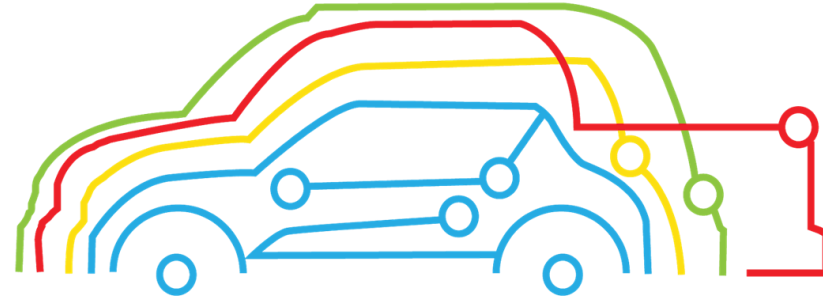


ECO CAR MOBILITY CHALLENGE

SWIMLANES





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ADVANCED VEHICLE TECHNOLOGY COMPETITIONS

PROPULSION SYSTEMS INTEGRATION (PSI)

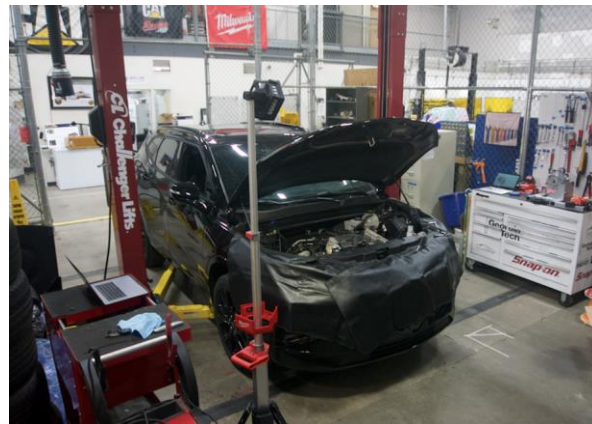
What is Propulsion Systems Integration?

- Year 1:
 - Design & analysis of the vehicle
 - Powertrain (I.E. engine, battery pack, motors, etc)
 - Electrical system
 - Planning for the future of the project
- Year 2:
 - Tearing apart the car & building it back up
 - Getting the brand-new car!
 - Strip out a lot of the stock components
 - Fabrication/purchasing of new components
 - Hardware integration – put all our new components into the car
 - Very important that our design from Year 1 works in the actual car
- Year 3 and 4:
 - Refinement of all vehicle systems
 - Fix anything that breaks
 - Calibration plan development and execution – this means optimizing the performance of our vehicle
- Sub-team sponsors:
 - GM, MathWorks, Bosch, Siemens, TRC, AVL, Tesa



What do students in the swimlane work on?

- Get hands dirty!
 - Work directly on the car and with many, many tools
 - Includes things such as installing a whole new engine!
 - Get to build and make changes to many different things
 - I.E. fuel tank, structure of car, A LOT of mounts, etc.
- Design the integration of the electrical and mechanical parts of the vehicle
 - Use computer software to plan and design the electrical and mechanical parts
 - Most common software's are called NX and Vesys



Skills students gain through PSI

- Learn software and hardware tools used in the automotive industry
- Gain valuable experience in engineering problem solving
- Engineering design processes
 - Design → Fabricate → Integrate → Validate
- Collaborating with other sub-teams
 - PCM → Work on how the components in the car communicate and know what to do
 - CAVS → Work on autonomous features of the vehicle
 - HMI/UX → Work on designing features that drivers will interact with



Why is PSI important?

- PSI makes sure the car works!
 - Without the design, integration, and repairs PSI performs, no other team would be able to work on the vehicle
 - Serve as the metaphorical backbone of the team
- PSI teaches many skills to its members that help them secure internships and jobs
- PSI helps other teams with their objectives too

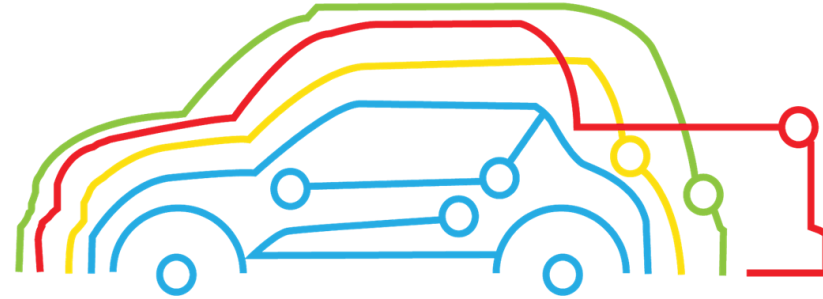


What kind of majors partake in this swimlane?



- Most PSI teams are made up of:
 - Electrical engineers
 - Mechanical engineers
- But... all majors are welcome to join the swimlane as long as you have an interest in working on cars!
 - Chemical engineers
 - Material Science engineers
 - Welding engineers
 - Computer Science engineers
 - Non-engineers





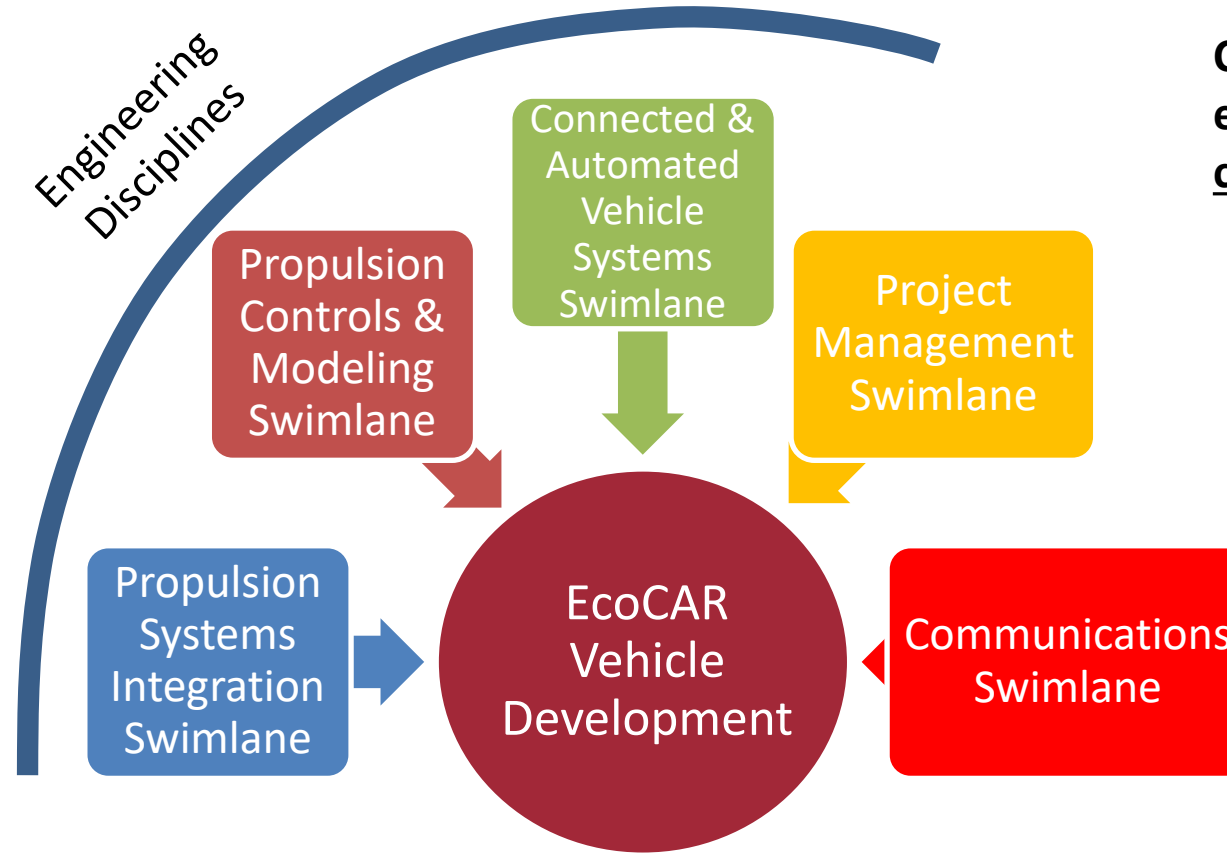
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ADVANCED VEHICLE TECHNOLOGY COMPETITIONS

PROPULSION CONTROLS & MODELING (PCM)

EcoCAR Multidisciplinary Approach

- **PCM** stands for **Propulsion Controls and Modeling** and is one of the critical subteams on our EcoCAR Teams!
- **PCM** works closely with PSI and CAVs team to **ensure vehicle efficiency and safety!**



Contributions from each “swimlane” are critical to success

What is PCM?

- The PCM team is responsible for...
 - Designing and implementing a **safe and efficient control system**.
 - Developing and testing models that simulate vehicle operation in **real-world environments**.



Why is PCM Important?

- PCM develops code to **control all powertrain components** in the vehicle.
- The CAVs autonomous driving algorithms works with PCM control code to **maximize fuel economy and ensure a smooth driving experience.**
- PCM works with PSI to test the vehicle to make sure it will **operate safely and efficiently.**



Technical Aspects of PCM

- **Modeling & Simulation**

- Simulink model development for accurate vehicle simulations

- **Controls**

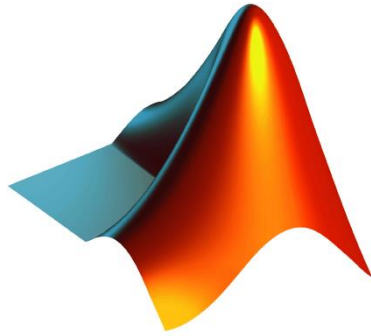
- Develop overall vehicle controls strategy, also known as the *brain* of the vehicle!
- Develop controllers that connect all the components together to work efficiently and safely

- **Testing**

- Support vehicle testing & component research
- Hardware-in-the-loop Testing
- Model-in-the-loop Testing
- Vehicle-in-the-loop Testing



PCM Skillset

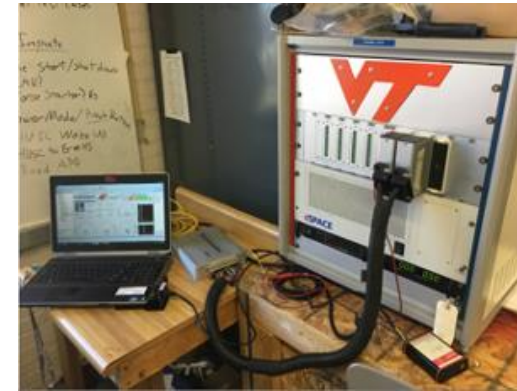


MATLAB/Simulink



**Systems level
vehicle knowledge**

**Curiosity &
desire to learn**



**Computer &
software skills**

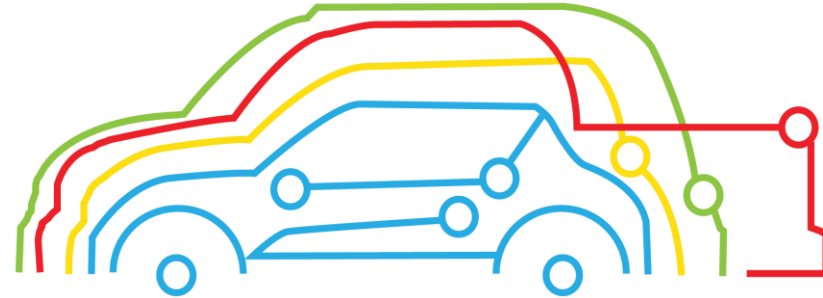


**Software & hardware
I/O interfacing**

Associated Majors

- Mechanical Engineering
- Electrical Engineering
- Computer Engineering





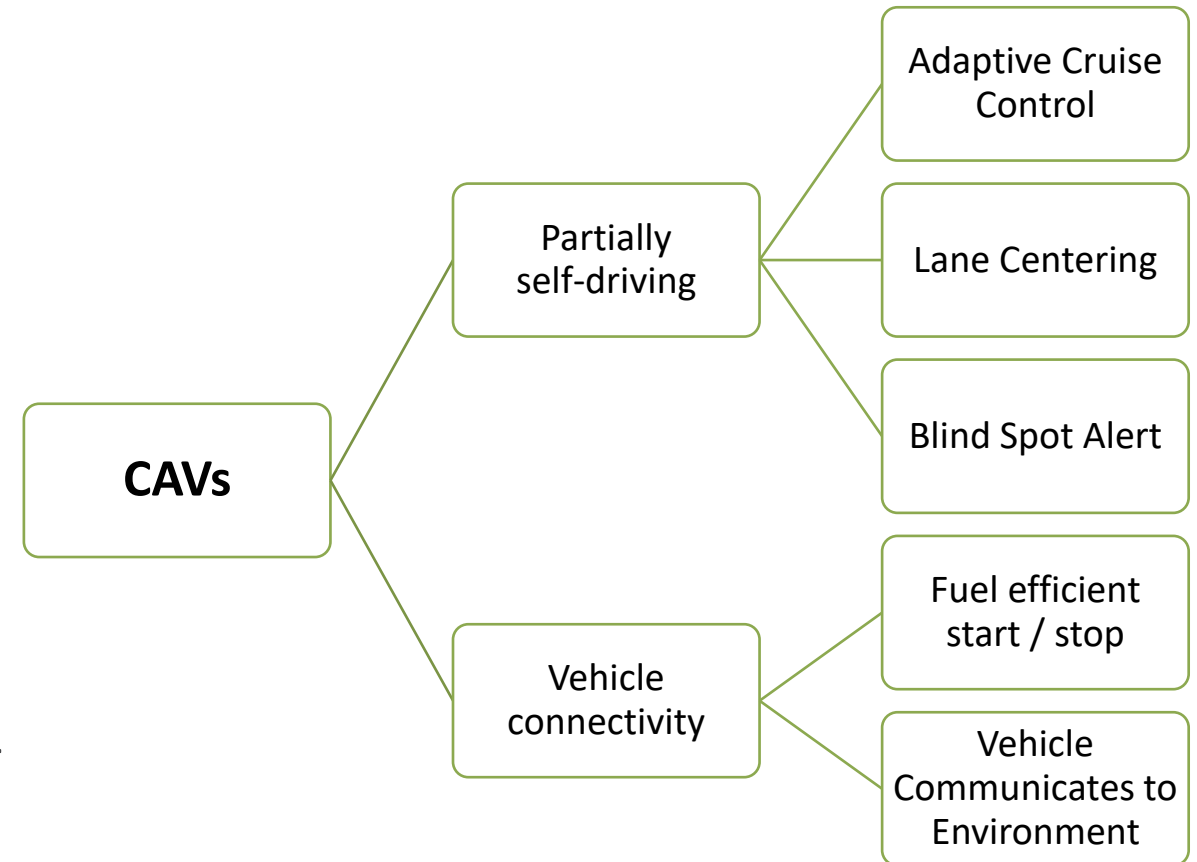
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CAVs

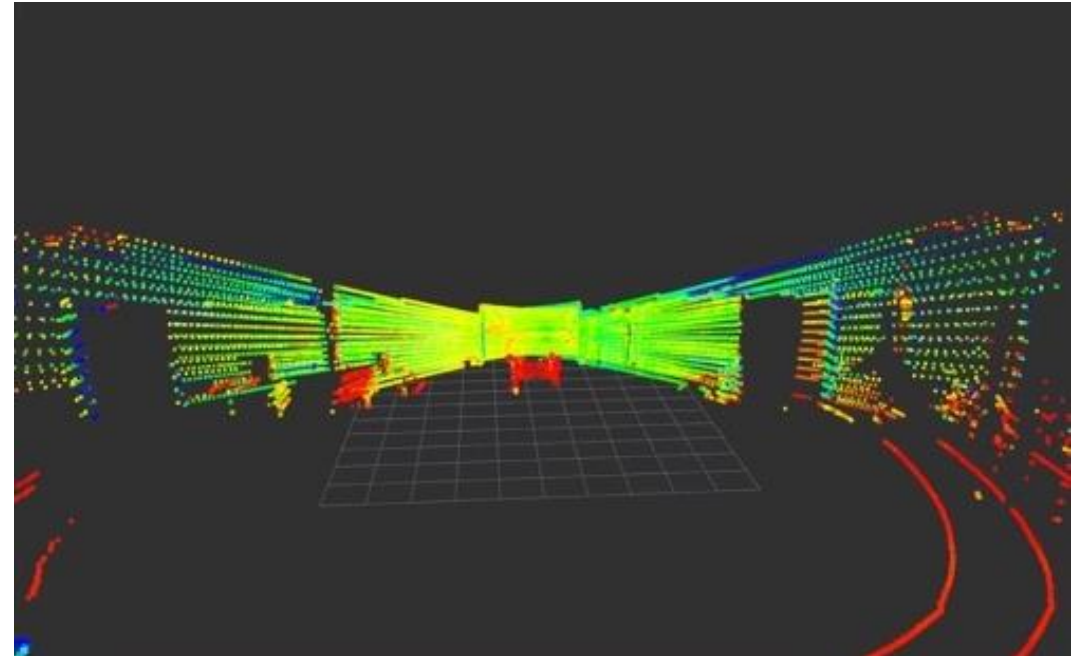
What is CAVs?

- CAVs stands for Connected and Automated Vehicle Systems.
- These vehicles use technology like sensors and cameras to help the driver steer, accelerate, and brake without them having to do it themselves.
- The technology can communicate with other vehicles, traffic signals, signs, and other things on the road, making the car aware of its own surroundings.



What do people in CAVs do?

- People working in CAVs essentially make a car into a real life video game by
 - Setting up lasers so the vehicle can watch what's happening around it.
 - Imitating how the car will act in real life on the computer.
 - Making the sensors talk to the computer in the car so it knows how to react to the vehicles around it
 - Testing the technology online to make sure every real world driving experience is safe



CAVs students learn how to...



- Plan a project
- Build technology for vehicles that make them safer for people and the environment
- Write code
- Work with companies and sponsors to gain real world experience
- Work well with others

Working in CAVs on an EcoCAR team...



- Helps students gain valuable experience that makes it easier to find a job after college.
- Advances the future toward safer and more fuel efficient cars.
- Provides funding to students.
- Offers in school job opportunities.
- Provides a safe place to experiment with technology and learn more.

What majors do they study?

- Most CAVs students study some type of engineering such as:
 - Mechanical Engineering
 - Electrical Engineering
 - Software Engineering
 - Controls Engineering
 - Aerospace Engineering
- Other CAVs students study Computer Science



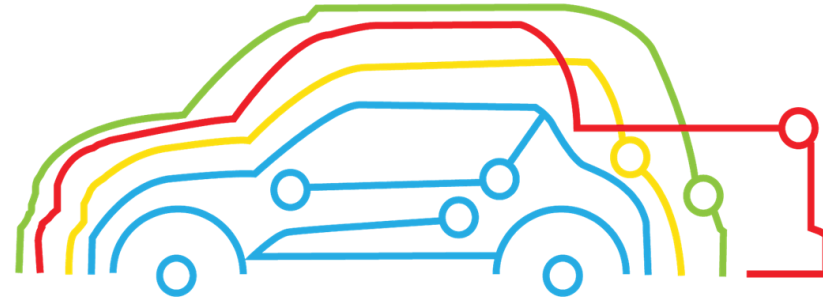
What jobs could they have in the future?

Careers they could have

- Software Engineer
- Systems Engineer
- Autonomous Hardware Engineer
- Automotive Engineer
- Sensor Fusion Engineer
- Calibration Engineer
- Project Manager
- Electrical Engineer

Companies they could work for

- The U.S. Department of Energy
- General Motors
- MathWorks
- NXP
- National Science Foundation (NSF)
- Intel
- American Axle & Manufacturing (AAM)
- Bosch
- Paccar
- So many more!!



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ADVANCED VEHICLE TECHNOLOGY COMPETITIONS

SYSTEM SAFETY

What is System Safety?

- Cross-functional group working with all sub-teams to ensure the system is safe by performing safety analysis on the systems and tracking requirements
- Discuss failures and hazards
- Help sub-teams work through the different ways functions can fail and find a solution
- Ex: Autonomous vehicles-designing adaptive cruise control systems

Procedure:

- CAVs team provides an idea of what functions they are trying to achieve. How can it fail? What do we need to implement to ensure it does not fail? What happens if the radar/sensor fails?



What Students Do and the Skills they Gain



- Understanding of safety analysis applies across any engineering/ science field
- Used in many different industries
- Understanding how to decompose a system
- Understanding the sum of the parts and how they interact to create the final system
- Troubleshooting/diagnostics

Why is System Safety Important?

- Useful in everyday life to ensure safety in vehicles
- Expected by consumers and governments
- In the event there is a catastrophic failure, mitigate damage by the system
- Prevent injuries



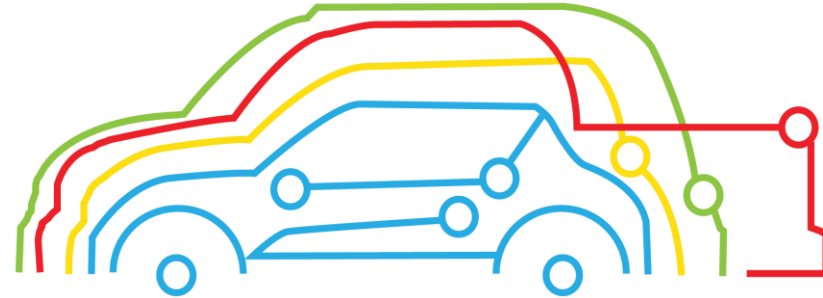
Who Works in System Safety?

1) Science majors

- a) Part of it is having a technical/analytical background, but this can be learned

1) Engineering

- a) Designing, testing, manufacturing electrical components and motors for safety (e.g. incorporating sensor controls on vehicles)
- b) Chemical hazard/risk analysis, fire suppression



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ADVANCED VEHICLE TECHNOLOGY COMPETITIONS

HUMAN MACHINE INTERFACE & USER EXPERIENCE (HMI/UX)

What is HMI/UX?

- Human Machine Interface & User Experience
 - Every interaction a driver has with a vehicle
 - Buttons on steering wheel is how the driver interacts with the vehicle
 - Ensure drivers understand vehicle components as technology advances.



Student Work Experience

How students gain experience working with Human Machine Interface & User Experience:

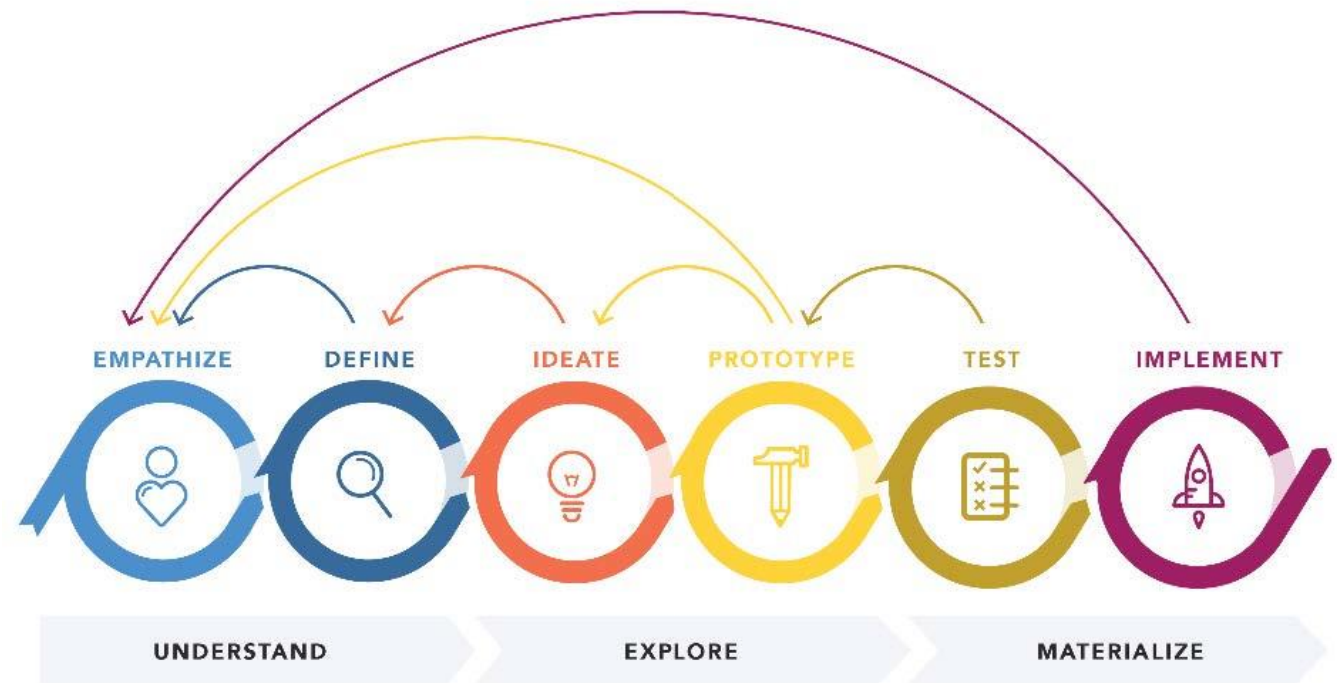
- By creating a product that consumers can interact with to learn the features installed into the vehicle
- By creating prototypes of systems to inform drivers of HMI/UX
- By conducting consumer research
- By influencing the future relationship between drivers and their vehicle



Skills Students Gain

Members of the HMI-UX sub-team gain many new skills, including:

- Prototyping
- User-centric design
- User interface programming skill
- Teamwork
- Research
- Critical Thinking
- Data Analysis



DESIGN THINKING 101 NNGROUP.COM

Importance of HMI/UX

The HMI-UX sub-team is an important part of each team. Some of their tasks and impacts on the team include:

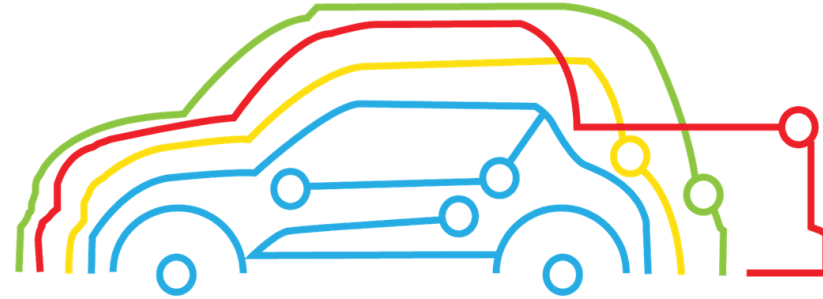
- Focusing on the consumer
- Researching the market to understand what consumers want in HMI designs for vehicles
- Team's must demonstrate the useability of their team designed vehicles



Disciplines Involved in HMI/UX

- Engineering
 - Possible areas of specialty: Mechanical, Industrial, Computer, etc.
- Communication
 - Possible areas of specialty: Public Relations, Media Studies, etc.
- Business
 - Possible areas of specialty: Marketing, Business Administration, etc.
- Other Majors
 - Graphic Design, Psychology, etc.





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ADVANCED VEHICLE TECHNOLOGY COMPETITIONS

TEAM LEADERS (PM/ CM / EM)

Project Management



What is Project Management?

- The Project Management swimlane is comprised of one student, known as the Project Manager, who:
 - Oversees the overall EcoCAR team
 - Works with the other swimlane leads to ensure each swimlane is staying on track in their project's progress
 - Forecasts and measures risks that may arise during the year
- Typically a graduate student
 - In terms of majors, has an Engineering undergraduate degree or is in an Engineering graduate program

PM: Responsibilities & Skills

- Responsibilities:
 - Scheduling and planning meetings
 - Monitoring the Gantt Chart to ensure team is staying on track with tasks and due dates
 - Creating a monthly status update to the EcoCAR organizers
- Skills Gained:
 - Leadership
 - Planning & scheduling abilities
 - Experience working with professionals in the automotive industry

PM: Contributions to the EcoCAR team

- Keeps team on track and improves efficiency of team's processes
- Acts as a bridge between the EcoCAR organizers and the team
- The central organizer of all swimlane projects

Communications Manager



What is Communications?

- **The Communications Manager:**
 - Oversee members of the Communications swimlane
 - Manage team's social media
 - Organize and hold outreach events with local youth grades 6-12
 - Manage relationships with companies that sponsor the team
 - Write blog posts highlighting team accomplishments
- **Undergraduate or graduate student**
 - PR or Communications curriculum is common, although many CMs come from other degrees such as Business, Design, etc.

CM: Responsibilities & Skills

- Responsibilities:
 - Maintaining teams social media
 - Planning youth outreach events
 - Obtaining and maintaining team sponsors
 - Write blog posts and press releases
- Skills gained:
 - Leadership
 - Maintaining an organization's brand/presence
 - Public Speaking
 - Event Planning

CM: Contributions to the EcoCAR team

- Spreads awareness about the EcoCAR team and program, gaining support for the project
- Helps obtain sponsors to support the EcoCAR team and project

Engineering Management



What is Engineering Management?

- The Engineering Management swimlane is comprised of one student, known as the Engineering Manager, who:
 - Understands all the technical sides of the project from a high level
 - Coordinates between swimlanes
 - Sets up design reviews
 - Advises swimlanes or brings in other technical help as needed
- Typically a graduate student
 - In terms of majors, has an Engineering undergraduate degree or is in an Engineering graduate program

EM: Responsibilities & Skills

- Responsibilities:
 - Assists all swimlanes with technical help on a high level
 - Find outside technical support when needed
 - Set up lab procedures to make the team more efficient
 - Set up design reviews to check in on process of swimlanes
 - Communicating with technical sponsors
- Skills gained:
 - Leadership
 - Experience Managing Teams of Engineers
 - Technical Skills

EM: Contributions to the EcoCAR team

- Has the high-level technical knowledge needed for every swimlane
- Advises all aspects of the EcoCAR team
- Keeps team on track and improves efficiency of team's processes