EcoCAR Technical Overview

EcoCAR Technical Goals

1. Integrate advanced propulsion systems to enable significant improvements in energy efficiency
2. Deploy CAV technologies to meet energy efficiency goals and Mobility-as-a-Service market needs
3. Balance energy efficiency needs with the consumer acceptability, safety and cost considerations unique to the Mobility-as-a-Service market

EcoCAR is Divided into Five Main Swimlanes

Connected and Automated Vehicle Systems (CAV)	Responsible for developing reliable and accurate multi-sensor vehicle perception systems, V2X communication systems, and autonomous control systems
Propulsion System Integration (PSI)	Responsible for all hardware packaging and mounting, electrical system design and integration, thermal systems, and vehicle ride & handling characteristics
Propulsion Controls and Modeling (PCM)	Responsible for design and implementation of a safe, robust and functional propulsion system supervisory control system and developing models used to simulate the vehicle and subsystems
Project Management (PM)	Responsible for defining organizational processes, creating project plans, providing project oversight, and asserting authority to monitor & control the execution of project tasks
Human Machine Interaction and User Experience (HMI/UX)	Responsible for developing a prototype that effectively educates drivers about their team vehicle's CAV features
Communications (Comm)	Responsible for team communication to target audiences, developing and executing strategies for social media, media relations, and event planning. Act as ambassadors for the team and the overall program in the local market

Propulsion System Integration (PSI)

Design, Integrate, Refine, and Calibrate all propulsion systems in the EcoCAR vehicles

Lucas Shoults

Technical Aspects

EcoCAR Year 1 — DESIGN

- CAD Modeling & Structural Analysis
- Electric System Design & Analysis
- Thermal System Design & Analysis

EcoCAR Year 2 — INTEGRATE

- Various manufacturing processes
- HV system integration and isolation practices
- Hardware integration techniques

EcoCAR Year 3 & 4 — REFINE & CALIBRATE

- Overall vehicle systems refinements
- Calibration plan development and execution
- Interdisciplinary team work

Sponsors

Hardware, Software, and Technical Support

GENERAL MOTORS
Vehicle platform and propulsion system components

MathWorks®
Vehicle Models and Simulation tools

AAM

SIEMENS
CAD tools

BOSCH

TRC Transportation Research Center Inc.

AVL
Drive quality event At competition

Tools – Wrench, Scredriver etc — Milwaukee Nothing but HEAVY DUTY

Various types of automotive grade tapes — tesa great to work with

Propulsion Controls & Modeling (PCM)

Develop, simulate, and test software for team's hybrid-electric vehicles.

Jessica Britt

Technical Aspects

- Modeling & Simulation
  - Vehicle performance and energy consumption metrics
  - Modeling Tools: Simulink and Autonomie
- Controls
  - Powertrain component control
  - Hybrid-electric vehicle energy management strategies
- Testing
  - Environments: model-in-the-loop (MIL), hardware-in-the-loop (HIL), and vehicle-in-the-loop (VIL)

Sponsors

GENERAL MOTORS

OEM

dSPACE VECTOR

Hardware Supplier

MathWorks Argonne NATIONAL LABORATORY

Software

Human Machine Interface (HMI) & User Experience (UX)

Elevates the importance of including customers in the vehicle design process

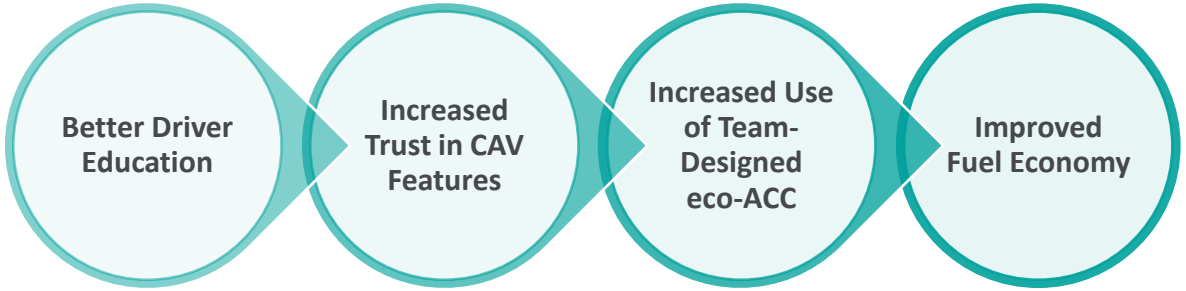
Jessica Britt

Objective

- **To develop a prototype that effectively educates drivers about their team vehicle's CAV features.**
  - No restriction on the prototype's medium (print, audio, video, haptic, etc.)
  - Prototype must work for a Mobility-as-a-Service (MaaS) platform (e.g. ZipCar).

Motivation for Adding the HMI/UX into the Competition

- Introduces students to user-centric design processes (i.e. design thinking); fosters creativity and innovation
- Lack of driver education is a critical industry problem without a solution



Sponsors

OEM: PACCAR

Suppliers: BOSCH, intel

Software: MathWorks

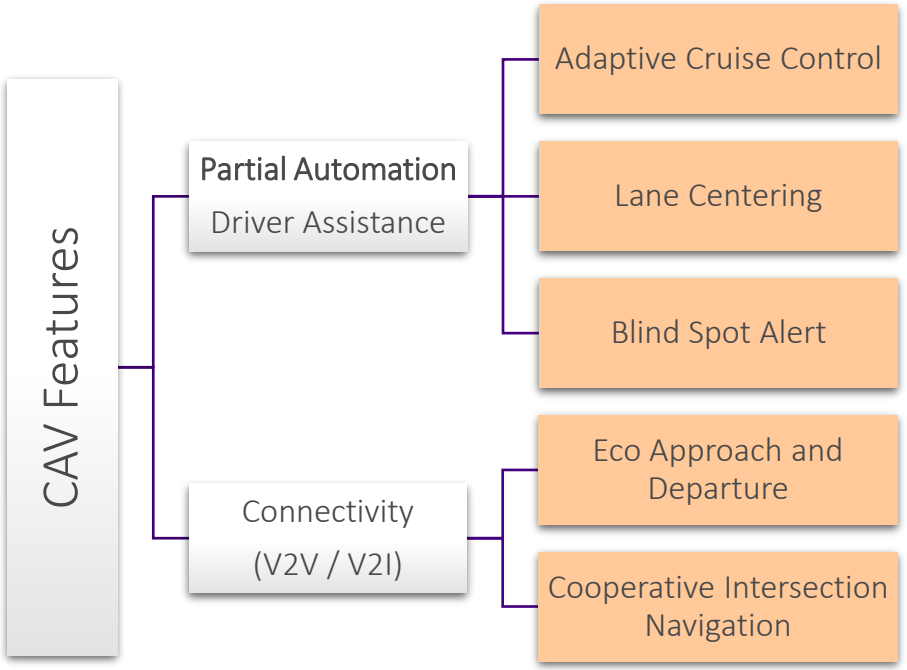
Consumer Advocacy: J.D. POWER, CR Consumer Reports

Connected and Automated Vehicle Systems (CAV)

New emphasis on CAVs, represents 40% of EMC

Trevor A. Crain

Priyash Misra



EcoCAR Year 1

- Select sensors and processors for CAV system
- Establish functionality on bench setup
- Algorithm development and simulation

EcoCAR Year 2

- Integrate sensors and processors on vehicle
- Perform calibration and deploy algorithms
- Demonstrate baseline functionality on vehicle

EcoCAR Year 3 Current Year

- Develop and demonstrate ACC capabilities on vehicle
- Integrate connectivity systems and demonstrate baseline functionality

EcoCAR Year 4

- Refine ACC for improving efficiency and drive quality
- Develop and demonstrate lane centering on vehicle
- Navigate connected corridors using V2V and V2I information

Connected and Automated Vehicle Systems (CAV) - Sponsors

New emphasis on CAVs, represents 40% of EMC

GENERAL MOTORS — Vehicle Platform
2019 Blazer

MathWorks® — Vehicle Models
Simulation tools

intel — MobilEye Camera
Tank processor

BOSCH — Radars

NXP | Cohda Wireless — Cohda Radios for
V2X connectivity

OXTS — Groundtruth equipment
To analyze performance
Of perception system

VECTOR — CAN data analysis and
logging tools – hardware and software

HORIBA

Levels of Automation (SAE)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

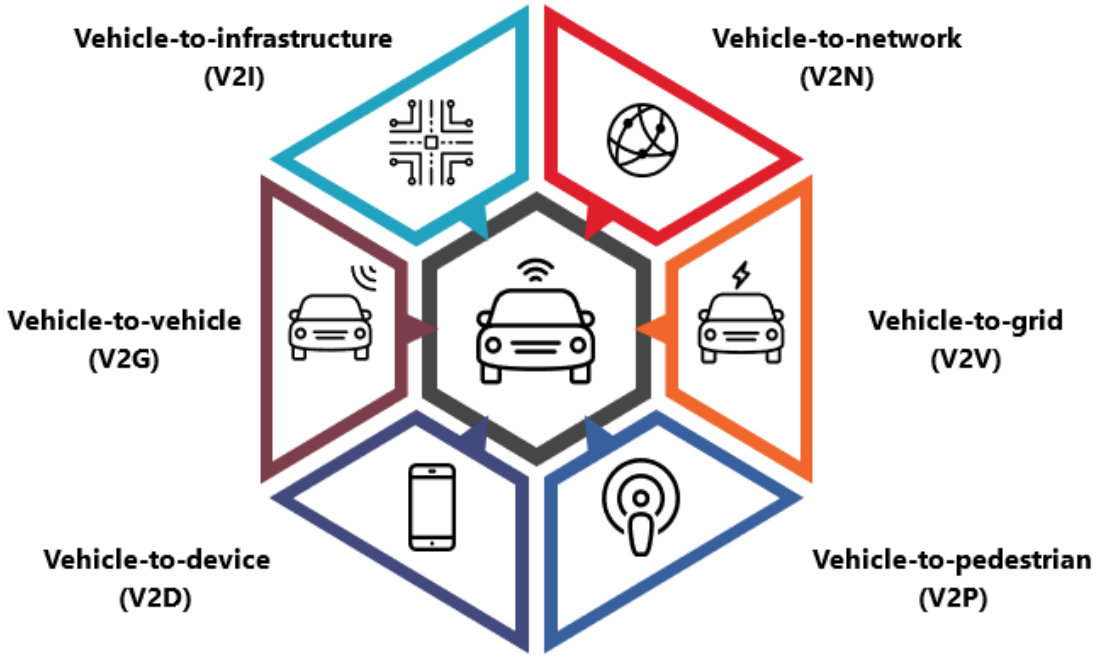
Full Automation

EcoCAR Applications

0	1	2	3	4	5
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**High Automation**	**Full Automation**
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Connected Vehicles

- Vehicles talking to each other or to infrastructure via radio
- Generally, V2X / Vehicle-to-Everything
  - V2V: Vehicle to Vehicle
  - V2I: Vehicle to Infrastructure
    - Road-side units (RSU)
    - Traffic lights
    - Pedestrians



What information is shared ? → Location → Speed → Accel → Braking status → And more..

Connected Vehicle Features

Safety

- Blind spot warning
- Lane change warning
- Stationary vehicle warning
- Braking activity warning

Mobility

- Intelligent traffic signals
- Smart Intersection Navigation
- Dynamic ride sharing
- Another way to charge tolls

Environmental

- Eco approach & departure at traffic lights
- Eco smart parking
- Connected Eco-Driving / Platooning

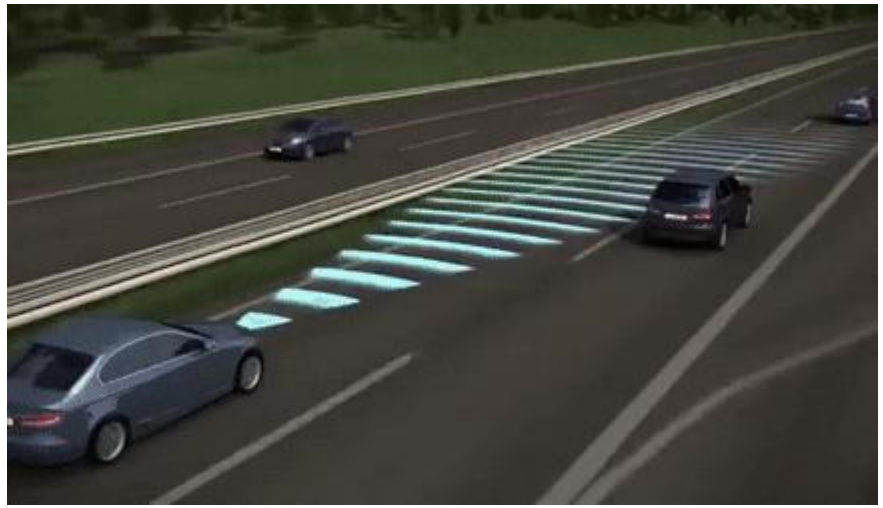
Cruise Control

Set your desired speed

Increase/decrease speed while CC is active

Braking disengages cruise control

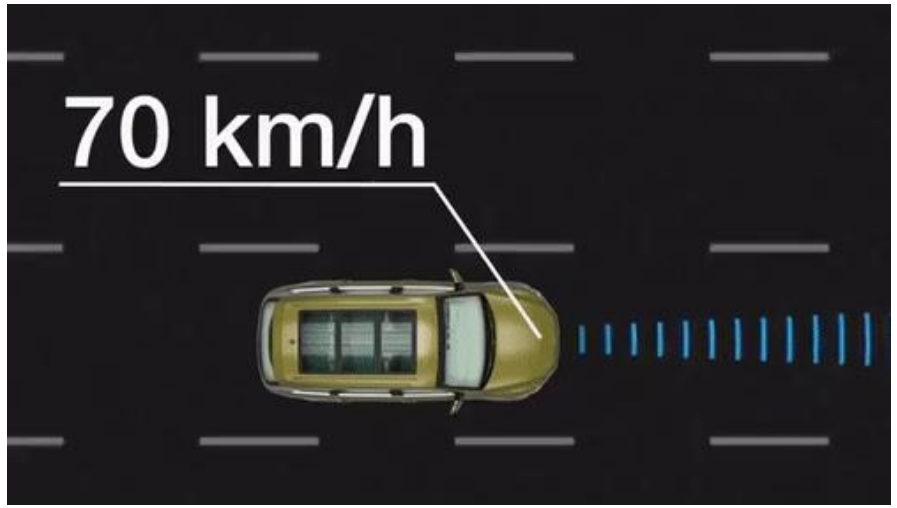
Adaptive Cruise Control



Set your desired speed

Set desired gap / following distance

If lead vehicle slows down, you slow down



Challenges for developing CAV systems

- Sensor capabilities
  - Effect of Weather
    - Rain, Snow, Dust
- Road condition
  - Road width
  - Lane marker visibility
  - Curves
  - Undulations
- Type, location and characteristic of object being detected
  - Cars, Trucks, Bikes, Pedestrians,
  - Location of object with respect to vehicle
  - Speed of an object
- Radio performance for connectivity
  - Open areas vs urban areas
  - Effect of weather and atmospheric conditions

Project Management Swimlane Overview

Provides leadership and organization that benefits all areas of the program

Jesse R. Alley

EcoCAR Project Manager Responsibilities

Comprehend project status at the beginning of the year
Recruit new team members & establish roles within the team

Develop a project plan to accomplish year-end competition goals

Complete deliverables in the PM swimlane

Track project progress and adjust project plan as needed
Communicate regular project updates to internal and external stakeholders

Archive all organizational process assets from the year

*PMBOK: Project Management Body of Knowledge guide, issued by the Project Management Institute

Common Learnings and Experiences

- Learn software and hardware tools used by the industry
- Engineering design process
- Requirements development
- Testing and debugging methodology
- Hardware integration techniques
- Knowledge of multiple algorithms
- Develop and execute test plan

… Thank You …