A Wideband Vivaldi Antenna for Drone-Based Microwave Imaging System

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Prof. Kai Ren, Wentworth Institute of Technology

Materials common in construction are reinforced concrete or cement-based materials. These materials occasionally develop cracks naturally due to deterioration throughout their lifecycle. The detection of cracks, erosion, voids, and gaps in walls and structural supports is critical in preventing structural failures. Microwave-based non-invasive techniques such as Non-Destructive Testing (NDT) is preferred to detect structural anomalies since there is no impact on the integrity of the structure or material due to the penetration capability of microwaves into dielectric materials. Current NDTs have several limitations and drawbacks, such as being heavy and bulky; however, they also share being expensive and restricted by maneuverability and scalability.

An Unmanned Aerial Vehicle (UAV) or commonly known as a drone, can be equipped with a microwave imaging system capable of generating 3D subsurface images and remotely controlled to nondestructively scan buildings, bridges, and other infrastructures to detect anomalies. The drone can be maneuvered to access specific locations, both interior, and exterior, and reach certain heights while keeping personnel safe. The system would be scalable in hardware and software to fit certain applications or needs. The drone-based microwave imaging system is light-weight, consisting of one or multiple antennas, software-defined radios for transmitting and receiving signals, and microwave imaging algorithms to generate real-time 3D images. To achieve the light-weight design, the drone structure could be metallized and utilized as the antenna instead of mounting additional antennas and hardware. The 3D microwave images can help in assessing progress during the construction process or during inspections of existing structures for timely repairs. The use of this system can lead to more robust construction and structures and provide a lower-cost and precise solution than conventional NDTs.

Lab-Based Antenna Course Using Full-Wave Numerical Simulation Software FEKO

Prof. Kai Ren, Wentworth Institute of Technology

Antennas are ubiquitous in our daily life, which are used in all wireless electronic devices and can be found in cellphones, laptops, cars, ships, airplanes, and satellites to support a variety of applications involving wireless communications and microwave sensing from civil to defense areas. To become a qualified antenna engineer, it requires solid background knowledge in electromagnetics (EM) field theory, which is one of the most difficult courses in electrical engineering. To help students maximize the transferable knowledge from EM field theory to antenna theory, brief review on vector analysis, coordinate systems, Maxwell's equations, and plane wave solution in unbounded free space are addressed at the beginning of the course.

In a traditional antenna theory classroom, the course tends to be more theoretical, including more physics and mathematical aspects, such as solving differential and integral forms of Maxwell's equations in a three-dimensional spherical coordinate system. Students may lose interests in finding electric field intensities generated by an antenna. To make sure students have a better understanding on antenna theory and visualize antenna parameters and performance, full-wave commercially available numerical EM simulation software FEKO is used. FEKO is a German acronym 'Feldberechnung fu¨r ko¨rper mit beliebiger oberfla¨che', which means electromagnetic field calculations of arbitrary shaped objects. To guarantee a better learning experience of students, multiple labs are designed and specific lab sessions are assigned to guide students to achieve antenna modeling. In this paper, the structure of the antenna theory course will be described. Definitions of antenna parameters are discussed, such as radiation resistance, radiation patterns, directivity, gain, frequency bandwidth, etc. Labs using FEKO simulations will be presented as well.

Let's Take a Look at the Exam Figure: A Heat Transfer Exam Review Activity

Dr. Najmus Saqib, University of Indianapolis

Exams are intimidating. Students can feel overwhelmed by reviewing for exams. While students need to know subject matter content, reviewing concepts alone before exams is not always an effective exam preparation strategy. Although example problems may help, instructor-solved ones are often less effective in preparing students than student-solved problems.

"Let's take a look at the exam figure!" In this engaging classroom activity, students in an undergraduate Heat Transfer course are given the opportunity to preview a figure from an upcoming exam as part of an exam review exercise. All exam questions are generally related to the heat transfer processes/geometries described in said figure. Students are asked to carefully scrutinize the figure to identify the probable mode(s) of heat transfer. During the review period, groups of students work together to come up with potential exam problems related to the covered content and then identify strategies, methodologies, and/or relevant equations to obtain solutions. The primary role of the instructor during these activities is to ensure that the discussions are relevant to the upcoming exam's content or focus. The majority of participating students are in the third year of their degree program. Review sessions are typically held the day before the exam, and the preview figures are provided in advance. The review activity is based on various studies supporting collaborative learning as a strategy that leads to enhanced academic performance.

This exam review activity has been used numerous times by the author. Students enjoy the experience, and it greatly relieves exam anxiety. This paper will provide instructions on developing and running the activity, provide examples, and present qualitative student feedback.

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Utilizing Virtual Reality to Support the ASCE UESI Student Surveying Competition

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Surveying engineering is a major with strong professional and historical ties to civil engineering. However, compared to civil engineering, surveying has a lower public profile, and many first-year engineering students are not aware of surveying as an option, what the major entails, and how surveying contributes to engineering projects. The American Society of Civil Engineers (ASCE) Utility Engineering and Surveying Institute (UESI) Surveying Competition organizes an annual surveying competition for Civil Engineering programs. The educational and professional goals include a recognition of the importance of basic surveying principles to all civil engineering projects. The competition is an innovative and interesting way to engage civil engineering students with surveying engineering and increase the awareness of surveying in civil engineering institutions. Due to the travel challenges brought by the COVID-19 pandemic, the 2021 UESI Surveying Competition was held virtually. The UESI Surveying and Geomatics Division in collaboration with University Name Hidden decided to utilize immersive and interactive virtual reality technology to simulate the field component in the student competition. Thanks to technological advancements of Head Mounted Displays (HMDs) in the past 10 years, immersive virtual reality technology has found widespread application in education. The SurReal (Surveying Reality) software that was used for the competition has a realistic virtual environment based on the University Name Hidden campus and a realistic differential leveling instrument. The software simulates all major components of the differential leveling process. This is the first national surveying competition with an integrated virtual reality component.This paper will discussthe virtual reality component, the approach followed toadapt the existing SurReal software from the Oculus Rift to the Oculus Quest 2 platform,the challenges in providing the necessary hardware to the participating universities from different parts of the US, and the feedback received by the students participating in the competition.

Redesigning the Flipped Mechanics of Materials Course to Support Diverse Learners

Dr. Sarira Motaref P.E., University of Connecticut

The Mechanics of Materials course has been offered in flipped modality over the past 8 years. This course is an entry-level course required for several engineering majors such as Civil, Mechanical, Biomedical, Materials Science, and Manufacturing Engineering. The class has large enrollments of 100 to 120 students per section and an annual enrollment of 400 students. In the flipped course, the lectures were being delivered using pre-recorded videos. The in-person class time used to present a brief recitation of the lecture material, discuss challenging concepts, and solve problems.

The course was redesigned in the summer of 2020 as part of a research project funded by the Engineering Education Center of the National Science Foundation to create an inclusive learning environment that empowers neurodiverse learners. It was attempted to achieve this goal by improving the accessibility of the content, promoting active (collaborative) learning, engaging students by using real world examples, and offering a variety of assessments in this course.

Actions such as adding captions to the pre-recorded videos, posting class notes, recording and live streaming the class, and using the smart book were made to enhance the course accessibility.

Active learning such as think-pair-share, collaborative problem-solving activities, and brainstorming were offered during class time to enhance peer-to-peer interactions, align students' progress with the class schedule, and improve student engagement. These active learning methods facilitated the instructor-student interaction which was challenging to provide in a large classroom.

To enable students to apply their knowledge in real world applications, a series of optional small strength-based projects (SBP) were added to the course. Students were able to contribute to the course based on their personal interests and expertise by completing small projects that application of a mechanics concept was demonstrated in a real-life example.

Multiple forms of assessment were offered to students allowing them to demonstrate their gained learning using alternative modalities. Class assessments included weekly homework assignments using McGraw-Hill Connect platform, online weekly quizzes, midterm exams, and in-class teamwork problem solving. In addition, students were given a second chance to enhance their final grade by taking an optional final exam.

Student feedback was collected by conducting an anonymous comprehensive survey on the principles of Universal Design for Learning (UDL). Students were asked to rank different course components based on their perception about the effectiveness of each activity in their learning. This paper will discuss the implementation of different course components to enhance inclusivity and engagement in this large class. The results of the surveys and future work will be discussed.

Engineering Reimagined: (Re)designing Next-Generation Engineering Curricula for Industry 5.0

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Dr. Marisha Rawlins, Wentworth Institute of Technology
Dr. Pilin Junsangsri, Wentworth Institute of Technology
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At our institution, like many others worldwide, it has been over a decade since we have imagined and designed our engineering curricula. Since then, we have ensured and confirmed compliance with accreditation agencies, perfected the delivery of courses, and assessed learning outcomes to ensure that our graduates can be successful in all the different stages of their careers. The problem is that in the last ten years the careers that await our graduates have changed fundamentally such that our curricula of today effectively do not prepare our students for the careers of tomorrow. More importantly, the way students learn has also fundamentally changed, swiftly rendering our instructional methodologies obsolete. Our motivation is the redesign our engineering curricula such that they can transcend the competency gap between the graduates of today and the careers of tomorrow.

In this paper, we focus on the redesign of our Computer Engineering (CE) curriculum and describe the reimagining process, which phase one started with the program faculty examining our latest curriculum via a set of guided questions to identify if and how it meets the future needs of industry and the learning approaches of our students, present and future. The faculty identified that the program was lacking in some areas and could be reimagined such that it can: provide skills that can be adjusted and adapted to new areas, allow for more flexibility and humanity in the treatment of students and faculty, focus on future fields (e.g., artificial intelligence, machine learning, internet of things) while meeting core learning outcomes, strongly push students towards independent learning, and provide the big picture of the learning outcomes and trajectory early and often. In phase two of the process, the faculty reached out to: industry partners to obtain insight into the desired skills of the CE graduates of tomorrow, our learning and teaching support staff to reveal modern teaching practices and tools that could be leveraged by our next generation curricula, and other CE programs to identify how they are adapting to the same challenges. The findings from the research, detailed in the remainder of this paper, were used to fuel the third phase of the Engineering Reimagined project, where the program faculty holistically considered all the feedback, including that of other university-wide committees, focused on inclusive excellence and student retention, to define the learning outcomes of the entire program and map them in knowledge areas, which are then encapsulated in classes (new and existing) that are finally scaffolded in our next-generation CE curriculum.

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The engineering accreditation process for STEM-designated study programs: Ukrainian Catholic University case.

Prof. Yuliia Kleban, Ukrainian Catholic University

The accreditation process in the Higher education system in each country is about verifying the compliance with the criteria that a specific governmental institution has established or/and an independent organization is using currently. The University presented in this paper is a non-profit educational institution. It states in its mission the goal of ”forming leaders to serve with professional excellence in the home country and internationally – for the glory of God, the common good, and the dignity of the human person.” The university’s internal managerial approach is to support the startup culture. This paper aims to apply the accreditation process as a prerequisite to improving the internal processes. This background provides the guiding toolkit input data for the study programs’ design and revision. Thus the final goal is to make the continuous improvement approach clear to all stakeholders.

The author has conducted the data collection process and further analysis based on the personal experience of undergoing the accreditation process for one Master’s program and two undergraduate study programs (Faculty of Applied Sciences). The methodology of the process-driven organization is at the foundation of the research. The process requires the academic directors of the program, professors, and students to comply with the National Agency of Quality Assurance (NAQA) criteria. The outcome of the analysis is a flexible dashboard as a process mapping tool. The central actors are the set of stakeholders: program directors, professors, students, internal supporting departments, and external stakeholders. There are two focuses of the study. The first one is to explain the accreditation criteria and the quality assurance regulations with the cases of university study programs when the actual compliance checking is taking place. The other one is the time between accreditation and the events that happen within the Faculty of Applied Sciences.

Furthermore, the description of the results uses a process-oriented methodology as the most appropriate for this problem statement. The process approach makes one think of the set of inputs (people, technology, and information) in an activity that will get you to the (expected) outcomes (outputs). Process thinking changes how one sets up the three elements, executes the activities, and analyzes the gained value. This methodology is widely used to adopt continuous improvement goals. By applying a process-oriented approach and data-driven decision, there is an improved dashboard designed and the build-in markers are presented to improve the experience of the main stakeholders.

Exit Tickets for the Introductory Engineering Physics Classroom

Prof. Andrew Michael Seredinski, Wentworth Institute of Technology

Exit Tickets for the Introductory Engineering Physics Classroom

Exit tickets are a well-established formative assessment tool, consisting of brief student feedback gathered at the end of a lesson. This work analyzes exit ticket responses from eight sections of introductory engineering physics courses over three semesters (approximately 240 total students). These tickets provided two prompts after each lecture period: 1) What question do you still have after today's class? and 2) Apply today's topic to something in the world around you. The first question provides the instructor with an opportunity to identify common gaps in student understanding, while the second provides students with an opportunity to organize their knowledge and forge connections. No more than five minutes of class time each day was allotted for these assessments.

The responses to these prompts provide a rich qualitative data set. Here, I discuss the formative value these prompts had for lesson planning in my introductory engineering physics classroom. I also evaluate several methods of exit ticket delivery for both online and in-person courses. Further, I discuss how these exit tickets provided a way for struggling students to reach out, likely by opening a simple (indeed, obligatory) avenue of private communication to the instructor. Drawbacks of implementing exit tickets with significant numbers of students are also considered, as qualitative responses demand individual attention. Finally, I ask whether quantification of the exit ticket results can be predictive of engineering physics course success more broadly, either by replacing open-ended responses with multiple-choice options, or by manually coding prompt responses.

Robust Cellular Connection-Based Smart Street Lighting System for Supporting Strategic IoT Smart City Applications

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The Smart city incorporates information and communication technology (ICT) and the internet of things (IoT) services to enhance the efficiency of the resident-related city operations and services. Smart lighting systems are evolving as an essential infrastructure that can support a wide range of existing and future smart city application. Each smart streetlight is transformed into multi-sensor-equipped smart node. Such a sensor (hub) node capable of capturing and transmitting/receiving real-time data (digitally controllable nodes). A smart streetlight has sensors embedded and connected to the cloud. Globally, many cities are in the replacement phase of the legacy streetlights by low-power light-emitting diodes (LEDs) to reduce energy utilization, expenses, and carbon footprint. In addition, some of these cities are installing intelligent controls with these smart streetlights, enabling a robust smart connected outdoor lighting network that can serve as the foundation for future smart city infrastructure. A smart connected lighting network employs sensors, smart light controller (LC), communication network, data collection, and cloud software to enable remote control and monitoring of LED streetlights over the Internet.

This paper reports the performance of commercial point-to point (P2P) 4G long term evolution (LTE) cellular networks when used to provide robust connectivity among massive number of smart streetlight hub nodes and the cloud. Each smart streetlight hub node is assumed to be running simultaneously few basic lighting control services as well as smart city applications. Smart city applications range from strategic applications to relaxed latency applications. Strategic applications necessitate strict latency and reliability requirements, particularly, HD IP video surveillance cameras, however, the relaxed latency applications do not demand such strict requirements, for instance, the smart meter applications.

The Control Center (CC) located at the cloud is the lighting infrastructure management module, which commands/configures each streetlight (e.g., light-on, light-off, dimming) and monitors the infrastructure operating conditions for maintenance functions. The information exchange between the CC and each streetlight takes place via a communication network. This network must provide adequate coverage throughout the whole area where the streetlights are deployed. A smart LED has embedded sensors along with smart LC (to activate the commands received by the CC and transmit the required information) and connectivity to the cloud.

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Use of Capstone Engineering Design Projects to Construct a Teaching Laboratory

Dr. Yiannis A. Levendis, Northeastern University

This paper intends to show that projects of the senior-level Capstone Engineering Design course can be used to design and construct a cost-effective teaching laboratory. The educational benefit of this undertaking is two-fold: students design and construct experiments, with the guidance of the instructor, and subsequently other students will use these experimental setups in a laboratory of a different course. Over the years, a number of capstone groups have been tasked with creating new experiments for the laboratory of the Internal Combustion Engines course at Northeastern University. The setups are used to provide hands-on experience with engine components and operation, and facilitate the demonstration of theories presented in class. User-friendly, educational experiments allow students to observe engine induction and exhaust processes, supercharging and turbocharging, engine valve timing, fuel injection timing, and spark timing. Students measure engine performance parameters and calculate engine efficiencies (mechanical, volumetric, and thermal). Finally, they study the operation of the geartrains in the transmission and the differential gearboxes and measure torque and rotational speed outputs. The design teams identify crucial elements of a successful engineering laboratory, such as team-based learning, objective data analysis, and theoretical vs experimental results comparison. These learning goals are routinely incorporated into the final design of the new experiments and laboratory procedures. The entire laboratory follows an aesthetic theme including vibrant colors, clean lines, and hidden wiring.

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A Closed-form Algorithm to Shadow Segmentation using a Single Image

Prof. Michael G Joseph, University of Bridgeport
Dr. Khaled Elleithy, University of Bridgeport

Abstract—The presence of shadow in natural scenes continue to pose a challenge to computer vision algorithms. While there have been many proposed approaches to detect and segment shadow in natural scenes, these methods fail to do so in real-time without requiring a priori information. This paper presents a model that can decompose an image into the product of an illumination component L and a reflectance component R and use the reflectance component to segment the shadow region, all in real-time. This is done by exploiting the fact that light intensity has less effect on the reflectance of an image and by assuming there is a single point light source. Our method is highly effective in detecting shadows in an image with a surface material that exhibits both specular and diffuse reflectance properties.

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Refining Competency-Based Grading in Undergraduate Programming Courses

Dr. Marisha Rawlins, Wentworth Institute of Technology
Dr. Pilin Junsangsri

This paper investigates different methodologies for implementing competency-based grading (CBG) in programming courses. In competency-based grading (CBG) students focus on mastering the individual topics, therefore, students must show their level of competence in the various topics or sub-topics by the end of the semester. For example, a topic User-defined Functions is graded on a scale 0 No Submission, 1 Beginner, 2 Competent, and 3 Proficient in one of the courses used in this study. A characteristic of CBG is flexibility; to accomplish flexibility these courses combined a flipped-classroom and unlimited resubmissions so that students had the freedom to move through the entire course at their own pace, and so that students can learn from their feedback. One disadvantage of this approach was the burden of grading on the instructor; with a large number of submissions to grade, it can be difficult to give students feedback quickly. In this study we started with the initial implementation of competency-based grading in two Junior-level programming courses in the Electrical Engineering and Computer Engineering programs in 2020, this initial version included unlimited resubmissions and the flipped-classroom. This study also tested the following refinements to the initial CBG approach (1) only one resubmission per assessment and (2) unlimited resubmissions with a live-coding lab demonstration. We compared the performance - overall grades and numbers of students receiving grade D, F, or Withdraw - for the initial implementation and our two refinements. In the case of allowing only one resubmission per assessment, we observed no overall change in performance. This showed that moving from unlimited to one resubmission does not affect performance while still allowing some flexibility and the opportunity for students to master the topic after receiving feedback. Additionally, the instructors' burden is reduced with fewer submissions to grade. In the case of adding in the live-coding lab demonstration, instructors were able to quickly grade the lab exercise and give feedback directly to the students in real-time, decreasing the time taken to grade the lab exercises. Students also perform better when they have a live-coding demo or exam since they know that they will have to answer questions on their code in real-time. In future work we plan to combine live-coding demonstrations with limited resubmissions.

A step towards an inclusive future via piezo generators

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The Americans with Disabilities Act of 1990 (ADA) revolutionized accessibility by mandating public spaces to be usable by all people, including those with disabilities. Though much has been done since then, accessibility continues to be an afterthought in many aspects of everyday life and is rarely prioritized in building designs. This hinges on several problems, one of which is that a lot of America's already dated infrastructure was built prior to acts like the ADA, making it expensive to update and implement accessible infrastructure like elevators and escalators due to the fact that they require entirely new systems to be implemented from what can be very old or outdated infrastructure. Knowing that the most recent ADA codes, published in 2010, require specific accessibility measures, our group wants to ensure that these codes are followed by making an easy-to-implement and cost-effective way to meet them. In building a prototype that represents a localized and easy-to-install system that harnesses power from the mechanical stress of individuals walking, we hope to make it more cost-effective for businesses and government agencies to implement features like elevators and escalators to their buildings, ultimately, making them more accessible. A big incentive to use our product would come from the way it is set up; our piezoelectric elements would be attached to walkways and stairs, and would store that energy locally to be used solely to power elevators, escalators, and other accessible technologies within the building - all of which can be otherwise very costly to power.

We hope that our prototype gives both private businesses and the public sector the incentive they need to implement accessible infrastructure by making it more cost-effective for them to do so. For private businesses, this means keeping costs low and being able to accommodate the needs of more people in their buildings, which in the case of customer-driven markets, can also drive up profits. In the public sector, a very little share of the national budget gets put into infrastructure, and even less of that share goes into accessible and inclusive infrastructure. Providing a cheap and overall cost-effective way for power to be generated makes it easier for these agencies to prioritize infrastructure that accommodates every American, not just able-bodied individuals.

The Virtual Laboratory: A Natural Vehicle for Simulation in Engineering Education

Dr. Brian Hong, MathWorks
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The Virtual Laboratory: A Natural Vehicle for Simulation in Engineering Education

As technology trends continue to evolve, educators must adapt to a rapidly changing landscape. Simulation is an essential component of new industry trends, allowing the design and planning of complex systems [1]. While modeling and simulation are highly valued in industry, education has not met the demand for the graduates trained with the required skills [2].

In education, simulation can be used either to learn how to model systems or learn about a domain using a premade model [3]. By learning to model systems with industry tools, students will be better prepared for the professional world. Using premade models exposes students to prototyping, develops intuition, and reinforces fundamental mathematical concepts. It is also possible to integrate these approaches in a complementary way with students alternating between studying pre-developed modules using mathematical analyses and constructing simple examples.

A challenge with this approach is the time investment required to create robust simulations. Designing materials that allow students to model systems without extensive prerequisite knowledge of specialized software or programming languages presents another obstacle. While many excellent online resources exist, they often lack interactivity or customizability necessary for fast integration into an existing course. New customizable resources will allow instructors to quickly merge simulation with industry tools into their classroom.

In this work, we present two resources designed to meet the mentioned needs: 1) a virtual controls laboratory and 2) a DC circuit analysis virtual laboratory. These resources provide instructors with simulations of physical systems using Simscape along with detailed lab manuals to describe the process and assigned tasks. The mechanical systems, such as the rotary pendulum, include 3D visualizations to enhance the realism of the simulation. To reinforce fundamental mathematics, DC circuit virtual labs incorporate guides for performing standard analyses, such as mesh analysis or transfer function analysis. The lab experiments promote active learning by having students interact directly with the pre-developed simulations: e.g., adjusting the PID constants in a controlled system or the capacitance value in an RLC circuit while the simulation is running. To introduce the students to industry tools, there are opportunities to build and tune models of PID controllers in Simulink and electrical circuits in Simscape, among others. These virtual laboratories can help instructors to achieve several education goals in their classrooms simultaneously such as: 1) they lower the barrier for integrating simulation models into course curriculum, 2) encouraging active learning, 3) enhancing ”learning by doing”, 4) increasing students’ engagement with course topics especially with the challenging concepts.

W. De Paula Ferreira, F. Armellini, and L.A. De Santa-Eulalia, ”Simulation in industry 4.0: A state-of-the-art review,” Elsevier, Computers & Industrial Engineering, Volume 149, Nov. 2020.

A.J. Magana, ”Modeling and simulation in engineering education: A learning progression, ”Journal of Professional Issues in Engineering Education and Practice, October 2017.

A.J., Magana and T. de Jong, ”Modeling and simulation practices in engineering education,” Computer Applications in Engineering Education, pp. 731-738, June 2018.

Student Self-Assessment Questionnaires using Hierarchical Bloom's Taxonomy

Prof. Ashanthi Shanika Maxworth, University of Southern Maine

This work presents a new set of student self-assessment questionnaires developed according to the hierarchical of Bloom's taxonomy for electromagnetic fields. Electromagnetic fields is an essential course for electrical and electromechanical undergraduate students covering Maxwell's equations, plane wave propagation, and electromagnetic applications. This complex mathematics can be intimidating for the majority of engineering students. Therefore, it is important to make sure that the instructors identify the difficulties students go through during the course early on to make necessary adjustments.

A sample question in the student self-assessment is as follows:

Gauss's Law for electrostatic fields and Maxwell's first equation.

a. I can neither explain, apply nor design an application based on Maxwell's first equation.

b. I can explain Maxwell's first equation. However, I can neither apply nor design an application based on it.

c. I can explain and apply Maxwell's first equation. However, I cannot design an application based on it.

d. I can explain, apply and design an application using Maxwell's first equation.

The keywords in the above choices were chosen based on Bloom's taxonomy. Choice a represents a student performing very poorly in class, and choice d represents a student who is excelling in the class. Choice b and c represent average and above-average students. These questions can be posed by the end of each chapter to identify the level of the students based on their own opinion. Also, these can be given at the end of the semester to make necessary adjustments for the upcoming semesters.

At the University of Southern Maine, this questionnaire was administered during fall 2020 and fall 2021 for ELE 351: Electromagnetic Fields, to collect students' feedback. According to the student's feedback, the majority of the students have chosen choice c, followed by choices d and b. These results indicate that the students were able to apply the concepts accurately, but they would prefer more hands-on design experience.

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Catalyzing Capstone Project Success through Readiness Reviews and Reflection

Prof. Hugh L Mcmanus, Northeastern University
Dr. Kris Jaeger-Helton, Northeastern University

”Catalyzing Capstone Project Success through Readiness Reviews and Reflection”

Capstone projects are a common way to finish an undergraduate engineering education. They have many advantages, but they can get off track for a variety of reasons. This can fuel unequal results, both technically and in terms of students’ educational experience. A growing body of work supports the idea of internal Project Readiness Reviews (PRRs) to help assure that all students have a successful capstone experience.

PRRs were added to and existing two-term team-based capstone framework. The framework already included advisor meetings, coordinator reviews of project progress and writing skills, and external expert design reviews. The PRRs were done by the course coordinators (the faculty of record for the entire program) near the end of the first term, after the final presentation, but before the final report was due. The coordinators reviewed all teams base on their work to date: a presentation, memos, problem statements and background research. The review was intended as a frank and critical, but not graded, review of the project. In the first iteration, the coordinators presented their assessment with questions only at the end; this was quickly modified to a more interactive format based on clear student feedback. The students were asked to reflect on the PRR experience about a week later at an end-of-term wrap-up event.

The results to date have been positive. An unanticipated but welcome effect was seen at the first-term presentation: the coordinators took a background role, collecting information for the review, resulting in much richer engagement between student peers, and with non-coordinator faculty. The PRRs were private, allowing more frankness (in both directions), thus informing students of problems that might otherwise have been minimized, and faculty of student concerns that they may have been reluctant to discuss in person. The student reflections indicate that they gained insight into issues such as insufficient planning, the need for technical writing improvement, and specific technical issues. They also valued positive comments in this environment highly, which helped with the stress that comes with uncertainty. The students noted they could put the feedback given in the PRRs to work immediately in their first-term reports; this seemed to have a positive effect although this is only anecdotal at this point.

This is work in progress; the good effects to date have been more than sufficient to earn the PRRs a place in the crowded syllabus, and the reflections have already driven improvements.

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Embedding Environmental Ethics in Engineering Courses

Dr. Uma Balaji, Fairfield University
Dr. Isaac Macwan, Fairfield University

This work focuses on embedding ethics topics in electrical and biomedical engineering courses. A dedicated course titled Engineering Ethics that existed in the curriculum has been replaced in the department recently by embedding ethics topics into several courses. This work focuses on including topics in the area of environmental ethics into two courses, Electric circuits and Biosensors. It is very relevant as it introduces students to current consumerism and its environmental impact. The global world relies on handheld devices that use rechargeable batteries. There is a need to educate public on the proper disposal of them. Some engineering students are unaware of environmental impact of the improper disposal of batteries and other electronic products and discard them as normal waste. The first course on electric circuits is taken by all engineering majors. Energy from mobile device batteries is discussed at the start of the course along with the need for safe disposal. A project to research on safe disposal regionally and internationally is assigned. The project includes students to survey family members and friends on disposal practices and on the need for advocacy and social responsibility. A survey of students on impact of this assignment will be presented here. Similarly, topics relevant to the study of environmental contamination are covered in the Biosensors course. Students are assigned a project on the use of biosensors to study environmental toxins and to survey family and friends on practices of hazardous waste disposal. A survey of the students on its impact will be presented.

The Engineering Design Process: The example of the Rio-Antirrio Bridge

Dr. Basile Panoutsopoulos, Community College of Rhode Island

The Engineering Design Process: The example of the Rio-Antirrio Bridge

Overtime Engineers have been recognized as problem solvers. For an Engineer to either reach a solution of a new problem or improve the existing solution of a previous problem follows several steps that form the Engineering Method. The Engineering Method is well established process, and the process is followed universally in the process' basic steps although sub-steps can vary due to the peculiarity of the original problem. A very common occurrence is that while trying to solve a problem a previously hidden sub-problem is discovered, then Engineers go back to make modifications on the specifications or change the design process based on what Engineers have learned, with this portion of the Engineering Process being repeated as many times as necessary. This is known as iteration and was a common phenomenon in the designing and building process of the bridge under consideration.

The National Geographic Rio-Antirion Bridge in Greece
(https://www.youtube.com/watch?v=dmwIjpjcPv0&ab channel=EllinikoM documents the effort.
The Rio-Antirrio Bridge was proposed in 1880 by then Prime minister of Greece Harilaos Trikoupis (The official name of the bridge is "Harilaos Trikoupis bridge") but the idea was abandoned due to technological shortcomings and exorbitant cost. The idea resurfaced in 1998 and was completed in 2004 just in time for the 2004 Olympic Games taking place in their birth country, Greece. The Bridge has been designed and constructed to cope with the exceptionally difficult physical conditions in the straits between Rion and Antirion, the Gulf of Corinth: high water depth; deep strata of weak soil; very strong seismic activity; strong winds; and fault displacements. For these reasons, quite innovative techniques needed to be developed, such as improving the strength of the in-situ soil by means of inclusions and suspending the bridge deck on its full length to be as isolated as possible.

The above example focuses on student success as the student transitions from academia to the industry preparing engineering students for the future real work environment and the challenges of complex problem.

SILENT WATERFALLS – A REVIEW OF SALINITY GRADIENT OSMOTIC ENERGY CONVERSION TECHNOLOGIES

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Many leaders of industrial countries, at the COP26 UN climate change conference in November 2021 in Glasgow, Scotland, pledged net-zero emission by 2050. Also, 12 states and 160 cities in U.S. have official goals to obtain100% of their electricity from clean sources. All these promises and pledges should revitalize interest in search for new clean energy sources. The aqueous solutions in natural resources include various types of ions serving as significant carriers in energy conversion and storage devices. Nature's hydrological cycle offers a significant source of sustainable energy through salinity gradient which was the first demonstrated in 1954 and is one of the untapped clean energy sources.

Osmotic energy is the entropy energy extraction technique from mixing of fresh (river) water and salty water (sea-water or saline brine) in a controlled fashion. The energy produced from water salinity is a clean energy source that is non-polluting and free of CO2 emissions with minimal environmental effects and is known as Blue Energy.

Energy is released during the spontaneous mixing of two solutions with different salinities; this is considered as Gibbs free energy that provides an upper limit of available energy. As an example, the chemical potential difference between ocean water and river water is equivalent to approximately 270 m of hydraulic head; river mouths have been termed "Silent Waterfalls." The energy stored in salinity gradient on earth has been estimated in the literature, using the Gibbs free energy analysis, to have a global potential of producing 1.7 to 2.8 TW electrical power worldwide.

There are different techniques for converting the salinity gradient energy to the electricity. Some of the promising methods and most studied includes pressure retarded osmosis (PRO) and reverse electrodialysis (RED) for membrane-based techniques, other techniques that don't utilized the membrane are electrode-based include capacitive mixing (CapMix) and mixing entropy battery (MEB). There are some advantages and disadvantages for conversion technologies of SGE in terms of generated power density, price, efficiency and the level of commercialization RED and PRO are two techniques which are based on the membrane so that they need ion exchange and water permeable membrane respectively. SGE systems based on (RED) or (PRO) have been demonstrated at a pilot plant level. Issues with the membrane fouling and cost prevent these technologies from widespread applications. The major challenge in the deployment of RED and PRO is developing cost-effective membranes with a long lifetime.

Non-membrane electrode-based technologies including CapMix and mixing entropy battery (MEB) produce electricity during a batch cycling which means these technologies are disabled to operate in a continuous cycle considering the current state of the art. The literature indicates that the nonmembrane technologies have the potential to deliver similar performance as the RED and PRO technologies. However, these techniques have been demonstrated in the laboratory to produce a net energy output and have not been demonstrated to produce continuous power outputs.

Osmotic energy conversion is a promising route for handling the world energy and environment crisis, making it an attractive research topic that should be included in today's energy curriculums and textbook to prepare students for tomorrow's diverse energy supply. To better prepare students undergraduate topics should include electrochemistry as well as battery and super capacitor energy storage. Thermodynamic courses should transition to covering chemical potentials, solutions, and flow through membranes to analyze SGE. In depth review of the above-mentioned techniques, along with examples of the benchtop undergraduate research experiments with PRO and RED at Wentworth and graduate level research experiment with mixing entropy battery (MEB) at Northeastern will be given in this paper to illustrate the need for curriculum revision to prepare students to design and simulate zero emission technologies.

Printable Flexible Robots for Remote Learning

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The COVID-19 pandemic has revealed the importance of digital fabrication to enable online learning, which remains a challenge for robotics courses. We introduce a teaching methodology that allows students to participate remotely in a hands-on robotics course involving the design and fabrication of robots. Our methodology employs 3D printing techniques with flexible filaments to create innovative soft robots; robots are made from flexible, as opposed to rigid, materials. Students design flexible robotic components such as actuators, sensors, and controllers using CAD software, upload their designs to a remote 3D printing station, monitor the print with a web camera, and inspect the components with lab staff before being mailed for testing and assembly. At the end of the course, students will have iterated through several designs and created fluidically-driven soft robots. Our remote teaching methodology enables educators to utilize 3D printing resources to teach soft robotics and cultivate creativity among students to design novel and innovative robots. Our methodology seeks to democratize robotics engineering by decoupling hands-on learning experiences from expensive equipment in the learning environment.

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Structural Evaluation of the Ontario & Western Railway's Original Bridge at Fish's Eddy

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A three-span pin-connected through-truss bridge over the East Branch of the Delaware River near Fish's Eddy, NY, was erected in 1882 for the New York, Ontario & Western Railway. Designed by the Central Bridge Works of Buffalo, NY, the structure experienced two collapse events during its rather short fifteen-year life. The first occurred in 1886 when a caboose, derailed by a broken rail, struck the end post of the northernmost span, dropping it into the river and killing the four crewmen riding inside the car. The bridge was rebuilt and continued in service until 1897, when the middle span collapsed while a train of empty coal cars traversed the structure. Since the span was lightly loaded by the empty cars of a train on orders to proceed no faster than five mph, officials were quite surprised by the failure, and were never able to establish a definitive cause. A recent detailed evaluation of the first panel hangers demonstrated that they were especially vulnerable to both routine overstress as well as fatigue under simulated traffic, and that the failure of such a hanger could indeed have been responsible for the 1897 collapse.

The authors are currently conducting a comprehensive evaluation of the remaining primary members of the truss to assess whether they also possessed vulnerabilities of a degree similar to the first panel hangers. This study utilizes both the railroad's original 1881 specification for iron bridges as well as the modern-day provisions stipulated by the American Railway and Maintenance-of-Way Association's recommended practices. With regard to loading, this includes the requirements for dead and live load, and where appropriate, impact and rocking effect. Employing the allowable stress criteria given by these design rules, a comparative analysis among the members of the truss will be completed based on the Cooper load capacity of each member. In addition, member stresses resulting from simulated loads based on the actual traffic that the bridge might have been subjected to while in service will be considered. By comparing Cooper capacity to actual equivalent load levels, assessments will be made regarding whether each member would have been overloaded, and if so, to what degree.

The paper will examine the history and various details associated with the bridge, including a review of the relevant portions of the railroad's specification for iron bridges governing the design of the primary structure, as well as important observations gleaned from the 1897 collapse. Methods of structural analysis, development of simulated trains and their loads, and the results of the comparative member assessment will be presented. Finally, conclusions will be made regarding the likelihood of an alternative failure mechanism relative to that previously demonstrated for the first panel hangers. This work will contribute to the body of knowledge regarding the history of bridges, and will provide insight for structures of this type and vintage that continue in service today.

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A practical method for improving Diversity, Equity, and Inclusion in Nuclear Science

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Since the early 1990's, the ability of public education systems to produce scientists, engineers, and technologists has become a central focus. Leaders around the globe in all areas of national importance have emphasized a growing need to produce a workforce that is fluent in science, technology, engineering, and mathematics (STEM). Countless resources have been dedicated to improving STEM outcomes in various ways including modernizing regulated curricula environments, including compulsory education. United States (US) compulsory education has a long history of successfully producing technologists, albeit inconsistently across represented demographics. US higher education has a long history of successfully producing scientists, engineers, and advanced technologists, albeit inconsistently across represented demographics. In addition to modernizing standardized curricula to produce scientists, engineers, and technologists more effectively, the elimination of inconsistent outcomes among various demographics in STEM education and careers is of primary interest. In order for society to continue advancing by continually producing increasingly advanced technology, an education methodology that can produce desired STEM education and career outcomes for all individuals is desired.

Starting in 1994, a small group of Engineering Education Researchers began developing a novel methodology to improve STEM learning outcomes for underrepresented demographics at Rensselaer Polytechnic Institute (RPI) in Troy, NY. More than twenty-five years of trial and error in various practical learning environments, including military, private sector engineering, public elementary and high schools, and academia, resulted in a two-part STEM Learning Model (SLM). One part of the SLM is an empirical cognitive model, the Human Learning Model (HLM), that is used as a guide for curricula developers to customize lesson plans for a target audience. The other part of the SLM is a reduced set of scientific theories, referred to as Small-To-Big Physics (S2BP), that has been demonstrated to enable mastery of certain STEM fundamentals, without the need for math proficiency, that serve as prerequisites to formal STEM learning. The SLM has produced successful STEM learning outcomes in student learners as early as 4th grade and through early career Engineers and Ph. D. candidates.

The current best practice is for Engineering Education Researchers to partner with volunteers and organizations that have existing programs dedicated to broadening participation of associated demographics in STEM Education and careers. Engineering Education Researchers collaborate with these organizations to develop customized STEM learning modules consistent with the needs and objectives of the target demographic. These modules include moderator training and lesson plan guides that enable members of these organizations to produce desired outcomes in STEM learning without the aid or input or presence of the Engineering Education Researchers.

This paper documents the preparation process, execution, and outcome of a STEM event titled "Demystifying Nuclear Science and Engineering". The long-term objective of this STEM event is to broaden the participation of Black / African Americans in Nuclear Science and Engineering careers by teaching nuclear science fundamentals to 10th-12th grade Black / African American students.

Autonomous Inventory Tracking

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Inventory management is a key part of the success of many businesses and organizations. Several methods to track inventory exist, the most common of which being manual tracking using items like hand scanners. However, manual input may be more prone to errors such as not scanning the item or double scanning. Some methods of autonomous tracking currently exist, however these are very large-scale and are expensive to produce and maintain. This project proposes a low-cost alternative for autonomous inventory tracking with a QR code-based inventory management robot utilizing a Raspberry Pi and Arduino. The robot uses a USB camera to detect product QR codes on a shelf while using several QTI sensors to follow a black line along the ground bordered at its edges to indicate the start and end point. On each run, the robot will move forward along the path, reversing when it detects the first border and finally stopping when it detects a second border. Meanwhile, as the robot moves along the path, the camera detects the QR codes along the shelves and records the data in a CSV format for easy exporting into databases and spreadsheet programs such as Excel. In practice, the robot functions in most rooms, even in those with lower lighting. Additionally, the robot can accurately and consistently read codes from a large range of distances, allowing for flexibility in its placement in a warehouse or store. Lastly, its cost-effectiveness allows for implementation in most businesses. Currently, more features are being implemented to improve the bot, including allowing it to read codes on higher shelves, improving camera quality and detection, researching alternatives to further reduce costs, and implementing a portable power solution for the Raspberry Pi.

Finite Element Analysis of 3D-Printed Implants in Knee Replacements

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Additive manufacturing is a constantly developing field that has proved to have many benefits in biomedical applications, some of which have even been cleared by the FDA, from screws and surgical tools to dental and orthopedic implants. Additive manufacturing is such an attractive option for creating implants because of the customizable aspects, allowing for patient specific prosthesis. The use of additive manufacturing in knee replacements is a subject that can greatly benefit the long-term comfort and success of implants. Total knee arthroplasty, TKA, occurs when there is damage to the knee joint that cannot be helped through any other means, like medicine or physical therapy. TKA is a major surgery that replaces the ends of the femur and tibia in the tibiofemoral joint. At the moment, most implants are pre-fabricated to different sizes, so when being used on the patient it is up to the surgeon's knowledge of how much of the bone to cut, shave, and drill in order to achieve an optimal fit.

Using 3D printing to fabricate knee implants that are patient-specific is something that could improve the comfort and quality of life of people who require this surgery. Using additive manufacturing and finite element analysis in the process would allow for an implant that is created to fit the patient specifically, so there is less damage done to the bones, and less approximation in the middle of the operation. In this study, simulations were performed to predict the distortions and residual stresses that arise from additive manufacturing, which was then used to evaluate the performance of the implant under typical conditions. These results allow for a thorough understanding of how the knee would behave at each position along with the stresses that would come from the loading. The study will evaluate the resultant stresses that come from loading along with the part distortions and residual stresses created by the additive manufacturing process. Finally, parametric studies will be conducted to show a viable option for the 3D printed implant, and how the design may be improved along with additive manufacturing process planning for optimal performance.

Open Source Hand-Crank Phone Charger

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Mobile phone is an essential tool of communication nowadays. Not only it can be used to connect with friends and family but more importantly to call emergency services in life threatening situations. We want everyone to be able to make a call even when there is a power outage, so in this paper we present a detailed instructions on constructing a portable hand-crank phone charger. We use as many 3D printed parts as possible, and describe explicitly all the calculations done, so that a person with no engineering background can assemble a similar device. Calculations include the required input rpm and gear box ratio determination. The final device has a common USB type A output, being capable of charging any modern smartphone.

Limiting Overuse of Water in Agriculture by Monitoring Water Content

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As climate change becomes increasingly more alarming and its detrimental impact on our society becomes greater, our freshwater access continues to decline rapidly. Currently, 70% of Earth's accessible freshwater is used in agriculture, and while agriculture calls for large amounts of water, a lot of it is wasted in excess. Overwatering is a big problem in agricultural practices, and can even "drown" crops, causing damage to the plant which contributes even more to the wasted resources issue. As a society, we cannot risk continuing to deplete our resources at this rate. To combat this, a sustainable watering device that would allow for precise amounts of water would be tremendously useful. Not only would a device of this sort eliminate water waste, but it would also allow for convenience on any scale.

Our paper focuses on this issue on a smaller scale, so our product primarily focuses on house plants. Our device is comprised of four main components: a water tank, a mini solar panel, an Arduino Board, and a gypsum block. To make the product sustainable, we incorporated a mini solar panel that would attach to the edge of the pot so that absorbed solar energy can convert to electricity which would allow the Arduino Board to run. Our main goal is to limit water waste, so the Arduino Board would allow the customer to input their plant type, which would be programmed to release a precise amount of water when the gypsum block (which would be submerged in the soil) detects that the soil water content is low. Our product would promote house planting, and as urban farming becomes increasingly more popular, it would contribute to its success since customers could use the product to limit their visits to the farm. The convenience and sustainability of the product would both benefit the environment and promote local farming, reducing the overall carbon footprint of agriculture.

Heat Energy Harnessing via Seebeck Generators

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Energy is what drives many aspects of everyday life. Humans use the energy from food, cars use energy from fuel, and the many electronic devices that we use every day all use energy in the form of electricity. To produce this energy, there are numerous natural and artificially induced processes that take place. As in, our body naturally processes the food we consume to provide us with energy, cars rely on artificially aided combustion and in the mix, and we also have renewable sources of energy. While all these sources of energy production and consumption are effective and highly useful, they are not entirely efficient. If we were to go running, our body would use energy to help move our muscles in the required manner, but at the same time, our body would produce heat, not all of which is useful. Another interpretation of such a situation is a fire pit on a cold night. It might provide warmth to those around it, but the energy lost to the pit itself and the environment, in general, is quite large.

Inspired to find a solution that can help harness this excess heat energy, we attempt to build a Heat Energy Harnessing Seebeck Generator to address the fire pit situation. The uses of such a concept are vast and can be expanded to a wide range of applications. The prototype is built in such a fashion that one can start a fire in the pan attached to the top of our device and if it is relatively colder towards the bottom of the device, as in if it were placed in snow or if elevated in a manner that cold air would pass from underneath, then from the change in temperature it would be able to generate a voltage using the Seebeck effect from the help of thermoelectric pads sandwiched within the device. The prototype would be able to harness excess heat energy and provide useful electricity, which can then be used for other purposes such as charging a phone. This can be a very practical tool for purposes such as camping and the applications of such a concept are endless.

This paper discusses the process of mind storming the approach towards the solution, followed by the design, material choices, construction choices, and the construction itself of the prototype. While also presenting the results of testing that the prototype has undergone and further applications of such technology.

Low-Cost Open-Source Robotics for Education

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In recent years, robotics in the classroom has become a popular form of teaching STEM topics to young students. The modular and freeform nature of robotics allows students to exercise creativity while exploring concepts in STEM fields such as programming, engineering, electronics, and more. However, one underlying issue has prevented robotics in the classroom from being more widely adopted – cost. Many of the high-end student focused robots offer a myriad of features but trade a high cost for additional functionality; while many lower-cost options do exist, but these do away with many creature comforts in an attempt to lower the price. The WitBot was designed as an affordable, open source, and modular alternative to popular educational robotics platforms. Using off-the-shelf components including a Raspberry Pi Zero, and a number of readily available sensors, the WitBot is able to complete many of the same tasks as much more expensive units. The design goals of the WitBot were to remain cost-effective, user friendly, and open source. The open-source nature of the WitBot is critical in allowing students to exercise creativity, be it by adding additional components via the 3D printed chassis, or by adding additional blocks to the Blockly control interface. If interested, an end-user could even go as far to forgo the WitBot web interface in favor of a custom solution or add additional functionality to the existing open-source code. A provided image file can easily be burned to a Raspberry Pi compatible micro-SD card in order to quickly deploy new WitBots. The comprehensive user guide provides build instructions, either to be completed by a student or an adult, and covers all topics from bot assembly to software deployment. A custom lesson plan was constructed to introduce a number of key programming concepts such as loops and conditionals, aimed at students within the age range of 8 to 10 years old. The low-cost design goal of the WitBot was put in place to help robotics become available to more audiences. Building multiple WitBots at once lowers the price considerably due to the cost savings of buying wires, resistors, and other electrical components in bulk. While building a single WitBot is a viable option, building in bulk allows the WitBot to match the price of even the cheapest competitors while offering advantages. Included in the WitBot's many advantages is the on-board Linux-based Raspberry Pi which allows users to program in any language they are comfortable in, not just limiting them to C or Micro-Python like other products on the market. This idea of end-user customization across all hardware and software aspects is core to the WitBot and is reflected in every part of the design.

Kinetic Mousepad

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In today's digital world, individuals spend much of their time in front of a computer. While there have been many attempts to harness energy from this group of people, one area that has seemingly never been tapped is the movement of a mouse, an essential component of using a computer. This paper explains our process for harnessing this untapped energy source. By utilizing force exerted on piezoelectric sensors from the movement of a mouse over the sensors, we are able to generate current via the force of the hand and the mouse on the mousepad. Piezoelectricity is the charge accumulated in certain solid materials due to applied stress (mechanical stress or vibration, such as sound waves). Initially, we found that the force directed specifically onto the sensors was not concentrated enough to generate substantial current. To better localize the overall force on the sensors, we utilized magnets within the mouse and below the sensors. When the mouse passes over the sensor, the magnets attract, which pulls the sensor into a hard object separating the sensor from the mousepad itself. With an array of these sensors set up, much of the movement of the mouse is able to be converted into alternating current and further rectified into direct current.

In this paper, we will provide proof of concept, description of design details, data analysis and potential future applications. We hope that this idea can play a role in the real world or lay the foundation for the next generation. What's more, these project-based experiential learning activities help students to master various skills, such as research, collaboration, design, construction, and technical writing, and more.

Energy Creation via Seesaw Up and Down

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We are striving to find sources of renewable energy, either by improving current designs or by harnessing wasted energy. As today's world becomes increasingly aware of the advantages of reusable energy, it is becoming very beneficial to look for sources of wasted energy in everyday life. When people play in parks, much of the energy that they apply to the equipment in the park go to waste. The energy output by a person during their play often works to create a torque on some piece of equipment, which then translates into rotational kinetic energy, which is then transferred to heat energy through frictional forces. By waste, we mean that this rotational kinetic energy is not harnessed into a form of energy that could be used later, rather being converted to thermal energy which is lost to the surrounding space. This potential source of unused energy could be used to power much-needed electrical devices, such as lighting, which can help increase safety and comfort in and around the park. In order to solve this problem, we need to design a way to convert the rotational kinetic energy applied to the park equipment into a usable form of energy. While there is a wide array of possible equipment that could be used to harness this energy, we focused on the seesaw. We think that our seesaw while moving up and down could produce a sustainable source of energy to help reduce electricity needs in parks. We hope that this prototype can play a role in the real world, or lay the foundation for the next generation of energy innovation.

Harnessing Gym Power

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With humanity facing the ramifications of climate change due to the extended use of fossil fuels, the need for renewable power sources is as urgent as ever. With 17.5% of global emissions coming from the production of electricity, the amount of emissions we produce must be reduced, lest the planet becomes unlivable. The way we do this is by creating more forms of renewable energy. Currently, the common form of this takes the place of rotational energy, whether that be in the form of hydroelectric, wind, or even nuclear power. On a smaller scale, systems such as dynamo generators are common in many handheld appliances. The object that we have developed to add to the need for renewables is a miniature generator that is meant to be attached to a variety of machines commonly found in gymnasiums, harnessing their rotational energy to produce electricity.

This study explores the practicality of converting human energy into electrical energy with an innovative design using simple science and engineering concepts. Our device is marketed to gyms, and due to its universal nature, it can be used for any machine. Furthermore, individuals will be able to procure one as well for personal use, should the need arise for it. Our device is very small, so the power generated by a single one cannot match a wind turbine. However, our device is meant to be used in mass, and in tandem with other forms of renewables in order to ensure the greatest capacity for the production of electricity.

Design, Analysis, and Fabrication of A 3D Printed Violin for the Public

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The goal of this project was to develop a high-quality violin that can be 3D printed and assembled at a low cost. This low-cost alternative to the traditional wooden violin would allow financially underprivileged people to participate in, and experience music and music education. Given the increase in accessibility of 3D printers, we focused on modeling a violin that can be 3D printed and constructed with off-the-shelf parts and a non-commercial 3D printer. During the creation of the model, we performed simulations of the governing physics and physical analyses. These physical analyses involved testing of the constructed instruments, measuring the sound acoustics and quality compared to a traditional violin. The structural and frequency simulation analyses allowed us to modify our prototypes without the need for numerous physical models as we experimented with the violin's shape. Our target was to build the violin for less than $50, making it nearly a quarter of the cost of an in-expensive traditional violin.

Our methodology started with measuring a traditional violin and using the measurements to develop 3D printed violins using different modeling methods. The first method was a mesh model created in Blender, which allowed for the complex curves and angles of a violin to be created and modified. The second modeling method used SolidWorks, which is a traditional CAD modeling environment, and involved creating and modifying solid geometries to create the violin.

Once printed, we were able to use sensors to measure and collect data on the instrument, such as the strength of the glue bonds, as well as its waveform, sound, and frequency responses. Structural and frequency analyses of the virtual models were conducted and compared to those available from the literature for traditional wooden violins. An analysis was also conducted to see how the acoustic pressure, tension and frequency change over time for a given instrument and its material composition.

We revised the designs through multiple iterations to accommodate issues we encountered during the design and testing process. These modeling adjustments included the placement and alignment of the strings, the body wall thickness and infill to better match that of a traditional violin as well as creating more support for the neck of the violin due to material differences. Additionally, the model was modified so that the 3D printed violin's waveforms were close to its wooden counterpart. The prototype models were tested and assessed by independent music professors.

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Inclusive Teamwork: Using Participatory Action Research (PAR) to Improve Teamwork Projects in Intro to Mechanical Engineering

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Teamwork projects can be difficult and unsatisfying experiences for first-year engineering students, especially for those with racial, ethnic, and/or gender identities that have been historically underrepresented in engineering programs. Using participatory action research (PAR) and qualitative research methods, this study explores whether engaging students in a series of focus groups and online surveys help disrupt negative teamwork interactions and encourage inclusive student engagement with team projects in an Introduction to Mechanical Engineering class. All participants in this study are engineering students at a college of engineering in New England, and include 6-7 students in the focus groups, two students (one junior, one senior) who served as peer facilitators, and over 35 students who responded to the online surveys.

PAR is a research framework that prioritizes the active participation of all community members – in this case, engineering students and faculty members – to create an inclusive action process for problem-solving and constructive change. The researchers previously used PAR to successfully improve student satisfaction with an engineering summer bridge program. In this continuation study, focus groups and online surveys were tailored to specifically address inclusive teamwork practices. During the focus groups, students were encouraged to reflectively think on their core values and assets, as well as how they connect with teamwork in engineering. They were also engaged in constructive thought exercises regarding their initiative and what support they need from others, and have the opportunity to make recommendations to faculty regarding possible changes in the teamwork projects. The online surveys provided further opportunity for students to reflect on their teamwork experiences, and allowed the research team to use an intersectional approach for analyzing these experiences with regard to the students' racial, ethnic, gender, and educational backgrounds. This paper describes the process and challenges associated with recruiting participants, training student facilitators, designing PAR focus group activities, constructing and administering online surveys, reporting back to faculty members, and analyzing participant data. Student recommendations to promote positive teamwork experiences and a summary of variations in teamwork experiences are also discussed.

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An Application Driven Framework for Delivering System and Product Life-Cycle Management Concepts in Engineering Education

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Physical systems and products are being designed with information sensing capability and network connectivity to exchange data and decisions in real-time and across the life-time of the system or product (SoP). This architecture and capability provides engineers opportunity to integrate early in the design and development phase of the SoP, robust mechanisms to monitor and ensure that the SoP operates in expected ways and also be resilient to cyber-threats. The scale of the SoP is large ranging from electrical grid systems to a smart thermostat as an example. The field of product life-cycle management has a long history that has been developed for business management practices. The adaptation of these principles in the context of the emerging aforementioned cyber-physical systems (CPS) is presently being studied with particular focus on addressing the impact of SoPs on the environment and on ethical issues related to data collection and use. Two applications are considered in this work to highlight the relationship between CPS and Life-cycle Management (LCM). One relates to the design of a sensor network for monitoring air-pollution in various communities and the second addresses the LCM of a complex system, the aircraft engine. Graduate students are charged to co-create an educational module on how LCM concepts are being considered in these applications by interviewing experts in these two fields. To accomplish this, students are provided direction on posing questions and strategies for communicating in interdisciplinary groups with the goal of providing an engineering student audience an insightful introduction to life-cycle management and the need for careful consideration of this process in their future research, design and development roles. A particular focus is on designing the module such that it can be integrated in a subset of existing courses in the undergraduate engineering curriculum and techniques for LCM identified in the context of the course topic. This work investigates a novel model for curriculum enhancement that is student-centered and student-driven building on the techniques of project-based learning, co-creation and participatory action research in collecting and integrating information from experts implementing LCM of new and legacy technologies.

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Technical Survey and Literature Review on Bridge Joint Monitoring Practices

Daisy Ren, University of Connecticut
Pierredens Fils, University of Connecticut
Prof. Shinae Jang P.E., University of Connecticut

Expansion joints are essential components for maintaining the stability of numerous bridge types by accommodating and absorbing the movements of a bridge. Various factors cause bridge movement, including thermal expansion, weather variation, vehicle movement, and strain from different loads. To minimize damage and maintenance costs, joint monitoring is utilized to detect any negative changes or deterioration to the joint. Current methods of joint monitoring are costly and time-consuming, creating a demand for new processes that can alert engineers before the damage becomes extensive. Recently, Europe and Asia have been at the forefront of joint monitoring efforts, such as the inspection of 150 expansion joints on the highways in Portugal. In addition, many studies of temperature and thermal effects on bridge joints have been done on several bridges in China, including the Ting Kau Bridge in Hong Kong, the Zhanjiang Bay Bridge in Zhanjiang City, a suspension bridge over the Yangtze River, and a cable-stayed bridge in Ningbo. However, there are not many applications in the United States. In this paper, the current joint monitoring practices for six Department of Transportations in New England are presented as a technical survey. This survey on bridge joint monitoring provides details about the impacts on the expansion joints caused by certain factors such as structural movement at the joint, traffic loading, joint design, and the materials used. By understanding the effects of the surrounding elements on the bridge joint, a better process for long-term monitoring of expansion joints can be developed, which is beneficial for the safety and stability of the bridge.

Energy of Revolving Doors

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Ms. Megan Claire Baginski
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The world's rampant use of non-renewable energy and the resulting carbon emissions are causing dramatic changes to the global climate. Currently, fossil fuels supply roughly 80% of the world's energy. As we continue to burn more and more fuel, our climate crisis continues to progress and approach a critical point at which reversal is no longer possible. Our team aimed to create a new method of producing electrical energy that does not result in the release of greenhouse gases. To do this, we focused on opportunities where there was man made kinetic energy that was going unharnessed. The solution we came to is a revolving door that uses the rotation of the door panels to power a motor generator and produces clean and sustainable electrical energy. Our prototype is a significantly scaled down model of the revolving door, however, a smaller model will still be able to act as proof of concept, making it possible to estimate the amount of energy produced by a full-sized product.

We are aware that there are many kinds of renewable energy such as wind and solar that work well on a large scale. Our product is designed to work as a small addition to these larger power sources, not as a replacement to them. A small change in how energy is produced–if, for example, our product could power a hallway of lights in a building–when implemented widely in many buildings, can make a significant difference in non-renewable energy consumption. While it is obvious that harnessing the energy of the world's revolving doors would not be capable of acting as a replacement for fossil fuels, the idea is that there are a multitude of commonplace devices in our societies that allow the rotational energy generated as a byproduct of their operation to go to waste, and that if energy can be harnessed from this rotating system, energy can be harnessed from any system that involves rotation.

Cast-off Smartphone for Controlling Electronic Appliances

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Mr. Bavesh Matapathi, Northeastern University
Prof. Nathan E Israeloff, Northeastern University
Prof. Don Heiman
Prof. Haridas Kumarakuru, Northeastern University

Dual-Tone Multi-Frequency, or DTMF, is what is used by mobile phones to allow the automated transfer of information via pressing buttons on the keypad. Whenever a keypad button is pressed, two distinct tones are generated for both ends to hear, each with a different standardized frequency. This allows automated systems in call centers to process user input from specific button presses in order to perform a specific task.

Our device aims to use this protocol in order to enable customizable smart home automation using an Arduino or similar microcontroller. Many people have old cell phones that they no longer use, and these can be put to use in this device in order to receive calls, and then send any of the subsequent keypad presses to an Arduino. A DTMF decoder is used to translate this audio signal into a binary output that depends on the button pressed on the keypad. This binary output can then be input into the digital input of an Arduino in order to interpret these presses in any way the user wishes, allowing a variety of smart home automation systems to accept a simple phone call as input. A simple example could be to attach this system to a switch/relay, and turning off the lights in a certain area of the house if you were to give the device a call and press the number 1 on your cell phone keypad. Another, more complex example could be to input a specific temperature, and have the Arduino interface with a thermostat system in order to set the temperature of the house to what was input on the phone.

As relatively inexpensive components are used in this device, our aim is to allow easy access to DIY home automation systems for a low upfront cost, through repurposing old devices that are no longer in use. Additionally, the amount of use that can be gotten out of this device is only limited by the ability of the user, allowing them to create wireless smart home automations in any method they choose, rather than being limited to solely proprietary choices.

The Morse Code Game: Morse in a Minute

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Understanding the physics aspects of electronic elements is both interesting and useful to our day-to-day life. During our undergraduate lab course ”PHYS 2372: Electronics for Scientists” in fall 2021, we were asked to design and build a prototype device that accomplishes a specific purpose. Indeed, this is a challenge to us to prove how well we can translate our ideas into a device that is cost effective and efficient. During the entire semester we were inspired with a variety of electronic lab-based experiments, trouble shooting and data analysis. Since we loved to play electronic games in our childhood, we thought, ”why can’t we design a simple game to entertain people?”

As a result of our enthusiasm and dedication, we designed a game based on ”Morse Code,” which is named to honor one of the inventors of telegraph, Samuel Morse, born in 1791 in Charlestown Massachusetts, a few miles from our game-designing lab. Morse Code is a code for translating letters to dots, ”•”, which represent short signal duration, and dashes, ”—”, which represent long signal duration. For this game design, the circuit will have 3 buttons, for dot, dash, and slash, where a slash represents a separation between letters and two slashes represents a separation between words. In our game design, the winner is the one who writes a long message within the shortest time among other contestants. There are colorful LEDs decorating the design to indicate different types of code recognition while playing the game. The preliminary design was successful and was demonstrated in the lab. Currently, we are developing the design with some additional features and looking forward to presenting the project at ASEE-NE 2022.

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Damage Identification of Crumbling Foundation using Non-Destructive Methods and Image Processing

Mr. Rinchen Tsewang Sherpa, University of Connecticut, Civil Engineering
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During recent years, deterioration of the deeper core of concrete due to pyrrhotite reaction, so called 'crumbling foundation' has been an issue in Eastern Connecticut and parts of Massachusetts. Crumbling foundation is a devastating issue that not only affects municipal buildings, but residential ones as well. It has impacted families and residents of all backgrounds, causing an enormous amount of stress and worry in all cases. Providing a reliable and accurate way to determine the status of a foundation will not only be beneficial to the residents, giving them some ease in the end, but also the state and any local organizations looking to assess current cases of crumbling foundation. Current methods involve drilling out a four-inch diameter cylinder to test it for pyrrhotite, the main factor behind the crumbling foundation, and visual tests. In this paper, a collection of non-destructive testing (NDT) methods to assess the damage status of crumbling foundation is detailed. Using methods such as resonance frequency (RF) and surface resistivity (SR), the microstructure of the concrete foundation can be assessed and monitored. This is conducted in conjunction with crack monitoring devices such as digital calipers, crack width ruler, and a crack microscope to help verify and aid the data collected from the RF and SR devices. Additionally, image processing software such as ImageJ are used to also help in data verification and assessment. Accurately assessing the damage status of a building's foundation will help homeowners decide what is the most appropriate next step to take and, in the process, save them money and time.

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Improving the Learning Experience of Neurodiverse Students in a Fluid Mechanics Course During the COVID-19 Pandemic

Ms. Caressa Adalia Wakeman, University of Connecticut
Prof. Amvrossios Bagtzoglou, University of Connecticut
Dr. Maria Chrysochoou, University of Connecticut

The goals of this study were (a) to assess whether the adoption of a comprehensive suite of inclusive academic interventions within a large engineering course (Fluid Mechanics) would increase the engagement and learning outcomes of neurodivergent students enrolled in the course and (b) to observe student perceptions of program activities with the end goal of determining whether or not students perceived the program interventions to be helpful. The course interventions were conceived and implemented within the broader context of a research project that aims to transform the academic practices within an engineering department in the Northeast United States to embrace the unique strengths of neurodiverse students and improve the educational experience for all students.

Over the course of the semester, three surveys were handed out to students on a voluntary basis. Of a class of 52, 50, 48, and 39 participant responses were received for the three surveys, respectively. Each survey included several multiple-choice (or T/F) and open-ended questions, including aspects related to the instructor effectiveness, the course activities and assessments, and the student experience. Students were also asked whether they identify as neurodivergent during the first survey.

After the course was completed, the analysis of survey responses was conducted using a qualitative research protocol. First, mapping of survey questions with the goals of the study was done, then student responses were organized in a matrix and underwent various rounds of coding. The process of coding is an iterative process that results in a refinement of label codes which can result in the identification of emerging themes.

Some of the emerging themes that were identified by the students as barriers were the difficulty of exams, advanced mathematics content, and course mode of delivery that was hybrid due to the pandemic. Themes identified as supports were alternate exam modalities, course content and delivery, lecture videos, TA/recitation videos, lab videos, and live-streamed lectures. It was found that on several occasions that students who identify as neurodivergent reported supports and challenges differently than the remaining students who responded to the survey. At the beginning of the semester, only 29% of neurodiverse student responses expressed a positive outlook on how effective the learning experience would be in this course. Interestingly, as the course progressed, 71% of neurodiverse student responses indicated that the course was providing an effective learning experience for them.

Harnessing the Renewable Energy of Chairs

Ms. Gabriella C Butler
Miss Hailey Dooley, Northeastern
Mr. Liam O'Buachalla,
Mr. Matthew John Urbano
Prof. Bala Maheswaran, Northeastern University

In today's day and age it is becoming increasingly more important to find new ways to produce renewable energy. As a team we decided we wanted our project to address this problem. When presented with the prospect of inventing something of real use, we wanted to stick to the "hidden obvious". As a group, we began to consider the different aspects of our lives that are often overlooked. We perform a multitude of actions each day that could be easily used to produce energy. In our Cornerstone classroom, we noticed the amount of students fidgeting in their chairs during the class period. These mindless rotations, we decided, are a lost energy source. Therefore, the objective of our project was to harness the kinetic energy produced by chair rotation and store it in a battery as chemical potential energy. We designed the product to be adjustable to work on similar chairs across college campuses, office buildings, and public schools. This would allow us to gain a new energy source at no additional energy expenditure, since the rotation already occurs each day.

Our design contains two gears (one adjustable and one with a central axis), a generator, a tread, a battery, and a box casing. We made one of the gears adjustable so that this product would be able to be used across a variety of chairs, and included the box casing for protection. Out of many different options for gathering energy from rotating chairs, we believe that our solution addresses the problem the best due to its versatility and convenience. Our venture is a perfect way to harness a new source of renewable energy.

SEWAGE PIPELINE INSPECTION TOOL & ROBOT

Mr. Jiaqiao Liang, Wentworth Inst. of Tech.
James R McCusker PhD, Wentworth Institute of Technology
Dr. Gloria Guohua Ma, Wentworth Institute of Technology
Mr. Louis Munson
Mr. Chandler Chen

Pipelines are one of the most important parts of water supplies, oil/gas transportation, and sewage transportation. Within these categories of pipelines, sewers are one of the easiest pipelines to be affected by their operation environments where untreated human and industrial waste cause degradation and corrosion resulting in the leakage of toxic effluents to the environment. The difficulty of pipeline inspection increases significantly as the pipeline system increase in complexity.

The conventional pipe inspection methods are vision, ultrasonic, laser, and x-ray. Under these cases, novel inspection methods were proposed such as using the electromagnetic field and microwave measurements and scanning for detecting defects and cracks in the pipelines. These methods can operate in more complex pipe environments and provide more accurate results. Despite the benefits of these measurement methods, current methods utilize visual inspection using Closed Circuit Television cameras. Inspecting a storm drain often requires visual inspections, but in some cases, it may be challenging for untrained personnel to perform the inspection. This becomes problematic when an inspection needs to be performed on a regular basis, otherwise, the rate of debris buildup will be unknown which can lead to greater issues.

In this research, a self-propelled robotic device was proposed that utilizes both conventional and novel instruments for in-pipe inspection to increase the amount of retrieved data which extends beyond visual scans. The approach allows a more thorough evaluation in determining the health of an aqueduct. A modular sensor system is proposed designed along with a carrying robotic system. The modular sensor system has the ability to integrate the necessary sensors for novel inspection methods and the potential for future improvements and integration.

Materials Testing Machine: Design, Fabrication, and Assembly of a Bench-top Universal Materials Tester

Mr. Tim Reno Baci Snow
Mr. Michael James Cuddy

Understanding and documenting material properties are a critical aspect to the functioning of modern infrastructure and society; and because of this inherent significance, material specimen testers have become an incredibly lucrative and high-cost industry.
Producing results of a professional or basic tensile, compressive, or bending test of material specimen presently requires the purchase of expensive equipment and machinery. This project being completed by undergraduate mechanical engineering students aims to design, prototype, fabricate, and assemble simple and scholarly universal testing machines at an affordable price tag under $500 per machine. The machine is a hands-on, crank-operated mechanism, designed for average student operation to test a wide variety of metals and polymers. Such a project conveys the importance of material science and material properties through the creation of an interactive tool that anyone can use in order to produce high-quality results in academic, classroom, and benchtop environments.

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External Factors Affecting A Successful and Inclusive Secondary School STEM program

Mr. James Accuosti, University of Bridgeport

This paper discusses three broad but fundamentally sound factors to consider when educators brainstorm about possible effective STEM programs to implement; namely School Climate/Teacher Attitudes, Career/Job Forecasting, and Student Motivations/Demographics. We discuss these broad factors in some detail and find that the literature identifies these factors as critical to establishing a positive framework for a supportive STEM program. While not definitive, this framework supports ongoing research to accommodate 21st-century secondary STEM programs to prepare students for careers in science and engineering.

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Co-Creating a Cyber-Physical Systems Educational Module: A Project-Based Learning Approach

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Ms. Sarah Kamal, University of Massachusetts, Lowell
Justin An, University of the District of Columbia
Prof. charles thompson PhD, University of Massachusetts Lowell
Prof. Kavitha Chandra, University of Massachusetts Lowell

This research addresses the design of an educational module that supports experiential learning of the concepts governing cyber-physical systems (CPS). Such systems have become integral in the Industry 4.0 revolution and require an interdisciplinary viewpoint in their design, implementation, and analysis. A CPS interconnects physical systems, sensors, and computational engines through a communications network to support monitoring and decision-making functions that maintain a desired performance of the physical system. They entail many of the fundamental topics in engineering education such as differential equations, dynamics, signals and systems and feedback control but also require an understanding of how data-driven decision making takes place. In this work, a team of graduate and undergraduate students collaborate with faculty and experts from industry to co-create an educational module on CPS that will be integrated in selected engineering courses. A project-based learning approach is implemented that begins with observations of a simple dynamic system followed by a phase of posing questions to understand the behavior of the states of the system. The system considered is a regular tape measure that is fixed at one end and its deployment length incrementally increased until the system transitions from an equilibrium to a buckled state. This problem has relevance to more complex applications such as the stability of deployable structures used in satellites. These structures are designed to be compactly packed during launch but structurally designed to deploy with light-weight flexible material. The material properties can render the system to buckle under the influence of external forces. When coupled with a sensing system and a network that transmits this data to a computing system, it allows action to be taken to maintain functionality of the system. In this experiment the properties of the tape measure such as projected length, width, curvature, and mass applied on the tape measure are recorded and measurable system variables are assessed. A simulation of the dynamical system yields a time-series of relevant data that is applied to predict the state of the system and the likelihood that it may buckle. The project based learning and co-creation model supports students from both STEM and non-STEM disciplines to become engaged in the design and analysis of future technology, learn how to communicate with each other and with experts and non-experts in the field and contribute to a more inclusive design of interdisciplinary educational modules.

Determination of hBN thickness by optical contrast

Tedi Qafko, Wentworth Institute of Technology
Mr. Trevyn Larson
Dr. Andrew Michael Seredinski, Wentworth Institute of Technology

Van der Waals materials are crystals that can be peeled into atomically thin layers. When a number of different layer types stack upon one another, different physical properties appear. A commonly studied van der Waals material is hexagonal boron nitride (hBN). Hexagonal boron nitride is highly stable and has a structure similar to that of graphite. Such atomic arrangement allows hBN to be extremely hard, have novel electrical properties, and excellent thermal conductivity. However, whenever hBN layers are stacked upon one another, the physical and optical properties of the crystal differ with thickness, and so with the number of hBN layers. By using Fresnel's equations, a plot function was coded in MATLAB that compared a range of wavelengths with a range of hBN thicknesses. The ranges were plotted against the values of the light contrast from the samples. The plot was tested experimentally by shining 6 different colored LEDs with different wavelengths, at normal incidence, onto a sample made up of an unknown number of hBN layers on a Silicon (Si) chip with a 300 nm thermally grown oxide layer. A microscope was used to capture images of the different samples. The images were transferred into a python program that measured the contrast of the grayscale images and returned the thickness of the samples. The results of the code were compared to the thickness measurements of the sample received by an atomic force microscope (AFM). Flake 1 was measured using the AFM for a thickness of 5 nm and the equations using the image contrasts calculated a thickness of 3 nm. Flake 2 was measured using the AFM for a thickness of 14 nm and the equations using the image contrasts calculated a thickness of 18 nm.

Smart HomeKit-Enabled Peephole Camera

Mr. Emmanuel James Theodore
saurav basnet, WentWorth Institute of Technol
Mr. Brendan Gibbons
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Developing a Tool-Free Smart Peephole Door Camera

Authors: Luke J. Heinzmann, Cameron J. Dore, Brendan J. Gibbons, Emmanuel J. Theodore

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It can be difficult to satisfy the need for smart home convenience devices without invasive procedures that would go against living contracts in an apartment, dormitory, or any rented vacant living area. Creating a device that allows for convenience and security is imperative. The objective of this project is to develop and test a Smart Peephole Door Camera to identify who is at the door. A small, portable 3D printed enclosure that houses a Raspberry Pi, portable battery, and camera fits over a door's peephole on the inside of the door through a non-invasive process. This allows the dweller to hide a camera system from the person requesting access to the residence. The Peephole connects to the user's router via Wi-Fi to allow it to access Apple's HomeKit API to view the camera feed live from their iPhone, iPad, or Mac. An open-source platform by Apple on Github with the addition of the Homebridge lightweight NodeJS server allows this seamless integration between smart devices and the user. 3D CAD files created on SolidWorks will be printed and tested through multiple design iterations to ensure that the design of the enclosure and the mounting methods meet the fundamental criteria of this project.

DIY Remote Accessed Robot Car.

Trinh Huynh, Wentworth Institute of Technology
Dr. Pilin Junsangsri, Wentworth Institute of Technology

DIY Remote Accessed Robot Car

This paper presents how to build a remote accessed robot car, its challenges, and how to address these problems. Robot cars have gained a lot of attention from a lot of hobbyists and engineers. Unlike popular smart video car kits that are available in the market; where their parts and components are designed for the project themselves, majority parts in this project are collected from classroom's projects and personal use devices such as portable chargers, Arduino Mega 2560, and Raspberry Pi 4B etc. The mismatch of using these available components and devices is a big challenge for the entire system to run smoothly at voltages and currents recommended.

In this paper, Raspberry Pi is used as the brain of the system. Raspberry Pi's environment can be accessed remotely by using Remote Desktop Connection application in Windows when the user connects to the same WiFi network. GStreamer application in the Raspberry Pi terminal is used to execute commands that allow real-time video streaming of the car's camera to remote server (Raspberry Pi environment) and local server (the user's laptop) while Paramiko application is used when executing Python script to transfer data to or from an assigned host in the same network. Arduino board is used to control direction and speed of the car. Users can remotely control the car's movements by executing commands in the Arduino IDE and uploading them to the Arduino board via the Raspberry Pi environment. For the power supply, most DIY robot car projects have problems with an auto switch off of power supply when using a portable battery in low-current robotic projects. In this paper, two portable batteries are used. The 5V portable battery is responsible for the stability of the Raspberry Pi and Arduino boards. Another portable battery, which is capable of providing various output voltages (5V, 9V, and 12V), is used to power wheels' motors to vary the speed of a car. Within WiFi range, the car can be remotely controlled and operated basic tasks such as running from point A to point B, collecting images and videos data, and sending data files to an assigned host in the same network. In the future, the self-driving feature will be added into this robot car. The human-supervised will no longer be needed for the car to complete its tasks.

Alternative Education Options for Future Engineering Students

Mr. Brian Bartelo, Student
Mr. Sean W Bartelo

”Alternative Education Options for Future Engineering Students”

To become an aerospace engineer, one needs to study advanced math and science; however, one does not need to wait until they are eighteen years old in order to begin their journey. This paper discusses my educational journey as I hope to study engineering and law so I can become a space lawyer. From a position of aerospace expertise, I hope to litigate disputes to ensure space is available for all people to benefit from and stand in wonderment of forever.

Being homeschooled, my educational path has been different from traditional students. Covid has increased the number of homeschoolers exponentially and illustrated the benefits of being able to deep dive on interesting subjects. I will explore the various projects and contests that are available to students to expand upon traditional science learning. Online educational organizations will be explored for how they draw out individuals and inspire students to mature intellectually, collaborate with kindness, and problem solve to create a better future for all.

In my experience, I have been able to learn by doing. Creating electrical projects from kits has taught me firsthand how circuits work. Completing chemistry lab experiments has taught me more about the elements than just reading in a book. Creative video games have a sandbox mode, which is a fantastic way to learn without the risk of breaking or glitching something. Many organizations offer challenges using these products which allows students to work on projects with deadlines, simulating what might be experienced in the engineering profession.

In many ways, engineering information has been reinforced from video games such as Kerbal Space Program (KSP) and Minecraft. For example, KSP is a game about owning a space program and managing it to go to the outer reaches of the space. Minecraft is a game with an objective to survive in a fantasy world with highly imaginative creatures; however, similar to KSP, the Minecraft sandbox system removes the need to manage things like hunger, and focuses on learning on how the game works. Interactive and cooperative building and designing software teach cooperation and communication skills within engineering. Continuing on the topic of sandbox features, Tinkercad, a 3D modeling software, is a helpful way to learn computer assisted building and design. Learning through active engagement with a subject allows a student to formulate hypotheses, test assumptions, and experiment.

Traditional educational models consist of a ladder of learning. Homeschooling programs such as the ACE Program in New York State, allows qualifying homeschoolers to take concurrent courses to earn high school and college credits earlier than traditional public school. This allows motivated students to get a start on the basic required college courses. Many aerospace engineering students are taking advantage of these opportunities in order to graduate college early and start working.

In conclusion, one of the results of the Covid pandemic has been to usher in and highlight new ways of learning and meeting that are transformative. From my experience as a student who has benefited from an alternative educational journey, it is valuable to share this experience with others so that they too might benefit.

The Effect of High School ACT Scores on First-Year GPA of First-Generation Engineering Undergraduates

Dr. Ning Fang, Utah State University

First-generation (FG) college students are generally defined as those undergraduates whose parents' highest level of education is a high school diploma or less, or whose parents have never enrolled in postsecondary education. In the recent Executive Order on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce issued by the U.S. White House on June 25, 2021, FG college students are included as one of "underserved communities." This abstract, submitted for a poster presentation at the ASEE Northeast 2022 Conference, focuses directly on FG college students and addresses two conference topics: Diversity, Equity and Inclusion pipeline for engineering as well as success of diverse, underrepresented populations in engineering.

The recent 2017 statistical report from the U.S. Department of Education states that a significant percentage (24%) of college students are first-generation students, and many of them are from low-income families with racial and ethnic minority backgrounds as well. Existing research has shown that compared to their college peers, FG students are generally less prepared for entering college and have lower retention and graduation rates. However, not much research has been conducted to study how high school American College Testing (ACT) scores affect college Graduate Point Average (GPA) of first-generation engineering undergraduates. Conducting such research is important due to pressing demands to increase engineering retention and graduation.

This poster presentation will report our recent efforts to examine the relationship between high school ACT scores and first-year GPA of first-generation engineering undergraduates. A total of 168 FG engineering undergraduates at a land-grant research university in the U.S.A. were involved in the present study, including 53 FG students in Academic Year I, 57 FG students in Academic Year II, and 58 FG students in Academic Year III. The following data were collected from each student participant: first-year college GPA, ACT English score, ACT math score, ACT reading score, and ACT science score. Multiple linear regression was performed using first-year college GPA as the dependent variable and ACT scores as independent variables. In multiple linear regression, data collected from Academic Year I, Academic Year II, Academic Year III, and from all three academic years as a whole, were analyzed, respectively. Particular attention was paid to standardized coefficients (Beta) generated from multiple linear regression. Standardized coefficients (Beta) indicate the strength of the effect of independent variables (ACT scores) to the dependent variable (college GPA).

Based on the data collected from all three academic years as a whole, "in general," ACT math score is a statistically significant predictor of college GPA (Beta = 0.310, $p = 0.007$); ACT English, reading, and science scores are not statistically significant predictors of college GPA. One standard deviation of increase in ACT math score would cause 0.31 standard deviations of increase in college GPA. However, these "general" conclusions do not always hold in every academic year because students are different from one year to another. The research findings generated from this research emphasize the importance of math in the success of first-generation engineering undergraduates.

Direction Finding Using a Single Cellphone Antenna

Anna White, Wentworth Institute of Technology
Prof. Kai Ren, Wentworth Institute of Technology

In April of 2021 Apple released their newest line of products, the Apple AirTag. The AirTag was their version of the Tile, another small device used for locating objects. It can be attached to a variety of personal belongings like keys, wallets, pet collars, etc., in order to help owners locate their personal belongings when missing. AirTag is an ultra-wideband (UWB) transmitter, containing a transmitting antenna with an omni-directional radiation pattern. The transmitting antenna sends repeated pulsed signals, which can be detected by a receiving antenna array with multiple elements embedded in iPhone, iPad, and other Apple products. Missing belongings will be localized when the pulsed signals are received by the antenna array and the location can be retrieved by exploring the amplitude and phase of received signals through direction finding (DF) algorithms. If the lost items are out of the immediate vicinity, the transmitted signals are able to be relayed by nearby Apple products and the address can be sent through the Cloud.

The current AirTag DF system is limited by the receiver antenna array placed in iPhone or iPad, due to the large physical size compared to a single antenna element and high cost in antenna array fabrication. DF accuracy of the antenna array with multiple receiver channels will be deteriorated after certain amount of operational time without channel calibrations, since the signals received by different channels will be incoherent. Due to the size constraint, an antenna used for a cellphone is considered. To overcome these limitations, a single cellphone antenna-based DF system is investigated with a central frequency of 8 GHz using synthetic aperture techniques. The cellphone structure will be simplified and utilized for the DF antenna design.

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GROW: An Equity-Minded Framework to Support the Integration of Equity and Inclusion in Learning

Dr. David Lemar Simpson, Wentworth Institute of Technology
Catlin Wells
Tes Cotter Zakrzewski EdD, Wentworth Institute of Technology
Nicole Price

2020 brought awareness to many issues surrounding equity and inclusion across the nation. In colleges and universities, open forums on systemic racism and gender bias allowed new voices to shine through and strategic plans on diversity, equity, and inclusion (DEI) to be reimagined. A common theme that has emerged from these discussions is the critical need to effectively integrate equity and inclusion into the teaching and learning environment. As equity-minded institutions, we have a responsibility to not only meet our students where they are at, but also our faculty. Thus, we developed a framework that provides faculty with a self-paced journey toward equity mindedness. The GROW framework engages faculty through a collection of ”seeds” (i.e. easy to implement practices in equity and inclusion) that can be integrated into an assignment, project or course based on the existing DEI skillset of the instructor. To accomplish this, the GROW framework operates via four guiding principles that allows faculty to more effectively focus their efforts in integrating equity and inclusion into the teaching and learning environment. These principles include: Grow relationships, Reimagine representation, Optimize learning through accessibility and Work toward awareness and self-reflection. Embedded within each of these principles are a collection of research-backed seeds that are optimized to support instruction in science, technology, engineering, and mathematics. We believe the GROW framework will provide an effective means to meet faculty where they are at as it relates to the integration of equity and inclusion in learning.

Introduction to Computer Science + Society: A Multidisciplinary Course for All

Dr. Cuong H Pham, Wentworth Institute of Technology

Engineering education with a narrow focus on technology may have made sense in the past, it fails to meet the needs of 21st-century students, who will enter industries that fuse the Humanities with various forms of technology. The ubiquitous role assumed by Computer Science in particular, in recent decades has elevated individuals like Facebook CEO Mark Zuckerberg and Amazon CEO Jeff Bezos and the teams they lead to positions of massive political, social, and economic power. Having a strong background only in STEM fields will not prepare tomorrow's leaders for the complex social issues they will navigate. Broad, rigorous training in the liberal arts will meaningfully complement Engineering education. Multidisciplinary training in a variety of methods of research and interpretation prepares graduates to tackle complex problems with the humility and confidence to conceptualize their investigation in a nuanced and comprehensive manner. In this paper, we present the design and development of a unique multidisciplinary course for engineering students that provides extensive training in the tools of Computer Science as well as the analytical frameworks of the Humanities and Social Sciences, empowering them to meet the varied and challenging problems they will face in their careers. We also analyze our findings and discuss co-teaching best practices as the results of running the course.

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A Visually Interactive MATLAB Toolkit for Thermodynamics Courses

Dr. Ahmet Umit Coskun, Northeastern University
Prof. Kai-Tak Wan, Northeastern University

Thermodynamic courses introduce phase diagrams of solid-liquid-vapor. Many worked examples involve tabulated data in standard textbooks and linear interpolations when designated values are not available. Excessive efforts are usually required in repetitive interpolations which are prone to errors. Many beginners have difficulties in visualizing thermodynamic processes in P-V and/or T-V diagrams, which are essentially 2-D projections of 3-D P-V-T diagram. Instructors must spend extra efforts on usage of such tables, while struggling students might ultimately miss the fundamental concepts.

We present a new MATLAB based Toolkit where one can (i) define a state by entering any two independent properties such as pressure, temperature, specific volume, internal energy, enthalpy, and entropy, (ii) define processes between two specific states, (iii) read out properties of all relevant states, and (iv) visualize the thermodynamic processes using an interactive graphical interface. Hence excessive table look ups and interpolations are eliminated and learning is enhanced by visual aids. As a result, instructors can (i) focus on fundamental principles, (ii) solve more complex problems, and (iii) cover interesting topics such as bio-thermodynamics. The toolkit is first implemented and tested in ME 2380 Thermodynamics in Spring 2022. Student-instructor feedbacks are collected and analyzed to evaluate merit of the toolkit in learning and to make further improvements. The Toolkit is expected to be used in other engineering departments, physics, and chemistry, and in upper-level courses. Undergrad / graduate students participating in the Toolkit development are financially supported by a MathWorks micro-grant.

Detection of Red Palm Weevil Infestation in Palm Trees

Dr. Sharif IM Sheikh, Wentworth Institute of Technology
Dr. Ahmed Hassebo, Wentworth Institute of Technology
Mr. Forhad Hossain, King Fahd University of Petroleum & Minerals
Prof. Kai Ren, Wentworth Institute of Technology

Red Palm Weevil (RPW) is the most harmful pest for palm trees. Because of its rapid spread and devastating effect, the UN Food and Agricultural Organization (FAO) has recently declared RPW as a category-1 threat to the palm industries in the United States [1]. This destructive pest was first reported in South Asia and later found in the palm tree farms in other continents. In 2011, RPW was detected in the palm trees of San Diego and is believed to be migrated from Tijuana, Mexico. The weevil is also detected in Imperial County, California, as well as in the Yuma, Arizona, and Alamo, Texas. Further spread of this virulent pest can affect the date tree industry that contributes about $89 million a year to California's and Arizona's economies. Also at risk are date, coconut, African oil, sago, and decorative palm trees valued at more than $280 million a year [2]. So, early detection of RPW infestation is essential to avoid serious economic consequences and safety hazards.

Popular methods of detecting infested date trees include; visual inspection, thermal imaging, chemical and acoustic detection [3]-[5]. Visual and chemical methods are prone to human errors and can only detect the advanced stage of infestation. Thermal and acoustic methods use a scientific process for early detection of the infestation but are influenced by the thermal and acoustic noises present in the environment. In this research work, the change in the dielectric properties of the tree due to RPW infestation will be studied. Due to the difference in the dielectric constants of the healthy and the infested date palm tree, a non-destructive subsurface microwave technique is proposed to detect the initial stage of infestation. An antenna or antenna array is optimally positioned around the tree trunk to determine its dielectric property through monitoring the scattering parameters. Simulated results related to microwave scattering from different stages of infestation will be presented and analyzed. The microwave detection method can also be extended to treat the infected trees, where a high-power microwave signal is used to kill the larva's within an RPW infested tree. This can minimize the spread of the insects during the uprooting and discarding of the infected palm trees from the plantation.

REFERENCES

1 "Red Palm Weevil | Food Chain Crisis | Food and Agriculture Organization of The United Nations" Online Accessed in 2018. https://www.fao.org/food-chain-crisis/how-we-work/plant-protection/red-palm-weevil/en/

2 D. Danelski, "Invasive Weevil Threatens Californias Palm Trees and Date Industry", SCA Press release, 2014. https://www.iscatech.com/press_releases/invasive-weevil-threatens-californias-palm-trees-date-industry/

3 N. AlDosary, S. AlDobai, and J. Faleiro, "Review on the Management of Red Palm Weevil Rhynchophorus ferrugineus Olivier in Date Palm trees," Emirates Jour. Food Agriculture, vol. 28, no. 1, p. 34, 2016.

4 A. I. Mahmud, J. Farminhao, and E. R. A. Viez, "Red palm weevil (Rhynchophorus ferrugineus): Threat of palms," Jour. Biological Science, vol. 15, no. 2, pp. 56–67, 2015.

5 V. SOROKER et al., "Early Detection and Monitoring of Red Palm Weevil: Approaches and Challenges," Afpp–Palm Pest Mediterranean Conference, Nice, 16-18 January 2013.

Inclusion of PCB Fabrication and Testing within Lab experiments

Dr. Sharif IM Sheikh, Wentworth Institute of Technology
Dr. Ahmed Hassebo, Wentworth Institute of Technology
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Hands-on experiments to validate the theoretical concepts are essential for most of the Electrical and Computer (EE/COE) Engineering courses. The laboratory manual for these courses mostly requires students to construct the electronic circuit on breadboards and monitor the required response. But the electronic circuits within practical devices are fabricated on printed circuit boards (PCBs) and it is essential for EE/COE students to master the fabrication and troubleshooting process to enrich their measurement related training.

This paper presents a methodology to include PCB fabrication and troubleshooting as the last step of selected experiments. The proposed method started with identifying an experiment with a relatively simple PCB layout. For a junior course laboratory on Analog Circuit Design, the experiment on ”Single-stage amplifier design” was selected to introduce PCB fabrication and troubleshooting. The developed lab started with a prelab exercise, where students were asked to simulate the amplifier circuit designed earlier in the lecture section. They were asked to build the model and record the simulated operating point, input/output resistances, and the overall gain of the amplifier. Note that previous experiments are expected to teach the students how to effectively use the professional simulator needed for the prelab exercise. The lab started by comparing the calculated (from the lecture notes) and the simulated responses. Then the students collected the required components from the lab store and constructed the BJT amplifier circuit on the breadboard. Using the DC/AC sources, digital multimeter, and oscilloscope, the measured amplifier parameters were recorded and compared with simulated data. Finally, different methods of generating the PCB layout were introduced and students were asked to prepare the required PCB layout. The layout was implemented using either a PCB plotter or off-the-shelf PCB boards. Interestingly, all the students were highly motivated at this stage of the laboratory and actively took turns in placing and soldering the components on the PCB board. Although most of the circuit board worked during the 1st trial, some groups needed to troubleshoot to rectify the errors. As a bonus mark, students were asked to carefully de-solder the components without any damage. It was clear through the student survey that the inclusion of this last step made a huge difference in student participation and satisfaction.

Smart Door Knob Cleanser

Mr. Naziah Edwards, American Society of Mechanical Engineers Club at the University of Bridgeport
Mr. Elphaz Girma Gesesse, University of Bridgeportf
Nathan Sahle

During the sensitive times of a global pandemic, we have learned over time that diseases such as Covid-19 can live on surfaces for days. The senior project idea is to design, construct, and implement a prototype able to disinfect doorknobs after the surface has been encountered or used. In an effort to fight against harmful bacterias, there is a need to attack one of the main sources where bacteria is being transmitted the most. In fact scientists have determined that on average a minimum of at least five different colonies of bacteria are on a single doorknob at any given time. The purpose of the device is to spray a mist of alcoholic solution onto the doorknob surface allowing the solution to disinfect the main surface area. The main objective of this project is to keep the environment clean and reduce the spread of viruses and germs. In addition, the device is set to follow constraints that provide the opportunity for the device to be cost effective, efficient, and adjustable. As a result, these constraints will improve productivity, safety, and be more user friendly to consumers. By applying previous engineering coursework, the plan is to incorporate notes from classes such as fluid mechanics, machine design, network analysis, and computer aided design to fulfill the needs of the project. The device is planned to include a fluid mechanism that will be used to spray the alcoholic solution after the doorknob has sensed motion within a specific time interval. Also, referring back to the constraints of the project implementing a refillable cartridge with automated fill level notification would be ideal in making sure the alcohol solution can be easily replaced when the cartridge has reached a level of emptiness. These fill levels will be indicated in a form of red, yellow, and green lights communicating to the consumer that the cartridge is empty, half empty, or full and ready for use. This ensures the device is indeed performing and communicating whether the solution needs to be refilled. Overall, the goal is to create a sanitized and trusted environment for consumers when utilizing the smart door knob sensor. This device would be used as a combat against diseases being transmitted in public areas such as office buildings, schools, and public bathrooms.

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(Extended Abstract) Effectiveness, Enjoyment, and Equity: A framework for scaffolding, monitoring, and evaluating teamwork in a capstone engineering design course with industry-sponsored projects

Prof. Rafe Steinhauer, Dartmouth College
Prof. Solomon G. Diamond, Dartmouth College

What do we mean when we say that a team ”works well” together? How might we better scaffold teamwork in our engineering design courses? How might we better monitor and evaluate students’ experience on teams?

In the summer of 2020, a team of students and faculty reviewed the capstone engineering design experience course in an ABET-accredited Bachelor of Engineering program at a small R1 university. In this course, students work with the same team of between 4 and 6 students on an industry-sponsored project for six months. Perhaps unsurprisingly, the reviewers found that students’ perceptions of their experiences in the course was largely determined by their perceptions of their teams. Moreover, evidence of a gender imbalance in team experience was found.

Beginning in the 2021-2022 academic year offering and further updated in the 2021-2022 academic year, the course’s instructional team created a framework for scaffolding, monitoring, and evaluating teamwork. Nicknamed ”The 3 E’s,” the framework considered three interrelated domains for teamwork: Effectiveness, Enjoyment, and Equity. The interventions included: new approaches to team formation; new classroom activities; new teamwork assignments; regular individual pulse-checks to monitor each student’s experience on their team and offer targeted additional support; a new TA program; and analyses to evaluate teamwork in the course.

New methods for team formation included: attempting to avoid isolating women on teams; and development of a cost-minimization algorithm that considered students’ experiences and interests, the likely disciplinary demands of the projects, and compatibility factors. New classroom activities included: a team launch activity using the 3 E’s framework; and a workshop on equity and inclusion in teams with a focus on common manifestations of gender exclusion on teams. New teamwork assignments included: the early development of an articulation of team values and management strategies; and a reflection and revision of that articulation one month later. The individual pulse-checks asked students: to rate their team on a 1-10 scale for effectiveness, enjoyment, and equity; to comment on these ratings; and an option to raise a ”red flag,” which would prompt an instructor to reach out to that student for a confidential check-in. In the new TA program, three students—who had taken the course the prior year—were each assigned a set of teams with which to hold regular check-ins. Methods for evaluating these efforts will include: data analysis of the pulse-checks; and a review of students’ answers to both new and existing course evaluation questions.

These analyses will be completed in March and April, 2022, after this academic year’s version of the course concludes.

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Filling the Gaps Between Courses: A Proposal to Develop a Network Analysis Laboratory Manual.

Dr. Ahmed Hassebo, Wentworth Institute of Technology
Dr. Afsaneh Ghanavati, Wentworth Institute of Technology
Dr. Sharif IM Sheikh, Wentworth Institute of Technology

Filling the gap between the engineering courses is crucial to understand the theory and practice. The passive filter circuits are the circuits comprising the passive components or the circuits that do not include the DC power supply. The Passive filter circuits will be proposed to be a segue between the Course I and Course II circuit analysis courses at the institution. Although the proposed lab experiment(s) can be used as a smooth transition between any circuit analysis courses that are offered as sequences in engineering curricula, they are also helpful in making a bridge between the topics of DC and AC Analysis in a single circuit analysis course. This paper proposes that for a course sequence case, the assignment of RL and RC passive filters as the final experiment in course I would serve as a smooth transition between the course sequences. To explain the concept of passive filters, oscilloscope, function generator, and network analyzer equipment must be introduced. If the mentioned equipment is presented at the end of Course I, Course II instructor can demonstrate the equipment briefly and students will be prepared enough to use it immediately.

The passive low pass filter (LPF) and high pass filter (HPF) topics will be explained thoroughly in course II when students are prepared to learn the topics deeply. To achieve this, AC hardware measurements as well as the mathematical calculations (e.g., filter gain, the cutoff frequency, and the time constant ()) will be taught and explained. The simulation regarding LPF and HPF will be accomplished using Multisim and students will explore the coincidence of the hardware results and the simulation, particularly, the Bode diagram. Essentially, Bode diagram concept, will be introduced in Course II, however, authors' intention is to prepare the students for the concept in Course I. Furthermore, the instructor will utilize a continuous square waveform to show the charging and discharging diagrams of the capacitors in the RC circuit (i.e., square wave response). Course instructor will illustrate the effect of varying the time constants and its relation to the RC circuit applications (e.g., integrator and differentiator). Finally, students will be asked to apply a sinusoidal waveform as an input to RC/ RL circuits and compare the change of the output corresponding to the input waveforms. By changing the position of the resistor and capacitor in a simple RC circuit, a LPF can be converted to a HPF (and vice versa). This can be observed by exploring the frequency response.

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How to conduct oral exams as a more equitable and inclusive alternative format for knowledge assessment

Dr. Ying Yu, University of Hartford

Title: How to conduct oral exams as a more equitable and inclusive alternative format for knowledge assessment

Abstract: During the 2020 pandemic, remote classes became the standard for engineering and technology courses across the country. Oral exams have been frequently deployed as a means to ensure academic honesty. This presentation explores, analyzes, and discusses multiple factors that makes oral exam a more equitable and inclusive alternative format for knowledge assessment. The focus is on the loosely-structured, dialogue-type oral exams evaluated by the course instructor.

Oral exams are known to help improve students' oral communication skills and performance under pressure, but it is also known to be very time consuming and subjective. Another concern is that it might disadvantage students who do not have strong oral communication skills to start with. To address these concerns, an effective assessment rubric is needed to reduce subjectivity and improve efficiency for the instructors. Well-designed question lists and question sequences can not only help reduce the inequity, but also enhance students' confidence in their own ability and understanding of the material.

Another important topic addressed is how to design the overall course content to better prepare students for the oral exam format so that the overall course assessment is comprehensive and fair, and that students receive the maximum learning benefit. Peering instruction and self-recorded video presentations are two potential effective methods explored.

The specific course in question is an upper-level electrical engineering required course. The goal is to assess both students' "knowledge & understanding" as well as "applied problem solving ability". Some important general recommendations are made for engineering/technology courses regarding how to conduct and enhance oral exams to be equitable and inclusive in addition to being effective and efficient. An engineering/technical content focused oral exam rubric will be shared.

Active and Project-Based Learning in Medical Device Design

Dr. Susan Freudzon, Fairfield University

The field of Biomedical Engineering has grown rapidly in recent years. The Bureau of Labor Statistics states that there were approximately 19,300 jobs in Biomedical Engineering in 2020 and that employment of Biomedical Engineers is expected to grow by approximately 6% over the next 10 years [1]. Many students in Biomedical, Mechanical, and Electrical Engineering pursue careers in the medical device industry after graduation. To properly prepare engineering students for careers in the medical device industry, students must complete multiple hands-on design projects and receive training on unique aspects of the medical device industry, such as design controls and FDA regulations. We developed a new one-semester course to give students experience in designing a medical device, while at the same time following FDA guidelines for medical device approval. Students first identify an unmet clinical need by interviewing members who work in health care fields or by interviewing patients who use a variety of medical devices. Students also participate in an active-learning curriculum based on the FDA approval process, computer-aided design, and material selection for medical devices. By the conclusion of the course, students are expected to develop a feasible design and in some cases a prototype. Furthermore, the students' design notebook is transitioned to a Design History File at the end of the semester.

https://urldefense.com/v3/__ https://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm ;!!KIFmrYtlezdzESbnm ul-GcJzwrxbKhXG-78fyW1X5JiCTQx9wtisrm9OF4s-s7dGihC2PIxmriQ$

Some thoughts for teaching engineering statics

Dr. Xiaobin Le P.E., Wentworth Institute of Technology
Prof. Richard L Roberts, Wentworth Institute of Technology

Some thoughts for teaching engineering statics

Engineering statics is a core technical and gate-keeper course for the mechanical engineering program. During the last several years, it has been noticed that there are two common critical issues for this course: implementation of the parallelogram law and drawing a free-body diagram.

Per the engineering statics textbook structure authored by R.C Hibler, after a vector is defined and explained, the parallelogram law is used to conduct vector addition and the reversed parallelogram law is used to resolve a vector into two components. For some students, the implementation of the parallelogram law with the sine law and the co-sine law was a big obstacle. They had trouble in implementing the parallelogram law to solve problems in the first two weeks. Some students lost the fight and finally failed due to this obstacle. However, the parallelogram law is completely replaced by the Cartesian vectors' addition and is seldomly used in the rest of course. We tried to jump over the parallelogram law and directly discuss the Cartesian vectors and Cartesian vectors' addition after the vector is defined. It seemed that there was no significant impact on the course without explanation of the parallelogram law. We will continue to try this and cumulate more data about this approach.

A thorough understanding of how to draw a free-body diagram is of primary importance for solving problems in engineering statics. But some students have difficulties in drawing a proper free body diagram. They said that they didn't know how to draw a free-body diagram because there were so many different possible situations. They couldn't properly solve engineering statics problems because they couldn't draw a proper free-body diagram. We tackled this issue and listed all five possible types of free-body diagrams for engineering statics courses. For each possible type of free-body diagram, we demonstrated several examples. Because all possible types of free-body diagrams were fully explained, this approach did help some students to overcome the issue of drawing a free-body diagram.

This paper will present and explain how to jump over the parallelogram law and directly discuss the Cartesian vectors and Cartesian vectors' addition after the vector is defined. We will also present and explain all possible five types of free-body diagrams to facilitate students to overcome the issue of drawing free-body diagrams.

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Promoting Professional Identity Formation in the First-year Engineering Classroom Using Metacognitive and Reflective Pedagogical Practices

Joshua Luckens, Wentworth
Dr. Afsaneh Ghanavati, Wentworth Institute of Technology

The first-year engineering education curriculum at our university is currently being reimagined to meet the demands of a rapidly changing world. In addition to analytical skills, emerging engineers need to develop competencies like collaboration, creative problem solving, and innovative thinking. These 21st century skills are essential professional attributes which set up young engineers for success in the modern interdisciplinary workplace. ”Introduction to Engineering Design” is a required first-year course that empowers novice engineers with such future-oriented and broadly transferable skills.

”Introduction to Engineering Design” also aims to transform professional identity formation in first-year engineering students from a process of subconscious introjection to an intentional and explicit part of the curriculum. To do so, we are implementing the ”Engineering Notebook,” an active learning strategy which employs metacognition and reflection to help first-year students construct meaningful new worldviews as engineers.

The ”Engineering Notebook” writing assignments will prompt students to perceive and analyze the interconnected systems at play in the world from an engineer’s perspective, discern how to improve existing systems, create new systems, and propose creative solutions to a wide range of technical problems. We will design writing prompts and facilitate discussions to spark student curiosity about the multifarious ways in which the modern world depends on engineering for the infrastructure that allows societies to function. To develop their professional powers as systems thinkers and designers, novice engineers must begin by keenly observing the world around them, asking critical questions, and formulating novel approaches to solving the engineering problems of today and tomorrow.

Additionally, students need to understand their own thought processes, becoming conscious of the ways that they take in information, synthesize it, and make decisions. In this semester-long exercise in metacognition, first-year students will connect their lived experiences to the fundamentals of engineering, discussing issues of equity and bias as they relate to the technical systems that they will soon design and manage as engineering professionals. By doing so, they will develop emergent worldviews as engineering design thinkers and explicitly build their own professional identities as engineers from the ground up.

Using the ”Engineering Notebook,” students will make their development as engineering design thinkers visible to themselves, empowering them to enunciate their evolving skills as creative and analytical problem solvers. In the process, they will develop essential professional writing and oral communication skills. Additionally, the ”Engineering Notebook” exists to build novice engineers’ sense of belonging to and ownership over their newly forming professional identities. As such, we intend for this project to promote growth mindset and support retention efforts in the first-year engineering program.

Throughout the semester, we will continuously assess the efficacy of the project at meeting its stated goals. We will iteratively implement modifications to make the ”Engineering Notebook” a more powerful reflective tool for metacognition and professional identity formation. We aim to develop this project for deployment across our university’s transforming first-year engineering curriculum. In this paper, we will report on our findings, providing useful takeaways for first-year engineering curricula at a variety of institutions.

Deployable Log-Periodic Dipole Array Antenna for CubeSats

Mr. Gagik Sarkisian, Wentworth Institute of Technology
Prof. Kai Ren, Wentworth Institute of Technology

A CubeSat is a miniaturized satellite that has become increasingly popular as a way for smaller academic and commercial institutions to develop the skills and knowledge involved in launching space missions. CubeSats are low-cost in their design and deployment, which can perform many functions that larger satellites can such as imaging, space specific research, and inter-satellite/deep space communications. However, they are fundamentally limited by their strict size and mass requirement. This results in challenges on the antenna design, which must achieve required performance to communicate with ground stations. Conventional CubeSat-based antennas have fundamental limitations in low realized gain and narrow frequency bandwidth. This paper presents a high gain and wide bandwidth antenna by utilizing a deployable Log-Periodic Dipole Array (LPDA) that still provides enough surface area for the use of solar panels. This design should be able to achieve a 2:1 bandwidth ratio with a very low VSWR throughout the bandwidth while maintaining a gain of approximately 10 dBi. In comparison, most typical CubeSat antenna designs only achieve bandwidths ranging approximately from 1% to 45% with comparable levels of gain. It will operate in the S band ranging from 2 GHz to 4 GHz, which will be used mainly for communications, telemetry, and high data-rate downlinks. Due to the wide bandwidth, it will allow the CubeSat to send and receive multiple types of data simultaneously. This could be useful for more complicated missions that require large amounts of data to be collected, as well as allowing the CubeSat to achieve higher data transmission rate when in range of ground stations.

Mapping Technical Writing Across the Civil Engineering Curriculum

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Dr. Corinna Marie Fleischmann P.E., United States Coast Guard Academy
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Dr. Kassim M. Tarhini P.E., United States Coast Guard Academy

The Civil Engineering Profession expects graduates to develop sound communication and technical skills during their undergraduate education. A recent study reported 38% of new engineering graduates across all engineering disciplines indicated that having good communication skills is one of the most important factors impacting their advancement and success in industry. Similarly, it has been documented in the literature that good oral and written communication skills are required attributes for the success of engineering graduates in the workplace. Effective writing is one of the communication skills critical for the success of practicing civil engineers as they develop and write a wide variety of documents. The ability to write concisely and clearly in the workplace is critical for the graduate's success in winning contracts and reducing liability. As information technology advances, it is essential that engineering educators encourage students to develop and improve their communication skills, especially technical writing in the context of the current and emerging information infrastructure. In the Civil Engineering Program at the United States Coast Guard Academy (USCGA), specific performance indicators related to technical writing and information literacy have been developed and linked to several ABET Student Outcomes. Faculty members have developed technical writing instructions that are shared with students and mapped to various courses throughout the curriculum. The faculty have developed specific assignments and grading rubrics designed to progressively assess student writing skills and improve student development in technical writing.

Evaluation of the curriculum during the fall semester of 2021 resulted in the initiation of a comprehensive study to investigate how and when technical writing is taught in the civil engineering curriculum. Faculty members were interviewed to identify gaps in teaching and assessing technical writing skills in the curriculum. The information gathered was used to revise and develop new technical writing instructions that will be infused purposefully in various courses and labs within the curriculum. Preliminary assessment of the results indicate that students gain experience in a wide variety of technical writing assignments such as writing lab reports, journals, research papers, technical memos, and design project reports. Instructors are devoting time in their courses to discuss technical writing requirements or to teach aspects of technical writing. There are several themes that have emerged from this preliminary assessment:

Lack of attention to details. It is evident that faculty spend a lot of time preparing guidance for the students in their courses, but students do not appear to pay attention to all of the details in the guidance.

Presentation of results. Many students do not understand how to present data and communicate through effective visuals including tables, graphs, and design drawings. Students often resort to "the more words, the better" school of thought and submit all their data without trying to appropriately explain the results to the reader.

Proof reading before submission. Many students do not proofread their work before submission. They seem to heavily depend on the self-correction functions in the Microsoft Word processing software.

The authors will discuss the process of developing, implementing, and improving technical writing and information literacy progressively and consistently in the Civil Engineering curriculum at the USCGA. The goal is to help faculty coordinate their activities by mapping technical writing skills requirements into the curriculum and progressively infusing the appropriate technical writing throughout the required civil engineering courses. This coordinated effort will enable students to develop and hone the communication skills necessary for them to be successful in engineering practice, as well as encourage them to continue to grow through lifelong learning.

Using the Matlab Robotics Toolbox with an Introductory Robotics Course

Mr. Justin Dansereau, University of New Haven

Title: Using the Matlab Robotics Toolbox with an Introductory Robotics Course

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Abstract

When teaching an introductory robotics course, it can be difficult for students to understand certain topics, especially those with frame transformations. The MATLAB robotics toolbox has been adopted to give students an interactive visual representation of each main topic within this course. These examples include both representations of known robot configurations (i.e., PUMA 560) and robots with structures and dimensions which can be edited by both the student and instructor. These examples provide the mathematical representations and solutions of the designed robot.

• Homogenous transformation can be shown in two different ways, either the student can create their own robot links and rotate and translate them to observe the change in coordinate systems or they can use a predefined robot and fix links on either side of one joint and then transform in the same way.

• The DH parameters are shown by rotating or translating an individual link on a known robot to show the meaning of each parameter.

• Forward kinematics is visualized by creating a three-link robot. This robot will be given a specific transformation at each link. The robot will show the beginning and end positions of the robot. It will also show the DH matrix for the forward kinematics.

• The inverse kinematics is very similar to the teaching of forward kinematics except instead of giving the transformations the end effector position is given. The robot will represent the movements to the same position but will mathematically work backwards to find the transformations.

• To teach the Jacobian, a predefined robot is used to calculate all Jacobian(s). Then the robot is moved to all values found to show students the singularity at these points.

• The examples for trajectory planning will include a dynamic visual of a pre-defined robot along with graphs which show the velocity and acceleration of the robot in the dynamic system.

Statistical Tools To Produce Accurate and High-Value DEI Insights

Dr. Steven Sherrin, Wentworth Institute of Technology

This session will equip participants with new research ideas and statistical tools for analyzing, visualizing, and communicating diversity, equity, and inclusion (DEI) data in engineering disciplines. The session will focus on popular, free software, and will use statistical tools to address real-world examples. Example code and visualization will be provided, as well.

The session will be organized by four core DEI principles that can help institutions create high-value, accurate, and unbiased data insights:

1. Respect differences between groups, but don't overestimate them.

2. Respect similarities between group members, but don't stereotype them.

3. Account for the multifaceted nature of individual identity.

4. Analyze small sample sizes, but don't overstate their importance.

More details on each section are provided below:

• I will demonstrate how some summary statistics, such as the mean or median, can cause readers to overestimate demographic differences. I will show an easy-to-calculate alternative (effect sizes) that counteracts this bias.

• I will demonstrate how visualizations focusing on differences between demographic groups can lead stakeholders to underestimate variation within groups. I will present a statistical technique (cluster analysis) that naturally describes within-group diversity. In addition, I will provide a simple data visualization technique, outcome-based categorization, that can also be helpful.

• I will illustrate how demographic categories commonly used by higher education institutions can fail to represent the rich, multifaceted nature of individual identity(s). I will discuss examples of how to integrate standard demographic categories with meaningful information from other datasets, such as hometown information, family migration history, and more. I will provide links and example datasets to aid audience members in conducting their own analyses.

• I will discuss two statistical biases related to the analysis of small sample sizes: 1) trying to detect meaningful patterns where there are none and 2) being overconfident in the power of small sample sizes. I will show how researchers can use a simple statistical tool, sample size calculators, to help their stakeholders avoid these errors.

Plasma antennas – a gentle introduction

Dr. Paul Benjamin Crilly, United States Coast Guard Academy
Julian Blanco, US Coast Guard Academy

Abstract – In this paper, we describe the theory, practical construction, and experiments of a plasma antenna to radiate a VHF signal. The primary goal is to provide an introduction to plasma antennas to undergraduate electrical engineering students and eliminate some of the mystery surrounding this antenna type. In our experiment, we implement a half-wave dipole whereby the conductor is a ionized gas or plasma that radiates a 120 MHz signal and is created using a 20 kHz source and mercury vapor gas contained in a florescent tube. We characterized the antenna's voltage standing wave ratio (VSWR), input impedance, radiation characteristics, bandwidth and then compare these to a similar half-wave metallic dipole antenna. Our learning objectives of this project are how to practically implement a plasma antenna using easily obtainable, low-cost components, and experience how ionized gas, acts like any other metallic antenna element, and thus can be an effective RF radiator. Furthermore, by doing the experiments, undergraduates will better understand dielectric breakdown, how dielectric breakdown in a gas forms a conductor, quantum mechanics associated with how color or spectrum of the discharge is a function of the elements in a gas. We consider the practical advantages and disadvantages of plasma antennas as compared to their metal counterparts which include how a plasma antenna when de-energized, is stealthy, how multiple plasma antennas can be configured for spatial multiplexing and how other plasma structures can be added to form reflectors, directors, etc.

Coupling On-line Education with Workforce Development Initiatives in Surveying

Mr. Anthony R Vannozzi MS, PLS, University of Maine

At the core of workforce development is training and education. Historically this has meant that the jobs had to be plentiful enough in one location to bring in training and attract workers, or the jobs and workers needed to be convenient to existing bricks and mortar educational institutions. Combinations that have rarely existed in surveying. However, by accessing online education, and weaving it into workforce development programs, employers and prospective employees can couple jobs and workers and the necessary education simultaneously virtually anywhere. In just over three years, the University of Maine's ABET accredited 100% online baccalaureate degree program has revolutionized undergraduate surveying education in the United States. In the same way, the University's online surveying undergraduate certificate program can be leveraged to create a robust workforce development program for surveying professionals and technicians. The presentation will all touch upon applicable adult learning principles and an evolving understanding of "student engagement" as it relates to on-line learning in non-traditional student populations.

Monitoring and Management of Classroom Presentation Technology Using Crestron Fusion

Ben Thomas Bassett
Dr. Douglas Eric Dow, Wentworth Institute of Technology
Johanna Pierson

Many of the learning spaces across a typical college campus are equipped with tools to aid the learning process. These tools such as projectors, microphones, and document cameras should be monitored and when needed maintained to ensure that they remain operational for classes. Analytics of classroom equipment utilization could aid more efficient maintenance schedules, and better tracking for assets. Analog methods that require manually checking each space or just waiting for repair requests are inefficient and can disrupt the learning process in the classroom. By monitoring parameters of the classroom audio video (AV) systems, usage and functional data can be collected and utilized to determine the availability, operational status, and usage of these spaces. This information can enable university employees to act proactively to complete system repairs before hardware failure occurs. By connecting the utilization data from each AV system to a central server, the information can be aggregated and analyzed. Crestron (Rockleigh, NJ, USA) provides enterprise control and automation solutions for AV equipment. One of their products provides for system monitoring across a large network of AV equipped spaces. This product is Crestron Fusion, and it enables monitoring of connected systems, scheduling of services such as repairs and enabling of alerts for AV technicians. The purpose of this project is to utilize the Crestron Fusion service to track information about a room's AV system, such as lamp hours, microphone battery levels, and room occupancy. This information would be saved to a centralized database and would be available for analytics, monitoring, and generation of alerts when needed. Such a system would improve the ability to monitor classrooms' operational status, maintenance cycles, and appropriate usage.

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
ASEE NE Conference 2022 at Wentworth Institute of Technology, Boston

A Statics project to teach centroid, potential energy, stability and virtual work principle

Prof. Kai-Tak Wan, Northeastern University
Dr. Marguerite Matherne, Northeastern University

A project is given to mechanical engineering sophomore students aiming to introduce the difficult subject of virtual work principle in ME 2350 Statics. Though the topic appears in most standard Statics textbooks, it is mostly left out in most mechanical engineering programs. A roly-poly comprises a cone with radius R and height H attached to a base of spherical cap with the same radius and a depth of h. Centroid of the composite 3D object has to be derived from scratch by integrating over the spherical cap.

Application of a lateral force, F, leads to an inclination angle theta to the vertical while the curved base remains contact with a planar substrate. A balance of potential energy, V, or virtual work principle, is then used to derive F(theta) at equilibrium. Depending on the ratios of H/h and H/R, once theta reaches a critical value, theta*, the roly-poly rests at the base rim in contact with substrate and is free to rotate. The mechanical response F(theta) takes on a different form. Eventually once theta reaches another critical threshold, theta†, the roly-poly topples in an unstable manner under fixed-load control. To demonstrate fixed-displacement control and stability, the load is replaced by a linear elastic spring with spring constant, k, and F = k.x where x is extension. The calculation is repeated for a few combinations of (H/h) and (H/R). Calculation will be performed to identify F*, theta*, F† and theta†, and to derive the critical (H/R)* such that the object behaves as an authentic roly-poly. Students will have to write their individual reports, showing F(theta) and V(theta) for cone without a base, cone with a hemispherical base (h = R and a = R), and a few intermediate cases with a range of (H/h) including the special case of (H/R) *, and discussing the stability.

Extra credits are given to those who make roly-polies from readily available materials such as ice, wood, chocolate, or 3D printed polymeric materials, and to perform force measurement using primitive setup such as strings and pulley (to apply horizontal load), paper pans (to hold weights), and rice grains (incremental load). Measurements will be used to verify the theoretical predictions. Interested students are encourage to perform rocking of the roly-poly to measure the frequency of simple harmonic motion, which will be taught in the subsequent courses of Dynamics and Vibration.

Youth and the Engineering Outreach Industry

Mrs. Diane Ward, Educator

This paper will look at the emerging industry associated with prepping elementary and middle school students for engineering careers. It chronicles the different organizations and programs that entice students interested to learn STEAM skills in a kinesthetic way. Engineering needs to constantly attract new talent, and whether it is robotics, aerospace, or civil engineering, there are programs to support the interests of youth considering engineering.

Future engineers and their parents are anxious to find opportunities to increase STEAM skills. To this end, many families have chosen to seek out nontraditional educational opportunities, such as tutoring, homeschooling, summer camps, or supplementary educational programming. Parents want a solid basis of math and science for their children who express an interest in engineering and are willing to finance this extracurricular preparation.

Although traditional schooling in the United States places a high importance upon STEAM, students need to firmly understand the basics of mathematics to advance to higher levels of study in these disciplines. Early intervention in addressing math and science inequities in education is crucial. Not all nascent engineers have the good fortune to partake in engineering summer camps and extracurricular programs.

Various engineering-centric programs and student competitions are gaining prominence, making the field of engineering an even more popular field to pursue. For engineering schools (and eventual future employers) to attract the most committed talent, young students need to be prepared with soft and hard skills. Competition for placement at higher education institutions prompts parents to invest in programming to strengthen their student's exposure to engineering concepts.

Online educational organizations such as Synthesis, Astra Nova, Athena's, Outschool, Johns Hopkins University's Center for Talented Youth, Northwestern University's Center for Talent Development, Varsity Tutors, Virtual Homeschooling Group, and online homeschool co-operatives try to create learning opportunities that teach, while creating cohorts for students from all over the world.

While this is a profitable market, it is not always diverse and available to those in struggling economic brackets. The obvious divide of affordability and availability to some more expensive educational opportunities leaves out many young worthy students from gaining access, thereby losing out on exposure to engineering. Addressing inequities in elementary STEAM education is a first important step in leveling the playing field for all students to excel.

Furthermore, many academically gifted students in traditional educational settings are not challenged or adequately accelerated to suit their abilities. The active learning models of some online educational programs allow for a kinesthetic and collaborative learning environment. Project-based homeschooling models also tailor educational opportunities to aptitude. Organizations such as the Invention Convention, Imagination Destination, and Future Engineers try to provide egalitarian access to engineering challenges.

An unlikely assistant in helping to diversify the engineering field is You Tube. The current generation of students (roughly in the age group of 6-18) are assigning star power to a growing legion of STEAM stars. Fortunately, education entertainment personalities, such as Mark Robert, Janet Ivey, Steve Sherman, Hip Hop MD (Maynard Okereke), Tom Stanton, and Real Engineering have provided access to engineering principles for all students, thus democratizing it for young students.

In conclusion, I want to discuss how the rise in accessibility to engineering programming for young students is good for the profession and will ultimately help in strengthening and diversifying the field. Supplementing and disrupting the traditional class-based methods of learning engineering principles helps to democratize the discipline and attract new problem solvers.