Presentation and Workshop Abstracts

2024 ASEE North Central Section Conference
March 22-23, 2024
Kalamazoo, Michigan

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Session 1A [Best Professional Paper Nominees] – Room D204

41403 – Progress in K-12 Computer Science Education: Are Engineering Students Being Left Behind?

Catherine Molloseau, Grand Valley State University

Computer science education in the K-12 setting has evolved in the last decade with the development of new outreach programs, courses, and national standards. This ongoing effort has focused on both increasing the number and diversity of students pursuing computer science related fields as well as to help better prepare students for success where historically, it has been demonstrated that as many as a third of students fail introductory collegiate-level computer science courses worldwide. To determine if the implementation of these initiatives is having a positive impact on engineering students' performance in a first-year programming course, a correlational research study at a mid-size Michigan public university was completed over a three-semester period beginning in 2022. Students were surveyed regarding their prior experience with computer science at the beginning of the semester, and student scores on the first laboratory practicum and final course grade were recorded. The data demonstrates that nearly sixty percent of students had no prior experience with computer science and withdrew from the course at nearly double the rate as students with AP experience. For those that did complete the course, a Welch's t-test demonstrates that inexperienced students still passed at nearly the same rate as students with prior experience. The high withdraw rate suggests that engineering students that enter a first-year programming course without having completed an advanced computer science course in high school may be at a significant disadvantage to students that have had this opportunity. In addition, although nearly seventy percent of students attending public high schools in the state of Michigan have access to at least one computer science course, it needs to be better understood as to why more students planning to pursue engineering in college are not enrolling in these courses

44563 – Advancing Engineering Education with a Comprehensive and Continuous Course Assessment Framework

Promothes Saha, Purdue University – Fort Wayne

Course assessment plays a crucial role in engineering education, offering valuable insights into student progress and course effectiveness. Traditional course assessment methods, which primarily rely on end-of-semester evaluations, provide feedback only after the course has concluded, hindering opportunities for timely adjustments to improve student learning in the current semester. In response, this paper proposes a comprehensive course assessment framework that begins from the semester's start, aiming to achieve the desired outcomes by its end. This framework relies on summative assessments, such as unit tests, midterms, and finals, to evaluate student understanding at key points in the course. This approach allows for a more comprehensive evaluation of student achievement against course objectives and facilitates the identification of areas for course improvement. The proposed course assessment framework offers several advantages over traditional methods. Firstly, it provides ongoing feedback to students, enabling them to address shortcomings early in the learning process. Secondly, it

prioritizes deeper understanding and application of concepts, fostering a more meaningful learning experience. Lastly, it provides a more holistic view of student learning by incorporating summative assessments. While the proposed framework can be implemented across a wide range of engineering courses, tailoring it to the specific needs of the course and the students is crucial.

44583 – Updates on a Work in Progress Assessing Student Perceptions of the Benefits of Continuing HyFlex Course Format Beyond The COVID-19 Pandemic

Nicole Becklinger, University of Southern Indiana

The Covid-19 pandemic required instructors to rapidly adopt online, hybrid, and HyFlex course formats. This ongoing research study uses a survey to monitor student perceptions of academic and non-academic benefits to continuing to offer a HyFlex course format as we move further from the critical phase of the pandemic. Preliminary results from the Spring 2022 semester were presented at the American Society for Engineering Education 2023 national conference in Baltimore. This follow-up presents results from subsequent semesters through Fall 2023. Students from five courses taught using a HyFlex format across multiple semesters were eligible to participate in the study. This included multiple semesters of two introductory engineering courses, one sophomore/junior technical writing course, and two manufacturing technology courses. The HyFlex format used for these courses allowed students to choose on a day-to-day basis whether to attend class in person or synchronously online via Zoom. Video recordings of each class were uploaded to the course website for students who could not attend class synchronously and for all students to use as a study aid if they chose. Students who participated in these courses were invited to complete a short survey asking them how frequently they utilized in-person, Zoom, and video formats during the semester. Students were then asked to indicate their level of agreement with statements about whether the HyFlex format helped them meet course, other academic, health, work, and family responsibilities. Finally, students were asked several demographical questions, how many hours they worked per week during the semester, and whether they had caregiving responsibilities. This update for a work in progress presents new results from the Fall 2022 through Fall 2023 semesters and examines the full Spring 2022-Fall 2023 data set for any time-dependent trends. The utilization of Zoom and video formats has decreased over time. However, most students still attend class using a remote option at least once during the semester and perceptions of the benefits of HyFlex format are consistently favorable.

44602 – Finessing the Introductory Standards Workshop: Efforts Toward Active Learning

Matthew R. Marsteller, Carnegie Mellon University
Haoyong Lan, Carnegie Mellon University

The opportunity to introduce engineering students to technical standards literature is a rewarding experience for the engineering librarian. Librarians must be careful not to rely too much on the lecture as an educational technique. This paper describes creative efforts to introduce active learning techniques to the typical one-hour workshop. Following a shorter lecture, workshop

attendees will be given topics to tackle in small groups. The lecture will include ideas for discovering standards of possible interest such as literature searching (databases such as Compendex, which indexes standards or full-text databases like IEEE Xplore and ASTM Compass), references in handbooks or specialized encyclopedia entries (or other monographs), articles on the design of artifacts (products), discussions with colleagues/bosses, product descriptions when sourcing materials for a design, labels on items or cartons, or searching a standards supplier database. Attendees will work on the problem of finding related standards to a given engineering scenario. Scenario possibilities include 1) standards information needs for a small business for innovative piezoelectric products, 2) locating standards related to tissue engineering, and 3) standards need to be gathered for a university research group that explores microgrids. Scenarios have the possibility of appearing contrived unless academic librarians reach out to engineering professors for possibilities that could be explored for engineering design courses and capstone project courses.

44596 – Curriculum Design for Wind and Solar Energy Education

Mohammed Ferdjallah, Marshall University
Yousef Sardahi, Marshall University
Asad Salem, Marshall University

The proposed curriculum on wind and solar energy offers an educational opportunity to both undergraduate and graduate students, allowing them to acquire essential skills in renewable energy and engineering design. The primary objective of this curriculum is to expose and engage undergraduate students in interdisciplinary learning related to renewable energy. It provides them with a unique opportunity to expand their educational experiences and fosters a commitment to renewable energy. The long-term goal of this curriculum is to stimulate interest in learning and developing skills in renewable energy, especially in the context of West Virginia. In this paper, we outline a curriculum that includes various courses in renewable energy. Additionally, we design the necessary infrastructure and instrumentation to facilitate measurements that aid in understanding the generation and delivery of energy from environmentally friendly sources such as wind and solar power. We propose a framework for developing an undergraduate curriculum that incorporates project-based concepts in power courses. This curriculum will create new learning materials and teaching strategies, with a particular focus on introducing renewable energy concepts in the early phases of power engineering courses. It will integrate wind and solar energy considerations, challenges, and concepts into all aspects of power engineering. The unique goal of this paper is to raise awareness of green energy in power systems and provide practical training for the much-needed industry sector

Session 1B [Best Student Paper Nominees] – Room D115

44590 – Engineering Experiences and Lessons Learned from 2023 Annular Eclipse Ballooning

Wookwon Lee, Gannon University
Zachary Owen Dickinson, Gannon University
Hannah Paige Jacobs, Gannon University
Sara Jones, Gannon University
Damien Thiên Ân Chu, Gannon University
Hunter Dawson Yaple, Gannon University
Andrew Donald Snowdy, Gannon University
Zoey McClain, Gannon University
Nicholas B Conklin, Gannon University

High-altitude ballooning has been an attractive framework to promote knowledge and skills to college students in STEM disciplines. Having successfully participated in a nationwide total solar eclipse ballooning campaign in 2017, we continued revising our ballooning framework for the upcoming solar eclipse events in October 2023 and April 2024. In late 2022, we were selected as one of the 53 teams for Nationwide Eclipse Ballooning Project (NEBP) and in Oct. 2023, participated in a nationwide balloon flight campaign during the annular solar eclipse.

At the time of NEBP team selection in fall 2022, our ballooning framework primarily consisted of several payloads and two types of ground stations. On the balloon side, our payloads were for multiple Pi cam-based video streaming, 900 MHz RF-based balloon tracking, 144 MHz APRS-based balloon tracking, 1.6 GHz Iridium-based balloon tracking, 2 GHz cellphone-based balloon tracking, and 2.8/5.8 GHz microwave downlinks for real-time video transmission. On the ground station side, our equipment included a fixed ground station for reception of streaming video and other sensor data and two mobile stations for tracking and recovery of the balloon payloads. For the balloon tracking, our mapping software included a local copy of Microsoft MapPoint for 900 MHz RF-based tracking and several on-line position-mapping software tools that are specifically associated with the Iridium-based tracking, cellphone-based tracking, and APRS-based tracking, respectively.

As one of the NEBP engineering teams, in early 2023, we had received a new set of balloon payloads and two ground stations from the NEBP leadership team and this set of new equipment broadened our choices of technology for the 2023 annular solar eclipse and 2024 total solar eclipse. For the 2023 annular solar eclipse, among the various technology choices we had, we adopted the new set of NEBP equipment as the primary platform and incorporated additional functionalities. Although the NEBP leadership team provided detailed technical documentation of the NEBP payloads and ground stations, it was complex and challenging for a new NEBP engineering team to assemble, configure, and integrate them, as applicable, into a complete ballooning system in a relatively short time-period of about 8 months in 2023.

This paper describes our engineering experiences and lessons learned from preparing for and conducting the annular solar eclipse ballooning on Oct. 14, 2023 in San Antonio, Texas. Our

project team consisted of eight student members from freshmen through junior classes in spring 2023 and two faculty advisors. While collaboration was encouraged to help the others as needed, the student members worked on specific technical aspects in extracurricular project activities committing 5~10 hours per week in spring and fall semesters. Students' activities were facilitated under close in-lab supervision of the two faculty members. This paper is organized into the following subsections to present student members' technical work and lessons learned: 1) Iridium Payload and Control Commands for Vent and Cutdown, 2) APRS and RFD900 Payload, 3) Arducam-based Video Streaming, 4) Pterodactyl, 5) Webcam-based Video Streaming, 6) 3D-Printed Vent and Cutdown Unit, and 7) Balloon Launch and Payload Recovery.

44591 – Visualizing the Invisible: Object Detection via Wi-Fi Signal Mapping Emulation

Benjamin Lubina, Gannon University
Ramakrishnan Sundaram, Gannon University

This paper introduces a software tool designed to emulate and analyze Wi-Fi signal strengths from an array of ESP32 devices. This paper is a continuation piece to another work which outlines the hardware creation of the ESP32 array. This software serves as a companion to the already developed array and is meant to be integrated into the accompanying hardware setup. The primary goal of this tool is to create theoretical images of objects situated within the array by leveraging the variations in Wi-Fi signal strength caused by these objects. We present a comprehensive method that utilizes the unique properties of ESP32 microcontrollers to capture Wi-Fi signal metrics to generate a visual representation of the physical space and the object(s) within it. The inputs to this software mimic those provided by the hardware array and employs advanced algorithms to process the metrics made by the array. This technique, often referred to as Wi-Fi imaging or Wi-Fi based material sensing, has significant implications for various applications, including security, terrain mapping, navigation in visually impaired environments, and smart home systems. The results show our system's capability to detect and visualize objects of different sizes and hint at basic composition of materials. Additionally, the paper discusses the challenges and limitations encountered during the research, such as signal interference and the resolution of generated images, as well as software limitations and integration challenges. Our findings suggest that this Wi-Fi based imaging approach, while still in its nascent stages, holds great potential for various practical applications. The paper concludes with future research directions, emphasizing the need for enhanced algorithms and more sophisticated ESP32 arrays to improve accuracy and resolution of the Wi-Fi imaging process.

44604 – Development of an Experimental System for Plasma-Combustion Investigations

Ghazal Rajabikhorasani, Western Michigan University
Claudia M. Fajardo, Western Michigan University

This paper details the design and implementation of a combustion facility to investigate the impact of excited chemical species on combustion. Specifically, this system will be used to

systematically explore the impact of the oxygen singlet sigma state ($O2(b\ 1\Sigma g\ +)$) on the high-temperature reaction kinetics in methane-air combustion. The design incorporates a burner housed in a vacuum chamber to facilitate measurements below atmospheric pressure, a cooling system to maintain the burner and exhaust gases at target temperatures, and instrumentation for measuring and controlling critical experimental parameters. The combustion system interfaces with diagnostic equipment to enable laser excitation as well as non-intrusive measurements of flame properties. The resulting facility offers a robust framework for accurately quantifying the role of excited oxygen molecules in key combustion processes, such as fuel oxidation, hydrocarbon intermediate formation, and radical generation.

44612 – Design of a Smart Alert System Based on Electroencephalography Signal Analysis

Marina Almeida, Eastern Michigan University
Qin Hu, Eastern Michigan University

The rapid evolution of technology provides us with diverse opportunities to enhance our lives and well-being, addressing essential aspects such as socialization and health analysis. Expanding on this potential, utilizing brain-computer interface (BCI) would allow us to explore and improve aspects like attention deficits. Distractions present persistent challenges to sustained focus across various aspects of life, potentially resulting in compromised academic performance or risks to road safety. This shows how life-changing it would be to design an alert system that boosts efficiency and safety in these areas by targeting to minimize attention losses. By analyzing electroencephalography (EEG) signals associated with concentration levels, the proposed system aims to deliver timely alerts, prompting users to refocus when attention falls below a predefined level. Consequently, avoiding prolonged distractions and encouraging a greater self-awareness of the issue. This research aims to create a comprehensive warning system by combining EEG technology with deep learning techniques. According to some research, it may be possible to determine a person's level of concentration by monitoring the frequency ranges of different areas of the brain. Therefore, the initial phase of this project involves non-invasive data collection using a 16- channel EEG cap, complemented by Fast Fourier Transform (FFT) analysis to extract features linked to active and passive tasks. During this phase, adhering to the guidelines of the Office for Human Research Protections (OHRP) and the relevant university department is essential to maintain ethical standards and safeguard participant confidentiality and privacy. The collected data will then be used to write a Python code that employs deep learning to identify parameters indicative of various attention levels. The software will utilize this data to set an attention range and send alerts to an external device, notifying when the user has lost focus. Additionally, the system will exhibit intelligent recognition of recurrent short concentration periods, suggesting breaks to prevent mental fatigue. As the project advances, there is potential to enhance the system's capabilities by exploring signal classifications, particularly emphasizing evoked signals associated with external stimuli.

44615 – A Study of the Effects of Commercially Available Self-Cleaning Coatings on Photovoltaic Panels

Anton Petrenko, Grand Valley State University
Christopher P. Pung, Grand Valley State University
Heidi Jiao, Grand Valley State University

In response to the escalating global population, the demand for electrical energy is on the rise. Photovoltaic panels (PVs), employing semiconductors to harness solar irradiance and convert it into electrical energy, have become pivotal in meeting this growing energy need. Despite all the technological advances, the conversion efficiency of most commercially available PVs is around 20%. To address the effect of soiling on the PV efficiency, self-cleaning coatings have been developed. These coatings can be categorized into two main subgroups: hydrophobic and hydrophilic. This study investigated five commercially available hydrophobic coatings and one hydrophilic coating. Comprehensive testing, including transmittance, contact angle (CA), and sliding angle (SA), was conducted before and after coating application. Subsequently, transmittance was assessed for the two most effective coatings after dust accumulation and subsequent cleaning. The investigation extends to applying these coatings to two different solar panels, analyzing current-voltage (IV) curves before coating, post-coating, after dust accumulation, and post-cleaning.

After the application of the coating, there was a noteworthy increase in CAs, while the SAs remained close to the control except for Percenta Nano Coating and Aquapel glass treatment. Percent transmittance remained the same after coating, compared to the controls. Following dusting, the Solarshield-coated sample exhibited a lower percent transmittance than the control and Rain X-coated-coated sample. After rinsing the dust, the percent transmittance of the coated samples was restored to their original levels, whereas the control sample exhibited a slight decrease. IV curves showed that PV efficiency was not reduced upon dusting with Solarshield coating, whereas Rain X-coated PVs experienced reduced efficiency. For both coatings, efficiency quickly returned to original levels post-dust removal.

Session 1C [Professional Papers] – Room D109

44560 – Strategies for Improving the Quality and Effectiveness of Education Courses

Omar Ahmed Al-Shebeeb, West Virginia University
Thomas Azinger, West Virginia University

The Manufacturing processes Lab (IENG 303) is one of the courses that is taught in the Industrial Engineering Department. The students perform several manufacturing processes in this course and for every one of these manufacturing processes, the students need to submit a project report. One of these manufacturing processes is a CNC turning process. The turning project of this course has historically had extensive average time for completion. As such, it was deemed necessary that a way to improve the quality of a turning project be generated. Industrial Quality Control (IENG 316) is also taught as part of the industrial engineering curriculum, and it was determined that the quality tools in this course should be used to evaluate the initial performance of the turning project. An executive activities sheet has been developed for this IENG 303 turning project to collect data about the time required to finish this project and to check if that was meeting the expectation or not. The turning projects of Spring 2021 and Fall 2021 semesters were evaluated by using several analysis techniques, such as Shewhart's control chart, the DMAIC process, check sheets, scatter diagrams, pareto charts, and fishbone diagrams. Several quality control tools were used to evaluate the length of time for the in-lab turning process and overall project completion. Several assignable causes were found and resolved to improve this project in the Spring 2022 semester. Then, the project was reevaluated by using quality control tools. Significant improvements were obtained from this evaluation which reduced the time to finish the turning machining process by 50% and reduced the errors and needed troubleshooting in the process and minimized the scrap material in the process which all led to improving the quality of the turning project.

44600 – GVSU Combined Degree Program. A Great Opportunity Which Can Come with Hard Choices

Brian Krug, Grand Valley State University

Grand Valley State University (GVSU) offers high performing students the choice to continue their education past undergraduate studies and "fast track" into a graduate degree. Students who choose this route early in their academic career can complete their master's degree in about a year, less time than it would take had the student pursued a graduate degree independently. GVSU was awarded a grant to help high performing students who might not be able to afford graduate school the choice to participate in the combined degree program. This helps students from diverse, underrepresented backgrounds have a choice where there were no options before. Many of these students are the first generation in their family to attend a university, and never considered the option of an advanced degree. This paper investigates the options a student in West Michigan should consider when making such a commitment. This includes important decisions on financial gains and losses, committing to a master's topic that fits the student's overall interests, and overall perspective from West Michigan's employers.

The combined Degree Program was offered to students ranging from sophomore to junior year standings. Students were selected based on their grades and financial need by Grand Valley State engineering faculty. Some selected students were apprehensive to receive this award as there were many things to consider. Continuing straight to a combined degree meant that the student would not receive any degree until completing the requirements for both the undergrad and graduate requirement, with a bonus of applying some undergraduate credits to their graduate degree. This paper reviews important aspects learned by the Grand Valley faculty of this scholarship program after completing three rounds of scholarships to three groups of talented students.

44608 – Student Dropout Prediction in Regional Universities Using Automated Machine Learning

Bin Chen, Purdue University – Fort Wayne

The overall dropout rate of engineering students is between 40% to 50% in the United States, according to the American Society for Engineering Education (ASEE) survey from 2009 to 2018. The severity of dropout is not the same among all universities. Regional universities have experienced much higher rates of student attrition from engineering programs compared to Carnegie R1 universities. Reducing the dropout rate in regional universities becomes the most effective and economical way to increase retention and graduation for the nation. However, most studies are based on nationwide data or data from national universities, rather than regional universities. Students in regional universities are more diverse in personal background and academic preparation. They often face unique challenges, such as financial constraints, daily commutes, and the need to balance academic pursuits with employment and family responsibilities. Focusing on a few statistically significant factors and applying resources to improve them is not the most effective way to reduce dropout rates.

This study is to develop a machine learning framework with the capability of learning from heterogeneous data to identify students at risk of dropout from five main data sources:

1) high school information,
2) demographic information,
3) college and department program information,
4) academic information, course study and research activities,
5) student real time feedback to the web, mobile phone apps and course learning management systems

The first three categories change less frequently and have stable and long-term effects on the decision of dropout. The data in categories 4 and 5 have intermediate to high variations. The combination of all above data will include long-term to short-term influences on dropout decisions in a static, dynamic, and cumulative manner.

The data will be preprocessed and then split into training, validation and testing datasets respectively for machine learning. The predicted risk of a student dropping out from an

engineering program will be a probability between 100% for graduation and 0% for dropout. The completion of applied credits for a degree program will be linearly scaled between 0 and 1 as targets for supervised learning. If a student dropped out of the engineering program the following semester, the probability of graduation would be 0, otherwise, a new graduation probability will be assigned to the student until that student either graduates or drops out. Students will be ranked based on their predicted dropout probability, and the group with the highest dropout probabilities will be informed of their eligibility to enroll in services, subject to the students' own volition.

Regional universities often serve as gateways to higher education for underrepresented groups, including first-generation college students, individuals with disabilities, and minorities. By understanding and addressing these challenges with early identification of at-risk students, regional universities can play a crucial role in increasing the representation of underrepresented groups in STEM fields.

44594 – Impact of Mentoring and Skills Sessions on Student Professional Preparation

Matthew Cavalli, Western Michigan University

A significant portion of most engineering curricula focuses on developing technical knowledge and skills that students will need after graduation. Skills like time management, leadership, and conflict management may be implicitly included through team design projects, but are less commonly an explicit component of engineering degree coursework. Of these non-technical skills (sometimes referred to as ‘soft skills’), professional communication is the most likely to be taught in a dedicated course, often as part of a university’s general education curriculum.

Both formal research and anecdotal feedback from employers attest to the importance of non-technical skills for the success of engineers in the workplace. However, employers also often report that new graduates lag in the development of these skills compared to their technical competencies. Between the constant expansion of engineering knowledge, credits required for general education programs, and a consistent push from students, parents, and legislators to reduce credits to increase four-year graduation rates, adding credit hours focused on soft skills to engineering curricula is a difficult proposition. A potential alternative is co-curricular programming.

For the 2023-2024 academic year, [College] at [University] has implemented a Professional Skills Program which incorporates a series of seminars focused on soft skills with one-on-one mentoring between student participants and engineers from industry. Participants are expected to meet with their mentors at least twice per month and to participate in at least three (out of six) skills sessions over the course of the academic year. Students who complete the program receive a letter of acknowledgement from the dean. To understand the impact of the program on participants’ perception of their related skills, the current study presents the results of a survey from the end of the Fall 2023 semester. Qualitative feedback from students participating in the skills program is summarized and common themes identified. Suggestions from students for improving the program for the Spring 2024 semester are discussed and compared with research

from similar programs in the literature. Lessons learned related to program development and implementation are discussed.

44581 – The Service we Offer in Teaching About Common Sense

Craig Gunn, Michigan State University

There are many things that a university must focus on when deciding on what to teach our incoming and ongoing students. For engineering we hope that during their first years on campus students become acquainted with ethics, writing, speaking, and all the "soft skills" associated with the more liberal side of the institution. Many people do not realize that our students will sink or swim with their ability to function in a society that does not contain 100% engineers. But that is of little concern to many who simply say that controls, fluids, thermal sciences, and the many other engineering topics are the focus of the dedicated engineer and if have to teach let someone else worry about those "soft skills." Luckily, there are also many who feel that they need to provide their students with additional tools that will allow them to move more easily through the landscape of the future. These individuals talk of ethical behavior and proper communication techniques. They allow their students to perform in writing and speaking as they will in their professional careers. There is one area that seems to have been placed on a back burner and that burner has been turned off. The area is bringing to light Common Sense. We have all heard it numerous times in our lives from parents and teachers who have criticized some aspect of our behavior, but we have heard little from the classroom where good teachers can acquaint us with common sense by focusing on what it is, how it works, and how we can function in a society where common sense seems to have been complexly forgotten by large segments of the population.

During the semester of teaching a junior level engineering course focusing on professional issues in mechanical engineering, discussion, quizzes, and investigation into common sense are attempting to allow students to investigate the very simple topic of common sense, especially where it will impact them on their future employment. This paper will look at what common sense is, how students perceive its value in their lives, and provide student assessment of the topic in engineering.

Session 1D [Professional Papers] – Room C136

44562 – Towards Fuzz Testing a Procedurally-Generated Video Game

Erik M. Fredericks, Grand Valley State University
Skyler Burden, Grand Valley State University

Fuzz testing presents opportunities for discovering bugs in software projects that are unanticipated by developers as large amounts of either random or targeted inputs are applied to the system under test. Moreover, exploratory techniques such as search-based fuzz testing can discover new and interesting combinations of input data that can further lead to bug discovery. Video games are a subset of software projects that involve the additional overhead of audio/visual cues for gameplay, state management, and rigorous timing constraints. Procedural content generation (PCG) can be used to support development by incorporating unique game content (e.g., items, storylines, environments, etc.) via algorithms. As such, verification of PCG techniques is necessary to ensure that the generated content is valid for the situations in which they are deployed, given that such content can lead to emergent gameplay (i.e., unanticipated interactions that result in new features) or user dissatisfaction (e.g., the "same" type of rock is generated multiple times in a small area). We present our work-in-progress efforts and proposed run-time software testing methodology for developing an experimental testbed for fuzzing procedural generation in video games. This project was created as part of the Grand Valley State University RISE Scholars program for first-generation students to participate in an active research program. Delve the Dungeon is our prototype framework for exploring how software engineering can enhance assurance that PCG techniques are executing as expected. Specifically, this framework provides a roguelike-style video game environment that comprises procedurally generated dungeons and text, with common features of this particular game domain including turn-based gameplay, bump-to-attack, and different forms of monsters that attack the player. Additionally, we have developed a proof-of-concept requirements specification to support our software engineering activities, where the next phase of development will monitor those requirements at run time, use the requirements as a basis for creating test cases and generating fuzzed test data, and then incorporate the results of run-time requirements monitoring and test case execution to the application as part of a feedback loop to continuously improve its behavior.

44574 – Use of simulation and power electronics hardware trainer for teaching an introductory undergraduate power electronics course

Elizabeth A. Thompson, Purdue University – Fort Wayne

An introductory power electronics undergraduate level course at Purdue University Fort Wayne has been upgraded, incorporating theoretical and simulation analyses for comparison to actual measured values obtained from a Lucas Nuelle Power Electronics and Drives 300 W training system. Lecture and laboratory content have been revised to more fully integrate lectures with laboratory assignments. Close agreement between theoretical and simulation values and the measured values obtained in laboratory provide a strong argument that for educational institutions where the cost of such equipment is prohibitive, the combination of theory and

simulation yield a very effective alternative. In this work, the specifics of this course are explained in detail.

44653 – A Preliminary Study of Taxi-out Times Using Discrete-Event Simulation of an Airport with Intersecting Runways

Jiansen Wang, Purdue University – West Lafayette
Shantanu Gupta, Purdue University – West Lafayette
Mary E. Johnson, Purdue University – West Lafayette

Aircraft taxi operations at airports affect fuel consumption, operation efficiency, and emissions. Taxi operations refer to the aircraft movement on airport ground movement area. Understanding taxi operation patterns may potentially improve airport capacity and reduce fuel burn and aircraft emission. Student use of queuing theory and statistical analysis to answer questions is a common objective in many engineering and technology courses from several disciplines such as industrial engineering, mathematics, operations research, aviation management, and information systems, among others.

In this paper, the researchers use ARENA® to build a dynamic, stochastic, discrete-event simulation model of aircraft taxi operations at an airport with two intersecting runways. The simulation model is based on a fictional airport inspired by the layout of William P. Hobby Airport (HOU), Houston, TX. Take-off operations in the simulation model are generated from the airport operation data collected from the FAA Aviation System Performance Metrics (ASPM) dataset by determining the distribution and frequency of departure flights at HOU. In this study, the researchers develop and run a simulation model to measure aircraft taxi-out times 1) at two different numbers of take-off operations per hour, and 2) using either one runway or two. Deconfliction of runway and taxiway use are kept to one set of rules for all simulation runs. The research question answered by the model is: What difference does it make on taxi-out time when there are two different take-off rates and use of either one runway or two runways?

Learning airport taxi operation patterns may help researchers to make better predictions about airport operations. Airport engineers and managers may use similar models to better improve airport total capacity, and reduce congestion and emissions. Engineering educators may use this paper for classes with projects that involve data collection, data consolidation, and simulation analysis. Using ARENA® to build simulation models provides students with graphical and statistical outputs that may be used to enhance achievement of learning objectives. This research may also be useful for undergraduate and graduate students to better understand queuing theory using an example of airport operation and airport design.

41170 – Design of Simulator Test Interfaces for Wireless Sensor Networks

Hunter Dawson Yaple, Gannon University
Ramakrishnan Sundaram, Gannon University
Charles Julius Maier, Gannon University

This paper describes the setup of the interface between the physical nodes of the wireless sensor

network and the virtual sensors in the simulation environment. The wireless sensor network comprises WiFi modules, configured in a grid, to transmit and receive radio frequency signal data.

The interface between the actual network and the simulator enables the signal data from the actual wireless sensor network to be assigned to virtual sensor nodes in the simulation environment. In this manner, the actual network is replicated on the simulator. The creation of the virtual sensor network facilitates the virtual modeling of the actual sensor grid. Test interfaces are designed to compare actual and virtual network performance. CupCarbon is the wireless sensor network design and simulation tool used to interface with the WiFi modules used in the actual wireless sensor network. In addition to displaying key information from the actual network, one of the functions of the virtual sensor network is to compute the change in the received signal strength at each node.

The grid configuration, both actual and simulated, yields received signal strengths arranged as a matrix of values from each transmitter to each receiver. Each matrix constitutes a frame with a specific time stamp. The change in the received signal strengths at each receiver of the network is observed in the actual network and processed in the virtual environment. The change, an attenuation or an accentuation, is used to detect the obstruction within the network by solving the inverse problem. One of the virtual models will assign binary weights to the cells in the space occupied by the grid and solves for the shade of gray to be assigned to each cell. It is expected that as the obstruction passes through the real sensor network, the virtual sensor network determines the location and shape of the obstruction. The platform is being developed to test and model wireless sensor network grids at different geometric scales and with distinct spatial topologies. Its effectiveness to deliver STEM components across K-12 and advanced degree programs is summarized. Although platforms based on wireless sensors such as the TelosB modules have been designed, these cannot be easily integrated with the virtual environment for modeling and simulation studies. The platform is cost effective (approximately $200 for a 10x10 grid) and the CupCarbon software is accessible as a free download.

Session 1E [Workshop] – Room D132

Developing Self-Regulation in Student Teams: Integrating Project-based Learning with Scrum

Sakhi Aggrawal, Purdue University – West Lafayette

In the dynamic field of higher education, cultivating self-regulation within student teams is crucial for effective learning. This workshop, "Developing Self-Regulation in Student Teams: Integrating Project-Based Learning with Scrum", aims to explore the intersection of project-based learning (PBL) and Scrum methodology as a transformative approach to education. PBL, known for its emphasis on real-world problems, enhances student engagement and responsibility. When combined with Scrum, an agile framework designed for efficient project management, it offers a structured yet flexible approach that promotes self-regulation and collaborative problem-solving among student teams.

The workshop offers a blend of theoretical insights and practical applications. Participants will explore the principles of Self-regulated learning, PBL and Scrum, and their combined potential to enrich learning environments. Attendees will leave the workshop with a comprehensive toolkit, including detailed guides on implementing PBL and Scrum in their courses, templates for project planning and evaluation, and access to a network of educators for ongoing support and collaboration. This repository of resources, coupled with the practical experience gained, will enable educators to effectively transform their teaching methods and enhance self-regulation and teamwork in student groups.

Session 2A [Best Professional Paper Nominees] – Room D204

44584 – Cadence Setup for Chip Layout

Anu Aggarwal, University of Illinois at Urbana – Champaign
Shreela Dubey, University of Illinois at Urbana – Champaign

This paper describes an effort at understanding the Cadence flow set up for VLSI design in 180nm technology and updating it to the newer 45nm technology node. This project was undertaken because there are four VLSI design courses offered in our department that use Cadence. When the Cadence software license was updated to the latest version, the original set up for all these courses stopped working. So, we decided to systematically study the current setup files for Cadence tool for the 180nm technology and update it to 45nm. To integrate the update into machine problems (MPs) for our course, the manuals were updated to utilize the new library. Once updated, the MPs were tested to ensure proper integration. As part of this project, we learned how to set up Cadence for any technology library and learned the scripting language for writing the files. This work will be useful for anyone looking to set up a new Cadence license for use in circuit design, simulation, layout, and tape out for chip fabrication.

44586 – Development of a 3-Credit Multidisciplinary University Autonomous Vehicles Course Without Prerequisites and Open to Any Major

Nicholas Brown, Western Michigan University
Johan Fanas Rojas, Western Michigan University
Alyssa K. Moon, Western Michigan University
Ali Alhawiti, Western Michigan University
Pritesh Yashaswi Patil, Western Michigan University
Parth Kadav, Western Michigan University
Kira Hamelink, Western Michigan University
Wendy Swalla, Western Michigan University
Zachary D. Asher, Western Michigan University

Autonomous vehicle technology has tremendous potential for revolutionizing the current transportation industry. Companies and investors are funding a staggering amount of development, leading to a large number of high paying jobs that require new skills. But the traditional university engineering education model has not kept up with demand as evidenced by the popularity of Udacity, Udemy, and other massive open online courses. A new paradigm of multidisciplinary education is needed to meet learner and industry demand. To begin to address this need, this paper proposes a starting point for the design of a multidisciplinary 3-credit Autonomous Vehicle Engineering university course based on our experience from 3 previous course offerings. First, we discuss how the course evolved from the first to third offering. Specifically, how the course was intentionally developed to include practical applications of industry-standard writing and to center student learning with regular feedback and practice. Next, we break down the core concepts for autonomous vehicle engineering across engineering and computer science disciplines. We address the issue of prerequisites and how the class concepts were ultimately organized and how existing university research and computer labs were utilized.

Lastly, we also discuss group dynamics and techniques for ensuring course project teams have diverse majors. Our results section is primarily composed of survey results from our third course offering. We show the evolution of skills from the mechanical engineering students and the computer science students over the course of the class. For example, the computer science students typically have no controls experience, and this skill will (hopefully) have improved by the end. Lastly, we show overall grade trends in the course and qualitative information on final project complexity as the course has evolved. Our conclusion is that this proposed framework has potential to begin to address the university shortcoming of autonomous vehicle engineering education. Overall, this paper provides a perspective for educators and academic policymakers to acquire insights into how to develop an autonomous vehicle engineering course. Future work includes developing a blueprint for an autonomous vehicle certification program composed of several courses.

44595 – Implementation of a Semester-long, Real-World Problem Project in a Critical Systems Thinking Course

Mary E. Johnson, Purdue University – West Lafayette
Gustavo Sanchez, Purdue University – West Lafayette

A course in Critical Systems Thinking (CST) course is an elective in a graduate level aviation and aerospace management program at XYZ University. The program attracts students from aviation, technology, and engineering undergraduate degrees. The CST course is designed to improve the student's ability to solve complex problems by identifying and assessing the system from a systems thinking perspective. In a previous version of the CST course in this program, students read textbooks and cases that led to discussions of the systems and archetypes. However, the students came to the program with a wide array of experiences - most of which were academic and not from employment. Real-life experiences may better enable students to learn these systems thinking principles. The CST course was modified in 2017 to introduce hands-on discovery activities (HODAs). Students used HODAs to experience, explore, and analyze systems in a friendly, game-oriented, classroom environment. In 2020, the use of HODAs was limited due to pandemic restrictions of interactions in the classroom. Therefore, a real-life, open-ended, semester-long, complex problem, group project was added to explore the use of system archetypes and models. In 2022, the group project was to develop models to understand a different aviation problem from differing perspectives. These projects addressed the projected aviation maintenance worker shortage of 800,000 people over two decades in the US. This paper discusses the objective, preparation, and implementation of the personnel shortage project used in the CST course. The open-ended project is outlined and discussed. Student and instructor feedback are used to discuss the relationship of the project to the lecture topics and the learning objectives.

44643 – Sustainability-Focused Project-Based Learning in a Heat Transfer Course

Christopher J. Gioia, Slippery Rock University
Samantha Bortz, Slippery Rock University

Climate change is one of the most notable societal challenges that is being pursued in the field of Mechanical Engineering. As a result, sustainability-focused design is becoming more prevalent in industry, and the same is true of Mechanical Engineering curricula. In this paper, four projects that were assigned to undergraduate Mechanical Engineering students in their Heat Transfer course will be presented and examples of student design solutions will be discussed. To ensure an authentic engineering experience, the design projects were defined based on the immediate needs of the Macoskey Center (MC) for Sustainability Education and Research at Slippery Rock University. The director of the MC acted as the customer in the engineering design process, and she was responsible for defining the project scope and requirements. All projects had to use only sustainable processes and materials during the design process. Additionally, two design concepts were required – one with the goal of optimizing cost and the other optimizing performance. The educational goals included mathematical discussion of the mechanisms of heat transfer, design generation and selection using sustainable processes and materials, collaborating effectively in an engineering team, and technical discussion of the designs. Students were required to generate two concepts, one that prioritized performance, and another that prioritized cost and ease of implementation. Students presented their work in a written report as part of their overall summative assessment and through an oral presentation to the MC director. Overall, student project learning outcomes were achieved, and observations were noted that influenced course improvements. This work will be expanded in the future to assess educational outcomes and student perceptions of the projects, as well as extend the projects to a Capstone Design course.

44704 – Sustainability Components Assessment of Engineering Design Capstone Projects

Bilal Alhawamdeh, Western Michigan University
M. Muchson, Western Michigan University
Ahmad Mohammad Rasheed Al-Bodour, Western Michigan University

As the engineering community grapples with integrating sustainability into its curricula, assessing how sustainability concepts are infused across various engineering disciplines remains challenging. The senior design capstone project is pivotal in assessing students' understanding of engineering subjects. Thus, it acts as an effective measure of their awareness and proficiency in sustainability. This study assesses the integration of sustainability in senior design capstone projects across six engineering programs, namely, Chemical and Paper Engineering, Civil and Construction Engineering, Electrical and Computer Engineering, Engineering Design Manufacturing and Management Systems, Industrial and Entrepreneurial Engineering and Engineering Management, and Mechanical and Aerospace Engineering, utilizing a validated sustainability rubric. The assessment focuses on seven critical criteria: dimensions, cognitive levels, links, drivers, integrations, qualitative and quantitative incorporation, and sustainability topics. The assessment was conducted using an interrater reliability approach between two researchers. One key revelation from the study is that sustainability is more integrated within the projects' fabric than existing as a stand-alone element. This integration, however, is significantly influenced by instructor-driven expectations. The analysis across the six programs indicates that if sustainability is not highlighted as a primary project deliverable, students are less inclined to incorporate sustainability concepts acquired from previous coursework into their reports. This finding underscores the importance of explicitly embedding sustainability requirements within

project guidelines. The study advocates incorporating sustainability experts directly into senior design courses, acting as course advisors or project mentors, to strengthen the emphasis on sustainability. This initiative has shown promising results in specific projects across the examined programs, potentially setting a precedent for a more embedded and holistic approach to sustainability in engineering education.

Session 2B [Best Student Paper Nominees] – Room D115

44592 – Development of a VHF/UHF-Band Video-Streaming Payload for Near-Space Operation and Lessons Learned

Wookwon Lee, Gannon University
Sara Jones, Gannon University
Zachary Owen Dickinson, Gannon University
Andrew Donald Snowdy, Gannon University
Nicholas B. Conklin, Gannon University

Over the past few years, we have been developing a functional prototype of a real-time, multi-window video streaming system employing several Raspberry Pis and a pair of all-standard VHF/UHF/L-band modulator and demodulator. Our primary motivation for this effort stemmed from the 2017 total solar eclipse balloon flight. During the August 2017 total solar eclipse, we successfully conducted an experiment for real-time video streaming with four Raspberry Pis and four Pi cameras via a single wireless link between a pair of 5.8 GHz Rocket M5 modems. The real-time video streaming lasted about 7 minutes in flight before the radio connection was lost between the payload and the ground station which was stationed at the balloon launch site. From this experience, we desired to substantially extend the radio range between the payload and the fixed ground station to extend the time duration of video streaming between them. As a key enabler for this desire, we found a pair of VHF/UHF-band modems that could support the required data rates for video streaming. In our initial theoretical estimate, since the radio range is inversely proportional to the square of the carrier frequency, this new modem operating at the VHF/UHF bands would substantially extend the radio range for the same transmit power used by the 5.8 GHz Rocket M5 modems.

While our development and functional testing had been performed in a lab setting with a coaxial cable connecting the modulator and demodulator, we desired to test this video streaming system over a VHF/UHF spectrum band for application to future high-altitude balloon flights, including one for the 2024 total solar eclipse. With our goals set 1) to be able to test functionality in the extreme weather conditions of high-altitude ballooning and 2) to test the radio range at a VHF/UHF band utilizing an 8 MHz bandwidth for real-time video streaming, substantial additional efforts were made to convert what was for terrestrial operations to a battery-powered science payload that could properly operate in extreme weather conditions such as high-altitude balloon flights cruising near space.

This paper describes our development efforts and lessons learned, and is organized as follows. Section 2 provides an overview of our payload and key technical details of the payload subsystems under the constraints of extreme weather conditions and limited supply power. Section 3 provides our analysis of experimental data collected during a thermal and vacuum testing at the CSBF lab. In Section 4, our experience and lessons learned from our participation in the HASP 2023 balloon launch and data collection. Concluding remarks are provided in Section 5.

44603 – A Hands-On Activity on Equilibrium of Rigid Bodies in Statics

S.M. Seyed Ardakani, Ohio Northern University
Joshua Wiseman, Ohio Northern University

One of the most important, yet challenging topics for engineering students in Statics is the equilibrium of a rigid body in 3D. To analyze a rigid body in 3D, students need to know supports and free-body-diagrams (FBD) in 3D, be able to visualize vectors in 3D, and understand moments in 3D. The concepts of moment and FBD in 3D have various engineering applications such as ensuring the stability of aircraft in aerospace engineering. To enhance students' understanding of these concepts and connect them to a real-world scenario, a hands-on activity was designed and assigned for completion. Failure of a guyed antenna tower during a tornado was used as the activity prompt. Additionally, students were provided with a small-scale model representing the full-scale antenna tower. The model served as a physical and interactive visualization of the tower, allowing students to engage with the problem described in the prompt. The combination of hands-on experience and a real-world context aimed to foster a deeper understanding of the material targeted by the activity. Following the completion of the activity, a questionnaire was sent to students to gauge their understanding. The survey included multiple questions regarding students' confidence in the material. This paper aims to provide a comprehensive description of the activity, discuss the survey questions, explore the results of the survey, and assess the overall impact of the activity on students' comprehension of equilibrium of rigid bodies in 3D. It was found that the activity benefits students as a learning aid.

44616 – Converting Text Into 3D Printable Braille

Dax Amburgy, Ohio Northern University
John K. Estell, Ohio Northern University

Braille is a system of raised dots arranged in a 3-dot high by 2-dot wide grid that provides a tactile approach for a visually impaired person ability to read. Many buildings, including the engineering building at Ohio Northern University, provide accessibility accommodations by including Braille on all room signs; unfortunately, because of the need for external vendors to perform Braille renderings and the corresponding costs involved, many institutions provide no more than the bare minimum of just rendering the room number in Braille. However, as a room's occupants and/or purpose can change, having a way to provide all visually displayed information in Braille using an economical and convenient manner would provide greater benefits.

This undergraduate research project involves developing a methodology of rendering text into a 3D printable Braille file. This process involves first entering the text that the user would like to translate. This text is then converted into its Braille translation. From there, it is converted into an image. This is necessary for the 3D printing process. The current methodology for converting the 2D image into a 3D object is using an art technique known as a lithophane. This is a thin, translucent material that when light is shined behind it, the thicker sections show the image that is engraved in the material. In 3D printing, the thicker sections would receive more material, and therefore creating the dot matrix of each Braille character. The current time to print is approximately 30 minutes to 1 hour. To provide greater accommodations, magnets will be

installed on the back of these signs to allow for transportability of the Braille plaques. This would allow professors to place temporary nameplates for classrooms, curators to announce art project names in the art building, and for dining services to label various dish names at the dining hall.

44681 – Quantum and Classical Supervised Learning Study of Epitaxially–Grown ZnO

Andrew Steven Messecar, Western Michigan University
Steven Durbin, University of Hawai'i
Robert Makin, Western Michigan University

Material synthesis parameter spaces typically have a very high dimensionality and are often intractable in size. Exploring these vast, multi–dimensional processing spaces by trial–and–error experimentation – even for well–studied materials – is not feasible on reasonable time scales. Thus, considerable interest exists in the development of machine learning–based approaches for the rapid and accurate identification of optimal materials designs and synthesis conditions. In this work, data describing over 125 plasma–assisted molecular beam epitaxy (PAMBE) synthesis experiments of ZnO thin film crystals have been organized into a single data set. For each growth record, the complete set of PAMBE operating parameters for ZnO synthesis are associated with a measure of crystal surface morphology as determined by in-situ reflection high–energy electron diffraction (RHEED) patterns. Quantum and classical supervised learning algorithms – including logistic regression, support vector machines, and a quantum variational circuit – are trained on the data and used to study which growth parameters are most statistically important for influencing surface morphology in epitaxially–grown ZnO thin films. Comparisons are drawn between the generalization performances of the various algorithms that are trained on the data. The support vector classifier exhibited superior generalization performance among the compared algorithms and is used to predict the surface morphology of ZnO thin film crystal across processing spaces defined by the most statistically important synthesis parameters. These supervised learning–based predictions yield experiment design rules which can be used to inform future ZnO PAMBE growth trials. This analysis offers a valuable perspective on the mechanisms that are active during the PAMBE synthesis of ZnO and other related oxide compounds.

44674 – Creating Interdisciplinary Sustainability Focused Projects for Engineering Students Through Industry Partnerships

Aiden James Landis, University of Pittsburgh
David V.P. Sanchez, University of Pittsburgh
Tony Lee Kerzmann, University of Pittsburgh
Robert Kerestes, University of Pittsburgh

Teaching students how to manage complex sustainability industry challenges is an increasingly important initiative in many schools of engineering. At the University of Pittsburgh, undergraduate engineering students can pursue a certificate in sustainability and graduate students can earn their masters in sustainable engineering. Concomitantly, companies such as VaultE have done significant work to tackle many of the global sustainability challenges as

represented in the United Nations Sustainable Development Goals; bring clean electricity and clean water to underdeveloped communities across the globe. Given these two development goals it is increasingly important to explore partnerships between the University of Pittsburgh and companies like VaultE. An interdisciplinary partnership was developed with students in both the electrical engineering industry projects course and the sustainability engineering capstone course to work in interdisciplinary teams, with companies, focused on sustainability challenges. Through these many sustainability focused industry partnerships, the University of Pittsburgh has and is creating experience-based learning opportunities for students and will be a test bed for research the sustainable technologies developed by some of these companies. In this paper we share a model for building these partnerships for the development of our students, furthering the sustainability goals of our sponsor companies, and the plans for future educational and research projects.

Session 2C [Student Papers] – Room D109

44561 – Optimizing the Design for Additive Manufacturing Project in the Manufacturing Processes Lab Course Using the Taguchi Orthogonal Arrays

Omar Ahmed Al-Shebeeb, West Virginia University

As 3D printing technology becomes more extensively used and more users have access to its immense potential, questions regarding which machine parameters affect the performance of the produced object arise. One of the primary projects taught and implemented in the Manufacturing Processes Lab course is the Design for Additive Manufacturing (DfAM). One of the key challenges I had when executing this procedure was determining how to optimize the 3D printing parameters and increase the quality of the manufactured items. In the other course, Design for Manufacturability (DfM), that I am teaching, I was presenting Taguchi Orthogonal Arrays and Quality Loss Functions (QLF) as tools for Design for Quality projects in the DfM course. In the Manufacturing Processes Lab course, I opted to use Taguchi Orthogonal Arrays to investigate the performance of the DfAM project in the Manufacturing processes course. This report seeks to address some of these 3D printing difficulties. The Taguchi Orthogonal Array (L8 (2^7)) was performed 3D printing systems to assess the effects of 3D printer settings on part quality. In this evaluation, there are six factors (width, thickness, radius of fillets, temperature of nozzle, layer direction, and layer height) were investigated in this experiment, as well as one interaction between two factors. The width and layer height interaction were investigated. Three trials of eight distinct tensile strength experiments were performed to test the factors. The Taguchi orthogonal array was used to calculate the factors applied to each sample, and each factor was examined. The evaluation revealed that the width and thickness of the pieces were the most significant factors. Except for nozzle temperature, all lower values for the six parameters were shown to have a higher strength-to-weight ratio. The best signal-to-noise ratio was found in Experiment 1. When both parameters (width and layer height) were at Level 1 (lower values), the interaction between them was shown to be the best. Based on desirable qualities, the optimal strength-to-weight ratio was determined to be 35.09 MPa/g.

44639 – A Comparative Study of Topic Models for Student Evaluations

Joseph C. Sheils, Marshall University
Haroon Malik, Marshall University
David A. Dampier, Marshall University

Deciphering valuable insights from unstructured written comments in student evaluations within higher education poses a significant challenge, calling for advanced analytical tools. Previous research has underscored the importance of employing topic modeling as a vital tool for unraveling complexities in large volumes of unstructured textual data and extracting dominant topics. While Latent Dirichlet Allocation (LDA) has been a longstanding choice in past studies, the emergence of new and modern topic modeling techniques demands a comparative analysis of their performance against LDA when used with student evaluations. This paper evaluates four topic modeling methods – Latent Dirichlet Allocation (LDA), Nonnegative Matrix Factorization (NMF), BERTopic, and Top2Vec – based on two key performance metrics: topic coherence and

topic diversity. Using data from Rate My Professors, our assessment overwhelmingly endorses BERTopic, showcasing its superiority in producing the most informative topics, unmatched easeof-use, and overall functional excellence for extracting valuable insights from written comments in student evaluations.

44551 – Walk and Draw: Digital Cartography as Artistic Practice for K-12 Students

Andrew Goodling, Grand Valley State University
Erik M. Fredericks, Grand Valley State University
Sara Alsum-Wassenaar, Grand Valley State University
Hsaio-Ping Chen, Grand Valley State University

Creative cartography is a domain in which maps can serve as both a visual form and a conceptual strategy for learning and artmaking. One specific exploration of this domain presents interesting opportunities for students to understand their surroundings as field explorers, employing skills of observation, exploration, inquiry, and presentation of visual information. By navigating the walking paths and illustrating their sightings and experiences on a map, students can develop visual perception and spatial awareness. Traditionally, this process involves handing out printed maps and markers to the students who are then led on a guided walk. Although such an approach fosters students' creativity, problems may arise in terms of lost or crumpled drawings and the limited visual features of the traditional mediums offered. To address these shortcomings, we introduce a digital mapping tool, Walk and Draw, a browser-based application that allows students to follow predetermined walking paths while developing their spatial awareness and documenting their creative process. Walk and Draw equips students with a GPS-guided map that can be used for walks in any location as well as drawing features provided with different types of pens, customized colors, and user-drawn stamps to help them make visual connections, visualize data, and understand spatial relationships in places they visit.

This project was created as a collaborative undergraduate research experience between multiple disciplines, including communications, art education, and computer science, as well as in partnership with a local public K–12 school. Walk and Draw was developed as a browser-based application using the p5js library to enable ease of development and rapid prototyping of ideas. The program itself presents users with a large map of their current area based on a device's current GPS location and supports both touch- and pen-based drawing. Students can select multiple pen tips and colors and create stamps to record their journey and provide a setting for creative outputs. The aim of using the Walk and Draw application is to enable student creativity, support exposure to their surroundings, and preserve artistic outputs for public exposition. Walk and Draw has been deployed to approximately 50 K–12 students and community members thus far and has received positive feedback.

44642 – Campus Interactive Map Application

Alexander Duke, Ohio Northern University
Ethan Krause, Ohio Northern University
Mia Prasinos, Ohio Northern University
Lewis Schafer Ohio Northern University

The objective of this senior design project is to address the prevalent challenge of navigation on an anonymous university's campus. The issue noted is rooted in the fact that first-year students have no easily accessible, well-known, or efficient map. This hinders the accessibility and knowledge of campus as these students currently have to learn information and directions across campus on their own time, which often results in confusion and tardiness to important meetings. Along with this, prospective students may be visiting at a time when the admissions office is closed and they would not have the ability to easily navigate or learn about campus.

Although existing solutions attempt to combat this challenge, each of them lacks functionality which ultimately prevents the solution from being leveraged by the student body on campus. The proposed solution plans to address the issues noted in existing implementations and provide both current and prospective students with a web-based application to aid in their campus navigation. The use of a web framework will allow the system to be highly efficient, budget-friendly, easily maintainable, and scalable information schema.

In order to bridge gaps denoted in prior solutions, the proposed solution will meet frequently with the client, the Department of Information Technology at the anonymous university. In addition to client specifications, user feedback has already been collected through an Institutional Review Board (IRB) approved survey and will enable the application to be user-centric in the development process. Together, the findings from the client and survey will ensure the application provides optimal functionality to the users. Upon successful completion of the solution, the project will be transferred to the internal client for continued maintenance and support with training and documentation provided.

44617 – Enhancing Student Understanding of Digital logic and Computer Architecture Through Turing Complete Game Challenges

Eric McKanna, Ohio Northern University
Firas Hassan, Ohio Northern University

Turing Complete is a game released on the Steam platform designed to teach digital logic and computer architecture concepts through a series of challenges and problems. Its skill-tree approach covers digital logic, binary arithmetic, and memory. The end goal is to create a Turing complete computer through building blocks developed during each different section of the tree. In this paper, we suggest adapting and modifying problems from the game to emphasize key comprehension points in the students' coursework to both gauge understanding and build a more dynamic skill set with logic gates. In addition to being a superb source of content for labs or homework assignments, the game also provides students with an excellent sandbox and simulation tool to develop and experiment with their ideas.

Session 2D [Professional Papers] – Room C136

44635 – Assessment of Student Learning in First Year Civil and Architectural Engineering Project (Work in Progress)

Elin Jensen, Lawrence Technological University

Many engineering students lack confidence during the ideation phase of their senior project experience. Tasks associated with developing the project scope and alternatives, while considering diversity, equity and inclusion (DEI) and sustainability pose challenges. Faculty hypothesized that these challenges are associated with lack of prior experience in developing a comprehensive collaborative proposal. An improvement of the preliminary senior project proposal is desired and is hypothesized that improvements can be achieved by introducing educational strategies earlier in the curriculum.

This paper evaluates a first-year civil and architectural engineering project that prepares students for upper-level work while introducing them to stakeholders. The project is addressing a need identified by a city in their Sustainability Action Plan (SAP). The need is mobility by way of improving public transit and non-motorized transportation networks. Mobility hubs are suggested in SAP. The City identified key design features and priorities such as: comfortable waiting area for all users, micro- and macro mobility, low impact developments for storm water management, sustainability and DEI.

This project implemented multiple learning strategies. First the students engaged with city planners and community survey data obtained by city. Guest speakers shared the design and engineering considerations that went into the conceptual design of a regional multi-modal transit center. Later in the semester, the students are introduced to engineering terminologies and concepts such as analysis of transportation data and relevant geometric designs, team work, sustainability, environmental justice data, low impact development techniques for stormwater management, building systems, and conceptual cost analysis. The semester concludes with the students working in teams to prepare the conceptual project and the deliverables are; preliminary project plan, impact statement, and a final proposal presentation.

The student's learning will be assessed using student developed mind maps that captures their vision of the transit center meeting the needs of the stakeholders. The knowledge structure of the mind maps is evaluated to categorize the student's learning as non-learning, surface-learning and deep-learning. The quantitative assessment of the mind map is based on the number of concepts included, addition and removal of links between concepts, and the addition or removal of concepts between mind maps. Three sets of mind maps are developed and assessed. The first mind map is developed by the individual students after the initial project proposal has been submitted and evaluated by faculty. Immediately following this activity, the team collaborate to developed a mind map that reflects the collective vision. The last mind map is developed, by the individual student, after the project impact statement has been developed and graded and immediately before the final project presentation. The project is currently underway. The last and third set of mind maps will be developed by mid December 2023.

The study hypotheses are that:

1. The individual student mind maps become increasing more complex between the first and last mind map demonstrating deep learning.
2. The team mind maps are more complex than the first individual mind map demonstrating surface-learning and deep-learning.

44640 – A Three Year Perspective: Effectiveness and Lessons Learned from an Engineering REU Program

La'Tonia Stiner-Jones, The Ohio State University

Research Experiences for Undergraduates (REU's) serve an important role in providing students with an immersive research experience. In many cases REU's provide students considering graduate school with their first research opportunity, can influence them to go to graduate school, and prepare them for success in applying to and completing graduate school. Our REU SITE provided an opportunity for all of these. Our program was a 10-week immersive research experience that supported 10 students per summer and provided strategic professional development to support research success and success in applying to and completing a graduate degree. Here we summarize the outcomes from our three-year award. Each year we have published on different aspects of the project. Here we report outcomes of our objectives from all three cohorts and discuss lessons learned and next steps. The REU SITE program objectives were to 1.) increase the number of historically underrepresented students pursing a MS or PhD and prepare them for success when applying and completing a graduate degree, 2.) provide an independent scientific research experience in Biomechanics and Mechanobiology (BMMB), 3.) and develop the participants capability to comprehend, contribute to, and communicate about advances in BMMB. To evaluate the effectiveness of the program we conducted pre- and post-surveys using the Qualtrics online survey instrument. The statistical analyses were conducted and charts created using GraphPad Prism 9.5.1 software. Over the course of our program, we were successful at increasing the diversity of students pursing an advanced degree in engineering and BMMB. Of the thirty participants 83% identified as underrepresented minority (URM) and 67% identified as female. Ninety percent of our first cohort and 67% of the second cohort that have graduated have completed or is completing a graduate degree in engineering or BMMB. Of those who have enrolled or graduated from graduate school 83% were URM and 67% were female, thus contributing to the diversity of engineering. Moreover, students felt the SITE REU prepared them for success when applying to and completing a graduate degree $p<0.05$ and $p<0.05$, respectively. Additionally, students felt prepared to participate in the basic activities of successful graduate students. Specifically, they felt prepared to write an abstract, prepare and give research presentations, and find and read research papers $p<0.05$ for each. Similarly, students felt better prepared to participant in independent research $p<0.05$. Lastly, participants felt better prepared to contribute to and communicate about BMMB by the end of the program $p<0.05$. Over to course of the project we learned something new from each cohort and responded to student feedback. We also learned to expect the unexpected and to adapt to the changing backgrounds, experiences, and preparation of participants, particularly after the pandemic began. We noted the experiences, needs, and perspectives of students shifted as did the steps we took to

support them. Going forward we aim to continue tracking and supporting our participants and hope to continue offering what has been a successful program.

44667 – Undergraduate Research Experiences for Automated and Connected Vehicle Algorithm Development using Real Vehicles

Chan-Jin Chung, Lawrence Technological University
Joshua Siegel, Michigan State University
Mark Wilson, Michigan State University

We are experiencing a revolution in vehicle operation, with fully automated robotaxis deployed and available for public use in major U.S. markets in 2023. These vehicles, while imperfect, already are arguably safer than the average human driver. Despite this rapid progress, there remain significant research and development problems that must be addressed; beyond this, there is an underdeveloped workforce for skilled researchers, developers, and practitioners in these areas, a fact that may delay necessary advances. We have created and run for two years a National Science Foundation funded Research Experience for Undergraduates (NSF REU) focused on solving both unmet research needs, and workforce development and pipeline programs. In our REU, which makes use of simulation and two full-scale, street-legal drive-by-wire electric vehicles with perception, planning, and control capabilities, our primary goals include to (1) provide hands-on experiences to undergraduate students who otherwise might not have research opportunities to learn fundamental theories in autonomous vehicle development, (2) allow students to design algorithms to practice software development and evaluation using real vehicles on real test courses, (3) strengthen their confidence, self-guided capabilities, and research skills, and (4) increase the number of students, including those from diverse backgrounds and technical disciplines, interested in graduate programs to ultimately provide a quality research and development workforce to both academia and industry.

Over the initial two years, a cohort of 8 diverse students each year learned fundamental self-driving and computer networking skills including coding for drive-by-wire vehicles, computer vision, use of localization, and interpretation of richer sensor data, as well as network and communication protocols. The students were introduced to research ideation and publishing concepts, mentored in designing and testing hypotheses, and then involved in two challenges related to self-driving and networked vehicles. Two teams of 4 designed, implemented, tested various self-drive and V2X algorithms using real vehicles on a test course, analyzed/evaluated test results, wrote technical reports, and delivered presentations. After the summer program was over, the technical reports were published in peer reviewed conferences and journals.

Survey results show that students attained significant & real-world computer science skills in autonomous vehicle development leveraging real vehicles available. The programs also increased research career interests and strengthened students' confidence, self-guided capabilities, and research skills, while additionally supporting the development of workshop materials, simulators, and related content that provide valuable resources for others planning to develop an undergraduate curriculum to teach self-drive and networked vehicle development.

44572 – Narrative Integration in Engineering Education through Story-Based Pedagogy: Lessons from a First-Year Engineering Case Study

Claudio Cesar Silva de Freitas, Purdue University – Fort Wayne

This paper describes the instructor experience and preliminary findings obtained during the development and implementation of a narrative pedagogy in first-year engineering (FYE). The primary contribution of this research lies in detailing practical experiences to guide the development of new teaching strategies in comparable educational contexts. This research is embedded within a broader, long-term investigation aimed at rethinking the curriculum, evaluation methods, and teaching techniques of a FYE program. Specifically, we discuss an ongoing study and lessons learned focused on applying a narrative-driven pedagogy in FYE

44611 – Modeling and Simulation Analysis of Coal Fly Ash Compounds Settling in West Virginia

Mohammed Ferdjallah, Marshall University
Asad Salem, Marshall University

The objective of this study is to design a framework that allows undergraduate students, regardless of their technical expertise, to actively participate in researching complex interdisciplinary engineering projects. To illustrate this objective, we designed a framework focusing on modeling and simulating the settling of coal fly ash, a byproduct of coal-fired power plants. This study focuses on coal burning, aiming to raise awareness among future students about the implications of coal fly ash byproducts. This framework enables undergraduate students to investigate coal burning and its consequences. Utilizing modeling and simulation techniques facilitates the study of coal fly ash particle settlement as a starting point for these course-based projects. We have developed an application to illustrate these concepts, providing a foundational platform for students to explore and investigate issues related to coal burning. Through this application, students can expand the explored concepts and leverage them to tackle more intricate challenges of coal burning. Furthermore, our methodologies assist students in understanding the selection and application of engineering techniques of coal fly ash particle dynamics. West Virginia is the fourth-largest coal consumer in electricity generation, with coal contributing 91% in 2021. The state faces challenges in containing fly ash emissions. Despite efforts, around 1% of fly ash escapes, impacting both the environment and human well-being due to pollutants like sulfur oxide, nitrogen oxide, carbon dioxide, acid gases, and organic hazardous substances. Utilizing data from active coal-fired power plants, we estimated fly ash production and simulated settling for particle sizes from 0.5 μm to 100 μm. Our study indicates significant fly ash settlement in central, northern, and eastern counties, with lesser amounts in southwestern regions and areas closer to coal-fired power plants.

Session 2E [Workshop] – Room D132

How to Design an Interdisciplinary ABET-compatible Cybersecurity Curriculum? A Workshop for Creating Undergraduate Programs

Prakash Ranganathan, University of North Dakota
Jamison Jangula, University of North Dakota
Neena Goveas, University of North Dakota
Shree Ram Abayankar Balaji, University of North Dakota
Utku Kose, University of North Dakota

Nowadays, there is a remarkable need for running undergraduate cybersecurity programs. This is because of growing cyber threat landscape and the high demand for the workforce in industry. Creating of such undergraduate programs require designing curriculums ensuring interdisciplinary connections as a result of the technical and societal scope of the cyber security. Moreover, it is important to build well-rounded sets of courses, which are compatible with the ABET criteria. Eventually, such cyber security curriculum should also reflect strategies for attracting and engaging students from diverse backgrounds. Moving from the related state, this workshop aims to share experiences by the presenter team and trigger a collaborative study environment to think about how to design the desired cybersecurity programs.

The flow of the workshop will start with a general introduction to the impact of cyber world and threats, and a discussion on recent perspectives / future insights from the industry. Next, the workshop will point the role of higher education institutions for catching the needs effectively, and explain the foundational knowledge and skills of cybersecurity as well as their integration in the context of Electrical Engineering and Computer Science.

These will be followed by evaluating the compliance of a created program with the ABET criteria and discussing about the pre-requisite courses that can serve as a foundation for the students from different backgrounds. The next steps will include general evaluation of active cybersecurity programs around the U.S, and a brief presentation of the proposed curriculum design in the University of North Dakota (UND), School of Electrical Engineering and Computer Sciences (SEECS). The workshop will then divide the participants into small groups so that they can brainstorm ideas for creating similar programs in their institutions. After this collaborative brainstorming phase, the workshop will encourage groups to share their findings and ideas. The findings and ideas will be discussed among all participants and the workshop will be ended by summarizing the key takeaways and providing resources as well as next steps for the participants interested in performing similar initiatives.

The workshop presentation will be led by Dr. Prakash Ranganathan (University of North Dakota, prakash.ranganathan@und.edu). Dr. Ranganathan will be supported by his team members: Jamison Jangula (jamison.j.jangula@und.edu), Dr. Neena Goveas (neena.goveas@und.edu), Shree Ram Abayankar Balaji (shree.balaji@und.edu), and Dr. Utku Kose (utku.kose@und.edu). The workshop materials include presentation slides, whiteboard or flip chart for presentation as well as group discussions, access to a virtual platform if the workshop includes online

participations, and handouts or resources regarding ABET criteria, industry perspectives / insights, and the proposed curriculum / program.

Session 3A [Professional Papers] – Room D204

44618 – Incorporating Sustainability Concepts into the Course Design of Fluid Mechanics: An Approach to Improving Students' Problem-Solving Skills with Environment Science

Yingxiao Song, Muskingum University

It is crucial to pay attention to environmental sustainability with the current climate change. The definition of sustainability, which refers to the ability to maintain or support a process continuously over time, can be applied to different aspects. As potential engineers in the future, engineering students should develop their sustainability consciousness and mindsets. Fluid Mechanics is a course that is usually open to most engineering students in their junior or senior year, which means they have completed their introductory courses like physics and chemistry. Students who are at this stage are usually eager to solve more realistic problems than laboratory work. This paper shows the integration of sustainability concepts with the Fluid Mechanics class through lectures, laboratory work, simulations, and projects. Educational objectives, assessment methods, and sample problems are presented in this paper.

44622 – An Elective Course in Green Chemical Engineering and Sustainability

Joaquin Rodriguez, University of Pittsburgh

Embedding "sustainability" in the engineering curriculum, and particularly in the chemical engineering curriculum started over a decade ago, spurring from the landmark publication of Anastas and Warner on "green chemistry". It was early recognized the power of the idea of "sustainable engineering" along with the challenges to develop adequate frameworks, methods, and metrics to be implemented in professional work and the corresponding teaching and training of engineering students to prepare them for the job. The field has been growing fast and extensively in this 15-year period (an illustrative summary is included in the paper). Our university has been developing a large ecosystem of sustainability focused and sustainability courses across many disciplines, nucleated by an engineering center for the development of sustainability. Research, courses, industrial partnerships, and community service activities have fast evolving. Most recently (2023) a new elective course on green chemical engineering and sustainability has been launched to specifically introduce chemical engineering students (juniors, seniors) with fundamental framework, concepts, methods, and tools to start their journey in in the path to sustainable development. This 3-credit unit elective course has been extraordinarily well received by chemical engineering students, with an enrolment of 46 students, about half of the Class 2025. The course features lectures based on the adopted textbook. Lectures are documented with embedded references for students selectively advance in the topics of their interest. Short quizzes are taken online after every lecture to reinforce learning and retention. A most distinctive characteristic of the course is the series of invited speakers (a total of 12 in this first edition of fall 2023) from industry, academia, government, ONGs, and businesses. Also included are in-class activities (introduction to LCA software, introduction to solvent selection

software, mock questions for Sustainability CEO, proposal for EPA budget distribution for sustainability related projects). Students are presented with a list of homework problems after every lecture for their choice of one per lecture that best fits their interests. Students are requested to develop two team projects. A technical project researching a topic of interest in sustainability and proposing an innovative solution, mainly based on creativity. An outreach project taking relevant messages on sustainability to K-12 programs or through social media platforms or providing some community service. Projects are displayed in a publica event with the participation of representatives from industry and academia to discuss and grade their scope and performance. The paper elaborates on all these aspects of the course and the corresponding assessments.

43106 – The Bridge Down the Road: Review of Bridge Programs for Graduate School

Diane L. Peters, Kettering University

Students have many transitions that may occur as they progress through their education, and those can be challenging. While one of these is the transition from high school to college, another transition takes place as students who choose to go to graduate school enroll in that new program. This may involve changing to a new school or shifting the focus of their studies, and definitely represents a transition in the level of work that is expected, and this transition can be challenging for some students. While not as common as bridge programs designed for students matriculating into undergraduate programs, and not as well documented in the literature, some graduate bridge programs do exist. This paper presents a literature review of such programs, with a specific focus on those applicable to engineering graduate programs. General traits of these programs are noted, as well as some gaps in knowledge that can guide future research.

45027 – Determining Student Self-Efficacy as Engineers Through a Multi-Cohort Mechanical Engineering Design Project

Christopher J. Gioia, Slippery Rock University
Louis Christensen, Slippery Rock University

A multi-class design project was conducted in the mechanical engineering program at Slippery Rock University. Sophomore students in Dynamics (ENGR 240), Junior students in Machine Design (MECH 410), and junior/senior students in Manufacturing Processes (MECH 320) worked together in groups to design, analyze, build, and test trebuchets meant to launch baseballs. This design project occurred during the entire spring semester of 2023. The different courses completed their responsibilities and handed them off to the next course in the project throughout the semester starting in Dynamics, then Machine Design, and finally Manufacturing Processes. Upon the project's completion, the instructors made observations that influenced future student survey development and project iterations. This work presents the initial details of the project, faculty observations, and future data collection tools for project-based pedagogical research. The goal of the research is to use this project to identify when students self-identify as engineers and what events contribute to their perceived identities. Self-reflections and design competence surveys will be collected from the sophomore and junior students participating in

this project and as seniors when they complete their capstone design course starting in Spring 2024.

44637 – Revisiting Undergraduate Student Engagement in Hands-On Laboratory Activities

Claudia M. Fajardo, Western Michigan University
Ghazal Rajabikhorasani, Western Michigan University

Active learning is a key component of effective engineering education. Within Mechanical Engineering curricula, many courses provide rich platforms to engage students through active learning strategies to promote effective retention of theoretical concepts. Hands-on laboratory activities are one example. At Western Michigan University (WMU), the course Introduction to Internal Combustion Engines is offered every fall semester as a (2-3) laboratory elective to upper-level undergraduate students. The laboratory activities, which comprise at least 25% of the overall course grade, require students to conduct experiments, work in teams to analyze and display data, and prepare laboratory reports.

The course is structured such that the internal combustion engine is used as a platform for students to revisit core engineering topics within the field of thermal-fluid sciences from an application perspective, expanding this foundational knowledge through more advanced concepts. Pedagogical challenges include engaging a student population with diverse academic preparation, limited availability of specialized laboratory equipment, and assessing individual student contribution in team-oriented laboratory activities.

This paper describes efforts to strengthen the engagement of undergraduate students in hands-on laboratory activities in connection to an upper-level mechanical engineering course, with the main objectives of increasing critical thinking, knowledge retention, and strengthen the students' ability to connect theory and application. Strategies to manage the pedagogical challenges previously outlined, as well as post-pandemic adjustments, are described. Feedback from a post-assessment survey indicates that the modifications incorporated into the course assisted students with both preparing for the laboratory activities and developing the laboratory reports. Responses also suggest that the changes motivated the students to think more critically about the technical content, promoted accountability and more effective time management.

Session 3B [Student Papers] – Room D115

44623 – A Study of Ackerman Steering and Its Applicability to SAE Mini Baja

Ethan O'Neill, Geneva College
Christopher Jobes, Geneva College

Ackerman steering is one of the most common ideal geometries for steering systems. Based on the concept of each wheel turning on a radius around a point along the line of the rear axle, Ackerman steering minimizes tire scrubbing, thereby increasing grip, improving turning capabilities, and decreasing wear on the system as a whole. Ackerman steering is particularly applicable for low-speed, off-road vehicles whose tires dig into the ground more.

SAE Baja is a competition for collegiate vehicular testing, in which constructed vehicles undergo the various rigors of off-road racing. Geneva College senior engineering students work on a Baja kart every year, with the goal of competing each spring. This 2023-2024 school year, the Baja team inherited a Baja kart that had been damaged during competition the previous year. The steering system was part of the damaged equipment and had been subsequently mended with an old, retired steering rack. Due to this repair, the resulting steering geometry differed from ideal Ackerman by a significant degree.

The goal in this paper is to obtain a more ideal steering geometry. To that extent, the current geometry was first analyzed using the 2D physics modeling program Working Model 2D to understand and analyze the faults in the geometry. Following that, a system of three equations was used to obtain the dimensions necessary for constructing ideal Ackerman steering geometry. With the proper dimensions, as well as taking into account current geometrical constraints including wheelbase, track width, and tie rod geometry necessary for bump steer elimination, a new model was built in Working Model 2D and was confirmed to agree with ideal Ackerman steering. Following 2D analysis, both the old and the new steering systems were modeled in 3D space using Autodesk Inventor and then printed with an Ender 3 S1 Pro 3D printer. The 3D models were then tested, ensuring ideal Ackerman behavior continued on the new system as expected, even with a physical system. Finally, the new steering geometry was recommended for use by current and future teams, with the goal of promoting ideal steering geometry for a better handling kart.

44625 – Fault Recognition and Mitigation in Food Processing Equipment

David R. Mikesell, Ohio Northern University
Nathan Maenle, Ohio Northern University

Nearly a decade ago, a mechanical engineering capstone team from Ohio Northern University designed and built a hamburger patty-forming machine for a local restaurant chain. This successful design was tested and proven, then replicated, and now these machines make thousands of patties each day in each of the chain's three stores.

The chain owner has no maintenance technician on staff, and generally takes care of repairs himself. In order to make his job easier, he has requested some modifications to enable him and his machine operators to more easily identify when certain components are degrading. This will ideally enable him to replace these components at a time that is convenient to him, rather than have them suddenly fail when he is out of town.

An Ohio Northern University undergraduate student was given the scope of this work as a "contract course" for his Honors program. This work was performed as an extension of an Industrial Controllers technical elective course taken in Fall 2023. Several features were added to the machine and its controller to identify component degradation and give the operator a clear indication of the fault. Another feature was added to resolve a different common fault in the patty-maker machine.

44636 – Photogrammetry System to Reconstruct Syndactyly Hand Models

Caleb Edward Scheideger, Ohio Northern University
Anna Dillenbeck, Ohio Northern University
Hui Shen, Ohio Northern University
Xiangyi Cheng, Ohio Northern University

Syndactyly stands as one of the most frequent occurring congenital hand deformities, characterized by fused digits. To address this condition, a reconstructive surgical procedure is essential, aiming to separate the digital skin and cover the isolated digits with a dorsal flap. However, the selection of the shape and size of a dorsal flap can be subjective and may vary among surgeons. An inappropriate selection could lead to unbalanced stress levels in the flap, resulting in postoperative complications. A numerical study to investigate the stress distribution within the flap could potentially resolve the issue and determine the optimal shape and size. Since the numerical study requires an accurate 3-D model, our objective is to develop a photogrammetry system capable of autonomously constructing a 3-D model of the defective hand from a series of images taken at different angles. To demonstrate the feasibility of the system, we developed a testing platform to capture images of a silicone hand model. By evaluating the reconstructed 3-D hand models using the testing platform and two 3-D reconstruction software, we demonstrated the capability of the system in constructing a precise 3-D model of the hand.

44766 – Helping Pedestrians with Special Needs to Cross the Roads using a Robot

Lada Protcheva, Eastern Michigan University
Omar Abed Alkarim Darwish, Eastern Michigan University
Suleiman A. Ashur, Eastern Michigan University

The increasing pedestrian accident rate, especially among disabled individuals and children, demands innovative solutions. Many pedestrians in the US have lost their lives in motor vehicle-related crashes, occurring at a rate of one fatality every 75 minutes, as reported in 2022. Despite this, road safety rules have seen minimal changes, presenting a considerable danger to

pedestrians. Individuals with disabilities face heightened risks due to impaired mobility or sensory functions, and there is limited data on road traffic injuries for this group. Children, particularly at school crossings, are vulnerable, potentially struggling to analyze situations and panicking without adult or school staff assistance safely crossing the street. This research addresses the risks associated with road crossings by developing and testing a Python-based program on the NAO robot simulator. Focused on identifying key elements contributing to pedestrian accidents involving vulnerable individuals, the research aims to deploy the simulated design using a physical robot for testing and evaluation. The NAO robot's step-by-step actions, guided by its camera and sensors, seek to assist pedestrians in safe road crossings. Future advancements include integrating advanced machine learning algorithms for enhanced accuracy in pedestrian recognition and crossing actions. This interdisciplinary initiative aims to enhance urban mobility by promoting safety and inclusivity. While this research has demonstrated the potential of robot assistance in pedestrian crossings at a small lab scale, further advancement to full-scale implementation in real-world environments is recommended once resources become available. Additionally, it is suggested to utilize an IoT handheld or body-mounted device with the capability to interact with traffic signals, facilitating safe street crossings for pedestrians facing challenges.

Session 3C [Professional Papers] – Room D109

44597 – Factors Impacting Retention of Mothers in Engineering Careers: Flexibility, Bias, Balance, and Benefits of Social Networking

Anne M. Lucietto, Purdue University – West Lafayette
Diane L. Peters, Kettering University

Social networking allows for interactions among groups and people that have had little opportunity to do so in prior decades. There are many groups on different platforms, serving a variety of different needs for their members. One such group, established on Facebook, consists of engineering working moms, with the membership loosely defined as a mother who is an engineer and employed outside the home. This group was surveyed, with the survey questions including both quantitative and qualitative items, and appropriate data analysis was carried out. One area in which the social network had significant impacts was in the retention of engineering mothers in the workforce. Data showed that the support provided by the group contributed to the retention of the group's members in the workforce, and assisted in their efforts to balance work and personal life. This paper will address these particular aspects of the group's value to the members, and recommendations will be made for how to leverage the knowledge to better support this particular group in the workforce as they transition throughout their career from recent graduates to seasoned professionals while raising families

44631 – Work In Progress: Building Empathy without Community Partners

Aja Bettencourt-McCarthy, University of Cincinnati
Matthew Sleep, University of Cincinnati

Project-based learning is core to many first-year engineering, engineering design, and engineering capstone courses. Ideally, students in courses that use project-based learning work on real-world projects that are relevant to their communities with a sponsor or outside partner who helps to guide the work and assess deliverables. By working with a community partner or client, students practice incorporating outside perspectives and empathy into their designs. Realistically, a variety of constraints including time, location, class size, and workload prevent faculty from developing community partnerships/clients for all their student projects. This paper will discuss ways to use tools like personas in combination with secondary research to mimic many of the benefits associated with community partnerships. We provide suggestions for partnerships with campus units, discuss the impact of these tools in one civil engineering course, and explore areas for future research. Examples of defining and exploring community partners in these courses will be presented.

44641 – Data-Driven Methods for Improving Team Culture within Capstone Design

Morgan Bartley, West Virginia University
Andrew Nix, West Virginia University
Brian Woerner, West Virginia University

This paper outlines the West Virginia University (WVU) EcoCAR team's strategies for creating a positive and inclusive team culture within the context of the EcoCAR Electric Vehicle Challenge (EV), sponsored by the U.S. Department of Energy, General Motors, and MathWorks. The EcoCAR EV Channels centers on the redesign of 2024 Cadillac Lyriq, and forms the basis of capstone design projects for approximately 70 students per year across the disciplines of Mechanical Engineering, Electrical Engineering, Computer Engineering, and Computer Science. The project requires effective cooperation between diverse design teams, and includes a significant focus on Diversity, Equity and Inclusion (DEI).

The paper outlines four SMART goals: Enhance Internal Education and Team Culture, Fostering Inclusive Sub-Team Integration, Strengthen Cross-Sub-Team Collaboration, and Data Analysis for Continuous Improvement. Baseline data and the impacts on students' attitudes are presented within the framework of capstone design projects.

Key conclusions underscore the role of education, inclusivity, collaboration, and data-driven decision-making in the specific context of capstone design projects. Foreseen challenges provide opportunities for proactive solutions, positioning teams for success in fostering a diverse and inclusive design team culture within the field of sustainable mobility

44614 – Impact of Formative and Summative e-Assessment on Active Learning

Bilquis Ferdousi, Eastern Michigan University

Assessment, one of the most important elements of students' effective learning process, plays a vital role in efficient instruction to enhance students' learning achievement. Assessment can be mainly two different types: Formative assessment and Summative assessment. This paper focuses on studying the impact of formative and summative e-assessment on students' learning process, especially in an active learning environment. The paper examines the current scope of e-assessment, especially the probable efficacy it brings in the formative and summative e-assessment. For that purpose, the paper analyzed the authentic formative and summative e-assessments of active learning in the classes delivered in asynchronous and synchronous methods where students' interactive participation is required. Reviewing the current literature related to formative and summative e-assessment practices, this paper focuses on the impact of formative and summative e-assessments on students' individual and group assignments in active learning. The purpose of this analysis is to understand the potential of formative assessment that offers feedback in improving students' learning process. Furthermore, the summative assessment, which measures how much students have learned over a certain period, is also being reviewed. Consequently, both the formative and summative e-assessment in active learning situations,

especially in group settings where active interactions among group members are crucial, are discussed. An in-depth understanding of the impact of formative and summative e-assessments on students' active learning can be beneficial for instructors, students, and curriculum developers in higher education institutions.

44610 – Enhancing Student Understanding of Thermodynamic Principles Through 3D Visualization

Michael Hayes, Michigan State University
Geoffrey Recktenwald, Michigan State University
Rebecca Anthony, Michigan State University

Many engineering students struggle to develop three-dimensional visualization skills. Such visualization plays a key role in a variety of undergraduate courses, including thermodynamics. The pressure-volume-temperature (P-v-T) surface is a foundational concept in the discipline. It provides a visual representation of the relationship between the three physical properties and serves as the cornerstone for understanding simple compressible systems. This study investigates whether utilizing three-dimensional P-v-T surface models in instruction makes the content more accessible to engineering students. Participants in this investigation came from a flipped-classroom undergraduate thermodynamics course. Volunteers are divided into two groups. The control group receives the standard video instruction on P-v-T surfaces using traditional two-dimensional illustrations. The test group is presented with a video lecture featuring rotating three-dimensional figures. Aside from the P-v-T visualization techniques, the content between the two lectures remains the same. Following completion of the lesson, students in both groups complete a multiple-choice online survey to assess their understanding of key concepts. While students who received the modified lesson had a higher average score on the post-lesson assessment than those who did not, there is not sufficient evidence to establish a statistically significant difference between the two groups. Students in the test group performed better on four out of the five survey questions as well, but once again statistical significance is not observed. A larger sample size is required to more rigorously assess the efficacy of the visualization techniques. Even so, the increasing accessibility of three-dimensional visualization software makes the models implemented in this study a viable option for undergraduate thermodynamics educators.

Session 3D [Workshop] – Room C136

Enhancing Intercultural Learning for Engineering Students through Curricular Innovation

Aparajita Jaiswal, Purdue University – West Lafayette

Nurturing intercultural competence through the on-campus curriculum reaches more students than traditional approaches such as study abroad. This session focuses on using curricular innovation to scale up intercultural competence development on campus by leveraging the campus's learning management system (e.g., Canvas, Moodle, Brightspace). The goal of this session is to help participants implement the use of backward design model for creating short interactive modules on intercultural learning that could be integrated into any STEM course. We will showcase the Portable Intercultural Modules (PIMs), created by Purdue University, CILMAR team.

Session 3E [Workshop] – Room D132

Student Academic Performance Prediction Using Machine Learning

Bin Chen, Purdue University – Fort Wayne

Educational data analysis has become an effective tool to predict student academic achievements. This workshop will introduce machine learning algorithms for classification and regression, and use public student academic datasets as examples to predict student performance using the latest machine learning algorithms. Participants will gain hands-on experience with machine learning models and predictions, enabling them to tackle diverse tasks such as: forecasting final grades for a specific course, predicting overall GPA for an academic year, or estimating the likelihood of graduation.

Session 4A [Professional Papers] – Room D204

44588 – Designing Effective Cybersecurity Curriculum: Bridging Disciplines for Next Generation Workforce

Prakash N.A. Ranganathan, University of North Dakota
Jamison Jangula, University of North Dakota
Utku Kose, University of North Dakota
Neena Goveas, University of North Dakota
Shree Ram Abayankar Balaji, University of North Dakota

Digital transformation, leading to rapid automation, has brought about significant changes in all aspects of our lives. Unfortunately, today's interconnected digital networks have increased vulnerabilities and cyber threats. The frequency of cyber threats in critical infrastructures and across all application sectors has risen. Moreover, Artificial Intelligence (AI) has expanded the threat landscape to a new level by integrating sophisticated mechanisms (e.g., automated coding, deepfakes, social engineering) capable of manipulating and exploiting humans, systems, or networks. There is an urgent need to train the next generation of the cybersecurity workforce, equipping them with all the necessary skills to face growing attack vectors.

Educational institutions need to consider adding cybersecurity undergraduate programs, but questions remain about what constitutes a robust cyber curriculum. Factors such as the availability of qualified instructors, diverse faculty expertise or backgrounds, the lack of resources in laboratory infrastructure, local economy or industry needs, budgetary challenges, targeted student types, delivery modes (on-campus versus online), and the size of the department determine the type of curriculum offered. Most cyber programs reside in computer science (CS), computer engineering, or electrical engineering (EE) departments. This paper focuses on designing a cybersecurity undergraduate curriculum that attracts both EE and CS students through specialized tracks and leverages existing courses in departments where both EE and CS majors are housed within one School of Electrical Engineering and Computer Sciences (SEECS). The proposed cybersecurity curriculum is approved internally by the department and the College of Engineering and Mines (CEM), and UND is currently working towards seeking ABET accreditation. The paper discusses course mapping to EAC and CSAB cybersecurity criteria for two programs under two tracks: Track 1- Cybersecurity Engineering (CSE) and Track 2- Cybersecurity Science (CSS). Such a curriculum plan can also be suitable for other schools if programs can be leveraged.

44620 – Developing Teamwork Skills Across the Mechanical Engineering Curriculum

Mary M. McCall, University of Detroit Mercy
Nassif E. Rayess, University of Detroit Mercy

Not all employees, especially those in the technical professions, enjoy working in groups. Some prefer to work alone, sharing their ideas and results in a low-key way. They sometimes have trouble seeing their work as part of a larger picture.

However, employers assume a certain skill level from entry-level employees, including communication skills like being able to work effectively in teams. Exacerbating the issue, few companies offer sustained teamwork training but do conduct much of their work using employee teams.

It is incumbent on schools to produce future employees ready to be productive members of work teams.

Current Practice

Experience suggests that Technical Writing instructors cover Teamwork as a separate skill, taught in a class session or two and sometimes supported by a group project. Experience also suggests that few Engineering instructors devote significant time to discussion of teamwork. Technical Writing textbooks present teamwork in a descriptive way with some attention to practice.

Another Approach

Since U.S. business, industry, academia – indeed, every aspect of society – revolves around using teams, a more robust approach is needed to help students learn and nurture teamwork skills.

In the Embedded Technical Writing coursework for Mechanical Engineering students at X school, teamwork is discussed and practiced from day one through graduation. In a series of five technical writing classes from first through third year, students learn about the value teams can bring to problem solving, project management and relationship development. Hands-on practice and reflections help them internalize a teamwork approach to work.

The teamwork approach is used in other M.E. courses as well, such as the laboratory courses and the senior design courses sequence. These courses extend into the later years of the student's course of study and serve to reinforce the messaging and skills developed in the Embedded Technical Writing coursework.

Results

A sustained approach to teaching teamwork supports learning of this key concept to success in several ways by:

1. Emphasizing the importance of teamwork skills for current and future success.
2. Helping students develop communication skills around explaining ideas, setting goals, confronting colleagues, solving problems, and communicating with management.
3. Setting realistic expectations of their own and others' performance and experience giving and receiving productive feedback.
4. Engendering confidence in students that they have the necessary tools to succeed in team projects at school and in the workplace.

Contents of the Paper

The paper will follow the format of this abstract but will build out examples of how teamwork is presented, including skill building, practice and reflection. This portion of the paper is designed to give engineering instructors ideas that can be imported into their own classes.

44673 – Developing a Writing Rubric to Answer Research Questions (not for Grading!)

John William Lynch, University of Cincinnati
Sheryl A. Sorby, University of Cincinnati
Betsy M. Aller, Western Michigan University
Teri J. Murphy, University of Cincinnati

Industry leaders emphasize that engineering students' technical communication and writing skills must be improved. Despite various institutional efforts, which include technical communication courses or engineering design projects aimed at enhancing students' communication abilities, many believe there has been only slow improvement in this area. There has also been a dearth of longitudinal studies that examine the development of engineering students' technical communication competencies from undergraduate to industry. This paper aims to contribute to this area through the creation of a rubric that specifically examines the writing competencies and technical communication ability of engineering students. This paper is part of a larger, NSF-funded research study that examines the quality of students' written and oral communication skills and seeks to understand their relationship to the students' spatial abilities.

First-year engineering students in their second semester at a large R1 Midwestern university were examined. Students were tasked with creating a written report responding to a set of questions that asked about their team-based engineering design project completed in their first semester. As this occurred months prior, this non-graded report became a reflection on their experience and innate abilities. While low stakes, it mimicked a more authentic writing experience students encounter in industry. Students' responses were examined collaboratively by an interdisciplinary team which created a rubric through an iterative process. This rubric was distributed to the interdisciplinary team and outside evaluators composed of individuals in industry and engineering faculty. An inter-rater reliability analysis was conducted to examine levels of agreement between the interdisciplinary team and outside evaluators, and implications of this inter-rater reliability score and the process of rubric application were documented.

Results of this paper include details on the development of a rubric that examine students' technical communication and writing skills. Traditional rubrics utilized by engineering faculty usually address an entire project for engineering students, which includes students' content knowledge, writing capabilities, and the requirements of the project. Such rubrics are often used to provide feedback to students and evaluation in the form of grades. The narrower focus of the rubric being developed here can provide insights into communication and writing competencies of engineering students. Scores secured through the use of this rubric will aid in the research study's goal of finding correlations between engineering students' communication skills and spatial abilities (assessed outside of this current effort). Spatial ability has been well-documented as an effective indicator of success in STEM, and interventions have been developed to support development in students with weaker spatial skills. 23, 24This has prompted this research to explore links between spatial skills and communication abilities, as validated spatial interventions may help improve communication abilities. These current results may also provide unique insights into first-year engineering students' writing competencies when reporting on a

more authentic (non-graded) engineering task. Such information may be useful in eventually shaping guidance of students' communication instruction in hopes of better preparing them for industry; this is the focus of a planned future research study.

44671 – Integrating Innovation: A Transdisciplinary Approach to Engineering Education with AI and Lean Six Sigma

Omar H Albalawi, University of Tabuk
Ali Alhawiti, Western Michigan University

This paper proposes a novel transdisciplinary program integrating robust technical skills, entrepreneurial and management insight within the engineering discipline. The transdisciplinary program is essential as it aims to equip engineering students with technical and entrepreneurship skills that match the rapidly advancing technology space as well as the expanding engineering landscape where the technical know-how and management of the emerging technologies and the associated workforce.

The proposed transdisciplinary program incorporates diverse academic disciplines, community projects, and research initiatives to impact and nurture holistic innovation ideas among the student engineers. The program design integrates AI-driven techniques that intelligently match students with projects that align with their strengths and academic pursuits. This ensures optimized team dynamics as well as enhanced project outcomes. Additionally, students are exposed to tried and true engineering management methodologies, especially Lean Six Sigma. These methodologies instill a mindset of continuous improvement, waste reduction, and process optimization in students, which are critical skills in management and entrepreneurship.

The design of the proposed program emerged after reviewing numerous leading recent innovative programs and initiatives. Moreover, we saw the value and importance of the "Ultimate Innovation" program at the University, which supports entrepreneurial engineering projects. By merging engineering and entrepreneurship, students gain robust technical skills to be at the lead in tackling actual global challenges, incorporating effective management and entrepreneurial spirit.

This paper explores these programs' methodologies further, emphasizing the synergies achieved by combining technical education, AI interventions, and Lean Six Sigma principles. The paper advocates for an evolved paradigm in engineering education, where venture creation, technical expertise, and management excellence converge.

44664 – The Benefits of Design-Project Learning Approach in an Engineering Course

Reza Harirforoush, Cleveland State University

The Project-Based Learning (PBL) approach has been widely embraced as a teaching method, fostering collaboration among students to achieve a shared goal, and gaining knowledge and skills through the exploration of engaging and complex problems for a specific period. While

extensively studied in various educational contexts, from elementary to higher education, there has been limited exploration of the use of a design-project approach within PBL to enhance students' learning experiences.

This paper illustrates examples of incorporating a design-project approach into the kinematics course, a pivotal component of the mechanical engineering curriculum. The design-project method integrates PBL principles, requiring students to apply theoretical knowledge to create prototypes or concepts addressing real-life problems. The framework guides students to identify a real-world problem, develop an engineering approach in groups of three, build a prototype, present their work in class, and write a technical report. The participants in this study were undergraduate students enrolled in the kinematics course, and their performance was evaluated using a rubric.

The design-project approach provides students with opportunities to enhance critical thinking and problem-solving skills, explore innovative ideas, and improve communication skills by explaining design decisions and receiving constructive feedback. Completing design projects allows students to create a portfolio, serving as an asset when seeking internships, jobs, or further education. Furthermore, the use of various technologies, such as 3D printers, and tools to build prototypes significantly benefits students in their future careers. The paper concludes with recommendations for implementing the design-project approach.

Session 4B [Mixed Papers] – Room D115

44652 – Towards Streamlining the Process of Building Machine Learning Models for Your Artificial Intelligence Applications

Joseph George, Western Michigan University
Ajay Gupta, Western Michigan University
Alvis Fong, Western Michigan University

Rapid recent advances in Artificial Intelligence (AI)-based tools in diverse disciplines have created a need to develop educational material for AI-readiness of the workforce. In this work, we focus on the problem of designing and developing machine learning (ML) models with ease. This paper thus undertakes an investigation into the automatic development of machine learning models with minimal user expertise through the use of AutoKeras, an automatic ML python library. AutoKeras streamlines the typically intricate ML development process which traditionally demanded the expertise of ML engineers. This paper will first walk through the typical ML model development process. After this process is understood, AutoKeras' role in making this process simpler and more accessible will be discussed and showcased with an application to the proteomics domain.

44657 – A Dive into Vehicle Suspension

Kevin Stinnette, Lawrence Technological University
George Pappas, Lawrence Technological University

This paper explores the four main types of ride control in vehicle dynamics: passive, self-leveling, semi-active, and active suspension. Each system offers unique advantages and disadvantages, addressing specific challenges in safety and ride performance. Passive suspension, characterized by fixed parameters, controls a specific frequency range of vehicle oscillations. Self-leveling suspension, a variant of passive suspension, adjusts based off varying loads through its spring mechanism. Semi-active suspension introduces dynamic characteristics, enabling shock absorbers to alter their damping rate in response to road conditions. Active suspension, an advancement over semi-active systems, includes the ability to generate vertical forces to counteract road inputs.

The first section of this paper will introduce four passive vehicle models: a quarter-car model with two degrees of freedom, two half-car models with four degrees of freedom each (one for roll angle and one for pitch angle), and a full-car model with seven degrees of freedom. The second section will utilize these models to explore the concept of variable damping coefficients for compression and rebound, offering a more accurate representation of passive vehicle suspension. The final part of the paper will compare traditional models with those that include variable damping coefficients. This comparison will reveal improvements in suspension representation across all models, averaging a 5% enhancement for RMS acceleration, a 5% improvement for load fluctuations, and a 7% increase for road versus wheel displacement. This paper aims to familiarize the reader, who may be an FSAE suspension engineering student, with vehicle suspension systems, provide improved theoretical models for passive suspension, discuss

how performance can be assessed, and compare theoretical results with results seen from a Formula SAE Electric car.

44634 – The Effect of Injection Molding Process Parameters on the Mechanical Properties of ABS and PP Polymer

Wael Mokhtar, Grand Valley State University
Sumaiya Benta Nasir, Grand Valley State University

Injection molding parameters play a crucial role in minimizing defects and optimizing part quality. Factors like melt temperature, mold temperature, injection pressure, packing pressure, and cooling time influence the flow, orientation, and solidification of the plastic, ultimately affecting the part's properties and potential defects. By carefully controlling these parameters, manufacturers can achieve consistent, high-quality parts with minimal defects.

This study investigated the effects of injection molding parameters on the mechanical properties of polypropylene and acrylonitrile butadiene styrene (ABS plastic) materials by changing the melt temperature and maximum injection pressure. One-factor-at-a-time experimental designs are drawn using two factors and two levels. Moldex3D software was used for the simulation of each experiment. The results show that maximum filling volumetric shrinkage, maximum packing volumetric shrinkage, time to reach maximum ejection temperature, cooling efficiency, and maximum total displacement increase in both ABS and PP material with an increase in melt temperature from 240°C and 270°C, while maximum filling shear stress, maximum packing shear stress, and maximum von Mises stress decrease for both ABS and PP material with an increase in the melt temperature. The increase in melt temperature did not show significant impact on the filling time, packing time, or cooling time of the PP material. The results show that filling and packing volumetric shrinkage, packing time, cooling efficiency, maximum total displacement, and maximum warpage density of PP material are higher than those of ABS material under the same conditions.

The results show that the materials behave differently when melt temperature changes. Interestingly, these conditions remain unchanged while pressure is only increased. Modifying injection pressure does not lead to observable modifications, suggesting a need for further investigation into the extent of pressure changes to create significant effects on the studied parameters.

44676 – Assessment of the Integration of Artificial Intelligence (AI) into Building Information Modeling (BIM) for Smart Construction Management and Decision-Making

Nada S. Al-Muntaser, Eastern Michigan University
Suleiman A. Ashur, Eastern Michigan University

This paper explores the integration of Artificial Intelligence (AI) with Building Information Modeling (BIM), emphasizing potential benefits and addressing associated challenges. Utilizing a web-based AI-BIM tool on a single house model, the case study focuses on design indicators

like radiation, sun hours, shadow study, LEED views credits, and energy and water usage. Although additional analyses, such as daylight and glare analysis, COVID-19 occupancy, and façade prototype, are available, they are not covered in this paper. A key highlight is the positive outcome of the energy consumption comparison between AI and commercial software, affirming AI's accurate simulation capabilities. The user-friendly nature of the AI-BIM tool supports swift model creation and analyses, emphasizing the ongoing exploration of AI integration for enhanced construction management efficiency and productivity.

44781 – Promoting Distance Learning in Metal Casting by Implementing Four Simulation Activities

Sam Ramrattan, Western Michigan University
Matthew Cavalli, Western Michigan University

The metal casting industry has less than thirty certified Foundry Educational Foundation (FEF) university/colleges in North America. For this reason, it is important to support and maintain quality educational programs. For the past thirty-five years, metal casting simulation tools have been affiliated with academia primarily in research and development. At the same time metal casting industry has adopted a digital approach to manufacturing where simulations play a major role. Educational institutes need to involve solidification and simulation technologies at the undergraduate level. Can solidification simulations be an effective tool to support student understanding of metal casting concepts in an introductory engineering course via distance learning? The authors investigated scaling up the use of a sequence of modules containing real-world simulation problems (hot-spot detection on castings, surface area-to-volume issues on castings, fluidity of various casting alloys, design optimization and yield calculations).

The implementation of flow and solidification simulations activities were explored in an introduction to Metal Casting course when the COVID-19 pandemic prohibited the conventional, face-to-face, and hands-on learning activities of the engineering course. Participants were eighteen sophomore/junior level engineering students at Western Michigan University during the Summer Semester 2020.

Casting flow and solidification predictive analysis were verified from actual casting trials where gating designs were experimentally evaluated preceding the course. The effectiveness studies were reported after comparing the evaluations of course assignment and examination scores prior and post the solidification simulation activities. At the end of the course evaluation, feedback from students was solicited regarding the distance learning solidification simulation experiences.

The simulation activities were described, and output analysis was provided. The experience conveyed insights into the role of simulation as an efficient and effective teaching tool in distance education. Results supported an adoption and implementation of the simulation software tool when teaching introduction to Metal Casting on any platform.

Session 4D [Workshop] – Room C136

Test Drive Simcenter FLOEFD

John C. Oliva, Siemens Industrial Software

FLOEFD is a CAD embedded computational fluid dynamics (CFD) tool that puts the power of a general purpose CFD suite in the hands of engineers without the need for advanced training in fluid mechanics or computational methods. We have thousands of corporate customers that use FLOEFD around the world to design and analyze systems spanning industries and disciplines.

This is a hands-on workshop for the 2024 North Central Section Conference in which attendees can try FLOEFD out for themselves. The session will focus on how FLOEFD can be incorporated into engineering and technology curriculums to supplement learning objectives. The real power of a tool like FLOEFD can be leveraged in classes where insight into thermal / fluid systems is beneficial, but they are not the focus of the class itself. Simcenter FLOEFD is simple enough that it can be used by first year engineering students, or even pre-college students, yet it is still powerful enough to be used in industry by professional engineers.

At the end of the workshop, attendees will learn how they can get Simcenter FLOEFD for use by their students and colleagues back at their home institutions. Even though we are a software company, please recognize that we are not trying to sell anything through this outreach effort. Siemens has a well-established grant program in which our software is provided to academic institutions largely free of charge.

- Target audience(s) and size – engineering or engineering technology faculty members, and pre-college engineering teachers
- Maximum attendance that can be accommodated - 30
- Minimum attendance necessary to avoid canceling the workshop - 5

John Oliva is a Senior Solutions Consultant supporting thermal / fluids simulation tools at Siemens Digital Industry Software. John graduated from Michigan State University with a PhD in Mechanical Engineering. He joined Siemens two years ago from Dow Chemical and affiliate companies where he worked for 10 years. His responsibilities included design, simulation, and optimization of processing equipment involving applications such as structural analysis, vibration, heat transfer, and fluid dynamics. Other responsibilities included leading a global user group of engineers conducting finite element analysis and developing the engineering software strategy at Corteva Agriscience. Prior to Dow he worked at the National Superconducting Cyclotron Lab and Combat Propulsion Systems. He began his career in academia serving as a fulltime mechanical engineering faculty member for about 6 years

Session 4E [Workshop] – Room D132

Empowering Educations: Integrating Engineering Education with KEEN's EML Framework

Carmen Cioc, University of Toledo
Noela Haughton, University of Toledo
Sorin Cioc, University of Toledo

This session serves as an introduction and offers a platform and examples for seamlessly adopting and implementing Entrepreneurial Mindset Learning (EML) initiatives in engineering science and engineering technology education curricula. The primary focus is on sharing best strategies and practices implemented and tested by the workshop facilitators in their own courses.

This will be accomplished through demonstrating the efficacy of EML in enhancing students' engineering knowledge and skills and enhancing their preparation for the professional environment. The discussion also includes various forms of assessment to support EML.

It is important to clarify that this workshop session is not centered around initiating a business venture but rather aims to foster a mindset conducive to innovation and value creation. The advantages of introducing and cultivating an entrepreneurial mindset extend beyond senior design projects and apply to all levels of engineering education. Entrepreneurship enriches the educational experience by grounding technical content in real-world applications, promoting creativity, and encouraging thinking beyond conventional boundaries. The development of innovative and sustainable products and services contributes to the advancement of engineering education practice [1]. Entrepreneurship, as a flexible concept, can be applied across diverse settings and contexts, fostering economic development on a broader scale [2, 3]. Universities have integrated entrepreneurship into their engineering curricula to leverage these benefits and enhance existing active learning strategies [4-6]. Additionally, the advantages of Entrepreneurially Minded Learning (EML) align with critical accreditation learning, faculty development, and institutional outcomes.

A widely embraced EML framework in universities is Engineering Unleashed, and the Kern Entrepreneurial Engineering Network (KEEN). The KEEN's 3Cs framework has led to the increased integration of EML pedagogical activities into engineering education (EE) coursework [7]. These benefits are applicable to other fields of study, encompassing both STEM and non-STEM disciplines.

Consequently, there is an increased emphasis on evaluating these pedagogical practices and related student learning outcomes, including the establishment of means to assess EML growth in engineering students, which remains a priority [8].

This workshop aims to achieve three primary objectives:

1. Present and discuss entrepreneurship as an effective pedagogical approach.
2. Familiarize the participants with the KEEN EML framework.

3. Complete an activity in which EML is applied in a scenario:
    - Participants will collaborate to create rubrics for both individual and group-based assignments within their respective courses.
    - Engage in a brainstorming session to generate ideas for their individual EML-related projects and explore the concept of drafting a card.
    - Encourage participants to share and report on the proposed work.

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