodiesel? Check. NiMH batteries? Check.

The six top-finishing vehicles shown to the press in Mesa weren't quite ready for the showroom. Their proud but slightly glassy-eyed creators, each team in matching polo shirts, were refreshingly candid about how much was left to do—and about the complexity of the design challenges they had faced.

If the most common solutions among the 17 teams were averaged, you would end up with an Equinox retrofitted with a 1.9-liter turbodiesel running on B20 biodiesel, driving the front wheels through a six-speed manual or automatic

transmission, mated to a parallel hybrid system including a nickel-metal-hydride (NiMH) battery pack and an electric motor driving the rear wheels.

Variations within this theme showed each team's tradeoffs in design and adaptation. The University of Wisconsin at Madison team replaced the Equinox rear differential with a dual-output 45-kW integrated electric motor and transaxle with attached control electronics. This required them to re-engineer the rear floor and subframe and to fabricate new suspension components.

The Ohio State University team, on the other hand, chose a single-output 67-kW motor to drive the rear wheels through the standard differential. No rear suspension work was needed, but they had to fit the motor into an enlarged transmission tunnel—ending up with a driveshaft angled so steeply that the life of its universal joints was a concern.

While a turbodiesel parallel hybrid powertrain with battery pack was the de facto standard, some more unusual choices stood out. West Virginia University, for instance, dispensed with batteries altogether and used a 750-kilojoule ultracapacitor for energy storage. Since diesels have no throttling losses, recapturing braking energy requires high power adsorption rather than energy storage, making an ultracapacitor's high power density appealing. They also chose individual wheel motors to eliminate gearing losses. Their inability to interpret fault codes in the diesel's engine-control unit until the week of the competition, however, kept them from diagnosing signals that caused their engine to default to a self-protective low-power-output mode—giving them ninth place out of 17 overall.

Hydraulics and plug-ins and mules, oh my!

Another unique solution was the “plug-in” parallel hybrid created by the University of California at Davis team. They mated a 1.5-liter Atkinson-cycle motor from a 2004 Toyota running on E85 (85 percent ethanol, 15 percent gasoline) to a Nissan continuously variable transmission. Energy was stored both in a 350V lithium ion battery pack and a 10 kW hydrogen fuel cell. Their claimed range in all-electric mode was 50 miles at up to 60 miles per hour (97 km/h), after which the vehicle operated in conventional hybrid mode with power drawn from the engine and batteries according to need, and regeneration on braking to charge the batteries. And, of course, it could be plugged into household current at night to recharge as well.

Even more experimental was the University of Michigan's decision to use hydraulics for energy storage. Like many others, they used the 1.9-liter GM turbodiesel. Unlike any other team, they used it not to power the wheels but to drive a variable-displacement hydraulic pump, rated at up to 80 cubic centimeters per revolution (cc/rev) at 2200 revolutions per minute (rpm). The engine and pump charged a high-pressure—5000 to 18 000 pounds per square inch (psi [34 474 to 124 106 kilopascals, kPa])—accumulator coupled, in parallel to a low-pressure (300 to 800 psi [2068 to 5516 kPa]) accumulator, across two hydraulic pump/motors rated up to 55 cc/rev at 2500 rpm, one on each axle.

The University of Waterloo made the most ambitious choice of all: a series fuel-cell hybrid, with a 65-kW fuel cell and a 336 volt NiMH battery pack running two 67-kW AC induction motors. In doing so, Waterloo won the “Spirit of the Challenge” award (plus honors for community outreach and best Web site [http://www.uwaft.com]). Their vehicle was on display with the six top finishers, having been deemed not quite reliable enough to risk stranding members of the press deep in the desert.

None of these off-the-beaten-track choices garnered overall prizes, however. Scored on points, the top second-year finishers (from first to sixth) were: Virginia Tech, the University of Wisconsin—Madison, Mississippi State University, Ohio State, Pennsylvania State University, and the University of Tennessee.

All six winners were available to be driven on a closed course marked with cones in a many-acre sea of asphalt. They'd all been washed, and most were repainted in university colors. But their status as engineering “mules” was evident.

As GM's vice president of powertrain engineering operations, Dan Hancock, explained, “We call engineering prototypes ‘mules'. It's an apt word. Sometimes they're stubborn; they have a mind of their own … and once in a while, they need a swift kick to get them to go.”

Some vehicles had interior trim removed, to keep them under the weight limit after adding heavy batteries and electric motors. Others had large red power buttons, crude digital readouts or jury-rigged shift levers. The variety of Frankenstein adaptations was impressive. But they all ran.

Lurching and stalling

For the uninitiated, driving a turbodiesel electric hybrid—especially one early in its development—can be tough. The students were surprisingly sympathetic to (theoretically) car-savvy reporters who stalled or lurched their cars on takeoff, repeatedly. As Dan Bocci, a member of the second-place "Moovada" Wisconsin team, explained, "Electric assist for launch while the engine powers up from stop, that's in our Year Three plan. It reduces the stalling considerably … but we didn't quite get it done yet."

Other first-hand impressions among several vehicles included: requiring 1 to 2 second power-up routines before the ignition would engage, many clunks in the drivelines, and considerable noise from uninsulated electric motors during the charge cycle.

But this was precisely where the vehicles were supposed to be. A year prior, no team had even received its silver Equinox. Now untutored civilians were driving the vehicles into which teams had put wrinkled brows, sweat, and many, many late nights. All things considered, the students exhibited considerable grace as reporters flogged their vehicles.

That composure only faltered when GM's executive director for global integration and safety, Ken Morris, ran Ohio State's fourth-place vehicle through the slalom course. He did the entire course probably twice as fast as anyone else. Loaded with five people, the tall SUV leaned considerably as he snaked it through the pylons, tires squealing. And then he took an unscheduled detour onto the high-speed banked test track, not a part of the approved press tour.

The students were sympathetic to (theoretically) car-savvy reporters who stalled or lurched their cars on takeoff, repeatedly.

Mashing the accelerator to the floor, Morris listened intently for the rear motor to kick in with its power assist. As he drove—with both hands on the wheel, like all good test drivers—he quizzed team members in detail about their control logic. During one answer, he suddenly lifted off the accelerator entirely. The car jerked and pitched forward, the motor's whir changed to a noticeable whine as it switched to regenerative mode, and the vehicle slowed quickly until he mashed the pedal again. And so it went.

After one lap, he exited (passing a lightly camouflaged version of a future GM sport-utility to be introduced for 2008). Perhaps it was just imagination, but some of the team seemed to look slightly relieved.

Weight: The enemy

That relief will be short-lived. Next year, the teams face their most formidable challenge: the showroom demands of the average U.S. consumer who buys an SUV. Fuel saving? That's a good thing, certainly. But towing capacity, storage space, dozens of cup holders, iPod jack, imposing attitude, blazing acceleration? As they say, that's where the pedal hits the metal. Year Three promises to be every bit as challenging as the prior two.

While it's far from laid-back, Challenge X is nowhere as flashy as the recently concluded DARPA Grand Challenge (see: http://www.spectrum.ieee.org/oct05/comments/1145). Its First Place prize of US $7000 seems almost insignificant next to the $2 million won by the Stanford University team that created "Stanley" for the Grand Challenge. But Challenge X emulates the process of designing vehicles for real-world users. In the end, technologies like these are likely to be on the roads—and at your local dealer—well before cars that drive themselves autonomously.

The students take great pride in their in-process creations. They also matter-of-factly include advanced electrotechnology as an integral and necessary part of socially responsible vehicle designs. Their attitudes, and the various technologies

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APPENDIX 1:

Complete Print Clips (includes hard copy clips)

APPENDIX 2:

Complete Online Clips (includes hard copy clips)