Project Number	**1**
Project Name	96 Channel Pump Array
Faculty Name	Dr. Bruce Gale (bruce.gale@utah.edu)
Project Description	In medical labs modern drug discovery instruments are used to process several samples simultaneously. The sensor for the standard device is capable of processing 96 channels simultaneously. The development of a system that can handle 192 - 96 syringes would be very beneficial in the development of next generation of medical drugs. The pump will be required to handle samples as small as 1 ml and continuously flow as low as 5 µl/min with little pulsing. 
Project Objectives/Desired Outcomes	1. Device that can pump 96 channels simultaneously 2. Incorporate a control loop to ensure smaller pressure pulsing Develop a system that be easily maintained
Project Engineering Skills	• Microfluidics • Controls/ Mechatronics • CAD/ Manufacturing
Desired Team Size	5

Project Number	**2**
Project Name	Ultrasonic Vibration-Assisted Laser Cutting
Faculty Name	Dr. Wenda Tan (wenda.tan@mech.utah.edu)
Project Description	Laser cutting has become increasingly important for the industry due to its high productivity; but the technology suffers from two major quality defects, namely dross and striation. In this project we propose a novel process called Ultrasonic Vibration-assisted Laser Cutting (UVLC), in which an ultrasonic vibration will be applied to the laser during cutting, with the intention to reduce or even eliminate the dross and striation defects. The team is expected to conceptualize, design, and prototype a laser head that enables the UVLC, and conducted proof-of-concept experiments to demonstrate the feature of UVLC.
Project Objectives/Desired Outcomes	1. Conceptualize, design, and prototype a laser head that enables the UVLC 2. Conducted proof-of-concept experiments to demonstrate the features of UVLC
Project Engineering Skills	• Mechanical Design • Rapid prototyping (3D printing, machining, etc) • Computational Fluid Dynamics (CFD)
Desired Team Size	5

Project Number	**3**
Project Name	Cooking without Gas
Faculty Name	Dr. Shad Roundy (shad.roundy@utah.edu), Sponsored by Marshall NLV, llc.
Project Description	
Project Objectives/Desired Outcomes:	1. Gas range retrofit 2. Demonstrate functionality by cooking a meal with culinary arts students 3. Participate in video documenting the meal, the prototype, and a bit of the project (video will be sponsor's responsibility)
Project Engineering Skills:	

Project Number	**4**
Project Name	Soft Robotic Grub
Faculty Name	Dr. Henry Fu (henry.fu@utah.edu) & Dr. Kam K. Leang
Project Description	The team will need to identify typical movements of grubs (e.g., by researching videos) and then design a 1-10 cm long "soft" robot [controlled through the Robot Operating System (ROS)] that can mimic those movements. The grub should be able to deform its body as well as move its legs.  White grub or masked chafer larvae (University of California) Measurement of forces in the test environment is not part of the project, but the team will be given access to the test environment so that they understand the constraints imposed, mainly waterproofness. The long-term application of the project is to better understand how grubs burrow through soil, and what soil characteristics help or hinder grub movement. Since grubs are a pest that can cause agricultural damage, controlling their movement and spread has important economic and food-safety implications.
Project Objectives/Desired Outcomes	The goal of this project is to build a robotic model of a grub which will be used to study the burrowing locomotion of grubs in soil. The robot is needed to perform grub-like motions inside of a test environment composed of gelatin beads (0.1 mm to 5 mm diameter) and aqueous water solutions that allows measurement of forces exerted by the grub but which is inhospitable to living grubs.
Project Engineering Skills	• Experience with embedded systems (microcontrollers, programming, circuits) • Basic experience with robotics • Interest in both robotics and biology or animals
Desired Team Size	5

Project Number	**5**
Project Name	Brittle Test Device
Faculty Name	Dr. Sanford Meek (meek@mech.utah.edu)
Project Description	The goal of the project is to design a new manipulatum to be used to evaluate prosthetic hand control. The manipulatum is a device that simulates a brittle object such as an egg. The forces needed to grasp it must be high enough so as not to drop nor high enough so as not to break it. The current devices have only one grip position. The new design will be a cube with all six sides 'breakable' or instrumented for force loads. The weight and the 'breaking' strength should be adjustable. 
Project Objectives/Desired Outcomes	The main objectives will be: 1. Design the brittle cube 2. Construct a prototype with the needed instrumentation 3. Set up the manufacturing of multiple devices to allow for tests of prosthetic hands. The outcomes will be: 1. Completed device with adjustable strength and weight 2. Complete design for manufacturing - possibly 3-D printed devices.
Project Engineering Skills	• Instrumentation for force measurements with communication protocols such as Bluetooth or other • Machine design • Manufacturing, probably 3-D
Desired Team Size	5

Project Number	**6**
Project Name	Biomedical Device Development for Andrology Clinics
Faculty Name	Dr. Bruce Gale (bruce.gale@utah.edu)
Project Description	Male factor infertility affects millions of couples every year. Our lab has recently developed new microfluidic hardware to perform semen preparation which essentially consists of removing sperm from the semen sample in preparation for IUI or IVF. Our method improves on existing protocols in speed, sperm recovery, and simplicity. We now want to commercialize the instrument with the help of a $1M government grant. In order to do that, we need to integrate this solution into a clinic-ready device. Specifically, we need a single machine that will perform the several steps for sample preparation: liquefaction (holding sample at 37 deg C to reduce viscosity), filtering of larger particulate, and an integrated pumping mechanism to operate the microfluidics. This device would need to be easy to use for medical technicians, able to handle many types of samples, and compatible with existing lab hardware.
Project Objectives/Desired Outcomes	• Functioning prototype with total device package size to 12” x 18” x 18” • Ability to process variable sized samples within 25 minutes total • Simple operation, by a technician with minimal training
Project Engineering Skills	• CAD, product design • Mechatronic design (electro-mechanical design and programming) • Rapid prototyping, manual machining, and/or CNC machining • Interest in biomedical devices, including FDA pathways
Desired Team Size	4-5

Project Number	**7**
Project Name	Automated Litter Box
Faculty Name	Dr. Owen T. Kingstedt (o.kingstedt@utah.edu)
Project Description	The American Veterinary Medical Association (AVMA) states that 30.4% (approximately 36.1 million) of American households own at least one cat [1]. Cats are known carriers of the toxoplasmosis. Toxoplasmosis is a parasitic infection that presents a possible danger to pregnant individuals as it can be transferred to a fetus. If transferred during early stage development, serious and significant birth defects can occur including impaired eyesight, seizures, and intellectual disabilities.  To avoid possible transfer of toxoplasmosis during pregnancy, it is encouraged to have non-pregnant individuals change cat's litter regularly. The proposed senior design project will look to improve current generation automated cat litter boxes. Improvements needed include decreased noise, automated refilling, reduction of waste order, and faster cycle times. As an initial prototype the developed system must be able to reliably self-clean (or sift) litter to remove waste, have an automated refilling system that doesn't interfere with normal operation, and be able to accommodate cats of all sizes (from kitten through adult).
Project Objectives/Desired Outcomes	1. A stand alone, automated litter box capable of sifting litter with reduced cycle time compared to current market products. 2. A system that limits sound produced to 40 decibels or less. 3. A system that can self-refill without interference of normal operation. 4. Safety interlocks to prevent system from actuating while in use.
Project Engineering Skills	• Arduino Programing • Mechatronics • Product development • Light machining/3D printing • Machine Design
Desired Team Size	5

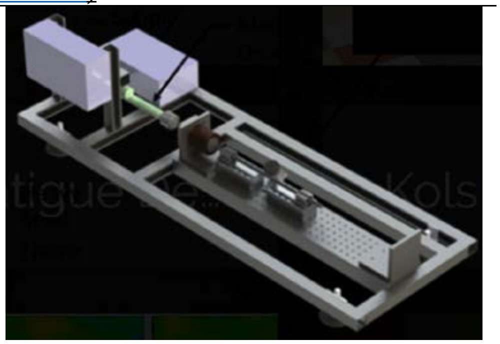
Project Number	**8**
Project Name	PDMS Vacuum Mixer
Faculty Name	Dr. Bruce Gale (bruce.gale@utah.edu)
Project Description	Background: We work with PDMS (polydimethylsiloxane) on a daily basis. This process includes mixing specific ratios of the two components which yield 10-100mL of a very viscous liquid. The A and B components need to be well mixed. Currently, we stir the mixture for several minutes. This introduces significant air bubbles into the mixture. Next, the mixture is placed into a vacuum to have the bubbles removed. This degassing process generally takes 30 minutes to an hour. The entire process takes 30 minutes to an hour and a half depending on the volume to be prepared. Aims: We would like to build a robust system that mixes and degases a PDMS mixture of 10-100mL in a few minutes. This tabletop device should be easy to operate and automatically mix and degas input PDMS mixtures.
Project Objectives/Desired Outcomes	1. Size - Tabletop - ~1 cubic ft and 20lbs 2. Throughput - 100mL unmixed to mixed and degased in less than 15 minutes. 3. Cost - Less than $500 4. Easy to use - minimal user input/programmed settings for volume 5. Compatibility - is compatible with a disposable and low cost plastic cup (similar to a 100mL specimen sample cup) 6. Cleanliness - Does not introduce dust or other debris into the PDMS mixture 7. Component A and B metering not required but a bonus if possible.
Project Engineering Skills	• Machine Design - possible manual machining • Programming and User interface • Device Design and Usability
Desired Team Size	4

Project Number	**9**
Project Name	Advanced Navigation Control for a Portable Accessible Dock System (PAD)
Faculty Name	Dr. Andrew Merryweather (a.merryweather@utah.edu)
Project Description	The Portable Accessible Docking (PAD) System is a pontoon boat that is designed to allow patients with spinal cord injuries to go out onto the East Canyon Reservoir. This 9.75-meter-long boat is supported by two pontoons that hold approximately 35.6 kN. The design requirements for the Navigation for the PADS include: • The control system needs to enable the PADS to parallel park (translate in 3 degrees of freedom)  • The motor system should have a breakaway mechanism that prevents damage to the motor • The motor system needs to be able to keep the PADS in control of the boat in windy conditions • Motors need to be electric • The system can be controlled with a joystick and a Tetra Universal Control (TUC) • The Motor needs to integrate onto the existing PADS platform and not interfere with any of the functions of the PADS features • The system needs to be an uncomplicated design that someone with little to no experience will be able to operate in a short period of time • The propeller of the motors should not be located where they might harm the users 
Project Objectives/Desired Outcomes	1. An operational prototype that can be controlled using Joy Stick and Sip 'n' Puff Inputs 2. A control scheme to successfully maneuver the PAD and perform both trailering and docking/beaching 3. Integrated hardware and electronics into the PAD
Project Engineering Skills	• Electronics Design and Manufacturing • Control and Microcontroller Programming • Solid Works - Modeling, Technical Drawings, Simulation

Additional information or comments	This is a continuation from a team last semester. The project prototype must be ready in May for pilot testing on East Canyon Reservoir.
Desired Team Size	4

Project Number	**10**
Project Name	Robotic Adaptive Screen Mount (RASM)
Faculty Name	Dr. Andrew Merryweather (a.merryweather@utah.edu)
Project Description	The RASM will provide a replacement to a current passive mechanical arm used to position a computer monitor in front of a patient during rehabilitation. RASM will provide the user with a higher amount of independence than the current system can afford, as well as reduce the burden on hospital staff for the care of patients with spinal cord injuries. The RASM is a multi-year project. In year 1 a robotic arm was constructed with all necessary degrees of freedom and movement. A face tracking algorithm was developed and tested. This year the team must build upon prior work and finalize the prototype for patient use. A redesign of the arm and improvements in control and safety are needed.
Project Objectives/Desired Outcomes	1. Complete the prototype by integrating face tracking with online control/positioning of the RASM. 2. Design RASM v2.0 3. Manufacture and control RASM v2.0
Project Engineering Skills	• Mechatronics - Programming - ROS, C#, Arduino • Control - Feedback positioning, Inverse Kinematics • Electronics - Soldering, Board Design
Additional information or comments	There is a budget of $2000 to complete this project.
Desired Team Size	4

Project Number	**11**
Project Name	Tetra Fisher
Faculty Name	Dr. Andrew Merryweather (a.merryweather@utah.edu) & Jeffrey Rosenbluth, MD
Project Description	Persons with tetraplegia are limited by physical impairments. Tetraplegia defines a condition, often after a spinal cord injury that affects all 4 limbs. The Tetra Fisher would provide some mechanical assistance and control to allow different users the ability to successfully cast and reel a fishing line from a wheelchair. Ideally, the person could control the Cast and Reel with a joystick or sip 'n' puff controller, and additional haptic feedback would alert the user of a 'bite'.  Example Cast-Assist Mechanism: Allows someone with limited upper limb mobility to cast a fishing lure or bait from a wheelchair.
Project Objectives/Desired Outcomes	1. The assistive device should be able to cast a fishing lure from a wheel chair with minimal inputs. 2. The device must be able to cast in multiple directions. 3. The device must be able to be used with a regular fishing pole. 4. The Tetra Fisher should allow someone with limited hand/arm movement the ability to fish independently from a wheelchair.
Project Engineering Skills	• Mechanism Design and Fabrication • Mechatronics - Electronics Design and Fabrication • SolidWorks Drafting - Technical Drawings, Simulations, Models
Additional information or comments	There is a budget of $2,000 for this project.
Desired Team Size	4

Project Number	**12**
Project Name	Impact Fatigue Experimental Apparatus
Faculty Name	Dr. Owen T. Kingstedt (o.kingstedt@utah.edu)
Project Description	 Additive manufacturing (or 3D printing) has been promised as the future of manufacturing. Under quasi-static conditions AM parts have been shown to have excellent mechanical properties for a limited subset of materials, principally polymers. Metallic components have yet to reach maturation in their performance when compared to wrought materials, particularly in regards to behavior under extreme conditions such as high temperatures, fatigue and impact. The proposed senior design project will look to design, develop, manufacture and validate a table-top impact fatigue experimental set-up for investigations of AM metallic components, and example of which is provided in Figure 1. A number of different designs have been proposed in literature from which one will be selected and constructed in Prof. Kingstedt's Lab.
Project Objectives/Desired Outcomes	1. A stand alone, automated impact fatigue set-up for investigations of additively manufactured material behavior. 2. Well controlled projectile launch velocity. 3. Launch projectile re-load and re-launch cycle on the order of 10 seconds or less. 4. Robust system capable of achieving 100,000 cycles. 5. Real-time data acquisition and processing.
Project Engineering Skills	• CAD Modeling • Mechatronics and component integration • MATLAB/Simulink programming • Machining/3D printing
Desired Team Size	5

Project Number	**13**
Project Name	ASHRAE Applied Engineering Challenge: Temporary Shelter Design (https://www.ashrae.org/membership--conferences/student-zone/applied-engineering-challenge)
Faculty Name	Dr. Amanda Smith (amanda.d.smith@utah.edu)
Project Description	Introduction: According to CARE, every minute, 24 people around the world are forced to flee their homes. That's 34,000 people per day who leave everything behind in the hope of finding safety and a better future. This includes refugees who have been forced to flee their country because of persecution, war or violence, and people who are not legally-recognized as refugees because they fled due to natural disasters, climate change, famine, or environmental factors. The United Nations states, "All of these emerging trends pose enormous challenges for the international humanitarian community. The threat of continued massive displacement is real, and the world must be prepared to deal with it." UN High Commissioner for Refugees Filippo Grandi said, "Refugees have skills, ideas, hopes and dreams… They are also tough, resilient and creative, with the energy and drive to shape their own destinies, given the chance." How do we provide sustainable, scalable, and affordable shelter to those who have been displaced? Constraints: Designs should accommodate a family of 6-8 people in an Eastern European location. The structure will be limited to 24 m^2 (260 ft^2) with a maximum height of 2.6 meters (8.5 feet). Structures will have no access to municipal water and sewer. Power connections are 220V/1ph with a maximum of 15 amps.
Project Objectives/Desired Outcomes:	Design a temporary shelter for use by governments, municipalities, and humanitarian agencies that will provide shelter and essential domestic systems for displaced families. The submitted design should include detailed design documents including types of materials, system designs, estimated capital cost, estimated energy consumption, and maintenance requirements.
Project Engineering Skills:	

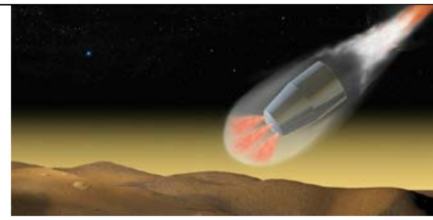
Project Number 14

Project Name Miniature rockets

Faculty Name Dr. Kuan Chen (chen@mech.utah.edu)

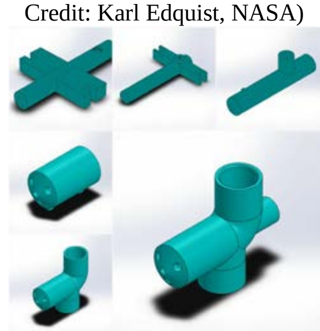
Project Description

Dr. Kuan Chen and his graduate students have investigated micro- scale aero/gas dynamics and miniature rockets for interplanetary flight and other space missions. At present, they are exploring various fabrication and testing techniques for inexpensive and easy ways to build and test millimeter-sized supersonic nozzles that can be used in miniature rockets and have the potential to replace the large, million-dollar rockets and test facilities currently used in the space industry.



Retro-propulsion used for re-entry (Image Credit: Karl Edquist, NASA)

3D printing was used to fabricate miniature nozzles by a senior design group in A17. Test facilities were also developed for flow and force measurements.



3D printed, miniature nozzles

The maximum Mach number was only slightly above unity in the preliminary tests due to the small storage tanks used in these tests. CFD simulation results were in good agreement with measured forces and pressures.

What is needed in S18 is to:

1. Assemble new Mach 2 test facility with 30 horsepower air compressor, and 120+ gallon air tank, and add humidity control to the test facilities.
2. Improve on the force and velocity measurement systems for higher Mach numbers (1.5 to 2.2).
3. Measure and improve surface roughness of 3D printed or CNC machined nozzles / air expanders.
4. Work on finding software methods to enhance optics visualization.
5. Perform 3D, transient CFD (Computational Fluid Dynamics) simulations for thrust vectoring.

Project Objectives/Desired Outcomes

1. Upgrade current test facilities for longer test time and higher Mach numbers
2. Add humidity monitoring and control
3. Improve on force and velocity measurements
4. Improve on flow visualization
5. Transient CFD simulations

Project Engineering Skills

- 3D printing and /or CNC
- Pressure and flow measurements and data acquisition
- Use of CFD software (and/or high-end PCs)

Desired Team Size	5

Project Number	**15**
Project Name	A wireless electrically triggered drug delivery system
Faculty Name	Yong Lin Kong (yong.kong@utah.edu)
Project Description	Introduction: An automated, electrically triggered drug delivery system could realize the next generation diagnosis and treatment strategies. The implantation or ingestion of such system residing in the body could enable a long-term, precisely controlled delivery of drugs directly into the human body, overcoming significant associated medical challenges, such as patients' non-adherence to therapy or over-dosage. Constraints: Designs should be within a size suitable for ingestion or implantation. The multiple triggered drug release mechanism needs to be achieved within the power capacity affordable within a limited overall device dimension, and is compatible with the biological organ at the implantation site.
Project Objectives/Desired Outcomes:	Design a drug delivery system that will only be triggered on-demand. The device should be robust prior to triggering.
Project Engineering Skills:	3D printing, CAD design, FEA Micro-controller programming Electronics performance characterization (e.g. power consumptions) Device mechanical characterization
Desired Team Size	Minimum 5