ENGINEERING DESIGN DAY

MAY 3, 2016 – FROM CONCEPT TO REALITY

THE UNIVERSITY OF ARIZONA
College of Engineering

INTERDISCIPLINARY ENGINEERING DESIGN PROGRAM

Showcasing innovative, real-world senior projects by UA engineering student teams working directly with professional sponsors and mentors

engineeringclinic.arizona.edu

AN INDUSTRY | UNIVERSITY PARTNERSHIP

ENGINEERING DESIGN DAY 2016

Sponsored by the University of Arizona College of Engineering

Sign on Now for a Design Project Sponsorship ▸▸▸

UA Engineering Design Project sponsorships provide low-cost, low-risk opportunities to:

- Explore new technologies
- Bring back-burner projects to life
- Try out potential employees
- Take advantage of faculty expertise
- Access University resources
- Help students experience the world of engineering

Design or manufacturing projects are 1,000 hours in scope and occur over an academic year (August 2016-May 2017). Contact us by June 30, 2016 to work out the details for project sponsorship.

"I thoroughly enjoyed working with the Senior Design team and I am impressed by the quantity and quality of the details in modeling as well as the analysis. The team showed a good understanding of how a design/development project works — requirements, design and risks are all accounted for."

— Randy Firor, Senior Principal Systems Engineer, Raytheon

Be a Part of Something Big... Sponsor Design Day 2017, Where It All Comes Together!

Supporting events and awards for Design Day, the best Engineering event of the year, expands your company's visibility and helps increase the pool of qualified engineers.

Contact Ara Arabyan at 520.621.2116 or arabyan@email.arizona.edu today for more information.

THE UNIVERSITY OF ARIZONA
College of Engineering

College of Engineering
Office of the Dean
Civil Engineering Building #72

P. O. Box 210072
Tucson, AZ 85721-0072
(520) 621-6594
FAX: (520) 621-2232

May 3, 2016

Welcome to the 14th Annual Engineering Design Day!

This is the best day of the academic year! This is the day when we show the world how engineers design solutions to societal problems and improve the quality of life.

In the Engineering Design Program at the University of Arizona, multidisciplinary teams of Engineering seniors work to solve design problems identified by industry partners, faculty and student clubs.

This event only exists because of the hard work of students, mentors, faculty, and, importantly, the many individuals and organizations that sponsor projects and help mentor and guide our student teams. On behalf of our students and faculty, thank you to all of our sponsors and industry partners. It is because of you the program continues to get bigger and better every year.

This year we have more than 500 students, majoring in every engineering discipline offered by the College of Engineering, demonstrating 100-plus completely original engineering projects, some of which will go on to be commercial products. Please enjoy the day and ask design teams about their projects. Our students are enthusiastic about their designs and appreciate opportunities to explain how they intend to help change the world for the better.

Sincerely,

Jeffrey B. Goldberg
Dean, College of Engineering

TABLE OF CONTENTS

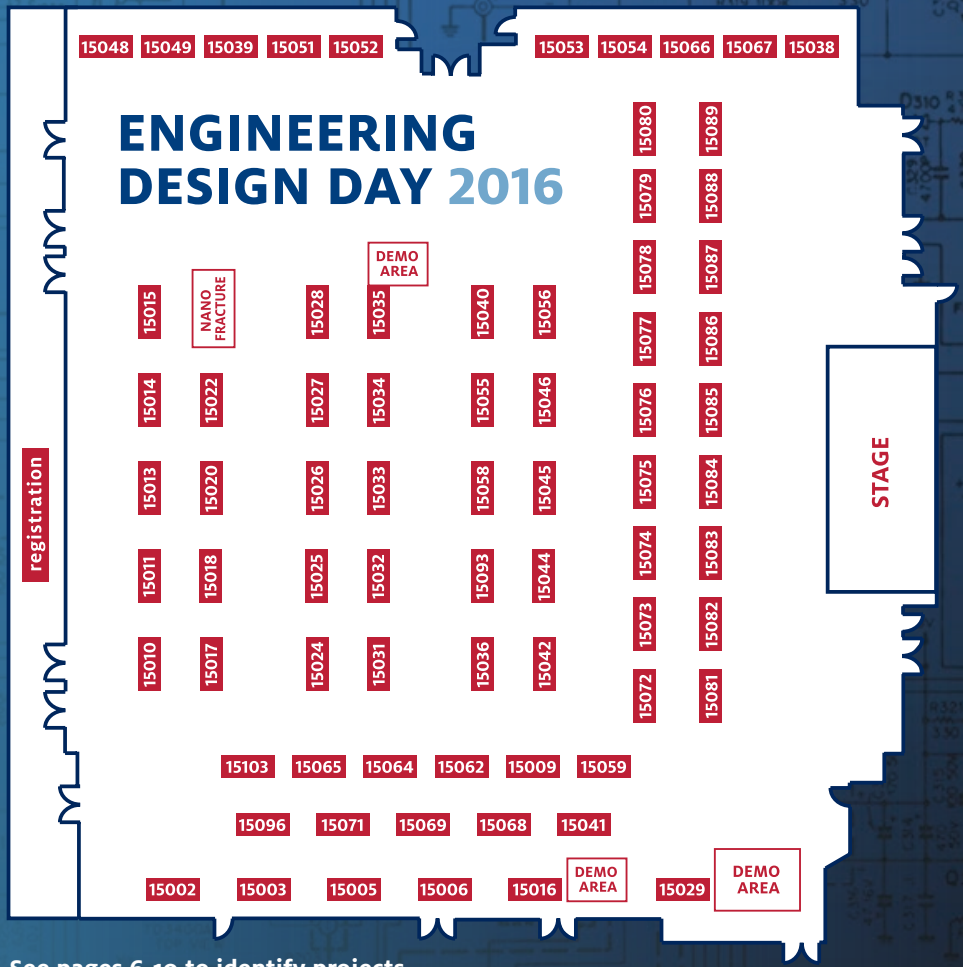
Engineering Design Day 2016

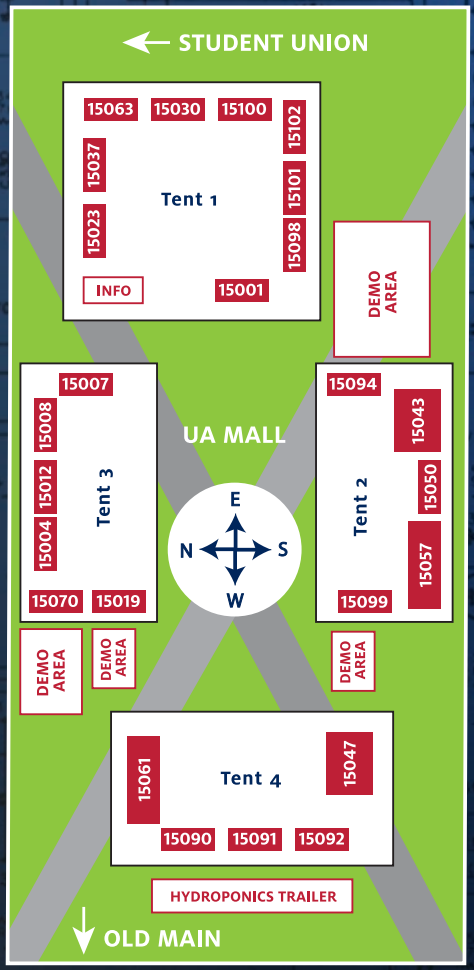
ENGINEERING DESIGN DAY EVENT SCHEDULE MAY 3, 2016

9 – 11 a.m.	Project Demonstrations for Judges	**12:30 – 2:30 p.m.**	Award Judging
11 a.m.	Design Day Open to Public	**4 – 5:30 p.m.**	Awards Ceremony

Projects will be in the Student Union Memorial Center Grand Ballroom and on the UA Mall south of the Student Union. The awards ceremony will be held in the Student Union Ballroom.

ENGINEERING DESIGN DAY 2016





See pages 6-10 to identify projects.

2016 LIST OF PROJECTS DISPLAYED

See map on page 5 to locate project tables

Interdisciplinary Engineering Design Program

Page	Team#	Project Title
20	15001	ASME Human-Powered Vehicle
21	15002	Ambient Embedded Intelligence for Assisted Living
22	15003	Dynamic Pressure Polishing Head
23	15004	Target-Location System
24	15005	Butterfly Valve Torque Shaping
25	15006	Plug and Play Mini-Infrared Camera
26	15007	Automated Rescue Launch Canister System for EMILY
27	15008	Sonar Module Integration For EMILY Rescue Robot
28	15009	Automatic Sticker Machine for Pit Stop Planning
29	15010	Turbine Disc Cavity Purge Flow Sealing Effectiveness
30	15011	Alignment System for a Miniature Echelle Spectrometer
31	15012	Formula Racecar Corner Assembly
32	15013	Polarimeter for Ice Detection
33	15014	Demand Control Ventilation Communication System
34	15015	Robotic Laboratory for Distance Education
35	15016	Autonomous Vehicle Navigation Testbed
36	15017	Autonomous Indoor Mapping System
37	15018	Wearable Wireless Body Area Network
38	15019	Stabilized Helicopter Landing Platform
39	15020	Inkjet-Printed Antennas for Wireless Communication
40	15022	Entry-Level Crossbow Design
41	15023	Energy-Harvesting Power Supply
42	15024	Nasogastric Tube Placement Verification System

(continued) # 2016 LIST OF PROJECTS DISPLAYED

See map on page 5 to locate project tables

Interdisciplinary Engineering Design Program

Page	Team#	Project Title
43	15025	Mobile Controllers for Naval Robotic Systems
44	15026	Robotic Knee Extension Simulator
45	15027	Soft Material 3-D Printer
46	15028	SensorBall
47	15029	Laser-Based Forward Collision-Prevention System
48	15030	Water Processing and Cleaning for Reuse
49	15031	Microfluidic-Based Human Lung Model
50	15032	Cloud-Connected Athletic Heart Rate Monitor
51	15033	Extreme Thermal Complex Geometry Ceramics
52	15034	Nerve Stimulator to Reduce Spasticity
53	15035	Augmented Reality Spacecraft Assembly
54	15036	Humidity Control in Space Suits
55	15037	Medical Device Tubing Measuring and Cutting Apparatus
56	15038	Slide Handling and Retention Apparatus
57	15039	High-Throughput Curing Oven
58	15040	On-Slide Reagent Concentration Feedback and Control
59	15041	Autonomous Aerial Tracking of a Herd of Ground Robots
60	15042	Microwaves and Ultrasound for Image-Guided Therapy
61	15043	Toilet Leak and Flood Prevention
62	15044	Deep Water Sensor System
63	15045	Containment Structures for Rotor Failure in Auxiliary Power Units
64	15046	Printed Circuit Boards for High-Power Transformer Windings
65	15047	In-line Swirl Particle Separator

(continued) # 2016 LIST OF PROJECTS DISPLAYED

See map on page 5 to locate project tables

Interdisciplinary Engineering Design Program

Page	Team#	Project Title
66	15048	Mechanically Optimized Composite Perforated Acoustic Panel
67	15049	Commercial Smoke Detector as an Aircraft Cabin Particle Sensor
68	15050	Aircraft Engine Bleed Air Contamination Detection System
69	15051	Thermomechanical Fatigue Testing System
70	15052	Caterpillar Machine Controls Electronic Testing Device
71	15053	Metal Surface Quality Characterization
72	15054	Direct Metal Laser Sintering Temperature Mapping
73	15055	Industrial Monitoring Sensors for Machinery and Systems Troubleshooting
74	15056	Performance Tools for Evaluating Microelectromechanical System Sensors
75	15057	Design of a Launch and Capture System for Small Unmanned Aerial Vehicles
76	15058	Feasibility Study of Alternative Cooling Technologies
77	15059	Liqua-Telecentric Autofocusing System
78	15061	Temperature Testing System for Buried Gas Pipes
79	15062	Manufacturing Virtual Companion
80	15063	Multipurpose Robotic Manufacturing Cell
81	15064	Optics for Aircraft Situational Awareness
82	15065	Commercial-off-the-Shelf Infrastructure for A 1U CubeSat
83	15066	Wireless Lighting for Aircraft Sliding Screens
84	15067	Storing TV Monitor in Super First Class Suite
85	15068	Wearable Virtual Reality Camera
86	15069	Defibrillator ECG Acquisition and Analysis

(continued) # 2016 LIST OF PROJECTS DISPLAYED

See map on page 5 to locate project tables

87	15070	Unmanned Aerial Vehicle Payload Optimization
88	15071	Portable Manual External Defibrillator: Shock Control and Function
89	15072	Removal of Biological Oxygen Demand & Metal Ions in Dairy Processing Wastewater

Chemical and Environmental Engineering

Page	Team#	Project Title
90	15073	Smart Glass Manufacturing and Photobioreactor Design
91	15074	Self-Healing Concrete
92	15075	Sustainable Microbrewery
93	15076	Distillation of Methyl Ethyl Ketone from an Industrial Waste Stream
94	15077	Helium Extraction From Carbon-Dioxide-Rich Pipelines
95	15078	Hazardous Compound Disinfection Truck Design
96	15079	Process Improvement to Minimize Fractures in Water-Soluble Mandrels
97	15080	Lithium Carbonate Extraction From McDermitt Clay
98	15081	Hydrodesulfurization of Diesel Fuel to Meet New EPA Requirements
99	15082	Refrigerant Replacement for the University of Arizona's Central Cooling System
100	15083	Solar-Powered Whiskey Still
101	15084	Biodiesel Glycerin Fraction Separations
102	15085	Membrane Distillation as an Industrial-Scale Process
103	15086	Ethanol Plant Repurposing
104	15087	Industrial Transesterification of Cultivated Algae for Biofuel
105	15088	Manufacturing of Material-Based Hydrogen Fuel for Lightweight Vehicles
106	15089	Vacuum Impregnation of Chip Capacitors for the Reduction of Water Corrosion

(continued) # 2016 LIST OF PROJECTS DISPLAYED

See map on page 5 to locate project tables

Agricultural and Biosystems Engineering

Page	Team#	Project Title
107	15090	Controlled Environment for Plant Production
108	15091	Irrigation Infrastructure
109	15092	Controlled Environment for Mushroom Production
110	15093	Optically-Paired Microfluidics for E. coli Detection
111	15094	Macadamia Nut Harvester

Civil Engineering and Engineering Mechanics

Page	Team#	Project Title
112	15096	Vincent Mullins Landfill Bridge

Aerospace Engineering

Page	Team#	Project Title
113	15098	X-56A Aeroelastically Scaled Modular Aircraft for Research
114	15099	Unmanned Aerial Vehicle Test Bed for Control Theory Implementation
115	15100	Design/Build/Fly Aircraft Design Competition
116	15101	Aileron Droop Mechanism for the Clipper Spirit Seaplane
117	15102	Red Cactus Wildlife Vertical Takeoff and Landing Unmanned Aircraft System

Mining and Geological Engineering

Page	Team#	Project Title
118	15103	Haul Truck Upgrade Feasibility Study for an Open-Pit Peruvian Copper Mine

(continued) **AWARDS**

Engineering Design Day 2016

Raytheon Award for Best Overall Design ($2,000)

While several designs may meet the judging criteria, this award is given to the design that does so the most effectively. The project that receives this award excels in many ways. The design is well thought out and its implementation is of high quality. It accomplishes all key design requirements and is supported by rigorous analysis and testing. Its poster and presentation are professional and easy to understand.

Bly Family Award for Innovation in Energy Production, Supply or Use (1st prize $1,500; 2nd prize $500)

This award recognizes the best project related to sustainable, cost-effective and environmentally friendly energy production, distribution or use. Winning projects could focus on developing new energy sources, reducing energy costs, improving efficiency or reducing cost of energy distribution, adapting existing energy distribution methods to better integrate new energy sources, and increasing efficiency of energy use.

Thorlabs Photonics is the Future Award ($250 per person up to $1750)

This award recognizes the most innovative use of optoelectronics and optomechanics in a design.

(continued) **AWARDS**

Engineering Design Day 2016

Rincon Research Award for Best Presentation ($1,000)

This award reflects the quality of the overall verbal and poster presentations. Verbal presentations should be well structured to describe efficiently the overall problem being solved and the specifics of how the team accomplished its design. Answers to questions should be direct and demonstrate mastery of the project. Presenters should speak in a clear and easily audible voice, making good eye contact with the judges. The poster board should be visually interesting, and graphically well organized to tell a standalone story of the project.

Texas Instruments Analog Design Contest Award ($1,000)

Regardless of whether a design project is sponsored, who is sponsoring it, or what is being designed, analog integrated circuits are often required. Teams using three or more TI analog ICs in their designs are invited to enter the TI Analog Design Contest. Projects are judged on originality of design, quality of design, creativity of design, level of engineering analysis, and a written description of how each TI analog chip benefited the design.

Ventana Award for Innovation in Engineering ($1,000)

Innovation may include the novel use of existing components or the creation of entirely new components to meet customer requirements. The most innovative design is not only a creative solution to a problem but also an effective solution that is well implemented. This award recognizes the team that has created or made use of components in the most innovative way, or demonstrated excellence in the implementation of innovative design in its project, or both.

(continued) **AWARDS**

Engineering Design Day 2016

ACSS/L-3 Communications Award for Most Robust Systems Engineering ($750)

This award goes to the team that most robustly addresses all aspects of the project from the systems perspective. Criteria include requirements capture and flow down, technical risk identification and mitigation, manufacturability, integration and test plan. Judges look holistically at the program to determine overall effectiveness of the systems process.

Arizona Technology Council Foundation Award for Innovation in Manufacturing ($750)

This award is given to the team that displays the most innovative new or modified manufacturing method. Projects could include introducing a new technique for manufacturing, an innovative use of an existing technique, or new techniques that significantly reduce the cost of manufacturing and improve the quality of the product.

Edmund Optics Award for Perseverance and Recovery ($750)

Issues and roadblocks always occur during the engineering design process. Although they cause panic and distress, they also represent great opportunities to learn and often lead to designs that would otherwise be impossible to conceive. This award recognizes a team's ability to learn and to overcome issues or roadblocks encountered during the design process. The award is judged based on the ingenuity of solutions to problems caused by issues or roadblocks and the features in the final design that contribute to recovery from them.

(continued) **AWARDS**

Engineering Design Day 2016

W.L. Gore and Associates Award for Most Creative Solution ($750)

This award honors the student team that has implemented a unique and creative solution within its project. It recognizes outside-the-box thinking that pushes boundaries and hands-on approaches to creative solutions. Projects are judged on the elegance and creativity of the technical solutions and their implementation. Teams should be able to communicate effectively their design and the processes they use for creativity.

Phoenix Analysis & Design Technologies Award for Best Use of Prototyping ($750)

This award goes to the team that best uses a physical prototype model to understand and study the fit, form and function of the device or system designed. Teams are judged on the appropriateness of the prototyping technology used, how effectively prototyping is used to improve design, and how effectively the use of prototyping is communicated. Prototypes can be made using rapid fabrication technology, traditional manufacturing, or can be hand built.

Arizona Technology Council Foundation Award for Best Engineering Analysis ($750)

This award recognizes the team with the strongest strategy, implementation and documentation of analyses supporting its design. Analyses vary from project to project, but may include market research and analysis, analysis of prior solutions to the design problem posed, trade studies that justify the final design selected from alternatives considered, system modeling to demonstrate that the final design is sound and should perform as desired, analysis of potential reasons for

(continued) **AWARDS**

Engineering Design Day 2016

failure and a mitigation plan, and economic or other analysis of the benefits of the final design in its intended application. Criteria for judging include the completeness of the project analysis based on the above categories, thoroughness of the analyses, application of sound engineering principles and practice, a demonstrated understanding by team members of any tools or models used, reasonableness of all assumptions, and the quality of the documentation of the analyses.

RBC Sargent Aerospace & Defense Voltaire Design Award ($750)

The French philosopher Voltaire is credited with the saying "Le mieux est l'ennemi du bien," which means "the best is the enemy of the good." Similarly, Leonardo da Vinci is credited with the saying "Simplicity is the ultimate sophistication." This award recognizes the design team that best emulates these ideals and resists the temptation to overly complicate the design to yield a clean, simple, elegant, lowest-cost design that simply works well.

Technical Documentation Consultants of Arizona Award for Best Design Documentation ($750)

Successful implementation of any innovative design requires that all members of the design and production team communicate effectively. Design intent must be communicated from the design activity to the rest of the team using design documentation with a clear map for others to reproduce the design based on documentation only. The mechanical portion of the design is evaluated on the use of drawings with geometric dimensioning and tolerancing, solids models, illustrations and presentations that can be used to manufacture and inspect design hardware. Software and other systems are evaluated on the use of documentation that clearly and fully describes the system.

(continued) **AWARDS**

Engineering Design Day 2016

TRAX International Award for Best Implementation of Agile Methodology ($750)

The design project is executed using a flexible and incremental approach. Final project outcome is achieved through several test and evaluation iterations in collaboration with the customer. The project team should continuously review and assess results, and quickly adapt to any changes or problems encountered.

Dataforth Corporation Award for Best Design Using a Data Acquisition and Control System ($500)

This award recognizes the design team that best implements a modern data acquisition and control system. Recognition is given for the use of the system to collect data that characterizes project performance and assists in project optimization and, ideally, uses the same data acquisition system to perform feedback and control operations.

Honeywell Award for Team Leadership (two individuals at $250 each)

This award recognizes students who best exemplify teamwork skills, including the ability to work cooperatively with others to produce high-quality work, to take the initiative, to support and respect the opinions of fellow team members, to give and receive feedback, to demonstrate effective leadership, to keep their team focused, and to elevate the work of their fellow team members. Nominees for this award are selected by their teammates.

(continued) **AWARDS**

Engineering Design Day 2016

II-VI Optical Systems Award for Best Use of Optical Design and Technology ($500)

This award is given to the team that demonstrates the most thorough approach to the design and engineering of its optical system. This award recognizes complete understandings of the optical design, system requirements, tolerance analysis, and optical component usage. Important criteria are integration of optics into the overall system, novel use of optical components, creative use of commercial off-the-shelf items, verification of optical components, meeting system requirements, use of standard optical design software, and manufacturability of optical design and components.

Latitude Engineering Award for Best Physical Implementation of Analytically Driven Design ($500)

Some engineering problems are straightforward: optimal solutions are found through the application of engineering best practices. Sometimes, however, the best design choices are not obvious, and only reveal themselves after a thorough analysis of the underlying physical principles. This award recognizes a design that could only have been arrived at after careful study and creative application of physics.

(continued) **AWARDS**

Engineering Design Day 2016

Prototron Circuits Award for Best Printed Circuit Design ($500)

This award recognizes the team that has designed or used the most elegant and efficient electronic circuits in its project. Priority is given to best PCB designs or applications. Originality and manufacturability of the design are key criteria in selecting the winning team. Any team that has used circuitry in its project is eligible for consideration. In the absence of any original designs, the originality of the use of off-the-shelf products and the manufacturability of the overall design are used as selection criteria.

Honeywell Award for Excellence in Aerospace Electronic System Design ($400)

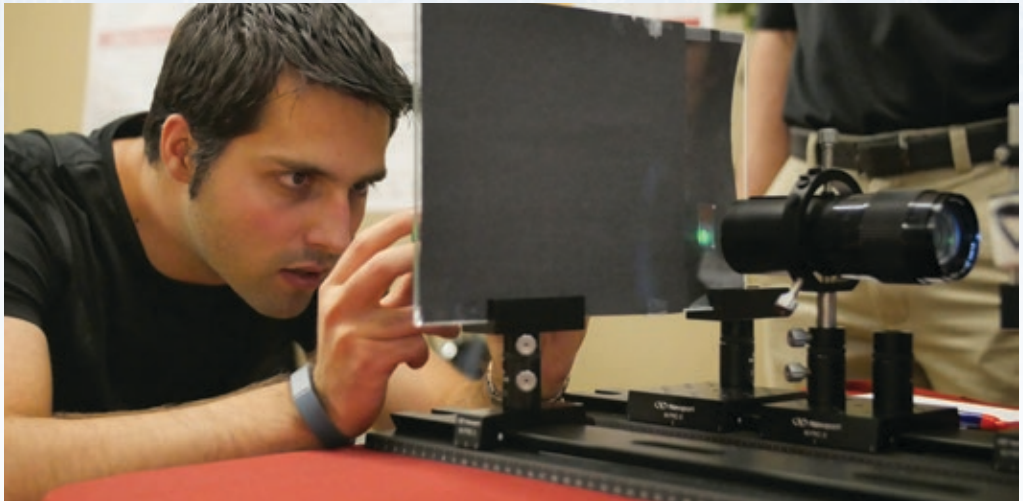
This award recognizes excellence in overall system design in a project that has an aerospace emphasis. Verbal presentations should be well structured to describe effectively the overall system and the specifics of how the team implemented its design project. A key feature of the presentation must be representative data that demonstrate how the system was thoroughly tested. Answers to questions should be direct and demonstrate a high level of team competency about the details of the electronic system for the project. The presentation should be shared among all members, displaying core values of teamwork and gracious professionalism.

(continued) **AWARDS**

Engineering Design Day 2016

Kristy Pearson Fish Out of Water Award (1st prize $250; 2nd prize $150)

The Fish Out of Water award congratulates students for successfully accomplishing a task that was not in their realm of expertise. The projects for senior design require skills from many disciplines, and students must sometimes learn a new subject or skill in an area outside of their major to help the team succeed. A student who not only learns this new subject or skill, but also uses it to effectively help the team thrive, shows dedication and initiative, traits that will continue to help in an engineering career.



ASME HUMAN-POWERED VEHICLE

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA American Society of Mechanical Engineers Student Chapter

Sponsor Mentor/Advisor

Dustin Huynh

Project Mentor

Clayton Grantham

Team Members

Christian-Gardner Kanekaualehua Brown (SE)
Kyle Timothy Daughenbaugh (ME)
Dustin Huynh (ME)
David Leister (ME)
Maurissa Nicole Wortham (ME)
Kaishen Xu (ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15001 ▸ PROJECT SUMMARY

The goal of this project is to design and build sustainable, practical, and competitive transportation alternatives called human-powered vehicles. These vehicles commonly consist of a recumbent-style frame, traditional bicycle drivetrain, and an aerodynamic full fairing or shell. The frame must be lightweight and economical. The frame determines the critical loading points needed to integrate the drivetrain and fairing components and was completed first. Like modern bicycles the drivetrain was designed with different gear ratios to allow for a wide range of speeds, topping out at more than 50 miles per hour. The final component is the fairing, which must not exceed the customer's desired maximum weight of 60 pounds. Another key feature of the fairing is the roll-protection system that protects the driver in the event of a rollover. Other features, such as lights, mirrors, and a parcel compartment, were installed to provide a safer, more comfortable commute. The team competed in the annual American Society of Mechanical Engineers Human Powered Vehicle Challenge to test the practicality, speed, design, and durability of the vehicle.

AMBIENT EMBEDDED INTELLIGENCE FOR ASSISTED LIVING

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

The Western Design Center Inc.

Sponsor Mentor/Advisor

David Cramer, David Gray, Bill Mensch

Project Mentor

Ivar Sanders

Team Members

Kendall Anne Carpenter	(BME)
Luis Hernandez	(ECE)
Bethany Ann Langdon	(BME)
Melissa T. Lee	(BME)
Reine M. Mager	(BME)
Erik Traulsen	(SE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
SE = Systems Engineering

TEAM 15002 ▸ PROJECT SUMMARY

The main objectives of this project are to develop a prototype of a device for use by people in need of assisted living, and to develop a lesson plan for elementary, middle, and high school students that sparks their interest in STEM fields. The team designed a device that uses Western Design Center's standard chip Xxcelr8r board, or SXB, to coordinate an IMU with a smartphone application. The device detects falls and conveniently displays the information on a smartphone. Device components are held in a case produced by 3-D printing, which can be kept on the user's hip along with a holder for the smartphone. The smartphone application can analyze data received from the device components and send an emergency message to designated recipients.

DYNAMIC PRESSURE POLISHING HEAD

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

PACE Technologies

Sponsor Mentor/Advisor

Don Zipperian

Project Mentor

Mike Nofziger

Team Members

Aiman Aween	(ME)
John Codde	(ME)
Paul Michael Cross	(ECE)
Hieu Luong	(SE)
Krysta Rhiann Pavlica	(OSE)
Moses Mucai Wangusi	(MSE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15003 ▸ PROJECT SUMMARY

The team was asked to deliver a dynamic polishing head that removes the need for an operator. The polishing device has a polishing head, a micro distance laser to sense deviations in the sample, a base and motors to hold the system and mechanically control the parts, and a microcontroller to interpret and act upon the data received from the laser sensor. The polishing head recognizes where a given sample has higher removal rates, and adjusts the polishing pressure accordingly to achieve the flattest possible surface. The prototype was built to the sample material's specifications, so the operator will only have to turn the machine on and off. This design will be a prototype that will allow PACE Technologies to evaluate the feasibility of running grinding and polishing machines without an operator.

TARGET-LOCATION SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

ACSS

Sponsor Mentor/Advisor

Christopher Correia, Robert McCullen, Benjamin Paulson

Project Mentor

Bob Messenger

Team Members

Mohammad K.A.S. Alrashed	(ME)
David Contreras	(ECE)
Ryan P. Grady	(SE)
Salomon Soumbey-Alley	(ECE)
Charles Musyoki Zakayo	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15004 ▸ PROJECT SUMMARY

Aircraft and air traffic controllers use Automatic Dependent Surveillance – Broadcast, or ADS-B, signals to prevent collisions and assist with general aviation. On January 1, 2020, all aircraft operating in the United States National Airspace System will be required to output ADS-B signals. The purpose of this project is to create a low-cost, lightweight transmitter that could be used to send ADS-B signals from any aircraft. Pairing the system with a smartphone would significantly reduce costs, so a secondary purpose of this project is to determine if an Android smartphone GPS is accurate enough to generate valid ADS-B signals. The design concept includes a modified microcontroller, a simple aerodynamic device capable of holding the electronics, and an Android smartphone. The device includes a shelf for the smartphone, a slot for the 9-volt battery, and a shelf to house the system's electronic components. The system is small and versatile enough to be attached to a drone or weather balloon, or placed anywhere in an aircraft cockpit.

BUTTERFLY VALVE TORQUE SHAPING

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Darrell Horner

Project Mentor

Frank Oliver

Team Members

Sarah Caro	(SE)
Guangji Chen	(ME)
Jesus Del Rincon	(ME)
Kevin Thomas Gilliam	(ECE)
Tyler Mead James	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15005 ▸ PROJECT SUMMARY

The project's objective is to design, analyze, and test a butterfly outflow valve that is aerodynamically loaded when closed. Air inside a pressurized cabin circulates constantly and new air must be cycled in to maintain oxygen levels, but adding more air to a fixed cabin volume increases cabin pressure. The butterfly outflow valve maintains cabin pressure by allowing air to flow out of the cabin to the atmosphere. Pressure on the valve plate at some opening angles causes valves as currently designed to be aerodynamically loaded when open, which means the valve would stay open, causing a loss of cabin pressure, should an actuator or other system fail. Redesigning the valve plate to be aerodynamically loaded when closed means that pressure across the valve plate keeps the valve closed in the event of a failure, thus avoiding sudden loss of cabin pressure.

PLUG AND PLAY MINI-INFRARED CAMERA

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Control Vision Inc.

Sponsor Mentor/Advisor

Dan Crawford

Project Mentor

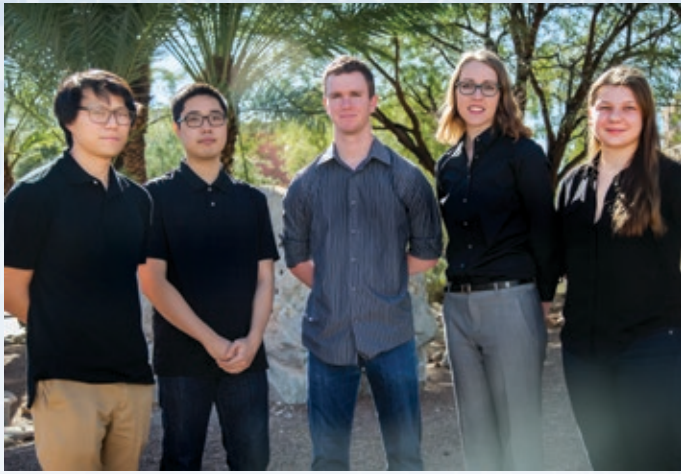
Gary Redford

Team Members

Gabrielle Marie Debbins	(AE)
Matthew Foley	(SE)
Emily Hunting	(OSE)
Stephen Nguyen	(ECE)
Julian Kyung sup Yi	(ECE)

AE = Aerospace Engineering
ECE = Electrical & Computer Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15006 ▸ PROJECT SUMMARY



This project requires the team to design and assemble a low-cost plug-and-play mini-infrared camera with a protective mechanical package. The sponsor provided the team with the FLIR Lepton IR sensor for the integration. With a resolution of 80x60 pixels, the FLIR Lepton is the world's smallest thermal imager, but no USB interface and protective mechanical package are currently on the market. The team designed the electrical hardware, waterproof mechanical housing, and graphical user interface. Mounting holes were included in the housing to allow use with stationary and mobile devices. The camera system interfaces via USB to a Windows or Linux computer for power and user interface. The graphical user interface allows the user to capture and store snapshot images and videos. Applications for the product range from search and rescue missions to night vision for cyclists.

AUTOMATED RESCUE LAUNCH CANISTER SYSTEM FOR EMILY

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Hydronalix

Sponsor Mentor/Advisor

Daniel Okiyama

Project Mentor

Gregory E. Ogden

Team Members

Benjamin Bailey Bell	(ME)
Joseph Lamont	(ME)
Kevin Morris	(ECE)
Devin John Slack	(ECE)
Colton Thomas Sviba	(SE)
Benjamin Joseph Yates	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15007 ▸ PROJECT SUMMARY

The EMILY rescue boat is currently deployed manually using a handheld remote control. The team's objective is to automate the detection, deployment, and guidance of the boat in the vicinity of a coastal pier. The self-contained system will assist rescue personnel in unmanned waters or when visibility is low. The system also helps with ergonomics because throwing a 25-pound boat from a pier can be cumbersome. The design uses two infrared cameras on pan-tilt units that search the water in the desired target area. If image processing determines that someone is in the water, the lifeguard is alerted and the launch sequence initiated. Launch and control can also be conducted manually. The launch sequence extends actuators that hoist the enclosure from horizontal to the desired angle. The front door is opened, and the boat slides out on rollers. The navigation sequence assigns one camera to the person in the water and the other to EMILY. Steering and throttle commands are derived by comparing the coordinates of the person in the water with those of the boat. The system resets once EMILY reaches the person.

SONAR MODULE INTEGRATION FOR EMILY RESCUE ROBOT

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Hydronalix

Sponsor Mentor/Advisor

Jaime Lara

Project Mentor

Gregory E. Ogden

Team Members

Jeremy Burris	(SE)
Jordan McKinley Driggs	(ME)
Uriel Garcia	(ECE)
Matthew Sybrant	(SE)
Jessica Nell Vickers Toll	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15008 ▸ PROJECT SUMMARY

The goal of this project is to integrate a sonar system into the EMILY rescue boat, enabling it to conduct underwater scanning in search and recovery missions, such as finding submerged vehicles or searching low-visibility waterways that preclude diver assistance. The team chose a Humminbird sonar because of its wide use in rescue and military applications. Hydronalix requested that the team mount a front-facing waterproof camera on the boat to provide a real time video feed at water level. The sonar and camera were integrated into an adapted version of the boat's flotation cover. Live video and sonar feed can be controlled from at least 400 yards away, and boat operators can watch a live sonar feed on personal mobile devices via a downloadable Humminbird application.

AUTOMATIC STICKER MACHINE FOR PIT STOP PLANNING

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Raytheon Missile Systems

Sponsor Mentor/Advisor

Kevin Oxnam

Project Mentor

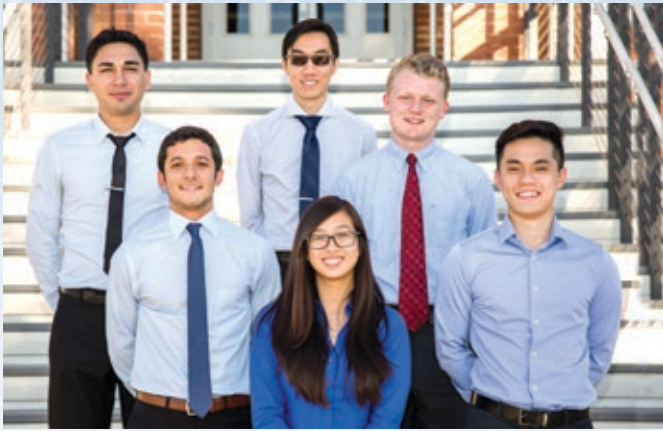
Doug May

Team Members

Erik Michael Baker	(SE)
David Hoang	(ME)
Patt Intarakamhang	(ME)
Alan Martin Lamadrid	(ME)
Matthew Linnaus	(ECE)
Lilly Truong	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15009 ▸ PROJECT SUMMARY



Raytheon's planning process, Pit Stop Planning, derives its name from motor racing because it requires all other work to pause so that planning can be focused on a specific program or project, enabling work to resume as quickly as possible. Pit Stop Planning, or PSP, allows teams to visualize the network of all tasks necessary to execute a program. Tasks and descriptions are printed on adhesive labels that are manually placed on various sizes of Post-it note. A typical PSP event requires several hundred stickers to cover the wide array of tasks associated with a program. Manually applying adhesive labels to sticky notes takes a lot of time for what is supposed to be a rapid process. This project's objective is to design a machine that automatically places printed labels on sticky notes while meeting specified size and speed requirements. A slider crank mechanism was designed to peel the label, which is then transferred to a four-bar mechanism combined with a cam that applies the label to the sticky note. An Arduino microcontroller was programmed to automate the process, incorporate an error module, and provide a user-friendly interface. At the conclusion of the project, the machine will be replicated and included in PSP kits used by Raytheon Company.

TURBINE DISC CAVITY PURGE FLOW SEALING EFFECTIVENESS

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Honeywell Aerospace

Sponsor Mentor/Advisor
Jacob Harding,
Alexander Mirzamoghadam

Project Mentor
Bob Messenger

Team Members

Ethan Samuel Beyak	(ME)
Daniel Jimming Chen	(SE)
Alex De La Rosa	(ME)
Guanghan Wu	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15010 ▸ PROJECT SUMMARY

The project sponsor asked the team to determine the mechanical changes necessary to improve the efficiency of a turbine engine. Turbines include a stationary disk with airfoils around its circumference, known as a stator with vanes, upstream of a concentric rotating disk, or rotor, also with airfoils around its circumference, and powered by an electric motor. The mainstream flow enters from the primary inlet and the purge flow enters via a cavity between the stator and rotor. The sealing effectiveness of the cavity is measured by two quantities: the pressure difference across the stator vanes to the rotor blades, and the temperature ratio of the mainstream and purge flows. The main independent mechanical variables that affect these two quantities are vane shape and angle, stator design, ratio of blades to vanes, blade shape and angle, and axial and radial gaps from the stator to the rotor. Changes in these variables were made one at a time and the effects measured by pressure taps and thermocouples across the stator. The data acquired was sent to multiple personal computers and MATLAB scripts were used to analyze the pressure pulses, temperature distribution, and the cavity resistance factor for each test run.

ALIGNMENT SYSTEM FOR A MINIATURE ECHELLE SPECTROMETER

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
UA College of Optical Sciences

Sponsor Mentor/Advisor
Russell Chipman

Project Mentor
Mike Nofziger

Team Members

Timothy Ebinger	(ECE)
Michael James Gardiner	(ME)
Kyle Solowiej Hawkins	(OSE)
Ethan T. Rickert	(SE)
Travis William Sawyer	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15011 ▸ PROJECT SUMMARY

The miniature echelle spectrometer, pioneered by Rigaku Analytic Devices in partnership with the University of Arizona College of Optical Sciences, provides high-resolution spectral analysis for laser-induced breakdown spectroscopy. Although miniaturizing the technology makes spectral analysis accessible to a wider range of applications, it also increases spectrometer alignment sensitivity. The design team was charged with designing an alignment interface and procedure to enable the efficient and accurate assembly of the spectrometer at a production scale. The design involves a complex mechanical interface, which provides a total of nine degrees of freedom across two optical elements. A digital interface is integrated with the mechanical assembly to provide access to computer-assisted alignment routines. The final procedure is designed to optimize the alignment time by targeting the most sensitive elements in series, preventing crosstalk between variables, and simplifying the high-dimensional challenge of aligning all nine degrees of freedom.

FORMULA RACECAR CORNER ASSEMBLY

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Society of Automotive Engineers Student Chapter

Sponsor Mentor/Advisor

Don Nguyen

Project Mentor

Gerald Pine

Team Members

Abdullah Haidar	(SE)
Joseph V. Mardesich	(ECE)
Don Nguyen	(MSE)
Brandon Michael Toland	(ME)
Parker Williams	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15012 ▸ PROJECT SUMMARY

The Formula SAE student competition challenges engineering and other university students from around the world to design, build, and compete with a single seat open-wheel racecar. This project focuses on the mechanical design of the vehicle corner assembly, which includes the wheel hub, upright, wheel bearings, brake rotor and caliper, wheel, and tire. Analysis of the physical forces, material capabilities and benefits, product choice, machining techniques, and system integration was critical during the design process. The assembly's design met the intended static and dynamic requirements of the vehicle and satisfied competition rules. The team used CAD software, primarily SolidWorks, to design and simulate the various parts of the assembly, and procured the resources to purchase, fabricate, and assemble the design.

POLARIMETER FOR ICE DETECTION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA College of Optical Sciences

Sponsor Mentor/Advisor

Russell Chipman, Stanley Pau

Project Mentor

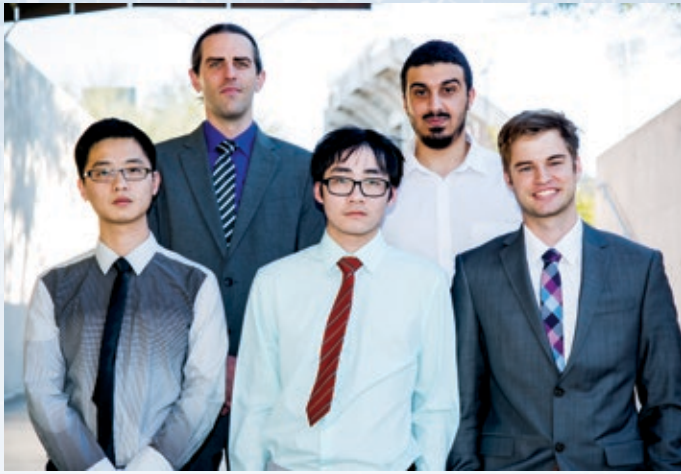
Gary Redford

Team Members

Sultan Saleh Alghufaili	(SE)
Jaden Robert Bankhead	(OSE)
Kevin Joseph Lin	(ECE)
Oliver Joshua Spires	(OSE)
Zhengting Wu	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15013 ▸ PROJECT SUMMARY



Black ice on road surfaces is nearly invisible to drivers and poses a significant safety hazard. Additionally, saline deicing fluid is often applied excessively, which is costly in terms of manpower and corrosion to infrastructure. The Polarization Lab in the College of Optical Sciences at the University of Arizona has completed preliminary laboratory research that suggests polarization may be an effective way to remotely detect ice on a road surface. The objective of this project is to develop a new instrument for gathering polarization data in the field. The completed system includes a full-Stokes imaging camera and a custom-designed near-infrared spotlight for irradiance at 760 nm. The associated software captures and processes a polarization image and makes a prediction about the state of the road surface. If data and results from this instrument support the preliminary research, deployment of polarimetric systems for ice detection could save lives and money.

DEMAND CONTROL VENTILATION COMMUNICATION SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Lightsense Technology

Sponsor Mentor/Advisor

Alan Kost

Project Mentor

Mike Nofziger

Team Members

Christina Lee	(BME)
Nicholas Paul Lyons	(OSE)
Stephannie S Okimura	(SE)
Phillip James Showers	(ECE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15014 ▸ PROJECT SUMMARY

The purpose of this project is to produce a more energy-efficient method of transmitting data from a carbon dioxide sensor to a receiver. In current configurations, carbon dioxide sensors send data via Wi-Fi to a controller connected to a heating, ventilating, and air conditioning unit, which processes the data and adjusts its output to condition the air. Wi-Fi power consumption decreases the battery life of the carbon dioxide sensor. The proposed design, which uses less power than Wi-Fi, is an optical communication system that transmits sensor data via light-emitting diode to a receiver that interprets the signal. The design borrows technology from existing infrared remote controls and modulates the LED signal, which results in a higher signal-to-noise ratio at a given power output. The electrical output of the sensor is modulated at 57.6 kHz, which is faster than typical infrared applications. The modulated LED then sends pulses at 940 nm toward a specialized receiver that filters this wavelength and driving frequency. The receiver decodes the data and displays the output on a viewing screen.

ROBOTIC LABORATORY FOR DISTANCE EDUCATION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA College of Optical Sciences

Sponsor Mentor/Advisor

Alan Kost

Project Mentor

Mike Nofziger

Team Members

Scott Appleby	(ME)
Ryan Kenneth Bergsma	(SE)
Kade Gigliotti	(ECE)
Timmy Hefferan	(OSE)
Kyle Walker	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15015 ▸ PROJECT SUMMARY

The project required the team to design and construct a remote laboratory experience. The system was designed to convey as much of the in-lab experience as possible by allowing the user to directly manipulate hardware and receive visual feedback in real time. The task chosen for the remote user is an optical engineering experiment: aligning a spatial filter. The team instrumented the physical laboratory with hardware, motors, cameras, and integrated software to allow a user at a remote location with an Internet connection to move the optical hardware and perform the experiment. Each degree of freedom in the experiment is motorized and accepts commands from a remote location. In addition, the online user interface provides visual feedback for the person performing the experiment so they can see what is happening and determine what to do next. These functions are coordinated by custom software and use microcontrollers and microprocessors. The remote user can learn important concepts from this experiment while connecting theory to the physical world by actually seeing the outcome of a procedure, a learning experience often lost in distance learning. The system also provides a laboratory experience for students taking online courses who may not have access to laboratory equipment.

AUTONOMOUS VEHICLE NAVIGATION TESTBED

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Aerospace and Mechanical Engineering

Sponsor Mentor/Advisor

David Gaylor

Project Mentor

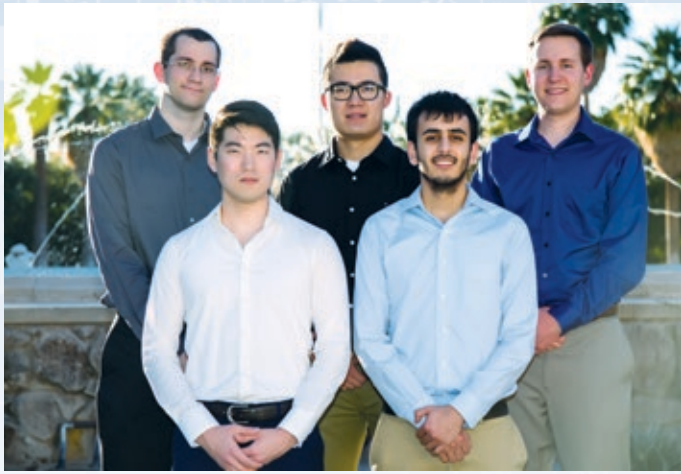
Frank Oliver

Team Members

Abdulaziz Mohammed S. Al Moaigel	(ME)
Matthew James Burger	(ECE)
Lindsey Skyler Carlson	(SE)
Junhwa Song	(ECE)
Bo Xiao	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15016 ▸ PROJECT SUMMARY



The team was asked to design an omnidirectional vehicle test bed and laboratory to enable faster and more cost-effective testing of autonomous vehicle navigation algorithms. Lab users can load algorithms into a microcomputer mounted on the vehicle, which is fitted with reflectors that allow infrared cameras to track its location. Algorithmic efficiency can be determined by comparing data from cameras with data from algorithms. An Xbox Kinect, inertial measurement unit, and six ultrasonic sensors provide information for the algorithm. Navigation calculations are performed on a Raspberry Pi 2, and an Arduino Zero is used to interface with sensors. Movable obstacles are placed in the testing area to allow users to custom build test scenarios. The test bed and laboratory have been designed with future expansion in mind. Subsequent projects could involve simultaneous use of multiple vehicles. The omnidirectional capability of the vehicle allows land- and space-based vehicle navigation algorithms to be tested.

AUTONOMOUS INDOOR MAPPING SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Electrical and Computer Engineering

Sponsor Mentor/Advisor

Michael Marcellin

Project Mentor

Ivar Sanders

Team Members

Xander Mitchell Deputy	(OSE)
Kevin Fox	(ECE)
Christopher J. Meyer	(SE)
Cody A. Mitts	(ME)
Jiaxiang Wang	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15017 ▸ PROJECT SUMMARY

The team's objective is to develop an autonomous platform that can map an indoor single-floor environment in two dimensions. The design integrates an autopilot with a system-on-a-chip board. The platform carries a camera to capture images or video for virtual reality interfacing. Video captured and stored by the platform is provided to the user after mapping is complete, and the user can experience remotely a simulation of the indoor environment via a virtual reality headset. Measurements of the environment allow the platform to autonomously maneuver and generate a building floor plan accessible by the user. Applications include realtors creating virtual reality experiences for customers.

WEARABLE WIRELESS BODY AREA NETWORK

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Electrical and Computer Engineering

Sponsor Mentor/Advisor

Kathleen Melde

Project Mentor

Ivar Sanders

Team Members

Nicolas Fajardo	(ECE)
Kevin Garrick	(SE)
Xaviere Giroud	(BME)
Brian Kehn	(ME)
Andrew Thomas Maggio	(BME)
Cecilia Maria Read	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15018 ▸ PROJECT SUMMARY

The project sponsor asked the team to design a wearable wireless body-area network – a Fitbit is an example of a wireless body-area network – that enables the user to monitor critical body functions by smartphone. The device, worn around the chest, contains three sensors: a combined accelerometer-gyroscope programmed to detect falls, and two sensors to monitor heart rate. Upon detecting a fall, the device's smartphone app notifies the user's designated contact. One heart rate sensor uses LEDs and a photodiode to measure changes in light intensity as it bounces off the skin and into the receptor; the other is a three-lead electrocardiogram. The user wears three stickers on the chest, from which wires carrying the heart's intrinsic electrical signals are fed into the device. The signal is conditioned and amplified, and the reading sent to the user's smartphone app via a Bluetooth transmitter.

STABILIZED HELICOPTER LANDING PLATFORM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Boeing

Sponsor Mentor/Advisor

Danielle Craig

Project Mentor

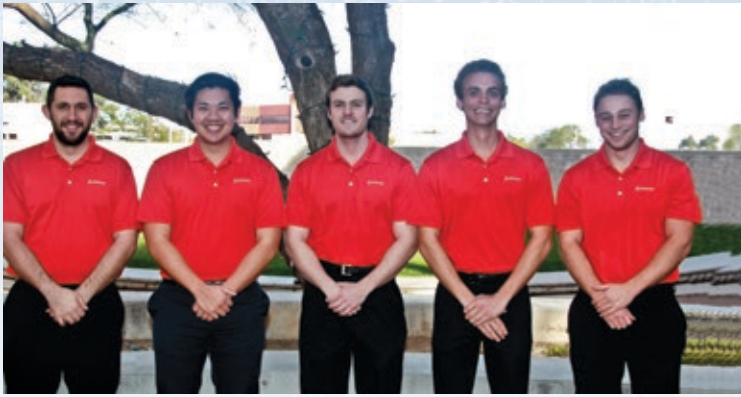
Doug May

Team Members

Nicholas Addison Hand	(SE)
Benjamin Devers Kaufman	(ME)
Jeremy David Loo	(ME)
Christopher P. McEvoy	(ME)
Ray Charles Weaver	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15019 ▸ PROJECT SUMMARY



The purpose of this project is to design, analyze, and fabricate an autonomous stabilizing helicopter landing platform. The prototype designed and built by the team is scaled to represent ship size (littoral combat ship USS Coronado), ship motion, and helicopter size. The prototype includes a scale model of the 20-foot-wide helicopter platform that remains stabilized through constant adjustment of the platform level with respect to the simulated ship motion. Using platform-mounted inertial sensors, the platform can adjust its pitch and roll in the opposing direction of the ship's motion. Because the helicopter platform is not located at the center of the ship, calculations were done based upon the full-scale center of mass dimensions of the USS Coronado. These results were scaled to 10 percent and are implemented in the design of the prototype system. The scale model landing platform is attached to a base that mechanically simulates the ship's pitch and roll motion. A stabilized helicopter landing platform mitigates the operational limits induced by the pitch and roll of the ship by autonomously tilting to cancel ship pitch and roll angles. This prototype system will be used by Boeing to demonstrate the complexities of landing helicopters on ships at sea.

INKJET-PRINTED ANTENNAS FOR WIRELESS COMMUNICATION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Electrical and Computer Engineering

Sponsor Mentor/Advisor

Michael Marcellin, Hao Xin

Project Mentor

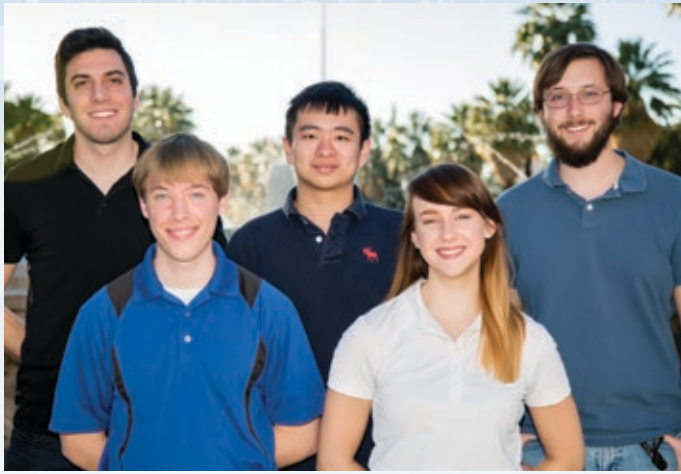
Gregory E. Ogden

Team Members

Santiago Burrola	(SE)
Charles William Hoskins	(ECE)
Yiming Shi	(ECE)
Joel Turnblade	(ME)
Alisa Zukova	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15020 ▸ PROJECT SUMMARY



Advances in small, nearly conformal wireless electronics have created a need for compatible flexible antennas. Potential applications include radio-frequency identification tags, unmanned aerial vehicle communication, radio technology, mobile phones, and sensors for cars and aircraft. The goal of this project is to use an inkjet printer with conductive ink to print functional antennas. Materials for this technology are readily available and antennas can be produced quickly and inexpensively. The team conducted a design of experiments to determine the best method for printing a working antenna by testing different printers, inks, substrates, and printing methods. Conductive ink was used with standard inkjet printers to create a two-dimensional antenna print. Size and flexibility were key design parameters.

ENTRY-LEVEL CROSSBOW DESIGN

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Precision Shooting Equipment

Sponsor Mentor/Advisor

Bret Simon

Project Mentor

Gregory E. Ogden

Team Members

Joseph Dominic Lucero	(ME)
Austin Jacob Masterson	(ME)
Matthew David Modean	(SE)
Ahmed Ismail Mustafawi	(ME)
Kyle Vinh Nguyen	(MSE)

ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15022 ▸ PROJECT SUMMARY

The project sponsor, a crossbow manufacturer, asked the team to design a new entry-level crossbow made 80 percent from pre-existing parts. The sponsor also specified use of its injection-molding plant to use up spare capacity and to create a carbon-fiber-reinforced thermoplastic component. Design focused on plastic part design and mold capability restrictions to ensure that designed parts could be made at the sponsor's production facility. Injection molding limitations required the team to research methods that would allow multiple pieces to be connected while maintaining the structural integrity of the bow. One of the difficulties with injection molding, especially with a carbon fiber material, is that a relatively uniform thickness is required throughout the design. This required the insertion of coring and ribbing features to the design to reduce the range between maximum and minimum thicknesses. The resulting crossbow is lighter in weight with a better center of gravity – that is, closer to the trigger – than the previous model.

ENERGY-HARVESTING POWER SUPPLY

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Tucson Electric Power

Sponsor Mentor/Advisor

Christopher Lynn

Project Mentor

Clayton Grantham

Team Members

Tareq A.A.M. Alsalem	(SE)
Juan Carlos Castillo	(ECE)
Jared Christian Guglielmo	(ECE)
Michelle Victoria Gutierrez	(ME)
Justin Javelosa	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15023 ▸ PROJECT SUMMARY

The design team was charged with finding an overlooked energy source and harvesting it to extract usable electric power. The team chose the magnetic field created by overhead power distribution lines, which yielded enough energy to power small electronics such as a Wi-Fi hotspot, communications repeater, phone, or a light that could be easily deployed in rural areas. The team built a device that clamps onto a 14kV power line. Using a current transformer, the device is able to induce usable alternating current in a circuit that is then rectified, smoothed, and regulated out to direct current via a secondary circuit. It is then able to provide 12 watts of power for the user's consumption. The device is equipped with a metering chip and a radio frequency communications module managed by a microcontroller. This circuitry relays the appropriate metrics to the user. The device information is transmitted to a computer equipped with a communications receiver module and displayed on a custom graphical user interface. Data made available to the user reflects voltage, current, and power levels being consumed. The harvested power is available to the user through multiple outlets, including a USB plug and general two-prong/barrel DC connectors.

NASOGASTRIC TUBE PLACEMENT VERIFICATION SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Xeridiem

Sponsor Mentor/Advisor

Erica Isaacs, Paul Melnychuck

Project Mentor

Ivar Sanders

Team Members

Christopher Gallo	(BME)
Summer Garland	(BME)
Nathaniel Alexander Husband	(BME)
Gary Tyree	(BME)
Hang Van	(SE)
Andrew Reid Werchan	(ECE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
SE = Systems Engineering

TEAM 15024 ▸ PROJECT SUMMARY

Nasogastric tubes are hollow thermoplastic tubes used to deliver nutrition to the stomachs of patients who cannot ingest food orally. A common medical malpractice event is the introduction via these tubes of liquid into the respiratory tract instead of the stomach, which can result in fluid aspiration that can lead to patient harm or death. Current standard of practice verifies tube placement in a hospital via a chest X-ray or stomach acid pH test. While these procedures are effective, they are not conducive to repeat verification and require the skills of medical professionals. The goal of the project is to develop a cost-efficient and easy-to-use device that informs the user when the tube has been placed in the stomach, not the airway. The device is small enough for use within existing tubes and can withstand the corrosive gastric environment for up to 30 days. This design uses an open circuit that is closed by ions present in the acidic fluid of the stomach. The closure of the circuit results in a differential voltage signal that provides the user with a “safe to feed” message.

MOBILE CONTROLLERS FOR NAVAL ROBOTIC SYSTEMS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Raytheon Missile Systems

Sponsor Mentor/Advisor

Huy Le

Project Mentor

Bob Messenger

Team Members

Shayla Raquel Austin	(ME)
Brandon Phong Bui	(SE)
Atta Kashmiri	(ECE)
Scott Morrison	(ME)
Kaitlyn Bea Sandford	(ME)
Brett Michael Spradling	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15025 ▸ PROJECT SUMMARY

The goal of this project is to design, build, and test a robust tablet with an application for controlling a robot unit onboard a naval vessel. The final design is a ruggedized iPad Mini using the Triton's Link robot-control application, which sends a signal to the robot telling it where to go and how to get there. The application contains control test procedures and monitors output data such as the robot speed, direction, and force of collision. Because security is paramount, a code generator was developed to provide a code to input into the robot application. To ruggedize the tablet, a 3-D shell case was designed and printed for the iPad Mini. The case is held together using HeliCoils and screws, contains thick foam for insulation and shock proofing, and is fitted with a watertight gasket. The case was developed to survive water, wind, and fluctuating temperatures, and to ensure that the iPad Mini still functions after hitting the deck from a great height. This ruggedized tablet and robot-control application could be a cheaper and more technologically advanced alternative to current U.S. Navy systems, which are old and expensive to replace.

ROBOTIC KNEE EXTENSION SIMULATOR

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Biomedical Engineering

Sponsor Mentor/Advisor

Dan Latt, John Szivek

Project Mentor

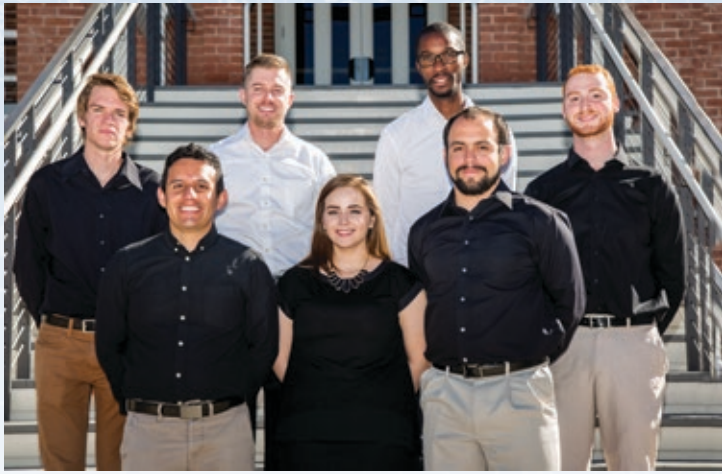
Ivar Sanders

Team Members

Czarina Lizette Aguilar	(BME)
Eze Ahanonu	(BME)
Ian Seamus Hoffman	(ME)
David Mendoza	(ECE)
Brian J. Nicodemus	(SE)
Daniel Palomares	(BME)
Zachary Jordan Remer	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15026 ▸ PROJECT SUMMARY



The objective of this project, which builds on work done by a previous team, is to produce a device that aids in research on dynamic loading of the knee joint, with a view to developing improved surgical techniques. The device facilitates analysis of how mechanical behavior varies between diseased and healthy joints. A primary requirement for the device is to collect and store data about two degrees of freedom in the knee, measuring such parameters as flexion, extension, internal rotation, and external rotation. As a mechanical system it is important to create a realistic movement incorporating the patella tendon, which was achieved by developing a pulley system and a nondestructive tendon clamp. As knee movement is simulated, each sensor collects data for research analysis.

SOFT MATERIAL 3-D PRINTER

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Arizona SimulationTechnology and Education Center Lab

Sponsor Mentor/Advisor

Allan Hamilton

Project Mentor

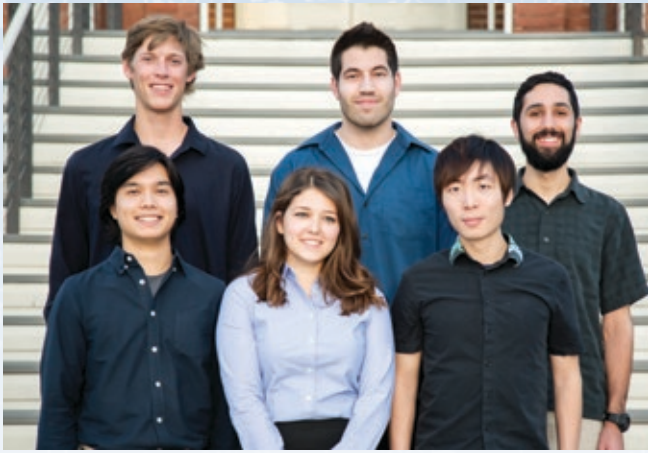
Brian O'Cain

Team Members

Alexandra Jordan Barbosa	(BME)
Cameron Luke Quenga Calvo	(ECE)
Huilong Gao	(SE)
Brandon Joseph Konieczny	(BME)
Brandon C. McCraw	(MSE)
Andres Angel Nuncio Zuniga	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15027 ▸ PROJECT SUMMARY



The Soft Material 3-D Printer was developed to reduce the high costs of personalized medicine in the medical simulation industry. Products printed in 3-D are cost-effective if they are within tolerance and comparable in resulting properties to currently used molds. Such 3-D products allow quick, cheap production of simulated patient systems suited specifically to the patient. The printer was designed to use stereolithography files generated from images of a patient's organs taken by, for example, magnetic resonance imaging. The files are run through a layering program called Slic3r and output to the 3-D printer, which is equipped with an interface for changing settings to optimize the print job. The goal is to print objects using materials chosen for their similarity to human tissue and ease of ultrasound signal penetration, which is achieved using an extrusion print method with a silicone solution that once cured simulates material properties of human tissue. The print specifications are manipulated by controlling pressure, temperature, composition, and pot timing. These factors allow a predicable result in terms of tolerance, reliability, and use in medical simulation.

SENSORBALL

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Texas Instruments

Sponsor Mentor/Advisor
Anthony Vaughan

Project Mentor
Gary Redford

Team Members
Maryam Alia Abdul-Wahid (ECE)
Tamara M. Alani (ECE)
Angel Josue Lopez (ECE)
Brian T. Ngo (SE)
Ryan William Stelzer (ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15028 ▸ PROJECT SUMMARY

Texas Instruments asked the team to design a marketing product that would attract more customers to the company's booth at a trade show and showcase the performance of its devices. SensorBall uses components from the TI analog portfolio, including an analog-to-digital converter, digital-to-analog converter, operational amplifier, voltage regulator, and microcontrollers. An accelerometer, vibration motor, heart rate monitor, light sensor, and temperature sensor complement the TI products and show what an integrated system might look like. Users interact via a graphical user interface with games and demonstration modes incorporated into the ball, which is made of clear plastic with an internal polycarbonate structure to house all the components. The ball communicates with a personal computer via Bluetooth Low Energy, and a user interface displays sensor output and enables mode changes.

LASER-BASED FORWARD COLLISION-PREVENTION SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Texas Instruments

Sponsor Mentor/Advisor

Vinay Agarwal

Project Mentor

Clayton Grantham

Team Members

Butti Abdulla Alshamsi	(SE)
Miguel A. Garcia Duran	(ECE)
Kaiqi Li	(ECE)
Ian Robert Nettleton	(ME)
Ramon A. Orozco	(OSE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15029 ▸ PROJECT SUMMARY

The team's objective is to design and build a laser-based collision-prevention system to prevent the forward collision of a radio-controlled car. The system relies on the analog signal provided by an optical laser detector. The laser functions in a controlled environment and detects objects in its forward path. The analog signal from the laser detector is processed, digitally converted, and sent to a microcontroller. Software in the microcontroller analyzes the data and determines whether the radio-controlled vehicle should brake. The design could be used in automobile, aircraft or other safety applications.

WATER PROCESSING AND CLEANING FOR REUSE

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Shamrock Foods

Sponsor Mentor/Advisor

Jack Garrett, Tiffany Hawks, Jim Kramer

Project Mentor

Gregory E. Ogden

Team Members

Justine Nichole Bacchus	(BME)
Brennen Guy	(ME)
Cory Luke	(BME)
Edward Francis Mackay	(SE)
Nicholas Bradley Siegel	(ME)

BME = Biomedical Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15030 ▸ PROJECT SUMMARY

The team was asked to design, build, and test a small-scale version of a proposed wastewater-reuse system for the Shamrock Foods facility in Phoenix, Arizona. Shamrock wants to reuse the 500,000 gallons of water per day it currently discharges into the city's wastewater system. The team created a process that uses a membrane bioreactor, reverse-osmosis system, and ultraviolet disinfection step. Shamrock Foods wants to recycle this water, treated to EPA guidelines, back into its various production processes.

MICROFLUIDIC-BASED HUMAN LUNG MODEL

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Biomedical Engineering

Sponsor Mentor/Advisor

Yitshak Zohar

Project Mentor

Brian O'Cain

Team Members

Elisa Camille Calabrese	(BME)
Kristin Nicole Calahan	(BME)
Christopher David Larkin	(BME)
Emily Masterson	(BME)
Mary Irene McIntosh	(BME)
Kristina Rivera	(BME)

BME = Biomedical Engineering

TEAM 15031 ▸ PROJECT SUMMARY

The goal of this project is to develop a system for converting a liquid-based suspension of biospecies into a bioaerosol that is driven at a controlled flow rate and concentration into a microfluidic device for lung-on-a-chip applications. The concept of lung-on-a-chip involves the co-culture of human endothelial and epithelial cells on either side of a porous membrane separating two microchannels stacked on top of each other. An air-liquid interface can be established by driving airflow through the epithelial microchannel while maintaining media flow through the endothelial microchannel. The result is a device that mimics the function of the respiratory zone bronchioles of the human lung. The lung-on-a-chip device can then be used to test the effects of various external stimuli, such as drugs and toxins, to mimic the response of a human lung. The team developed a method to generate and drive viable bioaerosols through lung-on-a-chip devices in a controlled manner, allowing quantitative characterization of the bioaerosol flow. Ultimately, these biomimetic microfluidic devices can be used to replace the standard cell monolayers and animal models in clinical and basic research.

CLOUD-CONNECTED ATHLETIC HEART RATE MONITOR

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Texas Instruments

Sponsor Mentor/Advisor

Ravi Kiran Raghavendra

Project Mentor

Clayton Grantham

Team Members

Annastasia Sophie Debolt	(SE)
Solomon Jay Jackman	(ECE)
Blake Stacy	(BME)
Harrison Webb Stovall	(BME)
Qidi Zhai	(ECE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
SE = Systems Engineering

TEAM 15032 ▸ PROJECT SUMMARY

The project's objective is to develop a chest-strap-mounted device that detects heart rate, then transmits data via Wi-Fi to the cloud and displays it on a smartphone. The team developed an app that receives analytical data from the cloud and allows the user to see heart rate, exertion level, and heart rate variability. Users can view previous workouts on the app and compare them to their most recent workout, as well as viewing multiple users' signals simultaneously. This would make the app ideal for an athletic coach, who could monitor an entire team, both on the scene and remotely, and study all team members simultaneously.

EXTREME THERMAL COMPLEX GEOMETRY CERAMICS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Materials Science and Engineering

Sponsor Mentor/Advisor

Erica Corral, Paul Neff, Ashley Ormsby

Project Mentor

Frank Oliver

Team Members

Jonathan Samuel Carson	(ME)
Matthew Lee Kelpien	(SE)
Angelin Putri McCormack	(MSE)
Nicholas Charles Wilcox	(ME)

ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15033 ▸ PROJECT SUMMARY

This project required the team to design and machine the tooling needed to produce a silicon nitride turbine blade in a high-temperature direct current sintering furnace. Following an in-depth study of furnace capabilities, the team designed a turbine blade made of an insulating aerospace material, grade M silicon nitride produced by H.C. Stark. Blade geometry design was based on computational simulation.

NERVE STIMULATOR TO REDUCE SPASTICITY

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
NeuroMetrix

Sponsor Mentor/Advisor
Shai Gozani

Project Mentor
Ivar Sanders

Team Members

Thomas Lawrence Bello	(BME)
Alyssa Jeane Benjamin	(BME)
Arminda Estrada	(ECE)
Elizabeth Harris	(SE)
Brooke Lindsay	(BME)
Thomas Vincent May	(ECE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
SE = Systems Engineering

TEAM 15034 ▸ PROJECT SUMMARY

Quell is a wearable transcutaneous electrical nerve-stimulation device used to treat chronic pain. A number of studies have shown that in addition to treating chronic pain, nerve stimulation can also be used to alleviate muscle spasticity affecting people with upper motor neuron disorders such as stroke, multiple sclerosis, spinal cord injury, and traumatic brain injury. The goal of this project is to develop an Android application to control a Quell device to reduce spasticity. The app allows the user to adjust settings such as intensity of nerve stimulation, time of therapy session, and various notification settings for ease of use. The ultimate objective is to enable full flexibility and control of the Quell device through the Android application and to improve the at-home treatment options available to spasticity patients.

AUGMENTED REALITY SPACECRAFT ASSEMBLY

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Raytheon Missile Systems

Sponsor Mentor/Advisor

Bryan Bergsma, Matt Taylor, Greg Toy

Project Mentor

Doug May

Team Members

Samuel Cotter	(MSE)
Phillip Tulio Gotobed	(ECE)
Gabriel Mercado	(ME)
Casey Ryan Philip Odom	(SE)
Savannah Nichole Sanchez	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15035 ▸ PROJECT SUMMARY

Raytheon, the project sponsor, wants to know if augmented reality could be used in its assembly operations, so it asked the design team to test and analyze the DAQRI augmented reality helmet, a wearable human-machine interface that allows users to interact intuitively with their surroundings. Using an iPad as a surrogate helmet, the team created animated work instructions on how to assemble a 3U CubeSat model. The team designed a CubeSat and created printed assembly instructions, which were then converted to augmented reality instructions viewable on the iPad. The overlaid instructions were tested by having two groups assemble the model, one using an iPad as a surrogate helmet, the other working from printed instructions. For both groups, the team recorded average time taken to build the model and the average number of errors.

HUMIDITY CONTROL IN SPACE SUITS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Paragon Space Development Corp.

Sponsor Mentor/Advisor

Patrick Pasadilla

Project Mentor

Doug May

Team Members

Hailey Marie Davenport	(BME)
Dakota S. Luepke	(MSE)
Joel Levi Mintz	(BME)
Kathryn Montrey Pflueger	(BME)
Andrew Michael Siemens	(ME)
Lindsay Small	(SE)

BME = Biomedical Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15036 ▸ PROJECT SUMMARY

The rapid cycle amine system developed by NASA to remove excess humidity from space suits makes the air in the suits uncomfortably dry for astronauts, so the project sponsor asked the team to design a space suit humidity-control system. The team used Paragon's Nafion bundle technology to control space suit humidity levels. Nafion is a copolymer of tetrafluoroethylene that is semipermeable to water. The design team designed a mathematical model of the system, including various orientations of the Nafion bundles, and determined the best bundle configuration. The team built and tested a prototype in the Paragon lab, which includes a test bed that simulates normal breathing, the Nafion bundle chamber, and a replica of the current rapid cycle amine system.

MEDICAL DEVICE TUBING MEASURING AND CUTTING APPARATUS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Ventana Medical Systems Inc.

Sponsor Mentor/Advisor

Chris Donat, Steven Lei

Project Mentor

Brian O'Cain

Team Members

Jennifer L. Battista	(ME)
Jessica C. Renner	(SE)
James Thomas Thayne	(ME)
Anthony Justin Valadez	(ECE)
Breanna Marie Wang	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15037 ▸ PROJECT SUMMARY

The objective of the project is to automate the measuring and cutting of medical tubing. The team designed a machine that accurately and precisely cuts tubing of various materials and diameters quicker than the current manual method. The machine accepts orders for tubes via barcode scanning or manually from a PC user interface. The ultimate goal of the project is to provide Ventana Medical Systems with a machine to automate its current manual tubing manipulation process that can be implemented on the manufacturing floor.

SLIDE HANDLING AND RETENTION APPARATUS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Ventana Medical Systems Inc.

Sponsor Mentor/Advisor

Rob Cisneroz, Dan Moore, Ben Randall

Project Mentor

Gerald Pine

Team Members

Andrew D'Arcangelis	(BME)
David Charles Duperre	(ME)
Erin Camille Evangelist	(SE)
Mykella Samantha Jones	(BME)
David Wayne Malboeuf	(ME)
Matthew Thomas Nadolny	(ECE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15038 ▸ PROJECT SUMMARY

Ventana Medical Systems asked the team to design and fabricate a slide-retention apparatus able to pick up a standard microscope slide with 1.2 milliliters of liquid and transport it to a designated location while retaining 90 percent of the liquid and finishing the cycle within one minute. Additionally, the device must be easy to operate and be an appropriate size to place on a standard lab bench. The device is designed to operate after a laboratory technician places the slide within the system and presses a button. Once the command is received, the system moves to an initial position, verifies slide placement via a photoelectric sensor, lifts the slide using a vacuum subassembly, and transports it to the designated location. The system then releases the slide and verifies successful delivery. The designed system can move with four degrees of freedom: 24 inches horizontally, 15 inches vertically, 10 inches in depth, and 180 degrees around the vertical axis. System liquid retention was verified by repeated analysis of the system cycle as determined by difference in initial and final slide weight.

HIGH-THROUGHPUT CURING OVEN

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Ventana Medical Systems Inc.

Sponsor Mentor/Advisor

Kenyon Kehl

Project Mentor

Gerald Pine

Team Members

Allison Nicole Bronstein	(SE)
Jesus Damian Chavolla	(ECE)
Yanjun Liu	(ME)
Corina MacIsaac	(BME)
Yaroslav Valerievich Pilipenko	(BME)
April Proft	(MSE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15039 ▸ PROJECT SUMMARY

Ventana Medical Systems asked the team to design a small-scale in-line curing oven for use in histological glass slide storage preparation. The oven heats a glass/polymer protective layer that after curing creates an airtight bond between the shielding glass and the specimen slide. The specimen is tissue being tested for cancer cells. When heated in the curing oven, the polymer layer on the slide changes from a solvent state to a pure polymer state, in which the slide, tissue, and the coverslip become hardened together, facilitating handling, microscopy, and archiving. The design allows the slide, cover glass, and tissue specimen to enter the oven along with the solvent-state polymer, which heats up to the necessary curing temperature within one minute. The slide then exits the oven and the polymer cures upon cooling. The oven is designed to sponsor specifications and can be adjusted for a variety of fit and form factors, and cures slides continuously as they are fed into the system rather than curing several at the same time.

ON-SLIDE REAGENT CONCENTRATION FEEDBACK AND CONTROL

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Ventana Medical Systems Inc.

Sponsor Mentor/Advisor

Kenyon Kehl

Project Mentor

Gregory E. Ogden

Team Members

Collin Andrew Gilchrist	(BME)
Jamie Lynn Hernandez	(BME)
Shawn Michael Iles	(OSE)
Pete Joseph Moya	(BME)
Tyler Daniel Toth	(BME)
Danton Xixo Whittier	(SE)

BME = Biomedical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15040 ▸ PROJECT SUMMARY

This project required the team to develop a system to monitor the concentration of an ionic buffer solution dispensed onto a standard 75x25 mm microscope slide. Because some tests done by Ventana are extremely sensitive to the ionic concentration of the on-slide fluid, the company wants a way to measure ionic concentration noninvasively. Evaporation and replenishment of the fluid containing the tissue sample cause variation in ionic concentration, which can adversely affect the quality of histopathology staining. The designed system uses a refractometer to measure in real time the refractive index of the buffer solution, which correlates with ionic concentration. When evaporation raises the ionic concentration, a technician can add a precise volume of buffer solution to compensate. By using an infrared laser to refract light into the solution and onto a complementary metal-oxide semiconductor sensor, the resulting angle of refraction can be used to assess the concentration as a function of temperature. A graphical user interface, which allows the user to measure concentration and see it change over time, is implemented using a touch screen and Raspberry Pi microcontroller.

AUTONOMOUS AERIAL TRACKING OF A HERD OF GROUND ROBOTS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Pima College UAV Club

Sponsor Mentor/Advisor

Frank L. Manning

Project Mentor

Frank Oliver

Team Members

Stephanie Guzman	(OSE)
Alberto Javier Heras	(ECE)
Stephen Gregory Jewell	(ME)
Colin Andrew LaSharr	(ECE)
Ryan Province	(SE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15041 ▸ PROJECT SUMMARY

The objective of this project is to design, develop, and test an autonomous surveillance system able to track objects without human intervention. The autonomous aerial tracking system developed by the team will be used in the International Aerial Robotics Competition in August 2016. Competition requirements stipulate that the unmanned aerial vehicle cannot use GPS, and that it must remain below 3 meters above the ground at all times. The competition arena is a 20-by-20-meter grid, which forces the detection device to have a large field of view. It must also be able to locate several small, mobile robots traversing the grid. The system uses four Pixy CMUcam5 cameras and an ELP 180 degree fisheye USB camera for detection. The system must provide the locations, velocities, and headings of the robots, in addition to its own location, velocity, and heading. All calculations are done onboard by a Raspberry Pi microcontroller and sent directly to the drone's autopilot, which makes decisions on vehicle and robot movement based on information processed.

MICROWAVES AND ULTRASOUND FOR IMAGE-GUIDED THERAPY

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Medical Imaging

Sponsor Mentor/Advisor

Russell Witte, Hao Xin

Project Mentor

Brian O'Cain

Team Members

Nicolas V. Guzman	(BME)
Caitlin Howard	(BME)
Sasikanth Nagisetty Ravi	(BME)
Olivia Lauren Poettmann	(SE)
Michael Shin Reed	(ECE)
Fabian Cipriano Wildenstein	(OSE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15042 ▸ PROJECT SUMMARY

The purpose of this project was to construct a prototype platform that integrates focused microwave therapy and thermoacoustic imaging systems to deliver thermal therapy to a tissue while mapping its temperature in real time. Focused delivery of microwave thermal energy to a region of tissue can potentially be used as a noninvasive treatment for tumor reduction, but the heating needs to be constantly monitored to ensure that proper temperatures for tumor ablation are reached while the surrounding healthy tissue is not damaged. Current clinical methods for this monitoring are expensive and time consuming. This project will serve as a proof of concept for an integrated FMT-TI system to selectively heat and safely monitor different regions in tissue. The design includes a microwave generation, power amplification, and distribution network that delivers microwaves through specially designed patch antennas into a phantom tissue to heat a specified focal region. The tissue's change in temperature is monitored by the FMT-TI system while it delivers secondary short-pulse microwaves through a waveguide into the tissue to induce an acoustic pressure wave, which is recorded by a scanning ultrasound transducer. This signal is processed and converted into a heat map displaying temperature intensity across a region of space.

TOILET LEAK AND FLOOD PREVENTION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

QuakeWrap Inc.

Sponsor Mentor/Advisor

Mo Ehsani

Project Mentor

Gary Redford

Team Members

Matthew Britton	(SE)
Ian Krispin Carmichael	(ECE)
Eliza R. Dawson	(ME)
Diego Morales	(ME)
Derek James Strickland	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15043 ▸ PROJECT SUMMARY

Toilets account for about 30 percent of home water usage, and the EPA estimates that household water leaks add up to more than a trillion gallons a year, over 10,000 gallons per household. The economic and environmental costs of these preventable household leaks are substantial. Current low-cost leak-detection systems are unreliable and require human intervention, so the project sponsor challenged the team to design a better way to prevent water loss due to leaks. The team designed a low-cost, autonomous water shutoff device that integrates with common household toilets and runs continuously off a 9-volt battery. A latching two-way solenoid valve is installed at the wall angle stop and connected to a control box and power source on the side of the toilet tank. An adjustable timer is set to account for variations in fill rate and water pressure that cause flush time to vary. The control system is connected to a waterproof momentary pull switch installed in series with the flapper chain. The switch is triggered upon flushing which causes the valve to open for the duration of the tank fill time, after which the valve closes again, protecting against slow intermittent leaks, constant leaks and flooding.

DEEP WATER SENSOR SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Texas Instruments

Sponsor Mentor/Advisor

Paul Frost

Project Mentor

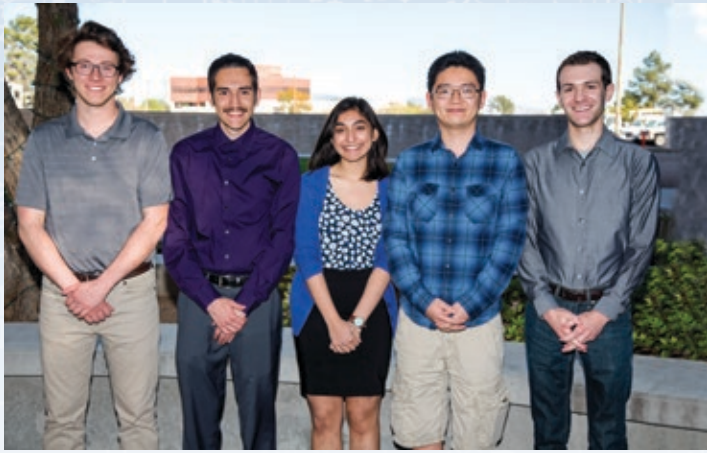
Clayton Grantham

Team Members

Matthew Ray Barragan	(ECE)
Austin Anthony Nawrocki	(ME)
Nikitha Ramohalli	(ECE)
Alexander Yudkovitz	(SE)
Yi Zhang	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15044 ▸ PROJECT SUMMARY



The Deep Water Sensor System is a complete subsea package for remotely sensing water conditions over long distances. It consists of an interacting base station and tethered remote-sensing unit capable of communicating data. The remote station uses temperature, pressure, and pH sensors to take measurements and characterize the quality of the water. The remote-sensing unit is enclosed in a water-resistant case for deep-sea capability. The tether, which connects the base station and sensing unit, is a low-resistance twisted pair enabling a 4-20 milliamp current loop, which is ideal for the transmission of high-integrity electrical signals and an effective data-communication method in long-range applications. The base station interprets signals from the remote-sensing unit using a highway-addressable-remote-transducer-compatible communication protocol. The base station compiles and illustrates the data using the LabVIEW graphical user interface. A Texas Instruments MSP-430 microcontroller unit is used in both the remote sensing unit and the base stations.

CONTAINMENT STRUCTURES FOR ROTOR FAILURE IN AUXILIARY POWER UNITS

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Honeywell Aerospace

Sponsor Mentor/Advisor
Deanna Chase, David Jan

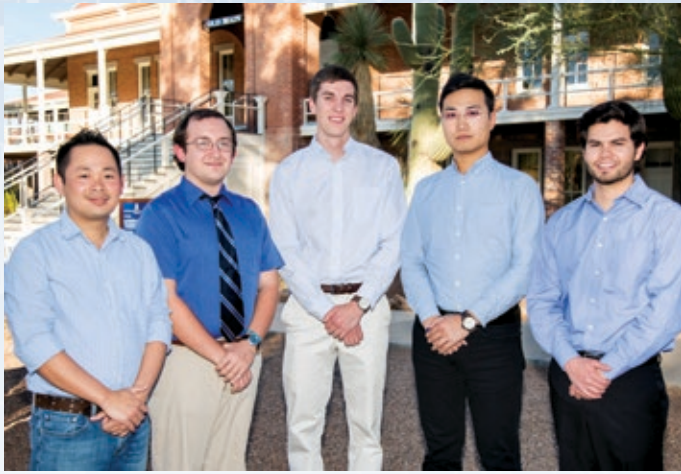
Project Mentor
Bob Messenger

Team Members

Michael Berube	(ME)
Andrew Ross Bitzko	(ME)
Heriberto Bujanda Preciado	(SE)
Kyle Nguyen	(ME)
Jianyang Wang	(MSE)

ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15045 ▸ PROJECT SUMMARY



A small engine in the tail of most commercial airliners, called an auxiliary power unit, satisfies the aircraft's power needs during boarding and refueling, such as air conditioning, lighting, pilot controls and in some cases engine startup. After passenger safety, reducing aircraft weight is a major aviation concern. If one of the rotors in the auxiliary power unit fails, it could exit the engine and cut through the aircraft cabin. The goal of this project is a design that will contain rotors in the event of a failure, and that weighs as little as possible without compromising passenger safety. This is achieved by placing containment rings outside the turbine and compressor rotors. The nickel-based alloy rings can stretch and absorb the impact of pieces from a fractured rotor. The design was tested using proven mathematical models and analysis. Cost precluded a real-world test, but the team developed a test plan should Honeywell decide to continue with the design.

PRINTED CIRCUIT BOARDS FOR HIGH-POWER TRANSFORMER WINDINGS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Keming Chen

Project Mentor

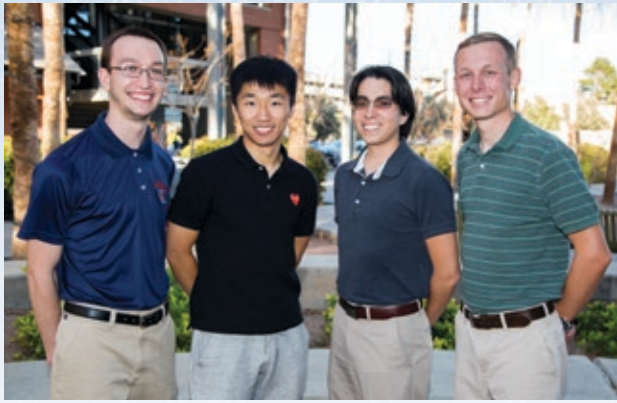
Brian O'Cain

Team Members

Tyler Baker	(SE)
Murey Alexis Luna Torres	(ECE)
Garrett James Tinderholt	(MSE)
Junfeng Xu	(ECE)

ECE = Electrical & Computer Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15046 ▸ PROJECT SUMMARY



The goal of this project is to design a power transformer using printed circuit boards as windings. If the boards have a sufficiently high number of layers, it is possible to complete enough windings for an effective transformer. The designed board contains 12 copper layers that act as windings. Layers are connected using a vertical interconnect access, or VIA, and the boards are stacked together to make a complete transformer. The two main focus areas of the project are the layout of the boards and their thermal performance. The layout design concentrated on the pattern of VIAs and shape of the copper layers. The boards have been designed to connect from layer to layer to ensure full windings around the core. The VIAs have also been arranged in such a way that the VIAs don't short on each other when the boards are stacked. Transformers generate heat, so it is important to minimize the heat buildup, which could melt the boards. A thermal analysis was performed using SolidWorks to keep boards below their melting temperature. Due to budget and time constraints, building a complete transformer was not feasible. Instead, a small prototype consisting of three boards stacked together was built, which proved that the repeatable layout design is feasible and that the complete transformer will not melt under normal load.

IN-LINE SWIRL PARTICLE SEPARATOR

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Daniel Aukland, Yori Sheoran

Project Mentor

Gregory E. Ogden

Team Members

Katelyn Nicole Alcantara	(MSE)
Tyler James Fenimore	(ME)
Vincent Charles Garcia	(ME)
Ricky Joseph Gonzalez	(SE)
John Manos	(ECE)
Jack Speelman	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15047 ▸ PROJECT SUMMARY

Airborne particles sucked into turbine engines can erode internal parts, necessitating extensive maintenance and increasing the possibility of failure. This project's objective is to separate particles from an airstream and reduce internal erosion. The design uses an in-line swirl particle separator that relies on centrifugal forces to remove particles from an airstream. A swirler, consisting of rotated blades extending at 90 degrees from a central cylinder, is placed at the front of the separator system. The swirler forces the airflow to spin as it hits the blades, generating centrifugal forces that throw particles to the outer edge of the separator as they travel down the migration chamber to be removed from the system at the diffuser gap. The cleaned air flows through the outlet of the separator and into the turbine engine inlets. To optimize the particle separation of the system, a design of experiments was performed with three factors: inlet diameter, swirler length, and migration chamber length. Each factor had two levels: high and low. All combinations of the three factors at each of the two levels were tested and an analysis completed to determine the optimal design choice for each factor.

MECHANICALLY OPTIMIZED COMPOSITE PERFORATED ACOUSTIC PANEL

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Honeywell - Aerospace

Sponsor Mentor/Advisor
Albert Kang, Patrick Mulloy, Bill Schuster

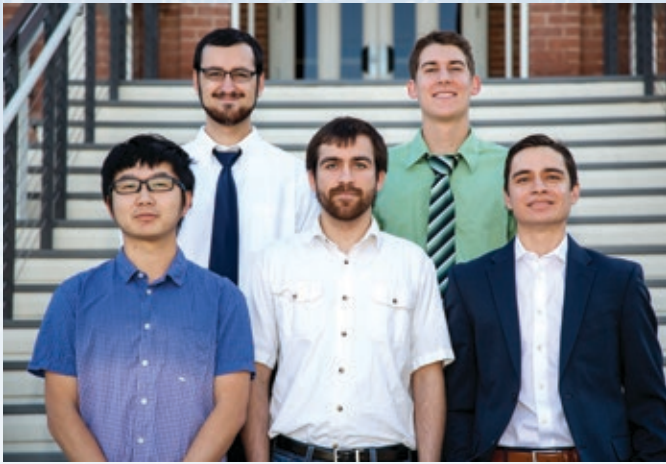
Project Mentor
Brian O'Cain

Team Members

Tarlton Verle Ferrin	(MSE)
Zackary David Fortuno	(MSE)
Ryan James O'connell	(MSE)
Matthew Andrew Prevallet	(ME)
Tao Shen	(ME)

ME = Mechanical Engineering
MSE = Materials Science & Engineering

TEAM 15048 ▸ PROJECT SUMMARY



Composites made using carbon-fiber-reinforced polymers, or CFRPs, are widely used in aerospace applications because of their stiffness and low weight, but their mechanical properties after processing, such as drilling, are not well understood. Software can emulate the mechanical behavior of CFRPs but physical tests are needed to validate such models are needed. The goal of this project is to quantify mechanical properties of CFRPs for a specific application using tests defined by the American Society for Testing and Materials. Acoustic perforated panels help reduce noise pollution inside aircraft, and CFRPs would be an ideal material for these panels, but would require extensive drilling. Because CFRPs are highly abrasive and tend to delaminate, high-speed steel drill bits quickly suffer catastrophic wear. The team ran ASTM tests to evaluate the tensile, shear, and compressive strength of the CFRPs before and after perforations. As part of the project, the team made a critical make/buy decision to produce the panels, made processing decisions to prepare testing specimens to specifications, oversaw material processing, ran the ASTM tests, and documented all results.

COMMERCIAL SMOKE DETECTOR AS AN AIRCRAFT CABIN PARTICLE SENSOR

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Deanna Chase, Richard Fox

Project Mentor

Jyoti Mukherjee

Team Members

James Arthur Bartley	(ME)
Jordan K. Lo	(SE)
David Mario Lopez	(OSE)
Chase Paules	(ME)
Megan Kristin Pritchard	(ECE)
Victoria Raught	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15049 ▸ PROJECT SUMMARY

The objective of this project was to repurpose a commercial smoke detector for use as a particle sensor on board an aircraft. The sensor software was modified using the Python programming language to extract obscuration data at 3-second intervals. The 3-second interval was necessary for response calibration. Particle response tests were conducted with an aerosol generator and two analyzers to determine the particle size and concentration response of the smoke detector. A robust mount was designed and assembled to fit the sensor and allow attachment near the air-circulation duct on the aircraft. Finite element analysis was performed and the mount was fitted with foam capable of absorbing at least 4 g of shock. Temperature tests were also conducted to see if the sensor could handle the temperature fluctuations typical on board aircraft.

AIRCRAFT ENGINE BLEED AIR CONTAMINATION DETECTION SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Deanna Chase, Richard Fox

Project Mentor

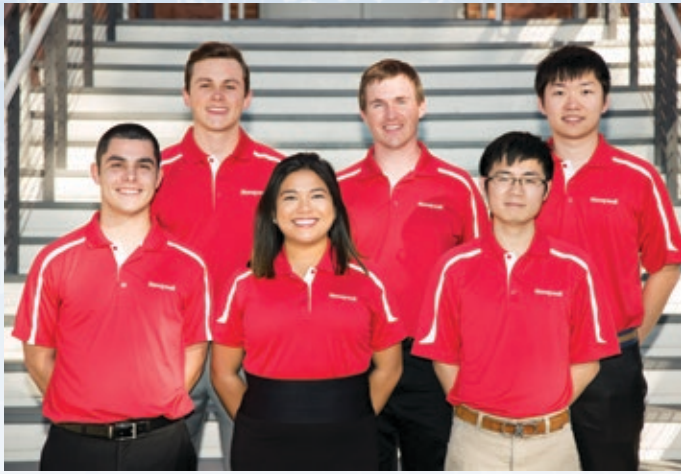
Jyoti Mukherjee

Team Members

Erika Joanne Balbas	(SE)
Zachary Joseph Fier	(ME)
Qichao Hu	(ME)
Joshua Johnston	(ECE)
Jeffrey Jon Mrkonich	(BME)
Hao Yuan	(ECE)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15050 ▸ PROJECT SUMMARY



Aircraft bleed air at high temperature and pressure comes directly from the engine before jet fuel is added. This air is used to perform aircraft functions such as pressurizing the cabin and running the air-conditioning unit. Contaminants in bleed air can damage aircraft components, and the goal of this project is to create a system to detect contaminants when they reach significant levels. The mechanical subsystems were designed to reduce the extreme conditions of the bleed air stream to within the functional range of the sensor used to detect the contaminants. The electrical subsystem communicates information about contaminant levels to a microcontroller for processing. The microcontroller also provides an indicator to the user interface for aircraft operators.

THERMOMECHANICAL FATIGUE TESTING SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Don Mittendorf, Mike Vinup

Project Mentor

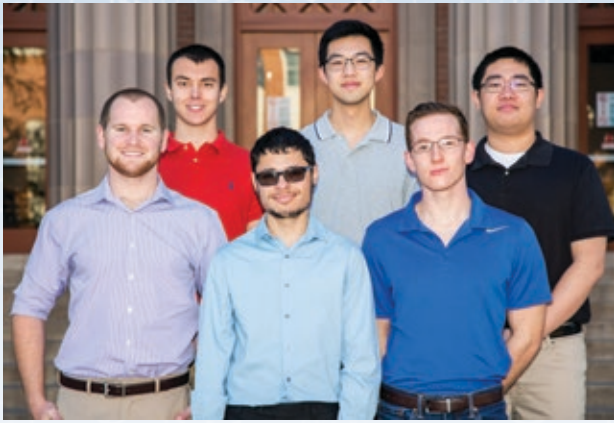
Bob Messenger

Team Members

Oscar Hernandez	(MSE)
Spencer Yushian Lee	(ECE)
Andy Luc	(MSE)
Bernt Rennie Powell	(ME)
Kevin Bryan Scheeler	(SE)
William David Sim	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15051 ▸ PROJECT SUMMARY



Thermomechanical fatigue analysis studies how cyclic thermal loading and large operating temperature gradients cause material fatigue. Test equipment often uses induction as a heat source, which makes systems expensive and difficult to analyze, so the team set out to find an alternative heat source. Using combustion heating and forced convection cooling, the team has devised a way to simulate real, accurate thermomechanical fatigue conditions at a fraction of the cost. The design optimizes the geometry of a nickel-based superalloy specimen to achieve a target stress of 80,000 psi and temperature of 2,100 degrees Fahrenheit when heated and cooled simultaneously. The method involves heating the top face of the specimen with a high-temperature oxy-propane torch while a vacuum draws air through a slot in the specimen at extremely high velocity. Simultaneous heating and cooling produces a temperature gradient between the top and bottom of the specimen, causing it to expand and compress at the same time, thus creating the desired compressive stress. This method will allow the sponsor to efficiently and cost-effectively explore thermomechanical fatigue properties of proprietary materials for future use in jet turbine engines.

CATERPILLAR MACHINE CONTROLS ELECTRONIC TESTING DEVICE

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Caterpillar Inc.

Sponsor Mentor/Advisor
Bill Notbohm

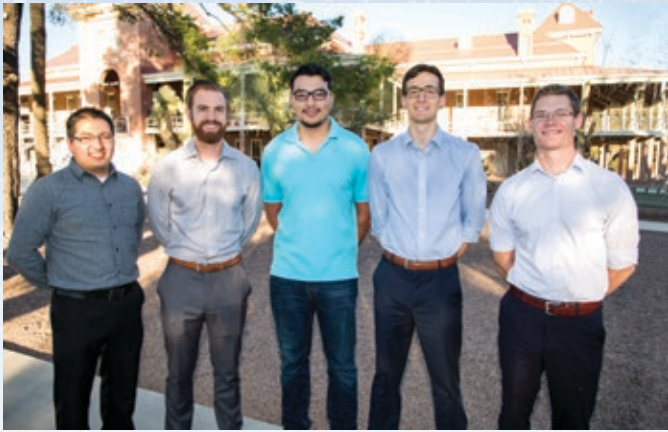
Project Mentor
Frank Oliver

Team Members

Julian D. Bostick	(ECE)
Steven Patrick Moreland	(ME)
Matthew Marvin Patchett	(AE)
Thomas John Reid	(ME)
Daniel Moises Zavala	(SE)

AE = Aerospace Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15052 ▸ PROJECT SUMMARY



Caterpillar tests electrical systems by simulating system failure using breakout boxes that communicate with various equipment subsystems via an electronic control module. The sponsor charged the team with designing an automated breakout box with a laptop-based graphical user interface to report results to the user. The designed system consists of an interface box in the cab, and a main box by the electronic control module being tested. The laptop connects to the interface box, where system power is provided by equipment being tested, and houses a microcontroller, LED indicators, and a memory card. The main box houses 18 printed circuit boards, each consisting of 14 relay boards, a power board, a signal-control unit, and a fault rail. Relay boards control signals from the electronic control module, sending them through by default or sending signals to the fault rail, which performs tests and records results. The signal-control unit facilitates testing and the power board distributes power from the truck to the test system. The entire automated breakout system is controlled by a custom user interface that allows tests to be performed at the click of a button. Tests can also be put in a queue and run without an operator.

METAL SURFACE QUALITY CHARACTERIZATION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Procter & Gamble

Sponsor Mentor/Advisor

Andy Fluxe, Mark Hayworth, Maria Papadaki

Project Mentor

Mike Nofziger

Team Members

Cole Lumsden	(MSE)
Steven Joe Murrell	(ECE)
Mohammad Rabata	(SE)
Maryam Amanda Tanbal	(OSE)
Jacob Robert Tevik	(OSE)
Jinghao Zhou	(ECE)

ECE = Electrical & Computer Engineering
MSE = Materials Science & Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15053 ▸ PROJECT SUMMARY

Residue on kitchenware in a dishwasher influences the decision to continue using a brand of detergent. The objective of this project is to design a system to quantify this residue and provide a cleanliness grade that mirrors how a human would visually grade the kitchenware. The team focused on measuring spotting and film left on knives, because knives can be modeled as mirrors. The team measured and graded cleanliness using distinctness of image, a metric that uses contrast degeneration to determine image degradation. For example, perfect mirrors reflect black and white stripes in sharp contrast, but a surface with degraded reflective properties blurs the distinction between the same black and white stripes. The team projected a striped pattern onto the knives and measured the degradation of distinction between segments imaged, investigating the correlation between cleanliness and distinctness of image.

DIRECT METAL LASER SINTERING TEMPERATURE MAPPING

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Honeywell Aerospace

Sponsor Mentor/Advisor

Edwin Martinez, Jim Neumann

Project Mentor

Jyoti Mukherjee

Team Members

Helal Suhail Almazrouei	(IE)
Alberto Becerra	(IE)
Ian T. Carr	(OSE)
Tao Yu	(ME)

ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
IE = Industrial Engineering

TEAM 15054 ▸ PROJECT SUMMARY

The project required the team to create a computational way to analyze efficiently the data generated by the build process of Honeywell's direct metal laser sintering additive manufacturing unit, which uses an EOSINT M80 3-D printer. The temperature of the material being sintered, and the rate at which the temperature changes, must be verified during printer operation. The high-powered laser used in the sintering process causes a major change in the temperature of each layer of the build. Printer data input to the software enables users to characterize the build in terms of heating and cooling rates, and peak temperature of material. The software notifies the user that analysis is complete and provides numerical and graphical data output for review and storage.

INDUSTRIAL MONITORING SENSORS FOR MACHINERY AND SYSTEMS TROUBLESHOOTING

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Texas Instruments

Sponsor Mentor/Advisor

Mark Irwin

Project Mentor

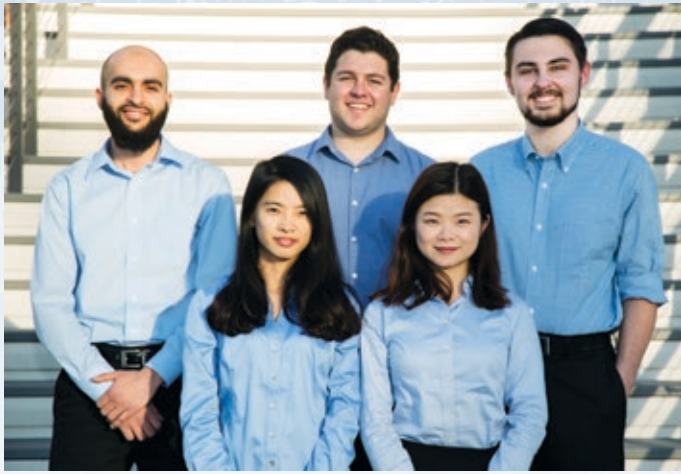
Clayton Grantham

Team Members

Gregory Alexander Depaul	(ECE)
Jose Luis Escobedo	(SE)
Xinran Fang	(ECE)
Chenmu Li	(ME)
Ezzulddin Imad Naji	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15055 ▸ PROJECT SUMMARY



The purpose of this project was to develop a portable remote sensor module to aid in troubleshooting by sensing real-world signals and recording the information over a selectable time period. The sensor module detects and records electrical current, temperature, light interruption, motion, and the presence of fluids. Recorded information is downloaded to a portable device such as a laptop or notebook, where users can view the data on an easy-to-understand graphical user interface. The sensor module uses the Texas Instruments MSP 430 microcontroller and several more of the company's precision operational and instrumentation amplifiers. The team designed the module to be marketable, with 15 percent profit margin as a minimum goal.

PERFORMANCE TOOLS FOR EVALUATING MICROELECTRO-MECHANICAL SYSTEM SENSORS

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Universal Avionics

Sponsor Mentor/Advisor
Steve Pagnucco

Project Mentor
Gary Redford

Team Members
Gregory Wilhelm Burleson (SE)
Ariel Munoz (OSE)
Joshua Uhlorn (BME)
Trevor Andrew Woodhouse (ME)

BME = Biomedical Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15056 ▸ PROJECT SUMMARY

Universal Avionics sometimes receives incorrect or inconsistent data from external inertial measurement and magnetic sensing units installed in its own attitude and heading reference system. The externally sourced units consist of gyros, accelerometers, and magnetometers and are classified as microelectromechanical system sensors. The sponsor has no way to test the external systems in-house and has to return them to the supplier. The team's objective is to create a test system that enables the sponsor to validate the functionality of the external units in-house. The system design includes communication with the units via a software interface, electrical power and communication, and a mechanical test system that simulates the environment of the unit installed on an aircraft. The environmental test system can be calibrated in the pitch, roll, and yaw directions and is strapped to a cart for mobility. The roll and pitch are adjusted using a precision tilt and turntable with the sensors mounted on top of the structure. The desired yaw direction is achieved by aligning pins on the cart with the sponsor's sight compass. Communication with the sensors is regulated via a graphical user interface and based on a custom circuit board containing three microprocessors and power regulators.

DESIGN OF A LAUNCH AND CAPTURE SYSTEM FOR SMALL UNMANNED AERIAL VEHICLES

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Northrop Grumman

Sponsor Mentor/Advisor
Dana Cordova

Project Mentor
Frank Oliver

Team Members

Callie Ann Branyan	(ME)
Reydesel Alejandro Cuevas	(ECE)
Sinan Elisha	(ME)
Nicole Louise Grisamore	(SE)
Megan Elizabeth Marquiss	(ME)
Luis Enrique Sepulveda	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15057 ▸ PROJECT SUMMARY

The team was asked to design and develop an assisted launch and capture system for unmanned aerial vehicles that can decrease takeoff and landing distance by 10 percent. The team tested the concept by designing and building a subscale prototype that uses compressed air to provide extra thrust sufficient to decrease the launch distance. For capture, the system slides the launch box from the center of the runway and uses a cable to catch the plane as it touches down. The cable provides the resistance to slow the plane down and stop it within the decreased landing limit. The modular design allows the system to launch and capture the plane efficiently without damaging it. The design can be scaled to accommodate full-size unmanned aerial vehicles and used for future testing.

FEASIBILITY STUDY OF ALTERNATIVE COOLING TECHNOLOGIES

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Lincus Energy

Sponsor Mentor/Advisor

Jorj Nofal

Project Mentor

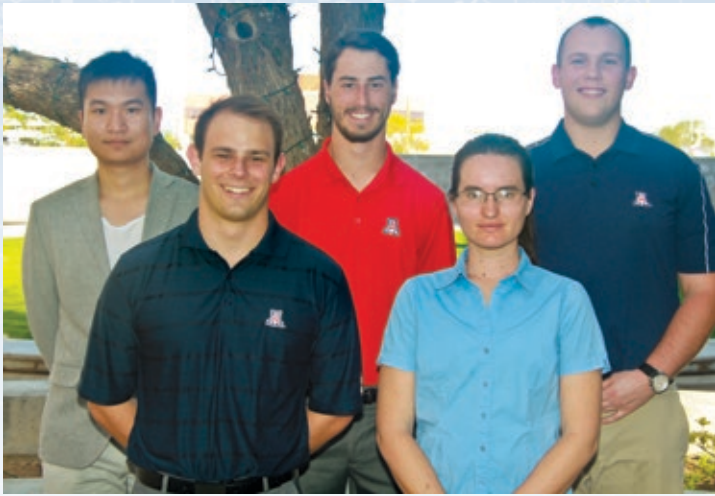
Gerald Pine

Team Members

Hunter Pitre Dixon	(ME)
Chang Jin	(ECE)
Connor Thomas McGreal	(ME)
Jason Scott Teich	(SE)
Aiva Elizabeth Teskey	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15058 ▸ PROJECT SUMMARY



The team was asked to review alternative cooling technologies for office buildings and single-family homes in Phoenix, Arizona. The typical structures selected for study were a 50,000-square-foot office building and a 2,500-square-foot single-family residence. Alternative cooling technologies were compared with respect to their energy efficiency, installed cost, and energy cost savings based on a typical utility company electric rate. The baseline cooling system is a standard efficiency direct-expansion cooling unit. The analysis used realistic building models to obtain cooling loads for input into the financial model and a cooling load model for each building type.

LIQUA-TELECENTRIC AUTOFOCUSING SYSTEM

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Edmund Optics

Sponsor Mentor/Advisor

Kurt Abdelmaseh, Jeremy Govier

Project Mentor

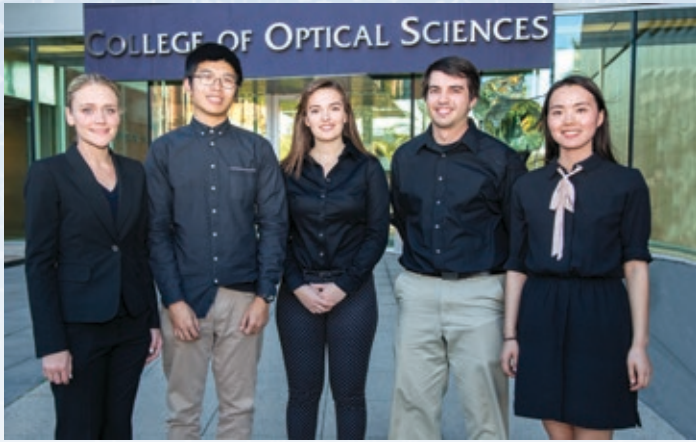
Mike Nofziger

Team Members

Yawei Ding	(ECE)
Olivia Fehlberg	(OSE)
Dana Kralicek	(OSE)
Timothy Ni	(ECE)
Edward Antonio Vergara	(SE)

ECE = Electrical & Computer Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15059 ▸ PROJECT SUMMARY



The project requires the team to design and test a telecentric optical system with autofocus capabilities for machine vision. The design integrates a liquid lens into an existing telecentric lens system, and incorporates both optical components with a control algorithm. The liquid lens provides the autofocus function without the use of mechanics to adjust the focus. The team had to solve problems such as camera selection, thermal stability, autofocus, maintaining object space telecentricity, and minimizing magnification change with focus. The algorithms accurately report to the user a view of the current focus and provide metrics for the user to decide how much to adjust the focus. The system was tested to meet optical specifications in a mounted environment with the test objective back-illuminated by a sodium source. Images captured of the test objective are processed against the magnification and modulation transfer function requirements and an adjustment to the focus of the system is patched to the liquid lens driver. Automating the focusing of this system allows for more efficient monitoring of any manufacturing process in which machine vision is a tool for qualitative analysis.

TEMPERATURE TESTING SYSTEM FOR BURIED GAS PIPES

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Southwest Gas

Sponsor Mentor/Advisor

Dominique Mitchell, John Spivey

Project Mentor

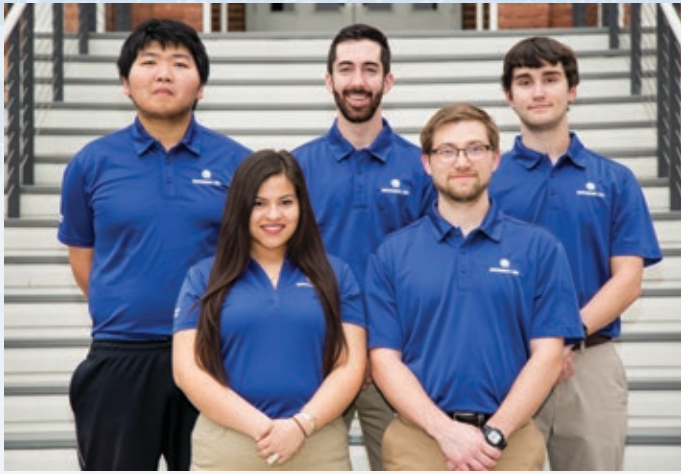
Bob Messenger

Team Members

Valeria Pinon Fuerte	(SE)
Caser Ray Johnson	(MSE)
Brandon Ross Mahoney	(ME)
Joshua Robert Malzahn	(CHE)
Jingwei Yuan	(ECE)

CHE = Chemical Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15061 ▸ PROJECT SUMMARY



High-density polyethylene, or HDPE, pipes are typically installed 18–36 inches below ground, where summer temperatures can exceed 110 degrees Fahrenheit in some areas. Southwest Gas is interested in quantifying the cooling effects of air moving through small-diameter HDPE pipes, and the goal of this project is to design and build a prototype system for testing 1-inch and 2-inch HDPE pipes. The test system varies the surrounding air temperature and the flow rate of the air moving through the pipe to user-defined values. Data is collected on volumetric flow rate, surrounding air temperature, and internal pipe pressure and combined with fundamental heat-transfer and pipe-flow knowledge to derive a temperature gradient denoting the cooling effect across the wall of the pipe.

MANUFACTURING VIRTUAL COMPANION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Continental Automotive Systems

Sponsor Mentor/Advisor

Fabian Machorro

Project Mentor

Jyoti Mukherjee

Team Members

Shaurya Aggrawal	(ME)
Xiuquan Fang	(ME)
Krystian Flores	(ECE)
Melesio Hernandez	(SE)
Ricardo Antonio Matty	(SE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15062 ▸ PROJECT SUMMARY

The goal of this project is to improve Continental's manufacturing efficiency and reduce human error by designing and building Virtual Companion, based on Vuzix M100 Smart Glasses, for assembly-line workers, who use multiple data sources to inform decisions and execute tasks. Several locations on the assembly line contribute to errors that lead to downtime and reduced efficiency.

The team designed algorithms and a user interface to help operators prioritize multiple upcoming tasks on the assembly line, enabling them to select the most important task for the effective functioning of the line. The system receives data from the assembly line modules and processes it to help the operator with real-time decision-making. The system also forewarns the operator of potential failure points in the upcoming assembly line process.

MULTIPURPOSE ROBOTIC MANUFACTURING CELL

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Continental Automotive Systems

Sponsor Mentor/Advisor

Fabian Machorro

Project Mentor

Jyoti Mukherjee

Team Members

Karla A. Beas	(SE)
Justin R. Gray	(ME)
Jonathan Glenn Hawkins	(ECE)
Quincy Mark Levien	(ME)
Kathleen Laura Stack	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15063 ▸ PROJECT SUMMARY

Continental Automotive Systems seeks to incorporate collaborative robots, designed to work side by side with human workers, into its existing assembly lines to increase plant efficiency and effectiveness. The design team was charged with designing and constructing a mounting frame for use in a collaborative manufacturing cell that can be integrated into current Continental assembly lines, where components are manually transferred from one stage to another. The team's collaborative manufacturing cell consists of a robotic arm, a MicroRAX frame, multiple pneumatic grippers, and a proximity sensor for safety. The manufacturing cell automatically transfers components from one location on the assembly line to another. The frame was designed so that the robotic arm could attach multiple grippers, which allows the manufacturing cell to transfer multiple components at once. The implementation of a collaborative assembly line robot will improve productivity, save space, and reduce cost.

OPTICS FOR AIRCRAFT SITUATIONAL AWARENESS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Securaplane Technologies

Sponsor Mentor/Advisor

Mike Boost

Project Mentor

Doug May

Team Members

Whit Bennett	(ECE)
Alex Joseph Erstad	(OSE)
Weslin Charles Pullen	(OSE)
Melanie Lee Sanez	(MSE)
Juldis Trakanthaloengsak	(ME)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
MSE = Materials Science & Engineering
OSE = Optical Sciences & Engineering

TEAM 15064 ▸ PROJECT SUMMARY

Taxiing aircraft cause an estimated $100 million worth of damage per year. To prevent such damage, Meggitt Securaplane has designed a forward-facing wingtip camera that acts much like backup cameras on cars. The complex curvature of the wingtip and its orientation with respect to the camera's optic axis cause an ordinary window to produce unwanted optical aberrations. The project's objective is to design a window that reduces aberrations in the final image from the camera. The team designed a window that was conformal with the aircraft wing on the outside, while changing the shape of the inside surface to remove the most aberrations. The window design includes a heating element to prevent mist and frost from accumulating on the window. Because installing the camera wire feed through the wings to the cockpit is extremely costly, the design includes an antenna to transmit high-quality images directly to the pilots.

COMMERCIAL-OFF-THE-SHELF INFRASTRUCTURE FOR A 1U CUBESAT

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
Raytheon Missile Systems

Sponsor Mentor/Advisor
Rigel Woida-O'Brien

Project Mentor
Doug May

Team Members

Benjamin Macleod Bossler	(ME)
Reed Matthew Hubbell	(ME)
Alfie C. Tsang	(SE)
Dean Michael Whitman	(ME)
Kaitlyn Elizabeth Williams	(OSE)
Steven Edward Wirth	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15065 ▸ PROJECT SUMMARY

CubeSat nanosatellites have a standard chassis size of 10 by 10 by 10 centimeters to allow low-cost space missions through the use of standardized components and launch systems. Many CubeSat missions, however, still cost tens of thousands of dollars because they use expensive space-rated components, creating a cost barrier for many CubeSat projects. The team was asked to develop a CubeSat infrastructure design costing less than $5,000 that uses off-the-shelf components, including a miniature transceiver, and 3-D printing for the internal structure. Off-the-shelf components include a Teensy 3.2 microcontroller and Arduino MicroModem for recording telemetry such as CubeSat surface temperature, system acceleration, attitude, and functionality; and a Yaesu VX-3R FM transceiver that uses amateur radio frequency for communications. The 3-D printer saves cost and mass, improves strength, and permits greater creativity in design beyond the standard CubeSat stack format.

WIRELESS LIGHTING FOR AIRCRAFT SLIDING SCREENS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

B/E Aerospace

Sponsor Mentor/Advisor

Ian Frost, Joe Warren

Project Mentor

Jyoti Mukherjee

Team Members

Jonathan Avila	(ECE)
Evan Lowell Hastings	(ME)
Joshua Hurley	(ECE)
Romeo Judeh	(ME)
Santiago L Solano	(SE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15066 ▸ PROJECT SUMMARY

The goal of this project is to enhance aircraft suite sliding doors with the addition of wireless lighting. Current super first class luxury suites have minimal or no lighting in the doors because of the limitation of exposing the wires, thus the design incorporates induction to transfer power wirelessly. The airplane power outlet supplies coiled transmitters generating a magnetic field, allowing power receivers on the door to supply enough current to turn the lights on. The design prototype also includes smart lights, which enable users to change the colors of each light area.

STORING TV MONITOR IN SUPER FIRST CLASS SUITE

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

B/E Aerospace

Sponsor Mentor/Advisor

Ian Frost, John Kuyper

Project Mentor

Jyoti Mukherjee

Team Members

Ivanna Barcelo	(SE)
Jose R. Migueles	(ME)
Robert Donald Miller	(ME)
Raul Mishiyev	(ME)
Jackson Mckay Pinney	(ME)
Hongning Shangguan	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
SE = Systems Engineering

TEAM 15067 ▸ PROJECT SUMMARY

The team's objective is to design and manufacture a microhydraulic-powered monitor-covering system for B/E Aerospace's super first class suites. The increasing size of television monitors in these suites has created a need to cover them up to improve the overall aesthetics of the cabins. To integrate the monitor-covering system into the existing interiors, the team had to carefully consider weight and size when determining a feasible design. The team created a monitor-covering mechanism consisting of composite blades set on rails to cover the television screen as needed. This mechanism uses a water-charged microhydraulic subsystem to power movement of the blades, giving an aesthetically pleasing solution that matches the style of the suites.

WEARABLE VIRTUAL REALITY CAMERA

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

Defiiant Technologies

Sponsor Mentor/Advisor

Brian Herrera

Project Mentor

Gerald Pine

Team Members

Rubi Roxana Ballesteros	(ECE)
Cory Stefan Boone	(OSE)
Brian Herrera	(ECE)
David Jordan Rico	(SE)
Andrew Mario Sharpe	(ME)
Robert Michael Starr	(ECE)
Zhaolong Zhang	(ECE)

ECE = Electrical & Computer Engineering
ME = Mechanical Engineering
OSE = Optical Sciences & Engineering
SE = Systems Engineering

TEAM 15068 ▸ PROJECT SUMMARY

The purpose of the project is to design and build a wearable virtual reality camera for use as a communication tool on social media. The team participated in a collaborative project between the Senior Design program and the McGuire Entrepreneurship Program. The Engineering team developed a wearable virtual reality camera to be used for 3-D social media while the Entrepreneurship team planned a path to market. The device, called Vidi VR, fits like eye glasses and contains small cameras above each eye that capture the user's exact perspective, and a stereo microphone to capture the sounds of the environment. The camera is connected wirelessly to the user's smartphone and experiences are sent to a virtual reality headset that lets the viewer experience a moment in realistic 3-D as if they were actually there. This patent-pending device will enable the transition from 2-D social media on smartphones to 3-D social media in virtual reality. Anyone with a smartphone can experience virtual reality via a $10 headset that uses their smartphone screen as the display, which lowers the barrier of entry into virtual reality.

DEFIBRILLATOR ECG ACQUISITION AND ANALYSIS

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

CardioSpark

Sponsor Mentor/Advisor

Carter Newton

Project Mentor

Gerald Pine

Team Members

Kevin Joel Arreaga	(BME)
Michelle Gary	(BME)
Nicholas Gage Schott	(BME)
Noel Hagos Teku	(ECE)
Alexandria Renae Yetter	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering

TEAM 15069 ▸ PROJECT SUMMARY

Automated external defibrillators are medical devices used to treat sudden cardiac arrest. If administered within minutes of cardiac arrest, a defibrillation shock can reset the heart to a normal synchronous rhythm and improve the outcome of cardiopulmonary resuscitation. The sponsor is interested in developing a prototype defibrillator intended for affordable personal ownership. The design emphasis is on small size, ease of use, and simplicity of function in light of FDA stipulations regarding safety and effectiveness. The goal of this project is to design the diagnostic front end of the defibrillator, which acquires, filters and digitizes the electrocardiogram sample. An algorithm analyzes heart rhythm and determines whether a shock is appropriate, as in the case of ventricular fibrillation or ventricular tachycardia, or not. The device's microcontroller determines actions required and if necessary can communicate with the shocking portion of the defibrillator designed by team 15071. All device activity is logged and stored.

UNMANNED AERIAL VEHICLE PAYLOAD OPTIMIZATION

Interdisciplinary Engineering Design Program

Class

ENGR 498A/B

Sponsor

UA Department of Electrical and Computer Engineering

Sponsor Mentor/Advisor

Jonathan Sprinkle

Project Mentor

Gary Redford

Team Members

Hala Alzarkan	(IE)
Christian Adolfo Becerra	(ECE)
Pierce Richard Simpson	(ECE)
Jacob Ernest Vigil	(ME)
Adam Williams	(ECE)

IE = Industrial Engineering
ECE = Electrical & Computer Engineering
ME = Mechanical Engineering

TEAM 15070 ▸ PROJECT SUMMARY

This project involves the integration of software algorithms and autonomous unmanned aerial vehicles, or UAVs, used for unmanned missions. It was initiated as part of Microsoft's Project Premonition to collect and analyze mosquitoes to look for early signs that potentially harmful diseases are spreading. The project is also part of the National Science Foundation's Cyber-Physical Systems Virtual Organization. The goal of the project is to design and build a UAV-based hook system to capture and retrieve a mosquito trap. The design includes an electropermanent magnet, Pixhawk autopilot system, cameras, and sensors. The UAV has sufficient power and agility to carry the payload through a specified course, and an algorithm has been modified to allow the UAV to perform certain other tasks. The combination of the designed physical system and the modified algorithm will be used in a competition to navigate through an obstacle course.

PORTABLE MANUAL EXTERNAL DEFIBRILLATOR: SHOCK CONTROL AND FUNCTION

Interdisciplinary Engineering Design Program

Class
ENGR 498A/B

Sponsor
CardioSpark

Sponsor Mentor/Advisor
Carter Newton

Project Mentor
Gerald Pine

Team Members

Lindsey Ann Bergquist	(MSE)
Michael Comeau	(ECE)
Andrew James Porter	(SE)
Carl Andrew Reusser	(SE)
Michael Patrick Sakata	(BME)

BME = Biomedical Engineering
ECE = Electrical & Computer Engineering
MSE = Materials Science & Engineering
SE = Systems Engineering

TEAM 15071 ▸ PROJECT SUMMARY

Automated external defibrillators are medical devices used to treat sudden cardiac arrest. If administered within minutes of cardiac arrest, a defibrillation shock can reset the heart to a normal synchronous rhythm and improve the outcome of cardiopulmonary resuscitation. The sponsor is interested in developing a prototype defibrillator intended for affordable personal ownership. The design emphasis is on small size, ease of use, and simplicity of function in light of FDA stipulations regarding safety and effectiveness. The goal of this project is to design the charging and shocking circuit elements to be used with the heart rhythm analytic algorithm developed by Team 15069. To deliver the required 200-joule shock, the charging and shocking circuit includes a large capacitor, a voltage multiplier, and a flyback transformer to ramp up the voltage. User-friendly and durable packaging was designed to protect the internal circuitry, and a model of the packaging was designed using SolidWorks and printed in 3-D using a static-sensitive material. The packaging also houses a speaker and LCD screen that provides prompts for user ease of mind while treating a patient. The packaging, shocking, and charging circuit will be integrated with the heart rhythm analytic algorithm to create the final product for CardioSpark.

REMOVAL OF BIOLOGICAL OXYGEN DEMAND & METAL IONS IN DAIRY PROCESSING WASTEWATER

Chemical and Environmental Engineering

Class
CHEE 442/443

Sponsor
Shamrock Foods

Sponsor Mentor/Advisor
Jack Garrett, Jim Kramer

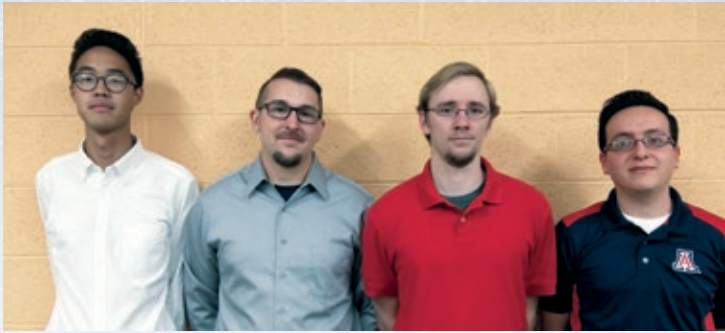
Project Mentor
Gregory E. Ogden

Team Members

Ismael Garcia	(CHE)
Austin Pyrek	(CHE)
Tate Brandon Tolson	(CHE)
Ben Heng Wu	(CHE)

CHE = Chemical Engineering

TEAM 15072 ▸ PROJECT SUMMARY



The Shamrock Farms processing facility produces 500,000 gallons of wastewater a day with levels of biological oxygen demand, chemical oxygen demand, total suspended solids, and metal ions that exceed allowable limits. The goal of this project is to reduce these levels to meet EPA specifications. The system design uses an anaerobic membrane bioreactor to reduce biological oxygen demand, chemical oxygen demand, and total suspended solids. The bioreactor produces methane that is captured and stored for further use within the facility; cell mass sludge that is separated, dewatered and sent to a municipal digesting facility; and a permeate stream that undergoes electrodialysis to remove metal ions, producing a brine to be processed by an evaporation unit, and a permeate to be treated with ultraviolet light to eliminate remaining biologicals. Processed permeate water can then be reintroduced into the facility.

SMART GLASS MANUFACTURING AND PHOTOBIOREACTOR DESIGN

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Lloyd LaComb, Kim Ogden

Project Mentor

Kim Ogden

Team Members

Gabrielle Nicole Tryon Ambrosio (CHE)
Dylan Jacob Kline (CHE)
Adam Louis Clayton Schmitt (CHE)
Brenna Maureen Wagner (CHE)

CHE = Chemical Engineering

TEAM 15073 ▸ PROJECT SUMMARY

The objective of this project is to design an efficient photobioreactor to produce algae as a food source for aquaculture. The design of the indoor photobioreactors incorporates smart glass, treated glass that refracts ultraviolet and infrared light to a solar cell while allowing visible light to pass through for algae to use in photosynthesis. The energy created by the solar cell could be used to offset energy consumption of a photobioreactor plant. The smart glass manufacturing facility designed by the team increases throughput, recycles waste, and conserves energy. These two processes could be combined to replace carbon-producing methods with carbon-consuming methods to help feed the world.

SELF-HEALING CONCRETE

Chemical and Environmental Engineering

Class
CHEE 442/443

Sponsor
Zelen Environmental

Sponsor Mentor/Advisor
Mike Kazz

Project Mentor
Kim Ogden

Team Members
Paola Andrea Lopez (CHE)
Katherine Ann Reynolds (CHE)
Sarina Ann Sedgwick (CHE)
Jean Wilkening (CHE)

CHE = Chemical Engineering

TEAM 15074 ▸ PROJECT SUMMARY

When exposed to varying temperatures, water, and stress, concrete develops tiny undetectable cracks that can spread and threaten its integrity until eventually it must be replaced. Self-healing concrete offers significant economic and environmental benefits. The goal of this project is to investigate the feasibility of using bacteria as a self-healing additive, and to design a plant for producing self-healing concrete. The concrete designed by the team includes dormant bacteria that are reactivated by water entering a crack. The bacteria naturally produce calcium carbonate, which seals the cracks resulting in a stronger, longer-lasting concrete. The team designed a system of bioreactors to cultivate the bacteria, Bacillus subtilis, which is added to lightweight aggregate, a component of concrete. The team also designed a plant to produce the cement necessary to make concrete. This design involves balancing the energy needs of several large crushers and grinders, a heating and cooling system, and a large kiln. The cement and aggregate are combined with water to form self-healing concrete.

SUSTAINABLE MICROBREWERY

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Kim Ogden

Team Members

Jacqueline A. Barrow	(CHE)
Ryan Cariaga Dormond	(CHE)
Christopher Ivan Hawkins	(CHE)
Sheng-Shuan Yeh	(CHE)

CHE = Chemical Engineering

TEAM 15075 ▸ PROJECT SUMMARY

Breweries use millions of gallons of water to make their products and sanitizing wastewater effluent is important to the brewing business. Despite significant improvement over the past two decades, water consumption and wastewater disposal remain environmental and economic hurdles. The goal of this project is to design a microbrewery that reduces biological oxygen demand, which is the amount of oxygen microorganisms need to break down soluble organic material, in the waste stream leaving the facility before it enters the municipal system. High biological oxygen demand means less oxygen in water for plants and animals and more work for city wastewater systems. The design has a blower system that aerates a stagnant pool of waste product, and an automated flow system to maintain the correct oxygen level. Optimal energy use is achieved when the pressure in the header is just sufficient to overcome the static pressure of the waste. In order to be more sustainable, the team also determined the feasibility of implementing a rooftop solar energy system.

DISTILLATION OF METHYL ETHYL KETONE FROM AN INDUSTRIAL WASTE STREAM

Chemical and Environmental Engineering

Class
CHEE 442/443

Sponsor
Zelen Environmental

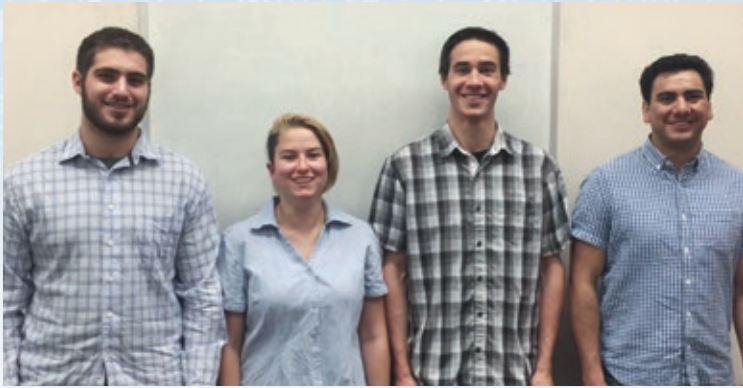
Sponsor Mentor/Advisor
Mike Kazz

Project Mentor
Kim Ogden

Team Members
Ari Samuel Auerbach (CHE)
Jazmin Jurkiewicz (CHE)
Benjamin Andre Mendiaz (CHE)
Gavan Kaoaoamakakuikalani Turner (CHE)

CHE = Chemical Engineering

TEAM 15076 ▸ PROJECT SUMMARY



The objective of this project was to develop a method to process an industrial waste stream consisting of methyl ethyl ketone and water. Distillation at various temperatures and pressures removes the bulk of the methyl ethyl ketone. Simulations and lab experiments were conducted to model the most effective conditions for removal and, to reduce costs, the remaining wastewater is processed using air stripping and thermal oxidation. This makes the water disposable by Pima County standards and removes sufficient methyl ethyl ketone to make the water reusable in the industrial process.

HELIUM EXTRACTION FROM CARBON-DIOXIDE-RICH PIPELINES

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Kim Ogden

Team Members

Aidan Io Blum	(CHE)
Jonathan Henry Dwyer	(CHE)
Michael J. Flammia	(CHE)
Cali M. Squire	(CHE)

CHE = Chemical Engineering

TEAM 15077 ▸ PROJECT SUMMARY

The National Helium Reserve is dwindling and new methods of helium extraction are required to meet global demand. The goal of this project is to design a system to produce helium with purity greater than 99 percent from industrial carbon dioxide pipelines with high helium concentrations. The team's solution is to feed the pipeline gas through a catalytic converter and pressure swing adsorption unit to remove most of the water and hydrogen sulfide. A compressor and condenser then remove carbon dioxide and hydrocarbons, leaving mostly helium and nitrogen, which is further compressed and condensed until liquefied. The stream then enters two distillation columns in series, which separate the helium from the nitrogen. The final product is high-grade helium, which is liquefied ready for transportation, and a separate stream of hydrocarbons and carbon dioxide that can be fed back into the pipeline.

HAZARDOUS COMPOUND DISINFECTION TRUCK DESIGN

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Kim Ogden

Team Members

Tyler Alanis	(CHE)
Daniel Diaz	(CHE)
Christopher Escalante	(CHE)
Hannah Ling	(CHE)

CHE = Chemical Engineering

TEAM 15078 ▸ PROJECT SUMMARY

The purpose of this project was to design a mobile hazardous compound disinfection truck to treat medical waste for proper disposal while extracting recyclable material from it. The design uses a continuous system that breaks down, disinfects, and stores many types of medical waste. An industrial-grade shredder reduces the volume of waste, which is then disinfected in an autoclave. This operation includes an optical sorting system that separates white paper and other cellulosic solids from medical waste for recycling. The design was based on extensive research and tours of recycling and trash facilities.

PROCESS IMPROVEMENT TO MINIMIZE FRACTURES IN WATER-SOLUBLE MANDRELS

Chemical and Environmental Engineering

Class
CHEE 442/443

Sponsor
Advanced Ceramics Manufacturing

Sponsor Mentor/Advisor
Zach Wing

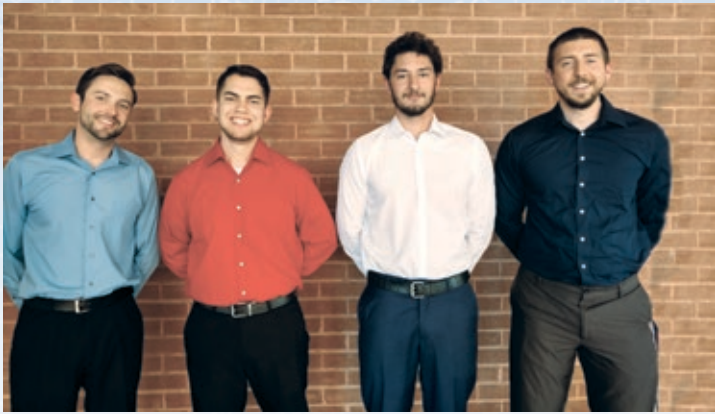
Project Mentor
Kim Ogden

Team Members

Matthew Nathaniel Bahr	(CHE)
Phillip Befus	(CHE)
Matthew Allen Fry	(CHE)
Juan Jose Sandoval	(CHE)

CHE = Chemical Engineering

TEAM 15079 ▸ PROJECT SUMMARY



The sponsor makes water-soluble mandrels to create products ranging from musical instruments to aerospace modules. The mandrels are composed of silica and alumina cenospheres, polyvinylpyrrolidone, and sodium silicate, which are formed into blocks and solidified, or cured, using carbon dioxide, microwave radiation, and convective heating. Mandrels can shear and crack, causing product loss, so the sponsor charged the team with finding a cost-effective and feasible solution to overcome compromised mandrel strength. The team analyzed the production process and investigated three potential sources of product damage. First, material composition was analyzed for any inconsistency, impurity, or noninteractivity that might cause weakness. Second, various curing methods were explored, such as carbon dioxide curing of sodium silicate for structure, and microwaving and using a constant-temperature convection oven to dehydrate and strengthen the mandrel. Third, transportation was investigated as a potential source of mandrel stress and rupture.

LITHIUM CARBONATE EXTRACTION FROM MCDERMITT CLAY

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

Process Engineering Associates

Sponsor Mentor/Advisor

Eugenio Iasillo

Project Mentor

Kim Ogden

Team Members

John Martin Bernal	(CHE)
Lauren M. Chon-Lopez	(CHE)
Scott Daniel Jauch	(CHE)
Diana I. Pantoja	(CHE)

CHE = Chemical Engineering

TEAM 15080 ▸ PROJECT SUMMARY

The International Energy Agency predicts that hybrid electric vehicles will account for 20 percent of global lithium sales by 2050, and lithium carbonate batteries are in demand for their higher voltages, energy content, chemical stability, long storage life, and good ionic conduction at ambient temperatures. The goal of this project is to design a production plant for lithium carbonate extracted from McDermitt clay found in Nevada and Oregon. The plant is expected to produce 56 tons of lithium carbonate per year from a feed of 2,000 tons of McDermitt clay per day. Key factors analyzed include a clay-gypsum-limestone feed ratio of 5:2:2, power costs for kiln and roaster, and crystallization parameters for glaserite and Glauber's salt byproducts.

HYDRODESULFURIZATION OF DIESEL FUEL TO MEET NEW EPA REQUIREMENTS

Chemical and Environmental Engineering

Class
CHEE 442/443

Sponsor
UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor
Kim Ogden

Project Mentor
Fred Brinker

Team Members

Jason Allen Green	(CHE)
Fausto Israel Mares-Davila	(CHE)
Toluwani Michael Omotinugbon	(CHE)
Jun Terashima	(CHE)

CHE = Chemical Engineering

TEAM 15081 ▸ PROJECT SUMMARY

When the EPA reduced the sulfur content allowable in diesel fuel to 15 ppm in 2010, many refineries had to upgrade their hydrodesulfurization units to meet the new limit. The objective of this project is to design an upgraded catalytic hydrodesulfurization unit that can treat 35,000 barrels per stream day of liquid feedstock containing 1.9 percent sulfur by weight. Performance data from an existing catalytic hydrodesulfurization unit was used to predict the performance of the upgraded unit. ChemCAD software was used for process calculations and the feed was modeled using boiling curve data. The desulfurization reaction kinetics were based on the reduction of dibenzothiophene. The project goals are 99 percent recovery of diesel fuel and a sulfur content below 15 ppm. To achieve these recovery levels the liquid feedstock is run through a catalyst-filled packed-bed reactor, where the sulfur compounds react with hydrogen gas to form hydrogen sulfide gas. The reactor effluent is run through a distillation column to separate the diesel fuel from the naphtha. More volatile and noncondensible compounds, such as butane, propane, nitrogen, and carbon dioxide, are run through an amine process to remove the hydrogen sulfide from the hydrogen recycle stream. Hydrogen is provided from a nearby hydrogen plant.

REFRIGERANT REPLACEMENT FOR THE UNIVERSITY OF ARIZONA'S CENTRAL COOLING SYSTEM

Chemical and Environmental Engineering

Class
CHEE 442/443

Sponsor
UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor
Kim Ogden

Project Mentor
Paul Blowers

Team Members

Iesha Monique Batts	(CHE)
Jasper Louie Tang Sia	(CHE)
Luke Brian Yarnall	(CHE)
Rodney Tadiwa Zinyemba	(CHE)

CHE = Chemical Engineering

TEAM 15082 ▸ PROJECT SUMMARY

The University of Arizona is nationally recognized for its central cooling system, but the three cooling sites on campus use 1,1,1,2-tetrafluoroethane, or HFC-134a, a known greenhouse gas that is likely to be banned in the future. The goal of this project is to find a refrigerant that could replace HFC-134a and determine what changes would need to be made to existing cooling sites to accommodate its use. A mathematical model of the entire refrigeration cycle was created to experiment with different refrigerants and determine the best replacement. Another objective of the project was to determine how choice of power source affects greenhouse gas emissions from the refrigeration process.

SOLAR-POWERED WHISKEY STILL

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Gregory E. Ogden

Team Members

Owen Michael Bertelsen	(CHE)
Hanah Veronica Boles	(CHE)
Erik Gibson Pastor	(CHE)
Austin Christopher Pudwill	(CHE)

CHE = Chemical Engineering

TEAM 15083 ▸ PROJECT SUMMARY

The goal of this project is to design a process to produce 90-proof whiskey using solar energy. The project is located in Yuma, Arizona, which experiences the nation's highest direct normal irradiance. Solar energy is gathered using a series of rotating parabolic mirrors that reflect light onto a tube located at the foci. The tube is transparent, vacuum-sealed, and contains a heat-transfer fluid designed to absorb solar energy, which is transferred to a series of two distillation columns. After dilution of the purified ethanol, the final product is 90-proof whiskey.

BIODIESEL GLYCERIN FRACTION SEPARATIONS

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

Grecycle

Sponsor Mentor/Advisor

Mike Kazz

Project Mentor

Kim Ogden

Team Members

Austin Dougless	(CHE)
Kayla A. Kraus	(CHE)
Karla Y. Murrieta	(CHE)
Kendra Lynn Staggs	(CHE)

CHE = Chemical Engineering

TEAM 15084 ▸ PROJECT SUMMARY

The University of Arizona biodiesel pilot plant converts waste cooking oil from student union restaurants into biodiesel to fuel campus vehicles. With community partner Grecycle, students have built a 100-gallon single-reactor plant and quality-testing laboratory to convert the waste oil into biodiesel that meets quality standards of the American Society for Testing and Materials. The goal of this project is to optimize separation of the biodiesel byproduct stream to recover methanol for recycling and separate water and glycerin, thus creating products of higher purity and value. The team used Aspen and ChemCAD software to simulate a pilot-scale divided-wall column separation method, and is developing a process template for future pilot- and large-scale biodiesel operations.

MEMBRANE DISTILLATION AS AN INDUSTRIAL-SCALE PROCESS

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Eduardo Saez

Project Mentor

Kim Ogden

Team Members

Sarah Abigail Brunswick	(CHE)
Tucker Hair	(CHE)
Martin Alexander Rubio	(CHE)
Jazryc Tatum	(CHE)

CHE = Chemical Engineering

TEAM 15085 ▸ PROJECT SUMMARY

Coastal desalination plants can release waste brine to the ocean, but inland plants are left with a generally unprofitable byproduct that can be costly to dispose of. The Kay Bailey Hutchison inland plant in El Paso, Texas, treats brackish groundwater, which is too salty for potable use but less salty than seawater, using reverse osmosis to produce 15.5 million gallons per day of potable water and 3 million gallons per day of brine waste. The purpose of this project is to design a membrane distillation desalination method to reduce this brine waste and increase the plant's output of potable water. Membrane distillation involves heating feed water to evaporation and running it along one side of a membrane. On the other side is flowing air, which causes pure water vapor to move through the membrane, leaving the salts and other dissolved solids behind. Modeling was used to design and optimize the membrane distillation process specifications and units, based on water composition and a conscious effort to minimize energy demands. Membrane distillation is typically a standalone process, often solar-powered, and this project determines the viability of using it on an industrial scale to further treat brine waste from reverse osmosis.

ETHANOL PLANT REPURPOSING

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Kim Ogden

Team Members

Michael Gabriel Bauman (CHE)
William M. Blair (CHE)
Joseph Daniel Gaul (CHE)

CHE = Chemical Engineering

TEAM 15086 ▸ PROJECT SUMMARY

The goal of this project is to design a modification enabling a plant that produces ethanol for E85 fuel to switch production to spirits such as whiskey. The Pinal Energy ethanol plant in Maricopa, Arizona, was used as a basis for modeling ethanol production. The design uses a new and proprietary technology that pumps ethanol through flavor additives such as oak chips, using a packed-bed reactor, to age whiskey about 120 times faster than standard barrel aging. During normal ethanol production, denaturant is added in the final step to avoid alcohol taxation. The modified plant design removes this last step and includes piping to the new whiskey-aging vessels. The whiskey produced would be roughly 80-120 proof. Other byproducts that could be sold are carbon dioxide and dried distiller's grain. The plant would be modified for two months of the year for whiskey production. Ethanol would be produced for eight months, with two months set aside for the plant to change processes. The ethanol plant produces 50 million gallons of ethanol per year. The modified plant would produce approximately 33 million gallons per year of ethanol and 16 million gallons per year of whiskey.

INDUSTRIAL TRANSESTERIFICATION OF CULTIVATED ALGAE FOR BIOFUEL

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Kim Ogden

Team Members

Brian Palmer Balch	(CHE)
Christopher M. Jabczynski	(CHE)
Kate Marie LaRue	(CHE)
Connor James Swensen	(CHE)

CHE = Chemical Engineering

TEAM 15087 ▸ PROJECT SUMMARY

The objective of this project is to design a chemical plant that uses cultivated algae, a sustainable energy source, grown on-site to produce carbon-neutral biofuel. The design includes a supercritical carbon dioxide extractor for the triglycerides in the algae cells, base-catalyzed transesterification in continuously stirred reactors in series, and final separation processes to produce a high-grade biofuel. The environmental considerations of the design include using carbon dioxide for algae growth and the solid-extraction process, and using methanol for the transesterification and liquid extraction, which makes recycling easy and further reduces the fuel's environmental footprint.

MANUFACTURING OF MATERIAL-BASED HYDROGEN FUEL FOR LIGHTWEIGHT VEHICLES

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

UA Department of Chemical and Environmental Engineering

Sponsor Mentor/Advisor

Kim Ogden

Project Mentor

Paul Blowers

Team Members

Solomon Roberto Figueroa (CHE)
Ali Khaghani (CHE)
Ian Middleton O'Malley-Keyes (CHE)
Jared Peter Souza (CHE)

CHE = Chemical Engineering

TEAM 15088 ▸ PROJECT SUMMARY

Vehicles powered by hydrogen fuel cells store hydrogen as a cooled liquid at 20 kelvin or a compressed gas at 10,000 pounds per square inch. An alternative that eliminates the need for these extremes of temperature and pressure is to heat a compound containing covalently bonded hydrogen, causing it to release the hydrogen to the fuel cell. Ammonia borane, which is stable at ambient conditions, requires minimal energy for dehydrogenation, and is rich in hydrogen, is a possible storage medium for hydrogen. If a viable storage system could be engineered, demand for ammonia borane as a source of hydrogen would increase. The goal of this project is to develop a processing plant and to optimize design specifications for scaling up processing of ammonia borane through the metathesis reaction pathway. Optimization of individual unit operations was determined using quality-by-design concepts, which allowed the team to confirm scalability, design limitations, and competitive market pricing. The final design involves the application of two mixers, two reactors, and four separators. The plant design should yield 99 percent pure ammonia borane.

VACUUM IMPREGNATION OF CHIP CAPACITORS FOR THE REDUCTION OF WATER CORROSION

Chemical and Environmental Engineering

Class

CHEE 442/443

Sponsor

Sigma Technologies International Inc.

Sponsor Mentor/Advisor

Ernesto Barraza

Project Mentor

Ernesto Barraza

Team Members

Zhewei Cai	(CHE)
Israel De La Cruz	(CHE)
Ning Du	(CHE)
David Humberto Lopez	(CHE)

CHE = Chemical Engineering

TEAM 15089 ▸ PROJECT SUMMARY

Potting protects electronics components from shock, vibration, and moisture by encapsulating them in substances like epoxies, silicones and urethanes, but vacuum impregnation is superior because it removes air and allows the potting material to fill micropores and channels. The goal of this project is to design a vacuum impregnation system that protects capacitors against corrosion by water. The system consists of a vacuum chamber connected to a sealed rotary vane pump. Capacitors and a range of potting agents are placed under vacuum at -15 inches of mercury, which degasses them, and the capacitors are coated with potting material. Vacuum is released and reapplied several times to ensure that voids in the capacitors are degassed and filled with potting material. Potted components are cured in an oven and kept in a humidity chamber for a week at 100 percent humidity and 90 degrees Celsius. Capacitance is monitored during this period; changes in capacitance are directly correlated to water corrosion in the capacitors.

CONTROLLED ENVIRONMENT FOR PLANT PRODUCTION

Agricultural and Biosystems Engineering

Class

ABE 498 A/B

Sponsor

UA Department of Agricultural and Biosystems Engineering

Sponsor Mentor/Advisor

Russ Abney

Project Mentor

Peter A. Livingston

Team Members

Maya Aldaghi	(BE)
Riley Jake Anderson	(BE)
Brooke Christine Conrardy	(BE)
Michael A. Lopez	(BE)
Haley Marit Odom	(BE)
Michael J. Pearse	(BE)

BE = Biosystems Engineering

TEAM 15090 ▸ PROJECT SUMMARY

The rise of food deserts, areas in which affordable and nutritious food is hard to find, prompted this project to design and build a compact and efficient hydroponic system housed within a shipping container that can be transported to such areas. The constrained area of the shipping container led to a design using two high-density growth hydroponic systems covering 200 square feet, in which Butterhead lettuce was grown in deep flow and nutrient film technique systems. Development of specifications and design of the lighting, nutrient, and growth system was based on research by the agricultural and biosystems engineering department and consultation with engineering experts. This mobile engineered system gives food desert communities the power to end the drought.

IRRIGATION INFRASTRUCTURE

Agricultural and Biosystems Engineering

Class

ABE 498 A/B

Sponsor

UA Department of Agricultural and Biosystems Engineering

Sponsor Mentor/Advisor

Russ Abney

Project Mentor

Peter A. Livingston

Team Members

Nicole Xuan Bui	(BE)
Patrick William Bush	(BE)
Brooke Christine Conrardy	(BE)
Ashley C. Hanno	(BE)
Victoria Alexandra Karlsson	(BE)
Claire Kristin Tritz	(BE)

BE = Biosystems Engineering

TEAM 15091 ▸ PROJECT SUMMARY

The purpose of this project is to design and install an irrigation system for a greenhouse built inside a shipping container. This system needs to provide sufficient quantity and quality of water to plants in a nutrient film technique system and in deep-flow hydroponics trays. A closed, self-sustaining system, with an ultraviolet filter on its exit pipes, was designed to allow reuse of irrigation water. The team chose a one-tank design to save space and water. When the deep-flow hydroponics trays are filling, no water is running through the nutrient film technique system. When the trays are full, the pump switches to circulating water through the nutrient film technique system. Shelf and outlet height are adjustable to accommodate different plants, which are fertilized by depositing nutrients directly into the water. A water outlet is provided for humidifiers.

CONTROLLED ENVIRONMENT FOR MUSHROOM PRODUCTION

Agricultural and Biosystems Engineering

Class

ABE 498 A/B

Sponsor

UA Department of Agricultural and Biosystems Engineering

Sponsor Mentor/Advisor

Russ Abney

Project Mentor

Peter A. Livingston

Team Members

Perla E. Ballesteros	(BE)
Brooke Christine Conrardy	(BE)
Qianwen Luo	(BE)
Elan C. Snitkin	(BE)

BE = Biosystems Engineering

TEAM 15092 ▸ PROJECT SUMMARY

While satisfying nutritional needs, mushroom cultivation is financially sustainable and can supplement carbon dioxide required by plants in a crop-production system. The goal of this project is to design and build an efficient and cost-effective mushroom growth chamber as part of a larger system of crop production.

The mushroom-growing system design consists of storage shelves, fruiting chambers, a laminar flow hood, and a humidity control system. The design includes a cabinet to convert the laminar flow hood to an inoculation station and a humidifier with microcontroller-based sensor control. The layout of the fruiting chambers and walking areas meet safety requirements and were designed in cooperation with the plant production and irrigation infrastructure teams (Teams 15090 and 15091). Through controlled environment practices, the mushroom growing system will deliver a nutritionally dense product to offset food insecurity, and provide an opportunity for further research.

OPTICALLY-PAIRED MICROFLUIDICS FOR E. COLI DETECTION

Agricultural and Biosystems Engineering

Class

ABE 498 A/B

Sponsor

UA Department of Agricultural and Biosystems Engineering

Sponsor Mentor/Advisor

Peter A. Livingston

Project Mentor

Peter A. Livingston

Team Members

Ella Monique Anguiano	(BE)
Vicki Chu	(BE)
Alexandra Michelle Downs	(BE)
Bailey Alleen Warner	(BE)

BE = Biosystems Engineering

TEAM 15093 ▸ PROJECT SUMMARY

Contamination of food and water by E. coli is a major global health problem. Although most strains are harmless, some are pathogenic and can cause food poisoning, severe infection, and death. The goal of this project is to design a system to optically detect E. coli in real time, with a focus on developing a device to read paper microfluidic chips, which are a low-cost, biodegradable sensing platform. Antibody-conjugated particles placed on a paper chip bind when exposed to E. coli, resulting in a change in optical signal caused by particle-size-dependent scattering. Current detection methods require smartphone processing and computational software, and are prone to error and false readings caused by inconsistent ambient lighting. The process was made more precise by creating a device that reads red, green and blue values of scattered light in a closed casing produced by 3-D printing. Using an Arduino microcontroller instead of a smartphone and desktop software reduces cost and makes the sensor more feasible for use in developing nations. The device could be adapted to detect other bacteria.

MACADAMIA NUT HARVESTER

Agricultural and Biosystems Engineering

Class
ABE 498 A/B

Sponsor
UA Department of Agricultural and Biosystems Engineering

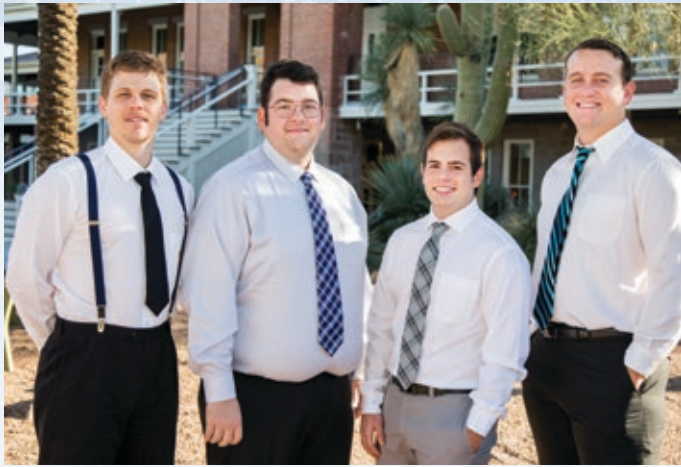
Sponsor Mentor/Advisor
Mike Hammer, Charles Defer

Project Mentor
Peter A. Livingston

Team Members
Kenneth John Hickman (BE)
Bryce Richard Kirkpatrick (BE)
Ryan Lester Neighbor (BE)
Marko Obradov (BE)

BE = Biosystems Engineering

TEAM 15094 ▸ PROJECT SUMMARY



Macadamia nuts are a valuable cash crop in Hawaii. Commercial harvesting requires at least three types of heavy machinery, each with a single specialized function. The project's purpose is to design and prototype a single robotic nut-harvesting vehicle to replace the multiple machines currently used, facilitating faster harvesting and eliminating the cost of harvesting by hand. The robotic machine must be able to navigate a macadamia nut orchard with minimum human interaction for the nine-month harvesting season. The objective is to increase crop yield from conventional small-scale harvesting methods, and to provide a consistent harvesting schedule for Kawainui Farm. The vehicle platform was designed to accommodate a hopper in which to collect nuts, electrical components for power and navigation, and a pickup head to collect nuts on the ground. The vehicle relies on GPS and computer vision to navigate a preprogrammed path through the orchard. Hawaii's heavy rainfall limits GPS use, so the vehicle can be manually radio controlled.

VINCENT MULLINS LANDFILL BRIDGE

Civil Engineering and Engineering Mechanics

Class

CE 408 A/B

Sponsor

UA Department of Civil Engineering and Engineering Mechanics

Sponsor Mentor/Advisor

Mick Mathieu

Project Mentor

Mick Mathieu

Team Members

Joe Thomas Griffin	(CE)
Alan Lorenzo Hatch	(CE)
Ali Taleb B. S. Mostafawi	(CE)
Benjamin James Sanders	(CE)
Indani Joshua Tabani	(CE)

CE = Civil Engineering

TEAM 15096 ▸ PROJECT SUMMARY

The goal of this project is to design a roadway in Tucson, Arizona, that extends from the existing Sabino Canyon Road south to connect to Kolb Road over the Vincent Mullins Landfill and across Pantano Wash. The roadway would ease traffic conditions at this site, which exceed design capacity during morning and evening peak hours. The project encompasses transportation, hydrological, structural and geotechnical design, and an environmental assessment. The team followed City of Tucson design codes and regulations, load and resistance factor design, and American Association of State Highway and Transportation Officials bridge design manuals during the design process. Different load combinations were used to design the 43-foot bridge deck span, which includes four traffic lanes, two pedestrian pathways, and parapet walls for safety. The team chose a slab design for its constructability. Based on soil types and soil borings, a geotechnical support structure was designed to elevate the span above the Vincent Mullins Landfill. A full hydrological analysis was conducted to evaluate the runoff from a neighboring park into an existing culvert, as well as drainage from the roadway. The Hydrologic Engineering Center's River Analysis System, or HEC-RAS, developed for the U.S. Army Corps of Engineers, was used to determine if channel improvements were necessary to convey stormwater runoff from the roadway and park to Pantano Wash. Environmental permitting and stormwater pollution prevention plan were completed to satisfy City of Tucson codes.

X-56A AEROELASTICALLY SCALED MODULAR AIRCRAFT FOR RESEARCH

Aerospace Engineering

Class

AME 420/422

Sponsor

UA Department of Aerospace and Mechanical Engineering

Sponsor Mentor/Advisor

Hermann Fasel

Project Mentor

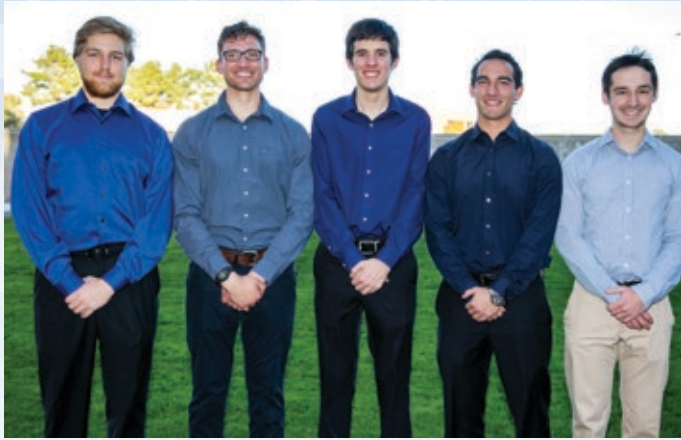
Hermann Fasel

Team Members

John Alexander Casey	(AE)
Dustin Taylor Leighty	(AE)
John Meersman	(AE)
Nicholas Robert Merendo	(AE)
Salvatore Antonio Vitale	(AE)

AE = Aerospace Engineering

TEAM 15098 ▸ PROJECT SUMMARY



This project continues the development of a one-third aeroelastically scaled model of the X-56A, an unmanned aerial vehicle designed by Lockheed Martin. The X-56A Multi-Utility Technology Test bed is used by the Air Force Research Laboratory to research flutter suppression on flexible wings. The team's design maintains the modularity of the full-scale X-56A, allowing for wing sets of varying stiffness to be combined with a single fuselage and radio control system. Straight-wing planforms and empennage were designed and integrated for increased stability during flight research. The use of room-temperature composite manufacturing techniques allowed the flexural properties of each wing set to be tailored to dynamically and elastically match the low- and high-stiffness wings of the full-size X-56A. Using fiber-reinforced composites allowed exact surfaces to be replicated across iterations of wing sets and parts to be easily reproduced. Ultimately, the team's design will be used by the Air Force Office of Scientific Research to investigate fluid-structure interaction and novel fluid dynamics models.

UNMANNED AERIAL VEHICLE TEST BED FOR CONTROL THEORY IMPLEMENTATION

Aerospace Engineering

Class

AME 420/422

Sponsor

UA Department of Aerospace and Mechanical Engineering

Sponsor Mentor/Advisor

Eniko Enikov

Project Mentor

Eniko Enikov

Team Members

Ethan Ryan Burnett	(AE)
Alberto Fabian Garner	(AE)
Jacob Spencer Gold	(AE)
Conner Louis LaMont	(AE)
Brielle Munsch	(AE)
Tierra M. Roller	(AE)

AE = Aerospace Engineering

TEAM 15099 ▸ PROJECT SUMMARY

The goal of this project is to design, construct and fly an unmanned aerial vehicle, or UAV, by computer control using a feedback-based program. Feedback loops take the system output into consideration, which enables the system to adjust its performance to meet a desired output response. For aircraft, a human pilot traditionally does this. For a UAV, the controller receives a signal and compares it to the desired signal value, then sends a corrected signal based on this comparison. This process repeats rapidly throughout the mission. In this design, the feedback-control system sends thrust and angle values to the flight controller, analyzes the reaction, and then sends corrected values. The control program can be uploaded to the aircraft for a mission instead of using a human pilot. The small, durable UAV is designed for indoor flight to enhance a control theory class by adding hands-on experience. The communication ground station can toggle between manual and computer control. The scope of this project is to demonstrate system communication, simple computer-controlled commands, and aircraft flight performance.

DESIGN/BUILD/FLY AIRCRAFT DESIGN COMPETITION

Aerospace Engineering

Class

AME 420/422

Sponsor

AIAA Student Chapter

Sponsor Mentor/Advisor

Jeff Jepson

Project Mentor

Jeff Jepson

Team Members

Ivan Almirudis	(AE)
Nicholas Michael Bley	(AE)
Kenneth Harrison Decker	(AE)
Julie Ann Imbornoni	(AE)
Jacob Kaplan	(AE)
Rolland Prempeh	(AE)

AE = Aerospace Engineering

TEAM 15100 ▸ PROJECT SUMMARY

The team's objective is to build two radio-controlled electric-powered aircraft in accordance with the rules of the American Institute of Aeronautics and Astronautics Design/Build/Fly competition. The production aircraft must be able to carry a 32-ounce soft drink bottle internally and complete a timed flight mission. It must be able to be disassembled and loaded into a manufacturing support aircraft, which also has to complete the flight mission. The team's objectives are to build the lightest possible planes and to minimize the subassemblies of the production aircraft. The team opted for two subassemblies and designed an aircraft with a minimized front profile that enabled optimization of size and weight. Manufacturing techniques include foam core composite prototyping, 3-D printing, carbon fiber wing layups, and precision, laser-cut wood structures. Using these techniques in tandem with mission-specific designs resulted in two aircraft capable of achieving a maximum score under competition rules.

AILERON DROOP MECHANISM FOR THE CLIPPER SPIRIT SEAPLANE

Aerospace Engineering

Class

AME 420/422

Sponsor

The New Nose Company Inc.

Sponsor Mentor/Advisor

Charles Simpson

Project Mentor

Edward Kerschen

Team Members

Matthew Kenneth Aaserud	(AE)
Pengcheng Cai	(AE)
Alejandro Daniel Castanos	(AE)
Daniel Ito	(AE)
Tynan Mark Newman	(AE)
Luke Aspen Stangl	(AE)

AE = Aerospace Engineering

TEAM 15101 ▸ PROJECT SUMMARY

When at rest on the water, the Clipper Spirit seaplane has one wing buoyed and the other suspended in air, which requires additional roll authority to stabilize the aircraft during takeoff and landing. The project goal is to design a mechanism that droops or retracts the ailerons during takeoff and landing, creating more lift at the wing tips, where the ailerons are located, which effectively adds roll authority. The droop mechanism must be purely mechanical, be independent from and not interfere with the aileron control system, retract or extend the bias linearly from 75 to 100 knots, and be free from pilot input. The design meets this requirement by using dynamic pressure to displace a piston. The piston linearly displaces a rack that turns a set of gears, the last of which is mounted on the aileron control shaft. When the gear rotates it will also rotate the shaft, which will effectively lengthen or shorten the control shaft depending on whether the ailerons are being drooped or retracted. Rotation changes shaft length by threading it into or out of the control horn, which translates into a droop or retraction of the aileron.

RED CACTUS WILDLIFE VERTICAL TAKEOFF AND LANDING UNMANNED AIRCRAFT SYSTEM

Aerospace Engineering

Class

AME 420/422

Sponsor

UA Department of Aerospace and Mechanical Engineering

Sponsor Mentor/Advisor

Sergey Shkarayev

Project Mentor

Sergey Shkarayev

Team Members

Parisa Footohi	(AE)
Andrew Granatstein	(AE)
Gibong Koo	(AE)
Daoyang Liu	(AE)
Cameron Michael Vissers	(AE)

AE = Aerospace Engineering

TEAM 15102 ▸ PROJECT SUMMARY

The objective of this project is to design, manufacture, and test an unmanned aircraft system capable of vertical takeoff and landing for wildlife surveillance. Red Cactus is a blended-body flying wing with vertical-thrusting ducted propellers and a horizontal-thrusting pusher propeller that enable vertical, horizontal, and hover flight modes. This hybrid design allows the aircraft to take off from a stationary ground position, cruise four miles to a desired target, loiter over the target for 15 minutes, and cruise back to the original location to land. Hybrid aircraft combine elements of fixed-wing aircraft with elements of multirotor aircraft to deliver multifaceted mission capabilities. The aircraft has no tail so its wing is constructed with an Eppler 330 reflex airfoil to provide stability during cruise. The aircraft cruises at 36 mph at 500 feet above ground level, using elevons (ailerons combined with an elevator) on each wing as control surfaces. The aircraft weighs 12 pounds and is fabricated from various weights of vacuum-formed composite fiberglass for the outer skin, carbon fiber tubing, plastic parts made using a 3-D printer, and balsa wood ribs for the internal structure. The internal structure consists of a network of spars joined to a large, stiff duct located in the center of the blended body, which houses two 15-inch counter-rotating lifting propellers.

HAUL TRUCK UPGRADE FEASIBILITY STUDY FOR AN OPEN-PIT PERUVIAN COPPER MINE

Mining & Geological Engineering

Class
MNE 498

Sponsor
Freeport McMoRan

Sponsor Mentor/Advisor
Timothy Smith

Project Mentor
John Kemeny

Team Members

Alyssa Hom	(MNE)
Christa Boon	(MNE)
Derrick Hendrix	(MNE)
Derek Bowerman	(MNE)

MNE = Mining Engineering

TEAM 15103 ▸ PROJECT SUMMARY

An optimized mining production fleet improves the safety, efficiency, and profitability of a mining operation. This project determines the feasibility of a Peruvian copper mine using larger trucks to cope with a rapid increase in production during the next 30 years. The infrastructure on the site, the crusher in particular, is already equipped to process a larger throughput of material. Most of the trucks in the operation's current fleet have a nominal payload of 218 metric tons, which could increase to 327 or 363 metric tons with new trucks from various manufacturers. Ascertaining the most profitable course of action for this mine site involved assessing existing and replacement trucks for capital, operating, overhaul, maintenance, and rebuild costs, and manipulating the data in spreadsheets to determine how many new trucks would be needed and how many would need to be rebuilt during the next 30 years.

THE UNIVERSITY OF ARIZONA
College of Engineering

SCAN THIS QR CODE TO
GET THE DESIGN DAY APP ▶▶▶▶▶▶

THANK YOU TO OUR 2016 ENGINEERING DESIGN DAY SPONSORS

Aviation Communication & Surveillance Systems ▸ Advanced Ceramics Manufacturing ▸ Arizona Technology Council Foundation ▸ B/E Aerospace ▸ Boeing ▸ The Bly Family ▸ CardioSpark ▸ Caterpillar ▸ Continental Automotive Systems Control Vision ▸ Dataforth Corp. ▸ Defiiant Technologies ▸ Edmund Optics ▸ Freeport McMoRan ▸ Grecycle ▸ Honeywell Hydronalix ▸ II-VI Optical Systems ▸ Kristy Pearson ▸ Latitude Engineering ▸ Lightsense Technology ▸ Lincus Energy NeuroMetrix ▸ New Nose Company ▸ Northrop Grumman ▸ PACE Technologies ▸ Paragon Space Development Corp. Phoenix Analysis & Design Technologies ▸ Pima College UAV Club ▸ Precision Shooting Equipment ▸ Process Engineering Associates ▸ Procter & Gamble ▸ Prototron Circuits ▸ QuakeWrap ▸ Raytheon ▸ RBC Sargent Aerospace & Defense Rincon Research ▸ Securaplane Technologies ▸ Shamrock Foods ▸ Sigma Technologies International ▸ Southwest Gas Technical Documentation Consultants of Arizona ▸ Texas Instruments ▸ The Western Design Center ▸ Thorlabs TRAX International ▸ Tucson Electric Power ▸ Universal Avionics ▸ The University of Arizona AIAA Student Chapter The University of Arizona College of Engineering ▸ The University of Arizona College of Medicine ▸ The University of Arizona College of Optical Sciences ▸ The University of Arizona SAE Student Chapter ▸ The University of Arizona ASME Student Chapter ▸ Ventana Medical Systems ▸ W.L. Gore and Associates ▸ Xeridiem ▸ Zelen Environmental