Engineering FEST-2 – Mechanical Engineering Program

December 9th, 2022, 9:00am-3:00pm, du Bois Center (South Union), Northern Arizona University

Overview

Engineering FEST-2 will cover both Mechanical Engineering and Civil and Environmental Engineering programs. For the Mechanical Engineering program, this part of the festival is divided into three sessions: Morning Oral Presentations, Industry Panel Discussion, and Afternoon Poster Session. Typically, the Mechanical Engineering program produces projects that support the following workforce development areas: Robotics, Biomechanics, Biomedical, Optics, Aerospace, Automotive, Design of Experiments, Material Science, and the Energy sector. For this Mechanical Engineering talk, Aerospace, Biomedical, Energy, Robotics, Material Science, and Biomechanics based projects will be presented.

Schedule

The schedule for Mechanical Engineering portion of this talk has a morning oral poster session, a panel discussion, and an afternoon poster session. Those schedules can be found below.

Morning Oral Poster Session – 9:00AM- 11:30AM

The Mechanical Engineering Morning Oral Presentation Sessions will be broken up into two different rooms. The first room will have a focus on Aerospace, Energy, and Robotics. The second room will have a focus on Biomedical, Biomechanical, Material Science, and a bit more on Robotics. Joining this session as judges will be industry professionals Dylan Pratt (InterLink Engineering LLC) and Josh Walton (W. L. GORE & Associates), both of whom are also NAU alumni.

Room One (Aspen Room B) – Moderated by Associated Teaching Professor David Willy

Abstract Title	Time Start	Time End
Flyable Cargo Plane for SAE Aero Micro Competition	9:00 AM	9:30 AM
Solar Powered Unmanned Aerial Vehicle (UAV)	9:30 AM	10:00 AM
Python-Based Wind Turbine Point of Common Coupling Data Acquisition System	10:00 AM	10:30 AM
Solar Thermal Collector Design-of-Exp. for the NAU Renewable Energy Laboratory	10:30 AM	11:00 AM
Robotics Engineering Track System	11:00 AM	11:30 AM

Room Two (Aspen Room C) – Moderated by Graduate Teaching Assistant Glen Dsilva

Abstract Title	Time Start	Time End
Thermal-Fluid Scaffold Clearing of 3D-Printed Neurovascular In-Vitro Models	9:00 AM	9:30 AM
Low Force Iris Stent Crimper for Endovascular Stents	9:30 AM	10:00 AM
Nitinol Shape Memory Alloy Resettable Hold-Down Release Mechanism	10:00 AM	10:30 AM
Adjustable Leaf Spring Ankle-Foot Orthotic	10:30 AM	11:00 AM
Interactive Robotic Arm	11:00 AM	11:30 AM

Panel Discussion – 1:00PM-2:00PM

The panel discussion will be in between the morning and afternoon session with the target audience being underclass students as well as the public. It will be covering the following topics:

Room Three (Aspen Rooms B & C) – Moderated by one ME and one CENE representative

<table>
<tr><th>Topics</th><th>Who</th></tr>
<tr><td>How to survive the program</td><td rowspan="2">2 ME and 2 CENE</td></tr>
<tr><td>Skills and lifelong learning needed for industry</td></tr>
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Moderators: ME Moderator: Dr. Armin Eilaghi, CENE Moderator: Dr. Paul Gremillion
Panel Members:
ME: Beau Wilson – W. L. GORE & Associates/NAU alumni, Ashley Jerome – InterLink Engineering LLC/NAU alumni
CENE: Julie Leid – Peak Engineering, Stephen Irwin – Shephard-Wesnitzer, Inc.

Afternoon Poster Session (Aspen Rooms B & C) – 2:00PM-3:00PM

The Afternoon Poster Session will cover the same projects as the morning session but in another format to meet the learning objectives of their capstone course and to make it easier for audience members to interact with the teams and ask good questions.

The judges for this session will be industry professionals from UACJ Automotive Whitehall Industries Inc.; Michael Oakes, Nick Johnson, and Ryan Kiedrowski. Ryan Kiedrowski is also a recent graduate from NAU.

Abstract Title	Poster Location
Flyable Cargo Plane for SAE Aero Micro Competition	ME01
Solar Powered Unmanned Aerial Vehicle (UAV)	ME02
Python-Based Wind Turbine Point of Common Coupling Data Acquisition System	ME03
Solar Thermal Collector Design-of-Experiments for the NAU Renewable Energy Laboratory	ME04
Robotics Engineering Track System	ME05
Thermal-Fluid Scaffold Clearing of 3D-Printed Neurovascular In-Vitro Models	ME06
Low Force Iris Stent Crimper for Endovascular Stents	ME07
Nitinol Shape Memory Alloy Resettable Hold-Down Release Mechanism	ME08
Adjustable Leaf Spring Ankle-Foot Orthotic	ME09
Interactive Robotic Arm	ME10

Project Details

Below are the project titles, team members, abstracts, and project websites for each team. Although the project websites are listed below, they all can also be found by following the QR code to the left. Project specific QR codes can be found in the presentation slides and the posters for each team. Websites are expected to be fully operational for the below teams by the time of the festival.

Flyable Cargo Plane for SAE Aero Micro Competition

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The SAE Aero Micro team is tasked with the design, development, and production of an electronic plane that complies with the SAE Aero Micro competition rules and regulations. The plane must successfully take off, land, carry a payload, and complete the aerobatic course, which are part of the competition regulations. The team chose an iterative design process that allowed them to make changes as the plane was built. This allowed the team to identify problems in the design process before they happened. While the current design has been successful for the team thus far, the iteration process is ongoing. During this current production phase, the focus of the team is to reduce the weight of the plane; building a lighter plane that can function within the weight to thrust ratio of the motor. This is done through eliminating unnecessary connections and using Depron foam for the main body. As this iteration process continues, the anticipated result is a successful remote-controlled aircraft.

https://www.ceias.nau.edu/capstone/projects/ME/2022/22Su01_AeroMicro/

Solar Powered Unmanned Aerial Vehicle (UAV)

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There is a current industrial revolution happening in the world. Because of this, renewable energy is being applied to every current leading-edge technology. Team Sol Avem is a multidisciplinary capstone team comprised of four Mechanical Engineers and two Electrical Engineers studying out of Northern Arizona University. The goal of Team Sol Avem was to design and manufacture an aircraft that could utilize the sun's power to prolong its original flight duration. Our team wanted to see if renewables, in this case photovoltaic solar cells, could be integrated into the aerospace sector. We approached this problem by completing extensive research in the field of aerospace and renewable technology to aid in the design of our delta shaped flying wing. We constructed multiple iterations, learning from each failure and applying it to the next. We conclude that a single wing aircraft with an aera of 6.8 ft^2 and 26 C60 solar cells integrated can achieve more than one and a half times the flight only using batteries. We believe these findings could be introduced into industry or future research. The principles could be used to survey large bodies of land with limited input or possibly introduce photovoltaic cells to commercial airflight. The possibilities are endless.

https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr06_SolarUAV/

Python-Based Wind Turbine Point-of-Common-Coupling Data Acquisition System

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The Wind Turbine Weather Data Acquisition System V2 project is an improvement on a previous design that was started at Northern Arizona University. This project was meant to improve the previous design in multiple ways, from physical appearance and specifications to highly technical aspects, such as improving voltage readings and adding more sensors to analyze weather conditions. The team working on this project has worked through it by establishing roles, working together, and performing extensive research to produce a quality product that meets all customer and engineering requirements. The team started by prototyping with a Raspberry Pi to create Python code files that were able to read data from

sensors. The team then focused on hardware and building a sufficient electrical enclosure to hold all the parts. The results of the project are a system that can measure the temperature, barometric pressure, wind speed, voltage, and current output of a wind turbine, and display all this data in graphs for easy analysis. The system was successfully built to measure these things at certain ranges with specific accuracies and resolutions, which indicates this system is a highly accurate, well-built, and safe data acquisition system.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Su02_PCCV2/

Solar Thermal Collector Design-of-Experiments for the NAU Renewable Energy Laboratory

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The Northern Arizona University Mechanical engineering department's renewable energy course is implementing new labs to inform students about renewable energy sources. These labs are intended to allow for hands-on learning and practical application experiences for students. The department has an evacuated tube solar thermal collector with a manufacturer-reported efficiency curve. The team designed an experiment that compares manufacturer performance efficiency values to experimental performance. To measure the efficiency experimentally, the team designed a solar thermal system using this collector along with necessary data collection instrumentation. Student operation, weather, and safety were considered while designing the testbed and operation procedures. The resulting system is successful in heating a glycol loop that then heats a load of water through a heat exchanger. From this, students can calculate efficiency values of the collector to compare to the reported values, analyze the system's performance in varying conditions, economic impact, and sustainability. The team hopes that by diversifying the labs offered in this course students will gain interest in renewable energy topics promoting workforce development and education within the field.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr03_SolarThermal/

Robotics Engineering Track System

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Currently off the shelf manufactured utilitarian robots are upwards of $20,000 to purchase. The College of Engineering and Applied Sciences currently has a utilitarian style robot tank base that houses the LOUIE Robot that will be used to give guided tours of the engineering building. Currently that robotic base costs $18,000 to purchase from the manufacturer. Our goal for this project was to design and create a utilitarian robot for $2,000. Reverse engineering techniques were applied while designing the track system (built in-house) and the metal frame housing the electrical components. The current design of the robot can carry a load of 75lbs while travelling at 5mph. The project demonstrates the successful use of reverse engineering techniques to design and manufacture a robot in-house that can provide functionality similar to commercially available robots within budget constraints.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr01_RobotRE/

Thermal-Fluid Scaffold Clearing of 3D-Printed Neurovascular In-Vitro Models

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Prior to U.S. Food and Drug Administration (FDA) approval, medical devices require in-vitro models to collect data that prove mechanical efficiency. 3D printing with VeroClear© Agilus 30© (VC-A30) is an ideal method for creating vascular in-vitro models due to its similarity of mechanical properties. However, the biggest challenge when deploying this method is eliminating the support material without destroying the vessel structure of the model and compromising its mechanical properties. The aim of this project is to create a fluid-based cleaning system capable of thermal and pneumatic control to prevent vessel damage when testing. This system can help the Bioengineering Devices Lab perform testing when prototyping various stents and catheters. The vessels are pre-treated with 0.5 mol. Sodium Hydroxide (NaOH) for 1-2 hours prior to cleaning. The system applies cyclic fatigue to the support material at a maximum pressure of 200 mmHg using water at a maximum temperature of 49 degrees Celsius. Results demonstrate that pressure and temperature aid the clearing process, but the initial breakdown significantly depends on NaOH absorption time. Results also show that the current system can clean a Circle of Willis model in about 3 hours, and a single channel model in about an hour after 2 hours of NaOH absorption. Further, the variable output of the pump also enables the user to clean models with different wall-thickness. Overall, this method can effectively clean in-vitro models while minimizing the risk of damage.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr02_BDL3D/

Low Force Iris Stent Crimper for Endovascular Stents

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W. L. Gore came to the team with this project looking for a low force stent crimper for endovascular stents that are cheaper than other similar units on the market. The unit must prepare endovascular stents for a high force stent crimper using low force. The market-available endovascular stent crimpers only function for either a specified force requirement input or a diameter input exclusively. The primary objective of the study is to create a stent crimper that can manage both force and diameter input simultaneously. The system outputs values of the force and diameter are displays them using the GUI system. Moreover, the device needs to meet the OSHA and ANSI standards applicable. The core challenges with this project are initiating the crimping system, determining the force, and output diameter. The team created prototypes of the iris system with various leaflet types to choose the final design. Additionally, the team completed a Finite Element analysis to see if the leaflet could survive the force applied to it. Pressure sensors determine the force applied by the iris on the stent. The system utilizes a chain drive on both sides using a 9:10 and 10:48 tooth ratio to increase the torque on the system. The client expects the device to crimp a stent with a minimum diameter of 5 mm and a force input with a max of 5 Nm. Overall, the team must complete the project with a strict USD $3,000 budget.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr05_GoreIris/

Nitinol Shape Memory Alloy Resettable Hold-Down Release Mechanism

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Hold-Down release mechanisms (HDRM) are typically single-use; preventing the user from testing it for manufacturer defects. They also are expensive in the sense that to test a satellite, a new HDRM would be needed for each test. We are proposing a fully resettable mechanism for a hold-down release mechanism, allowing the user to put a single unit through multiple actuation cycles before it needs to be replaced. Nitinol shape memory coils are used as it is a mechanically simple approach that doesn't use magnetism, hydraulics, pneumatics, destructive techniques such as fuse wire/explosives, or electric motors to actuate the device. A locking mechanism combined with the Nitinol coil offers resistance against accidental actuation and a greater actuation force than the force exerted from the Nitinol coil itself. The device is designed to actuate with a force of 5lb, powered with 7 volts of 1.3 amps flowing through the Nitinol, all taking up approximately 2.6 in3. This project and design will ultimately lead to further iterations of a resettable HDRM, inspiring new ways to implement the technology and eventually a greater use of Nitinol based devices being used in satellites. Additionally, this project should bring awareness and attention to the under-developed technology of shape memory alloys.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr04_GAHDR/

Adjustable Leaf Spring Ankle-Foot Orthotic

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Muscular disorders continue to be an issue for many people in the world. In order to aid in walking, Adjustable Foot Orthotics (AFOs) are used to provide ankle assistance through using established forces to provide a spring like effect, propelling the user. However, many AFO systems that use springs can be very bulky. We want to make a system that has the same functionality as the prototype Ankle Exoskeleton we were given while giving it a lighter, slimer, more comfortable design. Our approach to achieve this goal was to move several of the parts that were external and redesign them to be internal. This includes sizing down the pulley and the leaf springs. While this decreases the weight and volume, it could also cause a decrease in applied torque from the pulley. The team took the approach to take size down the important components just enough to reach the desired output, but still apply similar forces. We anticipate that testing results will show a durable product on same the caliber as the prototypes we are expanding on. We hope that our new design will result in a comfortable, sleeker AFO that provides helpful support to the users.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Spr07_ExoBML/

Interactive Robotic Arm

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Our group is responsible for designing an interactive robotic arm for the LOUIE Robot. Robotic arms are used to perform various tasks in the industry like welding, assembling, or performing high risk tasks. They could also be used for recreational purposes like on a larger humanoid robot to shake someone's hand. For this project, we are required to iterate on the previous design of the LOUIE robot project and

design arms that are more innovative and more human-like. In order to achieve this, we include a sensor in the palm which will help the hand automatically clasp when someone tries to shake hands with the robot. Also, we have designed the thumb such that it is more human-like. In addition, the current iteration of the arm includes slewing ring bearings which allows it to withstand higher loads and move more smoothly. Lastly, the robotic arm is expected to be waterproof so that it can withstand extreme weather conditions. With these design features, we expect that the interactive robotic arm can shake hands with people automatically and repeatedly without being controlled.
https://www.ceias.nau.edu/capstone/projects/ME/2022/22Su03_RoboticArm/