

University of Victoria EcoCAR 2 – Plugging in to the Future



University of Victoria



EcoCAR and EcoCAR 2



- Government and Leading Industry Sponsored Elite Student Design Competition (15 Universities Selected in US/Canada)
- Development of Future Hybrid Electric Vehicle (HEV) Technology by Designing, Modeling, Simulating, Testing, and Retrofitting a 2013 GM Malibu with a Newly Developed Hybrid Powertrain
- Open to Both Undergraduate and Graduate Students
- Getting Training and Experiences on Advanced HEV Technology, Mechatronics and Project Management
- Working with Leading Experts Worldwide through Direct Contacts with Major Industrial Sponsors
- Closely Supervision by Faculty Members with Related Background and Interests

Why It Is Unique and Exciting?

- Urgently Needed, Advanced Technology
- Well Funded Developments:
 - Federal (US, Canadian) and Provincial Supports
 - Extremely Strong Industrial Industry Sponsorship
- Integrated to Academic Program
 - Open to Undergraduate and Graduate Students
 - 3 Year Development Program
- Advanced Research and Training
 - Mechatronics, Hybrid Vehicle, Control, Modeling, System Design, Simulation, Instrumentation, Embedded Systems, CAD/CAE/CAM, Team Work, Project Management, etc.
- Hands on Experiences
 - Advanced Software Tools
 - Advanced Hardware Tools
- **Great Career Opportunities in High-tech and HEV Industry**

Sponsors and Supports

- US Department of Energy
- General Motors Corp.
- Natural Resources of Canada
- Argon National Laboratory, US
- The MathWorks
- dSPACE
- A123
- SIMENS
- National Science Foundation, US
- University of Victoria / Faculty of Engineering



The Perks



Government of Canada

Gouvernement du Canada



California Environmental Protection Agency

Renewable Fuels Association



MotoTron Control Solutions
Production Controls in a Flash



What We Do

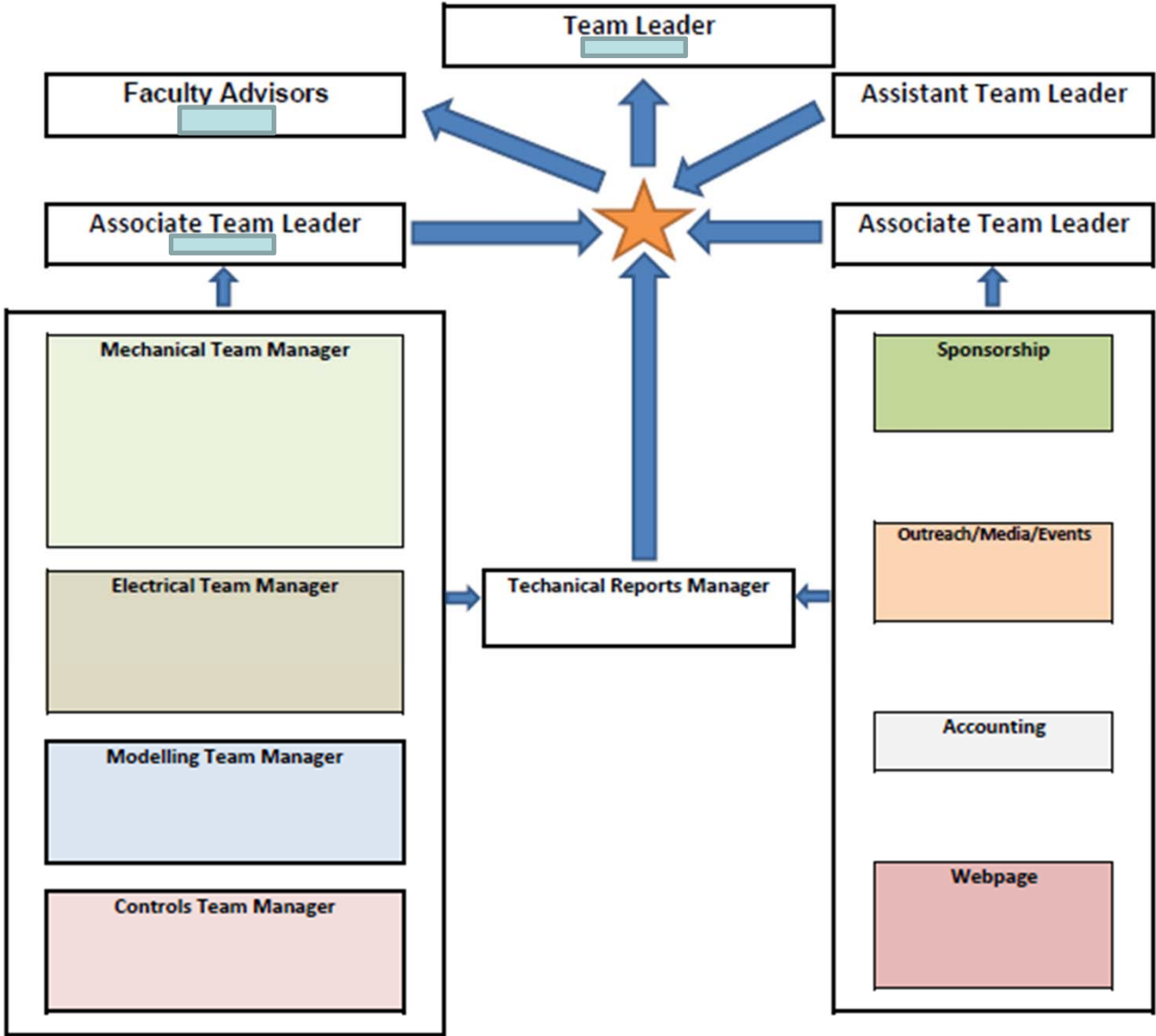
YEAR & OBJECTIVE	MECHANICAL	ELECTRICAL	CONTROLS
Year 1: Design	Lifecycle analysis, vehicle architecture selection and performance modeling		
	CAD - Component	Define Electrical Requirements	Control System Design
	CAD - Routing and Integrations	HIL Design/Setup	Simple Control and SIL/Prelim HIL
Year 2: Mule Vehicle	Finalized Component Selection		
	Vehicle Modification	Vehicle Harness/Systems Design	HIL Finalization & Communication Setup
	Component Integration	Vehicle Harness Setup	HIL Testing - Safety and Fault Mitigation Implementation
Year 3: Optimization & Refinement	Controls Integration and Vehicle Troubleshooting		
	Aero and Lightweighting, R&H, NVH	Refinement and Optimization	Refinement and Optimization
	99% Buyoff - Vehicle Ready for Production		

Major Groups

- Modeling/Simulation/System Design
- Mechanical Design, Analysis and Manufacturing
- Power Electronics and Electric Machines
- Control and Embedded System
- Programming
- Prototyping and Retrofitting
- Project Management
- Business Outreach

UVic EcoCAR 2 Team Structure

Up to date as of: July 18, 2011



Related Courses and Training (Rewards)

- **MECH459 - Fundamental of Hybrid Electric Vehicles (for 3B Students)**
MECH580 Selected Topics in ME (Open to All Grad. Students)
5:30 - 8:20 pm; Wednesdays; ECS104

ELEC496 Selected Topics in Electrical Engineering;

CENG496 Selected Topics in Computer Engineering;

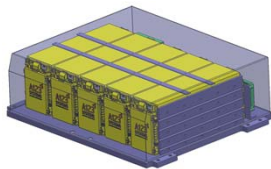
SENG480 Selected Topics in Soft Computer Engineering;

Instructor: Dr. Z. Dong (Open to Team Members with Home Chair Approval)

- **MECH497 Green Vehicle Technology Project (3 Units, Crawford & Dong)**
- **MECH499 Design Project (ME Faculty Members)**
- **ECE499 Design Project (Dr. K. Li)**
- **ENGR466 Mechatronics System Design (Dr. D. Constantinescu)**
- **MECH499 Honour Thesis (3 Units, ME Fac.)**
- **EcoCAR 2 Co-op Terms**
- **EcoCAR 2 Trainings (at Sponsors' sites) and EcoCAR 2 Developments**
- **Graduate Studies at M.A.Sc. And Ph.D. Levels**

New UVic Green Vehicle Research, Testing and Training Centre

- **First Class Green Vehicle Development and Testing Facilities**
 - Computer Modeling, Design and Simulation
 - Hardwire in Loop Testing
 - Advanced Battery Pack Development
 - 4WD, Active Braking Enabled Chassis Dynamometer
 - Engine Dynamometer
 - Emission Measurement
- **Hands on Shop**
 - Automotive Shop
 - Small Machine Shop
 - Small Electronics Shop

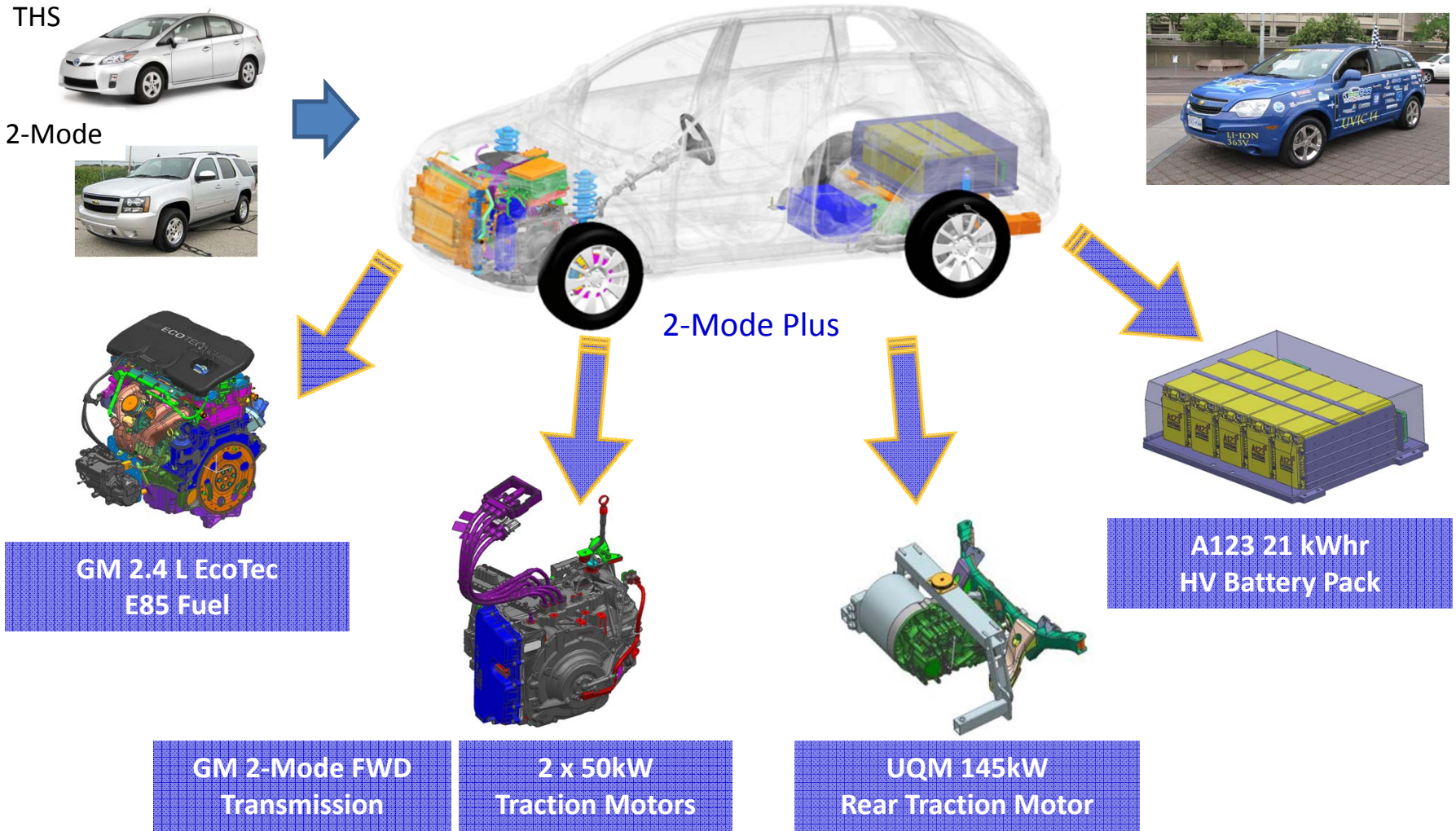


University of Victoria EcoCAR – the NExt Challenge 2009-2011

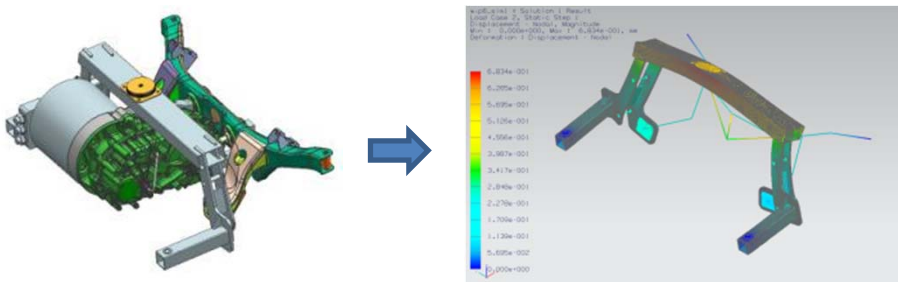
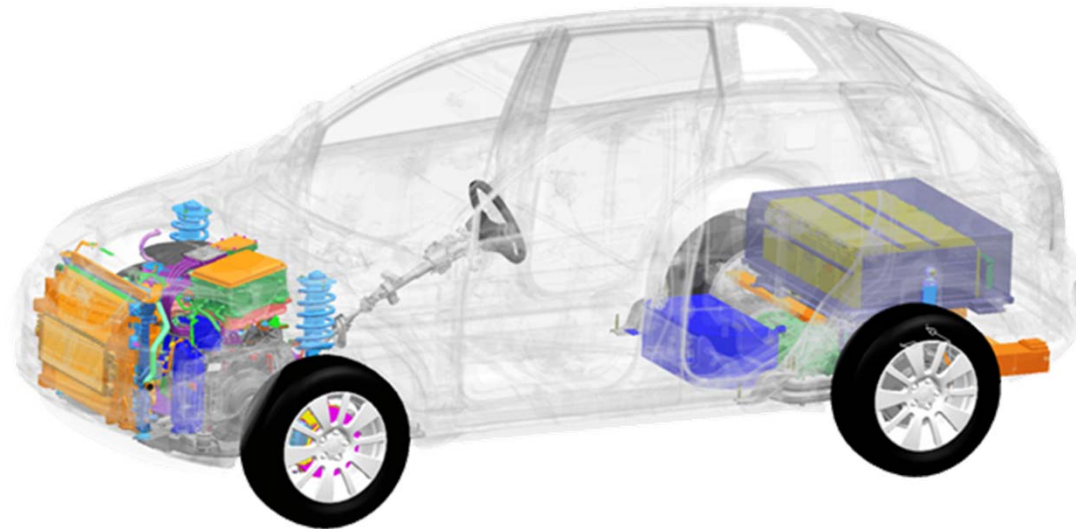


- Team Leaders
 - Jeremy Wise and Jeffery Walden
- Faculty Advisors
 - Dr. Zuomin Dong (zdong@uvic.ca)
 - Dr. Curran Crawford (ccrawford@uvic.ca)
- Website and contact: <http://www.ecocar.uvic.ca>

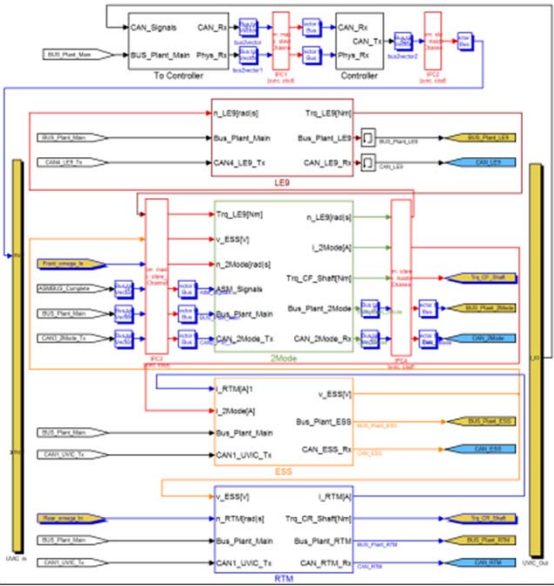
UVic EcoCAR 1 – Push the HEV Technology Boundary



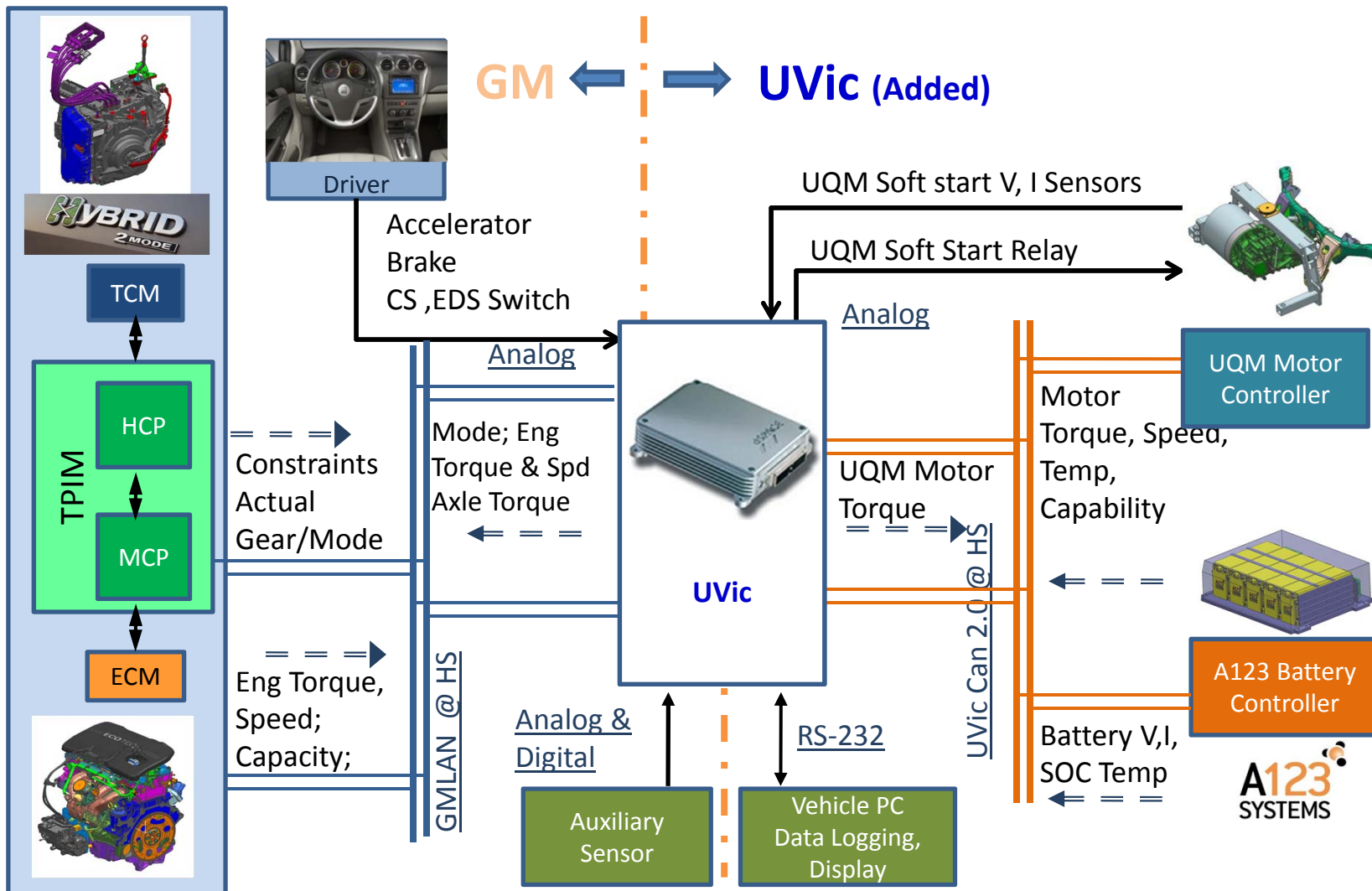
What We Do – Mechanical



What We Do – Electrical/Controls/Software



UVic 4WD 2-Mode Plus EcoCAR Control System

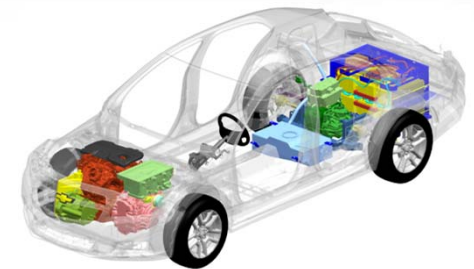


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EcoCAR 2 – Plugging in to the Future



- Team Leader
 - Daniel Prescott (dprescott@uvic.ca) (Year1: Stefan Kaban)
- Faculty Advisors
 - Dr. Zuomin Dong (zdong@uvic.ca)
 - Dr. Curran Crawford (ccrawford@uvic.ca)
- Website and contact: <http://www.ecocar.uvic.ca>



EcoCAR2
PLUGGING IN TO THE FUTURE

UVic EcoCAR2 through Optimization

Goals - Minimize emissions and energy consumption (Y2 & Y3 points; E&EC performance)

Powertrain design and prototyping - advanced powertrain architecture, sizing and control System

- Support flexible multiple mode vehicle operations
- Enable optimal vehicle operation for different demands

Leading-edge powertrain control technology

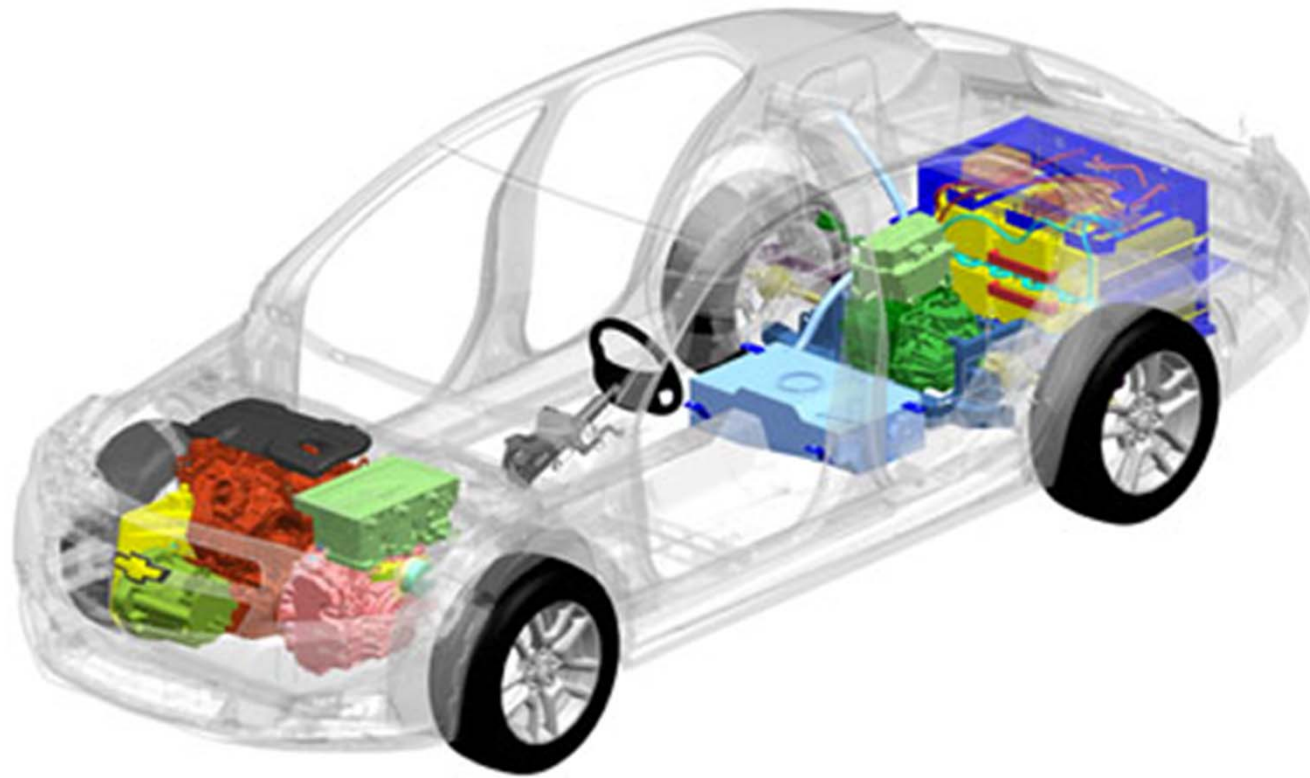
- Real-time optimal control to maximize efficiency/performance
- Optimal/intelligent energy management (fuel economy and life)
- Integrated Infotainment system (improved utility and efficiency)

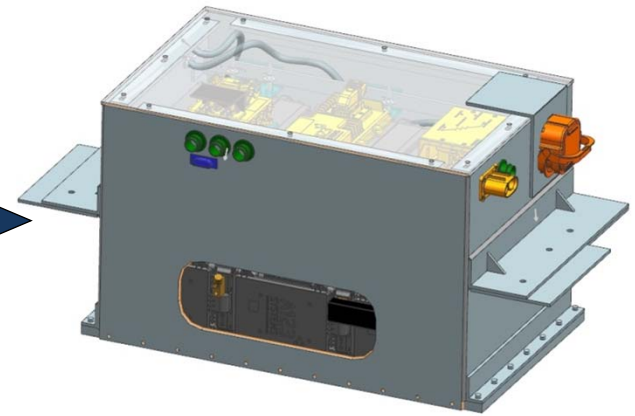
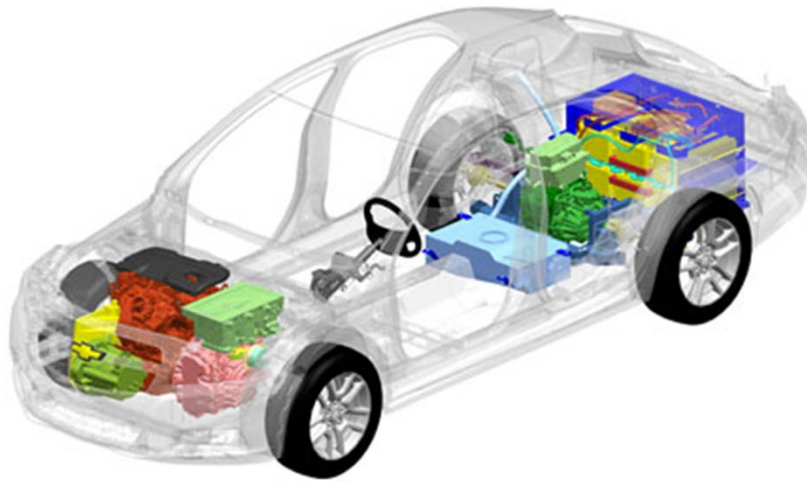
Design for manufacturing, maintenance and reliability

- Essential to have a fully functional vehicle
- Lesson from EC1

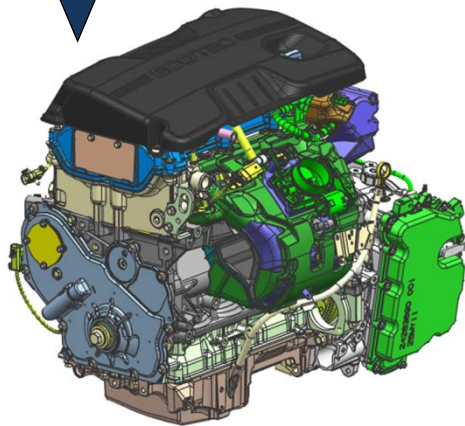


Multiple Mode AWD Series-Parallel PHEV

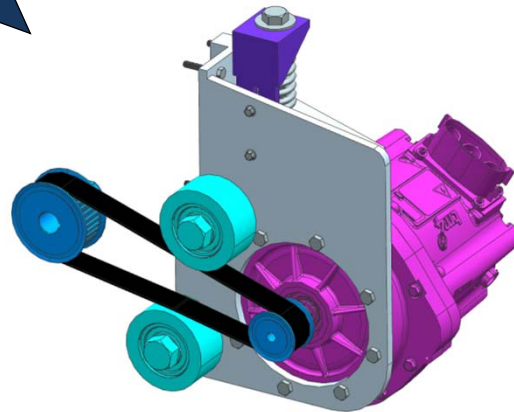




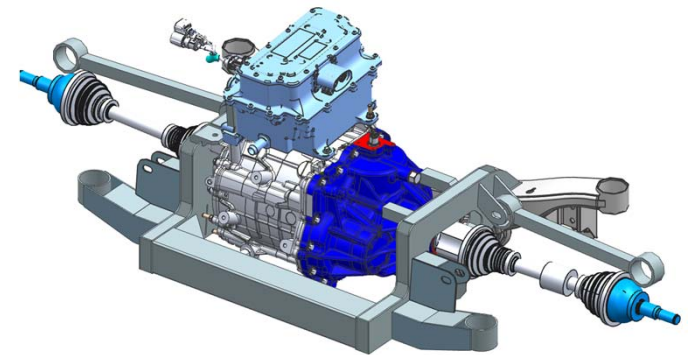
**A123 6s x 3s15p
Lithium-Ion Battery**



**2.4L GM EcoTec
LE9 Engine**



TM4 80kW BAS



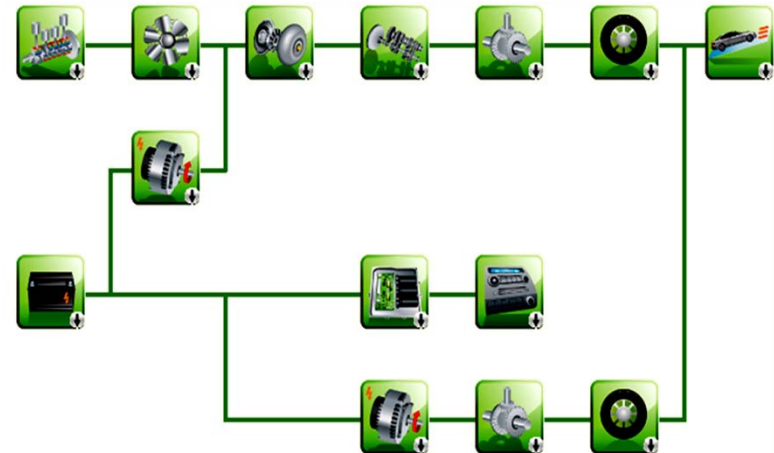
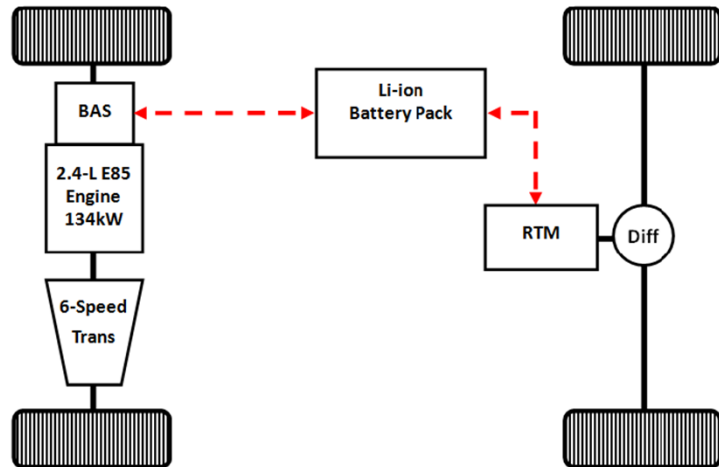
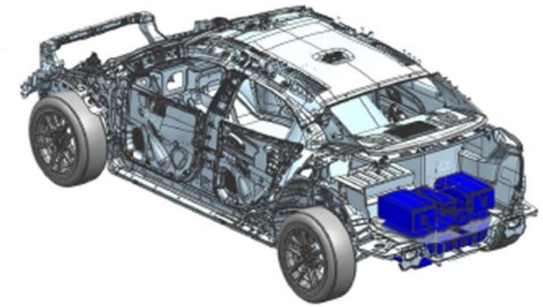
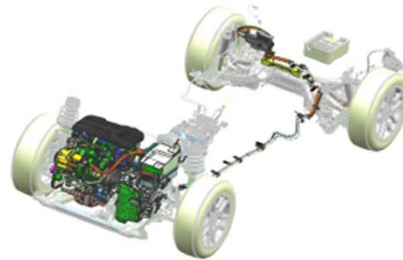
Magna E-Drive

Vehicle Technical Specifications

SPECIFICATION	PRODUCTION MALIBU	COMPETITION REQUIREMENT	TEAM TARGET
Acceleration (0-60 mph)	8.2 seconds	≤ 9.5 sec	5.8 sec
Acceleration (50-70 mph)	8.0 seconds	≤ 8.0 sec	4 sec
Braking (60 –0 mph)	43.7 m	≤ 43.7 m	43.5 m
Highway Grade Ability (20 min)	10+ % at 60 mph	3.5% at 60 mph	8% @ 60 mph
Cargo Capacity	16.3 ft ³	7 ft ³	12.7 ft ³
Passenger Capacity	5	≥ 4	5
Mass	1589.6 kg	< 2250 kg	< 2250 kg
Starting Time	< 2 seconds	< 15 seconds	< 5 sec
Ground Clearance	155 mm	> 127 mm	> 127 mm
Range	736 km (CAFE)	332 km	332 km
Criteria Emissions	Tier 2 Bin 5	Tier 2 Bin 5	Tier 2 Bin 5
Charge Deplete Mode Range	N/A	N/A	63.1 km
UF Weighted Electrical Consumption	N/A	N/A	165.6 Wh/km
UF Weighted Fuel Consumption	8.83 Lge / 100km [787 Wh / km]	7.12 Lge / 100 km [634 Wh / km]	4.86 Lge / 100 km [432.7 Wh/km]

New Challenge Now

An Entirely New AWD EREV Powertrain
Modeling and Design



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New to EcoCAR 2: Infotainment System

- Android and Ca-Fi: 6.2 inch touch screen LCD, powered by The Freescale™ Cartex™ A8 i.MX5x processors running at 1.2 GHz; music and other audio with output connections for camera, USB and antennas, designed to be compatible with all sorts of car.
- Mercedes-Benz A-Class concept
- Toyota Entune in-car infotainment system
- Other electronics and embedded systems: solar roof Prius, etc.



UVic EcoCAR 2009 Competition Awards

- 2nd Place Overall
- 1st Place First Year Technical Reports
- 1st Place, MathWorks Modeling Award
- Best Electrical Systems Presentation
- 2nd Place, Hardware-in-Loop Evaluation
- 3rd Place, dSPACE Embedded Success Award
- Best Media Relations Program



Faculty Advisors: Zuomin Dong and Curran Crawford



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UVic EcoCAR 2010 Competition Awards

- 4th Place Overall Award
- Best Technical Reports Award
- US National Science Foundation Outstanding Incoming Advisor Award (Drs. Dong and Crawford)
- Ron Stence Spirit of Challenge Award
- Dr. Don Streit Sportsmanship Award
- Modeling and Simulation (dSPACE) - 3rd Place Award
- Energy Storage System Design (A 123Systems) - 3rd Place Award
- Sprit of Outreach Award



UVic EcoCAR 2011 Competition Awards

- 1st Place MathWorks Award - Optimal Powertrain Design and Control
- 1st Place dSPACE Award - Hardwire in Loop Testing and Vehicle Dynamics Modeling
- Fastest 0-60 miles/h Acceleration (6.3 seconds)
- Fastest 50-70 miles/h Acceleration (3.5 seconds)
- Best Engineering Workmanship Award (Overall Appearance and Design for Service)
- 3rd Place A123 Workmanship Award - 21 kWh Li-ion Battery Pack Design and Prototyping
- Best EcoCAR Website Award (<http://www.ecocar.uvic.ca>)



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UVic EcoCAR2 2012 Competition Awards

- First Place - Mechanical Design Award
- First Place MathWorks (Modeling, Simulation and Optimization) Award
- Third Place A123 Battery System Award
- Third Place Infotainment System Award



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Become a Member of UVic EcoCAR2 Team

- No automotive experience necessary!
- All disciplines welcome!



Contacts

Website and contact: <http://www.ecocar.uvic.ca>

- **Team Leader**

- Dan Prescott ([dprecott@uvic.ca/](mailto:dprecott@uvic.ca))
 - ~ Stefan Kaban (Y1 TL) & Hassib Hasanzadeh (Outreach/Prj)

- **Faculty Advisors**

- Dr. Curran Crawford (ccrawford@uvic.ca)
- Dr. Zuomin Dong (zdong@uvic.ca)
 - Mechanical Engineering
- School of Business Faculty Contact: Dr. Adel Guitouni
- ECE Faculty Contact: Dr. Subhasis Nandi and Dr. Ashoka Bhat
- SENG/CS Faculty Contact: Dr. Mantis Cheng

Reception and Open House at “Q-Hut”

