THE OHIO STATE UNIVERSITY

4900/4901.XX: ME General Capstone Design

Russell K. Marzette Jr.
Assistant Professor of Practice
marzette.1@osu.edu

High-Level Course Goals

- Student will understand design as a process.
- Student will apply core engineering skills to the design process.
- Student will recognize and successfully navigate the challenges and complexity of the design process.
- Student will apply design as a process for taking an idea or need through to realization of a deliverable (component, system, or process).
- Student develops key professional and project management related skills, and understands their relationship to the design process.
- Student appreciates design as the culminating ability and skill arising from their studies.

4900/4901.XX : ME Capstone Design

- **Prof. Marzette's Course Philosophy**

  A student's capstone experience should be **memorable, enjoyable, and fulfilling**, while bringing together the deeply analytical aspects of the engineering curriculum with the fundamentals of design, and basics of engineering management (i.e. **practical**).

- **Changes:** Projects start in week 3 of the semester.

  Sequence: ME4900/4901.01/4901.02

ME490X.XX
Integrated, simplified, and reduced complexity project management (PM), systems engineering (SE), and designing engineering (DE) models.

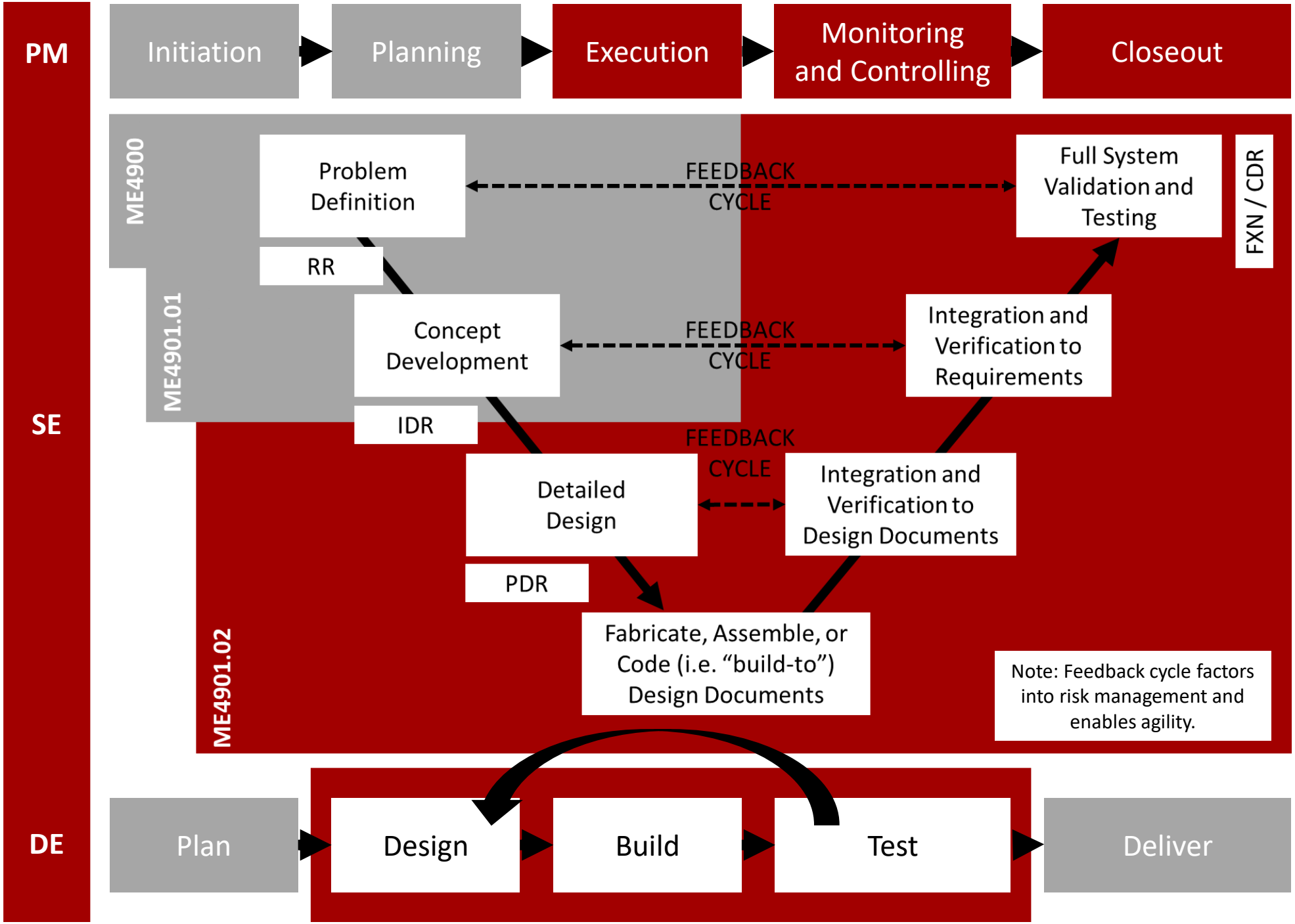
RR = Project, Product, Client, and/or User Requirements Review

IDR = Initial Design Review (Concept Review)

PDR = Preliminary Design Review

FXN = Functional Demonstration

CDR = Critical Design Review



Where do projects come from?

- **Buckeyes**
- **Community**
- **Industry**
- Depending on the size of the class there are between 20-30 project options offered each term!

PROPOSED PROJECTS

smartsheet

STATUS	Buckeye Proposed	Industry Project	SAU2016	SSPR2017	OAU2017	SPR2018	Primary Column	Subsection	Brief Description	Technical Areas	Key Technical Challenges	Project Technical	Budget Up To	Advisor Notes
Active		☆	☑	☑	SELECTED	OFFERED	Fish Team	Platform Development	The robotic fish has had many different iterations, but until AU2016 a fish had never successfully swam. The SPR2017 cohort successfully created a fairly reliable platform capable of (sponge) forward motion. The platform system required minor improvements to achieve reliability. The AU2017 cohort will further elaborate design with improve forward motion and depth control, and potential the addition of on-board sensors. In addition to continue to enhance the design of the fish, your team will ideally collaborate with the Working shelter or payload define, join the team and move the fish forward.	Fluid Dynamics Materials General Mechanical Design Mechatronics Packaging and Integration Physics Robotics Sensors	Creating a robotic fish continues to pose a challenge to every student team. Choosing best practices for integration in an underwater environment is critical. Understanding the mechanics of the motion of a fish is critical.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	SELECTED	NOT OFFERED	Strandbeast	Transmission Redesign	The strandbeast project embodies both engineering design and art. There is an opportunity an opportunity for both engaging design work and creativity. The project will focus heavily on achieving full functionality through understanding and avoiding the mistakes of the previous team. One key aspect of the project is a attention to detail around proper assembly and tolerances, relative to creating a solid drive train.	Kinematics Machine Design Strength of Materials Manufacturing and Assembly	Design a drive train that is able to be operated with the effort of an average cyclist and as smoothly. Involves understanding how loads will be imparted to the system in both the driven and structural sense. Good fabrication practices will be critical.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	SELECTED	NOT OFFERED	Strandbeast	Leg Redesign	The strandbeast project embodies both engineering design and art. There is an opportunity an opportunity for both engaging design work and creativity. The project will focus heavily on achieving full functionality through understanding and avoiding the mistakes of the previous team. This team is to redesign the legs to provide adequate strength and stability in all directions.	Kinematics Machine Design Strength of Materials Manufacturing and Assembly	Legs must operate smoothly and supply a variety of loading conditions. This is a good structure mechanical problem to tackle. The previous teams design which kinematically functional was not stable under loading conditions that could be reasonably expected.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	SELECTED	NOT OFFERED	Strandbeast	Frame Redesign	The strandbeast project embodies both engineering design and art. There is an opportunity an opportunity for both engaging design work and creativity. The project will focus heavily on achieving full functionality through understanding and avoiding the mistakes of the previous team. With a focus on structural design, easy of assembly, service and repair, tolerances, and proper interfacing with the feet of the strandbeast system this task is to redesign the frame of the strandbeast.	Machine Design Strength of Materials Manufacturing and Assembly	A well manufactured and designed frame will require deliberate thought about its functional needs relative to the two other "subsystems." The frame must be lightweight, relative stiff under expected loads, and support an overall "precision" assembly of the system. It must also be designed to support servicing of the system.	General Capstone Program	$1,000.00	
Inactive		☆	☐	☐	OFFERED	NOT OFFERED	DOA: Design an Activity Capstone Shuttle Run Target		Develop a novel means of illustrating a particular aspect of design, in this case design and build a portable target and scoring system for 4WD. Target should be able to be easily disassembling and stored. Target should also be able to count the number of successful scores. Team can redefine certain aspects of the game to make the system work. You get to define future Capstone teams experience.					
Inactive		☆	☐	☐	OFFERED	NOT OFFERED	Non-Standard Air Engine		Design a "non-piston cylinder" air engine.					
Active		☆	☑	☐	SELECTED	NOT OFFERED	Drone Constraint & Control Project		WHY: Ground due to drone is a rules based controls course in the future and it is desired to develop a drone with sub flight environment. In AU2016 a project was undertaken to build a constraining device in which to operate a drone and extract positional feedback for use in position control. Improve upon the drone constraint system created by the AU2016 team, develop basic control software to fly a drone safely inside the constraining box. Notionally control height and yaw. This project should focus on improved sensing of the drones position and implementing basic control.	Controls Kinematics Mechatronics Robotics	Improving upon the existing sensing and constraining mechanism while testing dynamics of the driven flight system. Understanding flight controls, flight dynamics, and control theory in order to implement vertical or other limited flight control.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	SELECTED	OFFERED	Burning Man Vehicle		Design a scale model of a "burning man vehicle." At the intersection between art and engineering find your way to your own unique creation. Related to the intent of the "Strandbeast" project, select your own unique vehicle to design and build.	Kinematics Machine Design Strength of Materials Manufacturing and Assembly	Technical challenges will depending on the vehicle selected.	General Capstone Program	$1,000.00	
Inactive		☆	☐	☑	NOT OFFERED	RETIRED	Bottle Top Remover		Design a device to aid in recycling. Specifically design a device to capture, open, and drain a plastic bottle.					
Active		☆	☑	☑	SELECTED	OFFERED	Robotic (Instrument)		A robotic instrument has played and has some in a row, now its your turn to create you own unique device and sound. Flute, Drums, and Baritone are taken, but Guitar is back on table this term. Team chooses which instrument they will tackle.	Music Theory Physics Mechanical Design Mechatronics Acoustics and Vibrations	Understand how the chosen instrument is played, the physical mechanism by which sound is generated, and what creates a quality sound. The challenges vary depending on the instrument.	General Capstone Program	$1,000.00	
Active		☆	☑	☐	SELECTED	NOT OFFERED	Coffee Roaster		The quest for a Buckeye Roast continues. Coffee roasting is an art and a not trivial, technical challenge to accomplish with intention. One group has tried and failed. But where they failed you will succeed because coffee is critical. Design a roaster from a capable (1-1) roasting, and (2) blending profiles. The roaster should be useful as a sample roaster and opportunities should be taken to learn how to roast coffee and engage with the local coffee community.	Mechatronics Heat Transfer Fluids Dynamics Materials Packaging and Integration	Understand the heat transfer characteristics of you system so that a roast profile can be developed and duplicated. Providing appropriate control and feedback to the user, integrate all the different components successfully into a roaster.	General Capstone Program	$1,000.00	
Active		☆	☐	☑	NOT OFFERED	NOT OFFERED	Cookie Extruder		Shape them, cut them, bake them. Well, baking them might be a bonus. In any case, create a "cookie extruder" that can take cookie dough and dispense it in specific shapes and transfer it to a baking sheet.					
Active		☆	☐	☐	NOT OFFERED	NOT OFFERED	Reconfigurable Bike Rack		Design your "Space Camper" for your bike, well, at least a "Space Camper" rack for the back.					
Active		☆	☐	☐	OFFERED	OFFERED	Mechanical Harmonic Analyzer		Synergy your own harmonic analyzer, a mechanical computer. Check out this video and other following on videos to see this amazing machine. (http://www.youtube.com/watch?v=4ysAnSRbcqc). The project involves understand Fourier Analysis Concepts and mechanisms. Sub Task: Dupcentering it on a mechanical lean. Your device does not have to have the same level of functionality as the one in the video.	Kinematics Machine Design Mechatronics Signal Processing Vibrations	Understanding the how to manipulate mathematical representation and analysis of signals to their mechanical analog.	General Capstone Program	$1,000.00	
Inactive		☆	☐	☐	NOT OFFERED	RETIRED	Rattle Repair Kit		Develop a repair kit to fix unwanted vibration in a vehicle.					
Active		☆	☐	☐	OFFERED	OFFERED	Hot-water Mixing Valve		Create a demonstration device to will hold the output temperature to a constant value. Can be prototyped by using an existing sink with hot and cold water access.	Fluids Controls Mechatronics Thermodynamics	Understanding the physics of fluid mixing, and developing the control algorithm to regulate temperature.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	OFFERED	OFFERED	Trying - Balancing Machine for Bicycle Wheels		Understand what is required to true and balance a bicycle wheel. Develop an automated mechanism to indicate the necessary spoke and weight adjustments. Device should notionally show left to right adjustments as well as "hop".	Machine Design Mechatronics Sensors	Understand the dynamics of a wheel and what must be done to balance it. Select the right sensing mechanism. Develop any interface that indicates appropriate feedback to the user.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	NOT OFFERED	NOT OFFERED	Traction Control on Bicycle		Show amount of traction available based on lean angle (chainwater function) as well as acceleration on a turn (accelerometer).					
Active		☆	☐	☐	NOT OFFERED	NOT OFFERED	Shell A Seed		Pick a seed, any seed, and design a means of shelling that seed.					
Active		☆	☐	☐	NOT OFFERED	RETIRED	Measure Rolling Resistance		Rolling resistance is a retarding effect experienced by any object rolling on a surface. In some sense it is a means of characterizing the irreversible energy lost experienced by a rolling object. Device a device capable of assessing the rolling resistance experienced by a bicycle (front wheel only).					
Active		☆	☐	☑	NOT OFFERED	OFFERED	Automated Lawnmower	Platform Development	Spring Learning Design and build your own automated lawn mower to safely cut and look along Smith Lab lawn. You start with the previous teams platform including sensors. You'll be challenged to improve in quality of cut and will need to develop your own software for the purposes of coordination, path planning, and autonomous operation.	General Mechanical Design Mechatronics Sensors Software Controls	Much of the code the team will need is open source, but effectively integrating the code with the mechanical hardware and sensor package can be challenging.	General Capstone Program	$1,000.00	
Active		☆	☐	☑	NOT OFFERED	OFFERED	Station Keeping Boat	Platform Development	Develop a means maintaining the location of a small boat located in the center of a pool. The team will start immediately with a simple pre-existing prototype platform created by the previous team to attempt the challenging problem. The team will need to understand the mechanical system, select the right sensor package, and develop your own localization, path planning, autonomous code for stationary pool boat.	General Mechanical Design Mechatronics Sensors Software Controls	Much of the code the team will need is open source, but effectively integrating the code with the hardware AND selecting the right sensor package will be challenging. This is in addition to understanding the physical system model and/or improving the mechanical or electrical system.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	OFFERED	NOT OFFERED	Cable Driven Parallel Robotic Manipulator	Camera - Virtual Tour	Cable robots are now a capable of highly complex translational and rotation motions. Here is one impressive example used as a simulator. (http://www.cable-robot.com/cdpm.html). Develop in minimum a planar cable driven parallel manipulator allowing for positional control of its end effector. Past projects in this area have involved development of a "window cleaning robot."	Controls Kinematics Mechatronics Robotics	Understanding the kinematics of a parallel manipulator cable driven robot. Understanding any control requirements as they may apply. Understand or develop hardware to implement project electronically and mechanically.	General Capstone Program	$1,000.00	
Active		☆	☐	☐	NOT OFFERED	NOT OFFERED	Cable Driven Parallel Robotic Manipulator	Window Cleaning Robot	Develop a more effective cleaning module for the current window robot platform. This may be combined with the "CDP" window robot tour.			General Capstone Program		
Active		☆	☑	☐	OFFERED	NOT OFFERED	Regenerative Braking - Electrical Regeneration		This project has several goals. Understand the key components of electro-mechanical based regenerative breaking for bicycles. Select the best components for custom integration into your own take, as well as for monitoring key aspects of performance. Determine the key aspects of performance you want to monitor and communicate to the user. A big portion of this project is integration of components. A for project, your team will have the opportunity to improve upon the last teams design. Some obvious goals include reduction and optimization of weight, increased energy storage and return of power to the rider.	Mechatronics Energy Conversion and Storage Heat Transfer Manufacturability Packaging and Designation	This project involves skillful integration of components in a bicycle, packaging and integration is not trivial. This project involves reaching outside of your mechanical background to properly integrate electrical components.	General Capstone Program	$1,000.00	

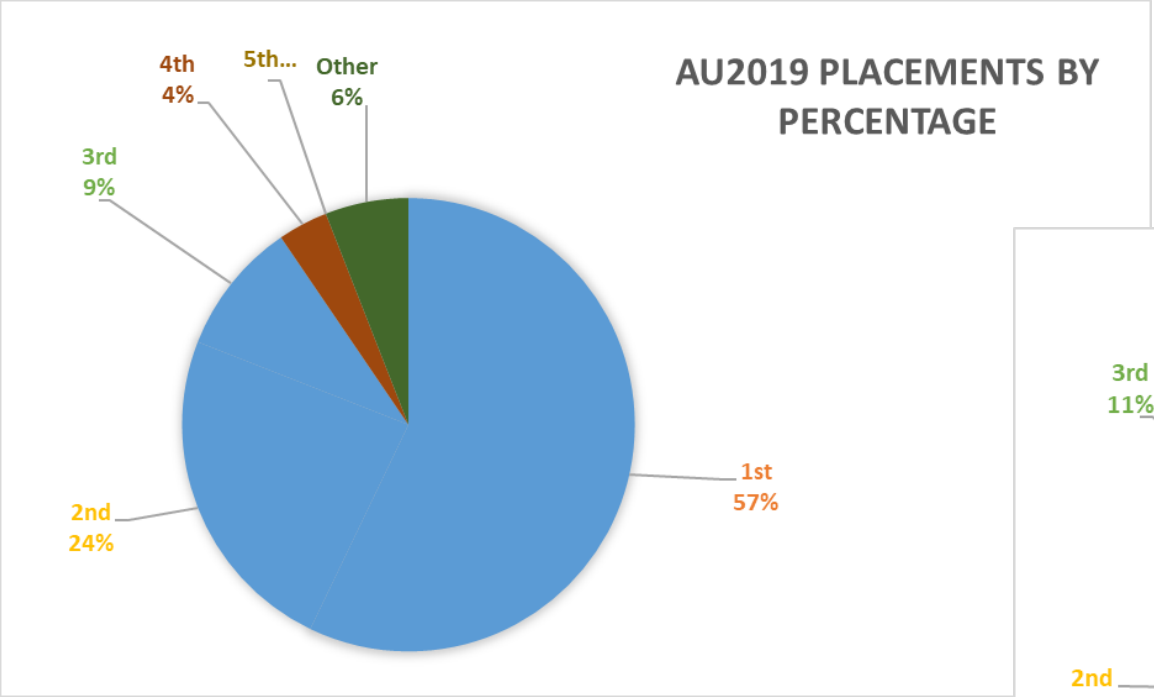
How are projects and teams chosen?

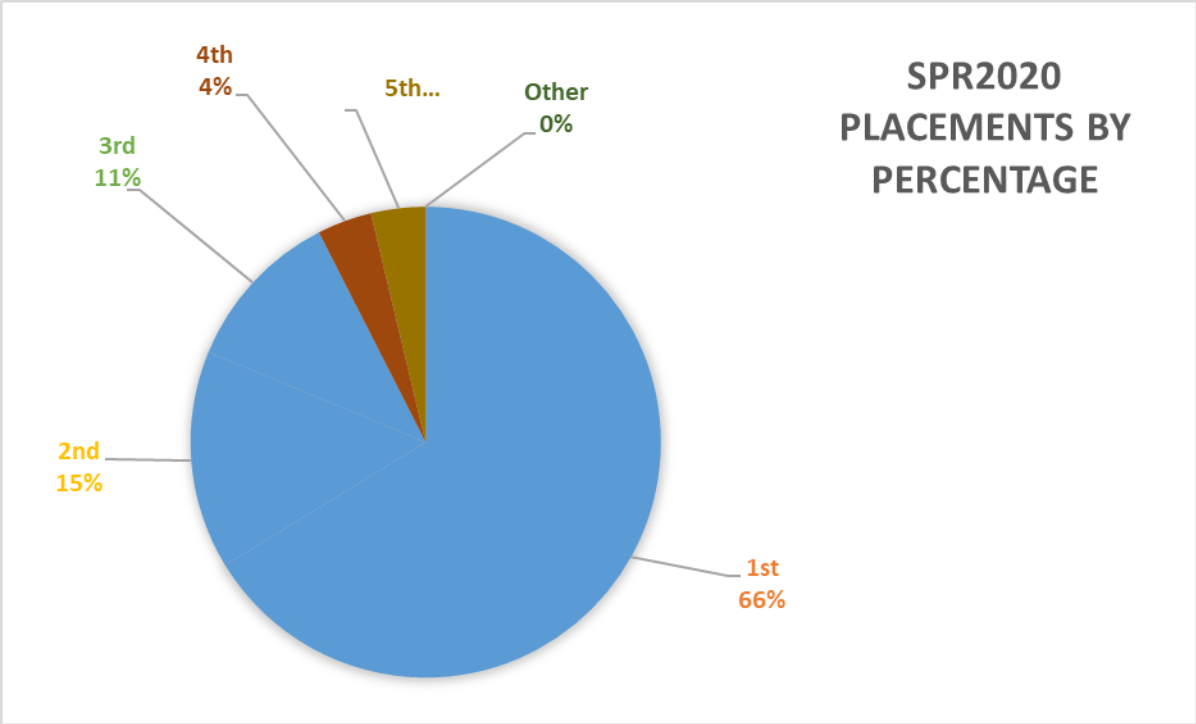
Students are surveyed at the beginning of the term for their project's ideas (students are encouraged to recruit others interested).

Students are then surveyed for their top 5 picks, areas of interests, and a short narrative for their top 3 of 5 projects

Rarely go outside of their top 3 picks.

How are projects and teams chosen?

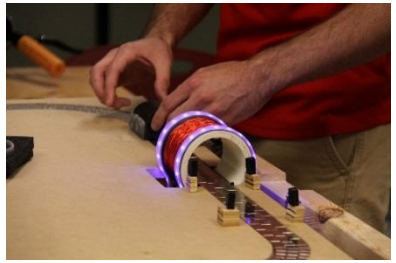


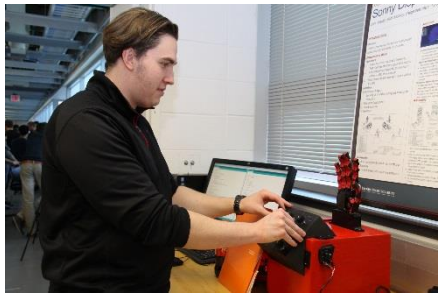


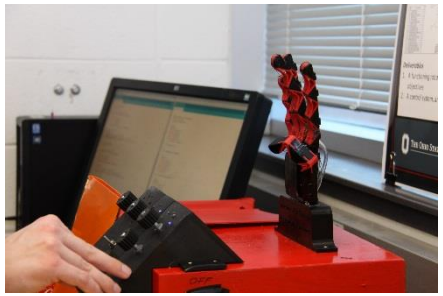
How are projects and teams chosen?

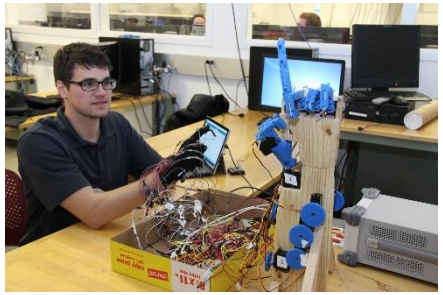
Team sizes:

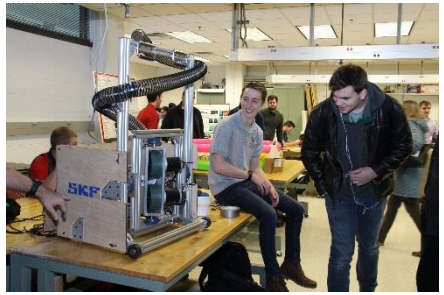
- 4 to 6 Generally
- Projects that can be split into multi-subsystem projects 6-10, with multiple sub teams.

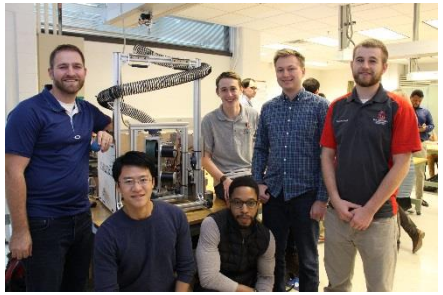


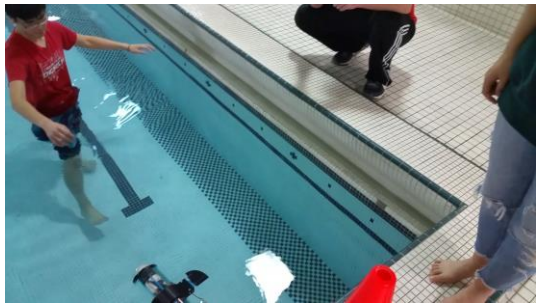


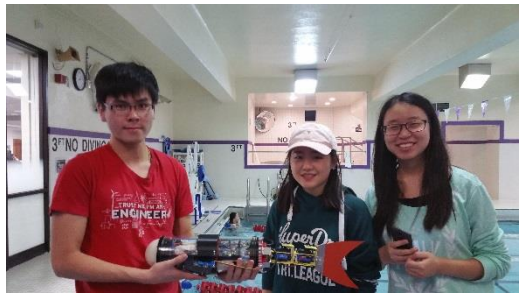





SKF







KEY
BOLD = COMMUNITY PARTNER
☺ = STUDENT PROPOSED
GRAY = CAPSTONE SPONSORED

Project Mix

AU2019 PROJECTS

- **(** MAE: **) Design, Prototyping, and Testing of a Robotic Prosthetic Hand with a Variable Stiffness**
- **(** MAE **) Solid State Battery Compression Tooling**
- **(** Honda **) Wrap Guard Equipment**
- **(** HRST **) Access Door Upgrades to Improve Sealing Reliability ☺**
- **(**Caterpillar**) OSU Caterpillar 2019 Will-Fit Fuel Injector Study ☺**
- **(** Honda **) Stamping Blank Destack Feeder**
- **(** Honda **) Stamping Die Augmented Reality**
- **(** Honda **) Parts Shipping Rack Strength Analysis**
- **(** Honda **) Die Casting Cooling System Analysis**
- **(** HRST **) Firing Duct Enhanced View Port Prototype Refinement and Testing ☺**
- Solar Water Purifier ☺
- Two axis inverted pendulum ☺
- Cable Driven Parallel Robotic Manipulator
- Fish Team: Docking Station

KEY
BOLD = COMMUNITY PARTNER
☺ = STUDENT PROPOSED
GRAY = CAPSTONE

Project Mix

AU2020 PROJECTS

- Climbing Rope Management System ☺
- **(** Design Outreach **) Wound Vacuum Pump ☺**
- Cam-less Engine Design ☺
- **(** NASA **) Lunar Excavator ☺**
- Gravity Battery System ☺
- Myoelectric Prosthetic for Quadriplegics - Mechanical Prosthetic ☺
- Autonomous QB ☺
- Myoelectric Prosthetic for Quadriplegics - Interface and Controls ☺
- **(** NSBE **) Project Arusha Rover Deployable Medical Workstation**
- **(** MAE **) Develop a Prototype 3D Printer**
- **(** MAE **) Design, Prototyping, and Testing of a Robotic Prosthetic Hand: Compact Joint Design**
- Inclusive Science - An Interactive Experience for Disabled Explorers ☺
- **(** MAE **) The Fine Motor Skills Project**
- Fish Team
- Coffee Roaster
- Multi-Mode Drone

Appendices

- Project History

KEY
BOLD = COMMUNITY PARTNER
☺ = STUDENT PROPOSED
GRAY = CAPSTONE SPONSORED

Project Mix

SPR2019 PROJECTS

- Anti-lock System Braking for Bicycles ☺
- **Auto Guardian**
- Autonomous Chess Board ☺
- Autonomous Lawnmower
- Autonomous Quarter Back ☺
- Cam-less Engine Design ☺
- Carbon Fiber Formula SAE Wheels ☺
- **Coffee Roaster**
- **Design Outreach Water Insecurity Solutions** ☺
- Develop a Prototype 3D Printer
- **Drive Ohio**
- Electric Riding Lawnmower ☺
- Fish Team - Platform
- Multi-Mode Drone
- **Project Arusha Rover Deployable Medical Workstation**
- Robotic Instrument - Reed Organ ☺
- ***Tackling Human Mobility*** ☺
- The Help-Me Device ☺

KEY
BOLD = COMMUNITY PARTNER
☺ = STUDENT PROPOSED
GRAY = CAPSTONE SPONSORED

Project Mix

AU2018 PROJECTS

- Cable Driven Parallel Robotic Manipulator
- Develop a Prototype 3D Printer
- Fish Team: Platform Development
- Haptic Feedback System
- **Honda: Brake Fill System Study**
- **Honda: NSX Paint Skid Cleaner**
- **Honda: Overhead Side Panel Carrier**
- **Honda: Overspray Collection System**
- **Honda: Paint Heat Recovery**
- **HRST: Duct Burner View Port Enhancement**
- **The Timken Company: Bearing Assembly Cycle Time Reduction**
- Truing Machine for Bicycle Wheels

KEY
BOLD = COMMUNITY PARTNER
☺ = STUDENT PROPOSED
GRAY = CAPSTONE SPONSORED

Project Mix

AU2017 PROJECTS

- **Honda: Brake Fill Study**
- **Honda: NSX Super Carrier**
- Burning Man Vehicle
- Cable Driven Robot
- Coffee Roaster
- Drone Constraint & Control
- Fish Team: Platform Development
- Make a Model Hand: Force Feedback
- Robotic Guitar
- Strandbeest: Multi-team Project
- Foot Pressure Monitoring Device
- *Silverware Roller* ☺

SPR2018 PROJECTS

- Automated Lawnmower: Platform Development
- *Autonomous Shuttle* ☺
- *Bicycle Automatic Transmission* ☺
- *Campus Personal Transport System* ☺
- Fish Team: Docking Station
- Fish Team: Platform Development
- Foot Pressure Monitoring Device
- Regenerative Braking - Mechanical Regeneration (Bicycle)
- Robotic |: Instrument:|
- *The Hockey Defensive Robot* ☺
- *Zenith Directional Heading of Multistage Rocket* ☺