2022 Spring Conference

Hosted by:

April 22-23, 2022

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Welcome from the Conference Chairs

Ashish Borgaonkar, Ph.D.
Asst. Professor, Engg. Education

Jaskirat Sodhi, Ph.D.
Sr. Univ. Lecturer, Mechanical Engg.

We are thrilled to welcome you to the American Society of Engineering Education (ASEE) Middle Atlantic Section Spring 2022 Conference at NJIT! We are sure that all of you, just like us, have missed being at an in-person conference and are just as excited to be face-to-face with our engineering educators community. We hope through this conference's keynote speech, workshops, full-paper presentations, and poster presentations you will be able to share and learn worthwhile best practices and tips to take back into your own classrooms.

The theme of this conference is Innovation in Engineering Education and we thank our presenters and speakers for bringing such innovative ideas to share with the community. We sincerely hope you enjoy this conference and get an opportunity to see old friends after a while as well as meet new faces!

Conference Organizing Committee

Dr. Ashish Borgaonkar	Dr. Jaskirat Sodhi
Ms. Angela Vega-Irvin	Ms. Kimberly Dripchak
Ms. Carolina Yanez	Ms. LaTosha Wilson
Mr. Phil Stickna	Mr. Ersal Aslam

Conference Organizing Committee is thankful to –
Dr. Basil Baltzis, Senior Vice Provost for Academic Affairs and Student Services
Dr. Moshe Kam, Dean of Newark College of Engineering
Mr. Blake Haggerty, Associate CIO, Dig Learning and Campus Support
The ASEE MAS conference is made possible by the dedication of many volunteers. Most notably-
Staff Volunteers: Ms. Sheryl Baker and Ms. Ivy Brown
Student Volunteers: Mr. Sanjeet Gajjar and Ms. Manjushree Ramachandrahosur

ASEE Mid Atlantic Section Liaisons
Dr. Alexander J De Rosa, Stevens Institute of Technology, Chair
Dr. Pritpal (Pali) Singh, Villanova University, Meetings Chair

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Conference at a Glance

All times Eastern Daylight Time (EDT)

Fri, Apr 22	Event	Lead Author	Location
2:00-7:00 PM	**Registration and Help Desk**		CKB Lobby
3:00-4:15 PM **Workshop and Technical Session 1**	Workshop: Trauma Informed Teaching - Teaching with Compassion	Melodi Guilbault	CKB G-08
	1-A Innovative Ideas for Pre-College Curriculum	*Moderators: Marie Aloia and Gale Spak*	
	Schools as Living Laboratories for Architectural Engineering Research Experiences for Teachers	Kathleen M. Hill	CKB 116
	Motivating Middle Schoolers to Be Engineers	Howard S. Kimmel	
	Training Middle and High School Teachers in Introducing Science and Engineering to Students	Rajpal S Sodhi	
	An Urban School's Approach to the Senior Capstone Project: Promoting a Culture of Excellence	Tina Powell	
	1-B Multidisciplinary Innovative Instructional Ideas	*Moderators: Kaitlin Mallouk and Bradley Sottile*	
	Cognitive Strategies in STEM Education: Supporting the Development of Engineers' Multi- and Cross-Disciplinary Competence	Laramie Potts	CKB 204
	Measuring adaptive expertise amongst first-year STEM students	Alexander John De Rosa	
	Python for chemical engineers: an efficient approach to teach non-programmers to program**	Gennady Gor	
	Constructively Aligned Instructional Design for Oral Presentations	James Lipuma	
4:15-5:30 PM	Tours: Makerspace and the Motion Capture Lab		Tours start from CKB 116
5:30 – 6 PM	Executive Board Meeting		CKB 116
5:30 – 7:30 PM	Dean's Reception		Campus Center Atrium

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Sat, Apr 23	Event	Lead Author	Location
8:00 AM-3:00 PM	**Registration and Help Desk**		CKB Agile Strategy Lab
8:00-8:30 AM	**Breakfast**		CKB Agile Strategy Lab
8:30-9:30 AM	**Welcome and Keynote**		CKB Agile Strategy Lab
9:45 – 11:00 AM **Technical Session 2**	2-A Teaching Entrepreneurship, Ethics, Design Innovation and Research in a Classroom *Moderators: Tracey Carbonetto and Pali Singh*		
	Teaching Entrepreneurship with Societal Impact to Engineering Students	Cesar Bandera	CKB 116
	Teaching of Professional Ethics in Engineering Design	Rajpal S Sodhi	
	Teaching Design Innovation in Product Engineering Classes	Sanchoy Das	
	Research for Undergraduates experiences from various academic institutions	Rajarajan Subramanian	
	2-B Innovative Curriculum: Graphic Design, Spatial Visualization and FEA *Moderators: Nelson Macken and Jaskirat Sodhi*		
	Engineering and Graphic Design Interdisciplinary Collaborative Product Development: A Wheelchair-Mounted Rotating-Head-Support for a Disabled Child**	Dylan Louis Vongrej	CKB 204
	Enhancing Understanding of Mechanics Courses using FEA Active Learning Modules	AHM E. Rahman	
	Use of Generative Design and Shape Optimization Tools for Advanced Engineering Design	Nadir Yilmaz	
	The relationship between persistence, effort, and achievement in a spatial skills training program	Maxine Fontaine	

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Sat, Apr 23	Event	Lead Author	Location
	2-C Innovative Curriculum: AI, Machine Learning and Games *Moderators: Kaitlin Mallouk and Bradley Sottile*		
	Preservice Teachers' Mechanistic Reasoning about Machine Learning and Artificial Intelligence++	Amy Voss Farris	CKB 217
	Evaluation of an AI-assisted Adaptive Educational Game System	Ying Tang	
	Mixed Reality Game for Active Geotechnical Engineering Learning	Ying Tang	
	Absorption and distribution of Arsenic by plants & role of soil conditions	Sunil Dehipawala	
11:00-11:15 AM	Networking Break/ Coffee		CKB Agile Strategy Lab
11:15 AM – 12:30 PM **Workshops**	The NJIT/Newark Math Success Initiative (MSI): A holistic program to prepare and support urban students to succeed in earning STEM degrees in college	Jacqueline L. Cusack	CKB 204
	From Remote to Flipped: Increasing Student Engagement through the Classroom Flip	Sarah E Zappe	CKB 116
12:30-1:30 PM	Lunch and Business Meeting		CKB Agile Strategy Lab
1:30 – 2:00 PM	Distinguished Teaching Award Seminar		CKB Agile strategy lab
2:00-2:30 PM **Posters**	Poster Session		CKB Agile strategy lab
	Measuring Entropy in Sleep EEG to Examine Complexity and Level of Biological Activity in Different Sleep Stages	Edgar Canario	
	Evaluating the Use of MicroPython and the Raspberry Pi Pico in Laboratory Activities for Undergraduate Classes in Engineering Electromagnetics	Eve Klopf	
	Using qualitative research methodology to examine women STEM faculty's participation in entrepreneurship education programs++	Aida Lopez Ruiz	
	Hands-on Teaching Module: Fabrication of Cost-Effective Microfluidic Chips**	Amir K. Miri	
	Addressing the Needs of Students with Disabilities during the COVID Pandemic**	Paul J Marchese	
	Validating survey instruments to measure entrepreneurship education out- comes for undergraduate students	Heydi L Dominguez	
2:30-2:45 PM	Networking Break/ Coffee		CKB Agile Strategy Lab

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	3-A Innovation in an Online/Remote Classroom *Moderators: Alex De Rosa and Tracey Carbonetto*		
	Remote Professional Development Opportunities for K-12 Teachers during a Pandemic	Howard S.Kimmel	CKB 116
	Excel optimization pedagogy using Van Hiele learning model of spatial abilities with Force Concept Inventory Test MRI and haptic learner data for COVID-19 online challenge	Sunil Dehipawala	
	Optimization of Student Learning Outcomes Using an Hours of Instructional Activity Tool	Tracey Carbonetto	
	Through the Looking Glass: STEM Students' Changing Relationships with Time Across the COVID-19 Pandemic	Bradley J. Sottile	
	3-B Innovative Curriculum: Electrical and Computer Engineering *Moderators:Tewodros Mamo and Marie Aloia*		
2:45-4:00 PM **Technical Session 3**	Designing Electrical and Computer Engineering Capstone Projects to meet ABET Outcomes	Pritpal "Pali" Singh	CKB 204
	Recommendation Engine using Adamic Adar Measure	Sourabh Dadapure	
	VLSI Design, Verification and Fabrication of an Arithmetic Logic Unit (ALU) Using the Cadence Virtuoso: A Case Study	Nian Zhang	
	A Feasibility Study on Building a Stand-Alone Community Microgrid in the United States	Salma Alami Yadri	
	3-C Innovative Design Projects *Moderators: Ashish Borgaonkar and Eugene Kwak*		
	Deadlift Energy Absorption and Dissipation Device for Athletic Weight Room	Henry Alan Freligh	CKB 217
	Design Analysis of Rocket Tail Fins Aimed at Higher Apogee by Computer Simulation	Justyn Allen Bunkley	
	Parametric Analysis of a Stirling Engine Using Engineering Equation Solver	Kaitlyn Kreider	
	Pure Circular Motion with Non-Angular Variables in One-Dimensional Motion Physics Problems	Daniel Blessner	CKB 217
	Investigation of Dominant Daily Uptake Factors on Gut Health from Samples in the Database of National Health and Nutrition Examination Survey	Margaret Dugoni	
4:00-4:30 PM	Awards and Closing Ceremony		CKB Agile strategy lab

* CKB = Central King Building
** Best Paper/Poster Nominee
++ Best Paper/Poster Winner

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NJIT COVID-19 Policy

- As per the current NJIT policy, masks are required, regardless of vaccination status, in all indoor instructional spaces. This applies to all technical sessions and workshops which are taking place in different classrooms.
- Masks are strongly encouraged but optional in all other spaces including indoor areas and outside. Please remember that all conference activities are likely to fall under 'areas of high occupancy,' and use your best judgment.
- If you come across someone wearing a mask then as a courtesy, we request that you also wear a mask while interacting with them.
- Additional information on NJIT's policy can be found on the pandemic recovery website - https://www.njit.edu/pandemicrecovery/

NJIT Internet Access

NJIT provides guests with access to wireless internet access. Guest WiFi is available by following instructions on this website (https://ist.njit.edu/connecting-njitguest)

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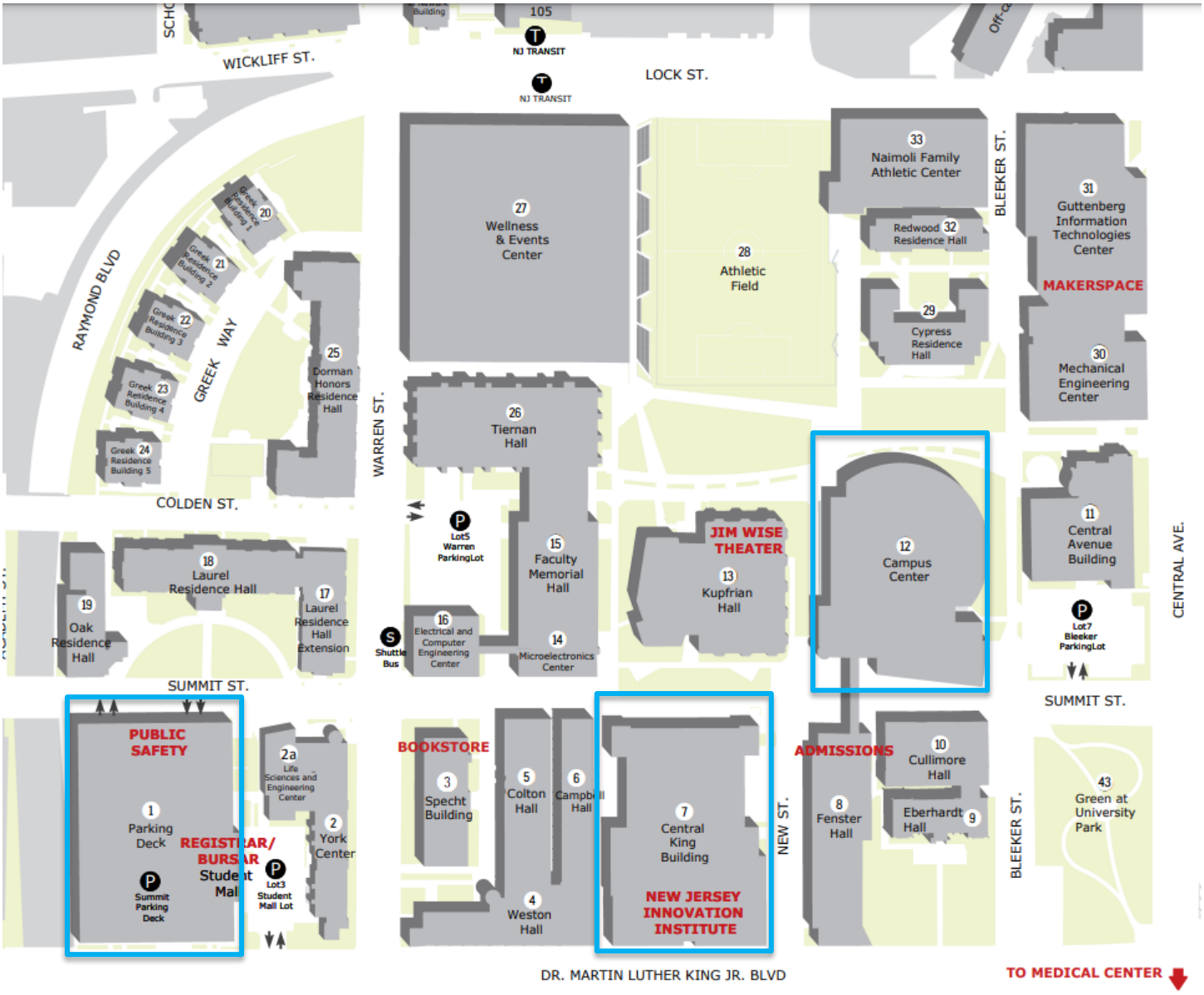
NJIT Map

Please see attached map. Most events will be held in Central King Building (#7 on the map) and the Campus Center (#12 on the map). Parking Deck is represented by #1.



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Conference Sponsors

Conference sponsors and affiliates play an important role in supporting the conference. We are grateful to these organizations who have generously supported our ASEE MAS Spring conference.

NJIT New Jersey Institute of Technology

ASEE

100 years
NEWARK COLLEGE OF ENGINEERING
NEW JERSEY INSTITUTE OF TECHNOLOGY

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Keynote Presenter

Joe Tranquillo
Associate Provost for Transformative Teaching and Learning
Bucknell University

Joe previously served as the Director of the Teaching and Learning Center and co-director of the Institute for Leadership in Technology and Management and co-founded the Bucknell Innovation Group and KEEN Winter Interdisciplinary Design Experience. Off campus, Joe is an ASEE Fellow, AIMBE Fellow, BMES Fellow, National Academy of Engineering Frontiers of Engineering Education Fellow, Senior Member of IEEE, NSF Pathways to Innovation Faculty Fellow, past chair of the ASEE Biomedical Engineering Division, co-editor of the Morgan and Claypool Biomedical Engineering Book Series, Media Director for BigBeacon and serves on several national and international boards. He has been recognized with awards including the National Biomedical Engineering Teaching Award, ASEE Theo Pilkington Outstanding Educator, and has been nominated twice for the CASE US Professor of the Year. Joe has delivered over 100 intensive teaching workshops, including in Peru, Finland, Chile, Argentina, Uruguay, United Kingdom and Columbia. Joe is the author of four books and over 200 articles and conference proceedings. His work, conducted exclusively with undergraduates, has been featured on the Discovery Channel, TEDx, Gates Foundation, Google, LinkedIn, and CNN Health. He has received ~$3M in funding from NASA, NIH, NSF, Kern Family Foundation, VentureWell, Degenstein Foundation, and the US Department of Defense. Joe is an affiliate faculty member of Cornell University, an international faculty member at Universidad Catolica de Chile, and was a visiting scholar at Stanford University and the University of Utah. Outside school, he loves to cook pasta, brew beer, travel and run ultra-marathons. He has performed with the Bucknell Dance Company, ElectroAcoustic Ensemble, the Techtonic Theater Company, Capacitor Dance Company, Chocolate Heads Movement Band and Bloomsburg Theater Ensemble. He is a dad to two wonderful children (Laura and Paul) with his wife (Lisa).

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Distinguished Teaching Award Recipient

Kaitlin Mallouk
Assistant Professor of Experiential Engineering Education
Rowan University

Kaitlin Mallouk is an engineering educator and researcher who is dedicated to creating impactful learning experiences by valuing her students as individuals and designing curriculum that employs evidence-based practices. She has a BS in Chemical Engineering from Cornell University and an MS and PhD in Environmental Engineering from the University of Illinois at Urbana-Champaign. Between her undergraduate and graduate degree programs, Dr. Mallouk worked for two years for Merck & Co., where she supported the scale-up of the purification process for the HPV vaccine, Gardasil™.
Dr. Mallouk has been a faculty member since September 2013 when she joined the Mechanical Engineering department at Rowan University as a tenure-track instructor. She subsequently took a full-time appointment in the Experiential Engineering Education (ExEEd) department and was tenured and promoted to Assistant Professor. In her roles at Rowan, Dr. Mallouk has been responsible for teaching and developing curriculum for Rowan's multi-disciplinary design course sequence, First- and Second-Year Engineering Clinics, and mentoring upper-level students in small, research-focused projects. Her research in the areas of faculty development, entrepreneurial mindset, and diversity equity and inclusion has been funded by NSF and KEEN

Dr. Mallouk has been a member of ASEE since 2013 and found her professional home in the First-Year Programs Division (FPD), joining the Executive Board of FPD in 2016. She currently serves as the Past Chair of the division. She was the FPD Program Chair during the 2020 Virtual Conference and, in 2021, she spearheaded a major revision of the FPD Bylaws. She was also actively engaged in the First-Year Engineering Experience (FYEE) conference steering committee from 2017 – 2019 and served as Co-Chair of the 2018 FYEE Conference held at Rowan University.

Beyond the academy, Dr. Mallouk finds fulfillment in the adventure of parenting, long walks with her dog, and reading fiction.

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Workshops

Workshop I: Friday April 22, 3:00 - 4:15 PM	Location
"Trauma Informed Teaching - Teaching with Compassion" by Melodi Guilbault and Megan O'Neill The session focuses on providing an understanding and some tactics to assist faculty in supporting student learning through a discussion of trauma-informed teaching principles. The session will include small group discussion.	CKB G-08
Workshop II: Saturday April 23, 11:15 AM – 12:30 PM	**Location**
"The NJIT/Newark Math Success Initiative (MSI): A holistic program to prepare and support urban students to succeed in earning STEM degrees in college" by Jacqueline L. Cusack, Kevin D. Belfield, Levelle Burr-Alexander, Bruce Bukiet, Monique Paden-Hutchinson, Kenneth Horwitz, and Angela Moncrieffe The NJIT/Newark Math Success Initiative (MSI) aims to increase the enrollment and success of Newark high school graduates in STEM programs at New Jersey Institute of Technology (NJIT). This holistic effort is a partnership of the Newark Mayor's Office, the Newark Board of Education (NBOE) and NJIT's Center for Pre-College Programs (CPCP) and the College of Science and Liberal Arts (CSLA). The program is composed of a 6-week summer program for rising seniors consisting of strengthening student math content knowledge through enrichment, and college and test preparation skills. This is followed by a math class for college credit at NJIT during senior year with weekly college preparation and support sessions. In this workshop, participants will examine the development and the implementation/assessment of the first three years of MSI: (a) how the program was developed; (b) how the MSI model has been executed and refined; (c) how students experience active learning through a hands-on activity from the program; (d) project outcomes and challenges including student reflections; and (e) opportunity for workshop participants to dialogue on lessons learned.	CKB 204
Workshop III: Saturday April 23, 11:15 AM – 12:30 PM	**Location**
"From Remote to Flipped: Increasing Student Engagement through the Classroom Flip" by Sarah Zappe and Stephanie Cutler With the transition to remote instruction due to the COVID-19 pandemic, new opportunities could be leveraged to implement a flipped classroom as faculty move back to campus. This workshop can help formulate strategies for how to use teaching videos and materials created during the pandemic as part of a flipped classroom. This workshop is intended for engineering instructors who have not yet flipped their courses but might be interested in doing so in the future. Additionally, we welcome instructors who have previously flipped their class to come share their experience and explore additional strategies related to flipped classroom. The workshop will be interactive and will allow time for participants to consider how they might flip their own course. Instructors are encouraged to bring their course syllabus with them to consider how different course elements can be taught in a flipped setting.	CKB 116

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Technical Session 1: Friday April 22, 3:00 - 4:15 PM	Location
1-A Innovative Ideas for Pre-College Curriculum	CKB 116

Schools as Living Laboratories for Architectural Engineering Research Experiences for Teachers

Dr. Kathleen M. Hill, Pennsylvania State University
Prof. Somayeh Asadi, Penn State
Dr. Matthew M Johnson, Pennsylvania State university
Mrs. Tiffany M. Lewis

Through a collaboration between the Department of Architectural Engineering and the Center for Science and the Schools at Pennsylvania State University, the Building Education RET project was launched as a strategic approach to address global challenges in energy, ecological systems, and human health through transformational integration of technical research into precollege curriculum. Schools are critical instruments for advancing knowledge about sustain-ability, and they provide the ideal context for active research and teaching in sustainability-focused topics designed to cultivate a new generation of STEM leaders. Our strategy involves engaging teachers and students with their school facilities as ”Living Laboratories” to provide a place-based context for math and science education. The Building Education RET site at Pennsylvania State University has immersed teachers in both fundamental and applied research on building science topics including indoor air quality, lighting effectiveness, thermal comfort, and energy efficiency and automation. Systems Thinking is an increasingly recognized competency in sustainability and serves as the over-arching learning objective of the Building Education RET program. To date, 12 secondary teachers were prepared to utilize experimentation on air quality, lighting systems, and energy use in their respective school buildings as hands-on and applied STEM-based teaching modules. In the spring of 2020, the Building Education team decided to implement the RET program remotely with teachers conducting research in their homes or in their schools. Teachers from mul-tiple states were able to participate in the program. To engage in research projects, we equipped teachers to collect data through instruments and observations about the quality of lighting, indoor air quality, occupant thermal comfort and health, building automation, building energy consumption, etc. in their teaching environments and other spaces in their school building, or their homes, and they learned different methods to analyze the results. We also engaged teachers in the mapping and evaluation of control systems in either their school facilities or their homes to manageheating, cooling, and fresh air. They learned state-of-the-art data analysis methods to identify opportunities to reduce energy demand. To translate their research into curriculum, science education faculty from CSATS engaged teachers in professional development focused on engineering practices. Weekly sessions supported teachers in identifying disciplinary ideas and engineering practices that were translatable to secondary classrooms. As a culminating product, the teachers developed a classroom research project plan for their students to complete in the academic year. importance. This workshop will present known curricular initiatives for incorporating experiential assignments within the first-year curriculum along with rubrics to grade assignments. These range from a cultural context inventory and communication star to a handedness exercise and identity mapping. Further, the participant will work to transfer these ideas and ideas from other participants to their particular institutional need.

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Motivating Middle Schoolers to Be Engineers

Dr. Howard S. Kimmel, New Jersey Institute of Technology
Dr. Gale Tenen Spak, New Jersey Institute of Technology
Dr. Ronald H Rockland, New Jersey Institute of Technology
Linda Hirsch

The paper will be a summary of the implementation and effectiveness of a one-week in-person workshop designed to introduce middle school students to engineering and what engineers do as part of an educational Summer Camp at Brookdale Community College, located in Lincroft, NJ. Other discussion highlights will include: research supporting the importance of introducing engineering to middle school students; the motivation behind the instructors' decision to conduct the program in a summer camp setting; the significance to the program's success of having had engineers and continuing education professionals design and teach the program; and plans for an expanded program during the summer of 2022, based on lessons learned. Regarding the 2021 Summer Camp program, the engineering design process was the vehicle for demonstrating the work in which engineers engage. Problem-solving was a key connector of the subject of science to engineering. Students were given the opportunity to solve problems just as engineers would while learning how engineers use science in their everyday work. The NASA Mars landing in 2021 was used as a theme to increase students' interest in engineering by engaging student teams in hands-on and fun real-life applications of engineering. This also provided a meaningful context for the middle school students to learn about science concepts, such as gravity, levers, and forces, as well as engineering concepts such as systems, building solid structures, mechanisms, and machines. Students were also introduced to the profession of engineering, the many different fields of engineering, the multi-disciplinary aspects of engineering, and examples of different engineering work places. The introduction of the engineering design process to student teams included the design and construction of spinning tops, gyroscopes, Rattlebacks, and Rube Goldberg devices. Then, the teams of students were involved in engineering activities, using everyday materials, related to the Mars landing. These included the design and construction of:

A parachute that can hold weight and descend slowly;
A lander that can keep items (such as people) inside the lander after impact;
A paper Mars helicopter;
A model of a space habitat;
A working robot arm; and
A Mars rover.

An end-of-program survey found that the program did increase students' interest in engineering and knowledge of
engineering careers by providing them with challenging real-life applications of engineering.

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Training Middle and High School Teachers in Introducing Science and Engineering to Students

Prof. Rajpal S Sodhi, NJIT

Students enrolled in elementary and secondary schools, who want to pursue a career in science and engineering need a realistic introduction to these topics through hands on and meaningful experiments not normally available in schools. Author has developed a workshop on Energy and Machines introducing teachers to these topics through simple mechanical models and computer based animated programs. This was accomplished through the Pre-Engineering Instructional and Outreach Program (PrE-IOP) at NJIT to enlarge the future pool of qualified high-tech workers in New Jersey, including those who have been historically underrepresented (such as minorities and women). We presented a two-week workshop which uses hands on experience to illustrate scientific laws related to mass, motion, work, power and energy. The concepts of machines and energy are presented for the training of grade 6-12 teachers. Principles such as Newton's Laws of Motion are explained through practical examples. The concepts of simple machines and mechanisms to solve practical real-life design problems are presented through geometrical constructions and model building. They learn how simple machines work through physical models. These include inclined plane, lever, wedge, screw, pulley, wheel and axle etc . Examples are given on how combination of simple machines produce complex machines such as a bicycle, pendulum clock and auto transmission.

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An Urban School's Approach to the Senior Capstone Project: Promoting a Culture of Excellence

Dr. Tina Powell, The Orange Public Schools

This paper offers an analysis of the implementation of the Senior Capstone Project within a mid-size urban public school district.The Senior Capstone Project is a multidimensional experience that serves as a culminating project for students, typically during their final year of high school or at the end of an academic program. Capstone projects are generally designed to encourage students to research, solve authentic problems, think critically, collaborate with peers and others (ex: mentors), and develop skills such as written and oral communication, civic and social responsibility, global awareness, etc. These soft skills will eventually prepare students for college, career, and real-world success and equip them with a nuanced set of skills that can prepare them for the unknown. In the mid-size urban public school district, the Senior Capstone Project is a celebration of learning. It is designed to prepare senior students attending the Academy for lifelong learning and productive citizenship through the opportunity to plan, complete, and present a self-directed project reflecting a civic interest. The Academy is a 4-year 'early college' model spanning grades 9-12. The racial/ethnic composition of the school is 59% African American and 40% Hispanic whereby 72% of our students are considered economically disadvantaged. The Academy's Senior Capstone Project underscores Carlton Jordan's position that capstone projects are only as successful as the work that precedes them (2016). The Senior Capstone Project is designed to reflect a culmination of the students' academic experiences in their respective 'track courses.' These courses are a sequence of advanced STEM courses beginning with exploratory courses offered in grade 9, then gradually advancing in scope and depth throughout grades 10 through 12. They mimic college majors by which students "declare" their track in Biomedical Engineering, Mechanical Engineering, or The Computing Sciences at the end of grade 9, then progress within the chosen track through grade 12. The Senior Capstone integrates 3 elements: Community Service, Project Design, and a Research Paper that explores an overall, student-selected research question. One example of a research question developed by our students addresses language barriers in healthcare: What disparities exist in the treatment of non-English speaking patients compared to English speaking patients? How can biomedical innovations be used with regards to programs, devices, or interventions to ensure that all patients receive quality care and clear communication with their providers? This Senior Capstone Project culminated in a written literature review a final research paper, an "app" developed in Apple's Xcode (an integrated development environment (IDE)) supporting the Swift programming language and designed to help non-English speaking patients navigate the medical arena, a poster, and PowerPoint presentation. Our white paper will underscore the importance of this unique Senior Capstone Project as a non-traditional educational requirement. By linking the Engineering Design Process to the Service Learning Model, our aim is to reinforce the transferable skills needed for success in the workplace and in a rapidly-changing and competitive world.

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Technical Session 1: Friday April 22, 3:00 - 4:15 PM	Location
1-B Multidisciplinary Innovative Instructional Ideas	CKB 204

Cognitive Strategies in STEM Education: Supporting the Development of Engineers' Multi- and Cross Disciplinary Competence

Dr. Laramie Potts, New Jersey Institute of Technology
Dr. Huiran Jin, New Jersey Institute of Technology

The Fourth Industrial Revolution (4IR) ushers accelerated pace of innovation with the digital technologies and computing advances that requires urgent upskilling and reskilling the workforce. An educational response to this urgent need compels Higher Education Intuitions (HEIs) to re-evaluate their programs to develop a STEM-literate workforce capable of making informed decisions given the complexities of today's world and to open up opportunities to fill the growing need for STEM professionals. The objectives of combining multiple engineering approaches and technologies are to resolve real world problems, to provide different perspectives on real word complex problems, to create comprehensive research questions, to develop consensus definitions and guidelines, and to promote improved engineering services that address 21st century problems.

Reasoning modalities have been the subject of interest and debate for the past decades in engineering education and for STEM in general. This study attempts to understand the various thinking modalities for multi-disciplinary engineering students. We also question the appropriate thinking strategy for cross-disciplinary engineering technology students given the 4IR-induced evolving workplace. A comprehensive literature review of empirical articles is also provided, which is aligned with the research questions published in scholarly journals over the past two decades and reveals the state of scientific thinking on these topics. Preliminary results informs instructional pedagogies on multidisciplinary engineering and cross-disciplinary engineering technology programs to exploit the capabilities of the 4IR innovations.

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Measuring adaptive expertise amongst first-year STEM students

Dr. Alexander John De Rosa, Stevens Institute of Technology (School of Engineering and Science)
Dr. Frank T Fisher, Stevens Institute of Technology (School of Engineering and Science)
Dr. Ashley Lytle

Engineering programs must weave coverage of disciplinary content with the ability of students to apply and extend this content knowledge to new contexts and for use in their professional practice as engineers. It is, therefore, necessary for schools to promote and cultivate additional dispositions within their students that better enable them to adapt and employ their disciplinary knowledge. The concept of an ”adaptive expert” (AE) has been previously developed within the learning sciences to describe an individual with deep content knowledge but who also displays additional cognitive characteristics that better enable them to employ their knowledge and skills in practice. Four constructs have been identified in the literature as forming the basis of this adaptive expertise: 1) multiple perspectives, 2) metacognition, 3) goals and beliefs, and 4) epistemology. Upon entry to an engineering program, it is likely that students will present with different levels of development and awareness within these particular dimensions. Baseline levels must, therefore, be measured in order to assess these levels of development and before research-based practices and activities can be designed to promote growth in these constructs, and the gains measured. In this work-in-progress study, the ”adaptiveness” of incoming undergraduate students (n=711) is measured using a previously developed, validated survey instrument used in other studies to measure levels of adaptive expertise amongst undergraduate students by determining their levels along the four identified dimensions of AE.

Based on this survey data, statistically significant differences were found in the AE constructs for men and women, with women outscoring men in three of the four AE subscales (MP, META, EPIST) and men outscoring women in goals and beliefs (GB). White students were found to score statistically higher than Asian students in both multiple perspectives (MP) and goals and beliefs (GB), while no statistically significant differences were observed when White and Black students were compared. The mean epistemology (EPIST) scores for White, non-Hispanic students was statistically higher than Hispanic students, and non-low-income students also scored higher than low-income students on this subscale. Further conclusions about the meaning of these results are currently difficult to determine as no prior baseline for measured data exists. [Blinded for review (information about larger project that this data will be used in) longitudinal measurement of AE after AE interventions are used to support student growth in AE]

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Python for chemical engineers: an efficient approach to teach non-programmers to program**

Prof. Gennady Gor, New Jersey Institute of Technology

Modern engineering calculations are hard to imagine without a flexible and efficient programming language. Python is such a language. Python is open source, free, easy to learn, and simple to use. These factors make Python one of the most popular programming languages in the world, highly demanded by employers. However, most undergraduate programming courses for engineers focus on languages other than Python.

In this presentation I will share the outcome of the successful experiment on developing and teaching a new course ”Python for Chemical Engineering calculations”, which was offered in spring 2021 as a 3-credit undergraduate elective. The goal of this course is to introduce undergraduate chemical engineering students to Python and demonstrate how it can be used for solving a spectrum of chemical engineering problems. The example problems were taken from the undergraduate chemical engineering curriculum, e.g., from such courses as Chemical Engineering Thermodynamics, Fluid Flow, Kinetics and Reactor Design, etc. Lectures and practical sessions were complemented by six guest lectures delivered by engineers working in industry who illustrated the use of Python in their jobs.

Not only the course content differed from a conventional programming course, but the course delivery method was also unconventional. The course was offered in spring 2021, when all the classes were taught in the synchronous online mode, so was this course. I used the ”flipped classroom” approach, so that the students watched the short tutorial videos before each class. Classes typically started from short quizzes based on the videos, after which the class time was utilized for hands-on activities. An online setting with the ”break-out rooms” provided a perfect environment to give feedback to students on their code. In addition to quizzes on syntax and in-class coding activities, the assessment included a midterm and a final exam. Each of the exams had two parts: a ”take-home” coding assignment, and an oral defense of the resulting code.

As seen from the official course evaluations, the course was very well received by the students. They spoke highly of the strong connection between programming and chemical engineering curriculum, which was impossible to see from taking a generic programming course. Guest lectures was another aspect enjoyed by many. Finally, the flipped classroom which provided a lot of time for in-class activities appealed to the students a lot. Based on this success, I will utilize the course materials and the overall approach to revamp the core undergraduate course ”Chemical Engineering Computing”.

** Best Paper Nominee

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Constructively Aligned Instructional Design for Oral Presentations

Dr. James Lipuma, NJIT
Cristo Leon, NJIT

The work described here was implemented at an R1 polytechnic University in New Jersey by the authors in oral resentation and senior seminar courses offered by the Humanities and Social Science department for engineers. To provide a coherent instructional design that can function in Face-to-face and online courses equally effectively, the ’General, Particular Specific’ (GPS) model was piloted and is now fully integrated. This scaffolding for students enhances their critical thinking about content and alignment with the audience when examining content to be delivered orally to diverse groups. The students are taught to effectively communicate technical information as responsible experts.

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Technical Session 2: Saturday April 23, 9:45 - 11:15 AM	Location
2-A Teaching Entrepreneurship, Ethics, Design Innovation and Research in a Classroom	CKB 116

Teaching Entrepreneurship with Societal Impact to Engineering Students

Prof. Cesar Bandera, NJIT MTSM
Dr. Regina S. Collins, New Jersey Institute of Technology

As entrepreneurship educators, we often recommend that students ”stay in their wheelhouse” and exploit their tacit knowledge during opportunity discovery and business model validation. We also hope that some of these nascent entrepreneurs will someday make an impact on the major crises affecting society including healthcare disparity and clean energy. Students are aware of these crises and that daunting challenges require even more resources outside their grasp, but few have the tacit knowledge on how to address them through entrepreneurship. How then can we prepare students to be entrepreneurs that make societal impact, or even convince them that this can be a viable future endeavor?

We present a one-semester entrepreneurship course that, building on three pillars, teaches undergraduate students how to pursue societally significant opportunities. The first pillar is the distinction between tacit and codified knowledge as drivers of entrepreneurship. The second pillar is metacognition to broaden students’ notion of ”wheelhouse.” The third pillar is the protocol of the federal Small Business Innovation Research program (”America’s Seed Fund”). While the traditional context of these pillars is technology innovation, the course emphasizes the multidisciplinary collaboration required by societally significant solutions, and is attended by students from diverse disciplines. The course also exercises skills required to achieve such solutions, including forming strategic partnerships, navigating funding protocols, and grantsmanship. These skills are of value not only to future entrepreneurship, but also to societally significant careers in the corporate, academic, and public service settings.

Teaching of Professional Ethics in Engineering Design

Prof. Rajpal S Sodhi, NJIT

Engineering has a direct impact on humanity and knowing the ethical aspects becomes essential. The study of ethics makes engineers more empathic and human, and also more aware of their responsibility as engineers. Despite progress in the industrial ethics program, there still remains a lot to be done in teaching ethics to students. This paper presents the integration of ethical, social and economic considerations in developing design solutions to meet human needs. The materials on Ethics are integrated at each stage of the design development process. Students are introduced to codes of ethics which companies have developed to assist engineers in answering questions which may arise in their profession. Case studies, specifically relevant in engineering design and product development situations are presented. Guidelines are used to separate known facts and assumptions while reaching solutions in Ethics cases. The responsibility of engineers towards their employers and issues of their personal conscience are explained through examples.

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Teaching Design Innovation in Product Engineering Classes

Prof. Sanchoy Das, New Jersey Institute of Technology

Innovation is a broadly defined term and anything from an incremental improvement to a revolutionary new design can
be classified as innovative. In product engineering classes we commonly will have one or more team projects where the team designs a new product, and the expectation is that the design will be innovative. The instructor faces two challenges (i) Providing specific product-focused guidance to the team so that they can make timely progress, and (ii) Catalyzing the innovation thought process in the team process. A common trap is that the application is novel (e.g., a breakthrough bio-medical device) but the design itself is not. This presentation highlights methods that have been successfully used to promote design innovation in course team projects. Three methods that can easily be integrated into the classroom are illustrated: (i) Structured definitions of innovation with validated examples, (ii) Guided ideation and innovation using design analysis tools, and (iii) Innovative redesign of existing products that are readily available in the market.

Research for Undergraduates experiences from various academic institutions

Dr. Rajarajan Subramanian, Pennsylvania State University, Harrisburg, The Capital College

The opportunities for doing research by undergraduate students help them to pursue further career interests in Science, Technology, Engineering, and Mathematics (STEM) field. Involving undergraduate students in research will make them take more interest in studies and motivate them to pursue graduate degrees. The undergraduate students at the XYZ institution can get involved in research usually conducted in the summer period for an 8-week or 10-week duration. The name of the program is ”Multi-campus Research Experience for Undergraduates” (MC-REU) and it is administered by the College of Engineering at the XYZ institution.

There are 21 campuses functioning under the system of XYZ University in Pennsylvania. To enhance the research opportunities for the undergraduate students in most of the campuses, the program MC-REU was started. The MC-REU program supports University undergraduate students to conduct research with the University faculty. Selected students will complete their proposed research project in conjunction with two University faculty members — one from the student’s home campus and one based at University Park (Main Campus). The goals of the MC-REU are (1) to promote undergraduate students participating in research early in their academic program to broaden their education and increase their chances of entering graduate studies, and (2) to promote mutual awareness and collaboration among faculty across the Commonwealth.

In the same way, a few more educational institutions are also heavily involved with Undergraduate Research, particularly during summer semesters. Those undergraduate students that are involved with undergraduate research were paid scholarships to cover boarding and lodging.

This paper will explain some of the REU experiences from different educational institutions and draw conclusions based on the students’ feedback. Students will not take any courses towards their academic accomplishments during the summer in which they are engaged in research. They will work 40 hours per week for the 10-week or 8-week period. During the 8-week or 10-week time period, they are also compensated with financial help.

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Technical Session 2: Saturday April 23, 9:45 - 11:15 AM	Location
2-B Innovative Curriculum: Graphic Design, Spatial Visualization and FEA	CKB 204

Engineering and Graphic Design Interdisciplinary Collaborative Product Development: A Wheelchair-Mounted Rotating-Head-Support for a Disabled Child**

Dylan Louis Vongrej
Juan F Galindo-Maza, Raritan Valley Community College
Mr. Luke P Ingenito, Rutgers, The State University of New Jersey
Mr. Darwin Arias Lizano, Rutgers School of Engineering
Jenna Nugent
Ms. Kate Rybak
Prof. Darren McManus, Raritan Valley Community College / Arts & Design Department
Dr. Peter Raymond Stupak, Main Engine Start a NJ Non-Profit Corporation

A collaborative interdisciplinary teaching methodology has been developed and successfully implemented where students from the Engineering and Graphic Design programs work together to create interrelated projects under authentic industry conditions. This educational experience is replicable and moves beyond traditional pedagogy by establishing a real-time, real-world learning environment for students across disciplines.

In the present project the Engineering students were tasked with designing and implementing a rotating-head-support
for a 12-year-old New Jersey boy who is wheelchair bound with multiple disabilities. Each Graphic Design student was tasked with developing a unique visual identity, product name, and branding campaign based on the perceived purpose and demographic of the rotating-head-support.The project required the work of several Engineering teams over a period of two years. The project started with input from the child's parents, Teacher, Physical Therapist, and Occupational Therapist. The key challenge was to enable the child to rotate his head, even a few millimeters, to activate electrical switches placed near his temples, thereby allowing him to interface with special educational software and communicate with his teacher. Since commercial wheelchair head-supports are stationary, the solution developed by the Engineering teams was a novel rotating-head support. The design was based on two intersecting circles of rotational motion. The center of one of the circles being the mechanical bearings and support components attached to the wheelchair, and the center of the second circle being the vertebrae of the child's neck. With this unique design, only the slightest effort on the child's part was required to rotate his head.

Furthermore, was the development of cushioning for the head-support so that the child's head was both comfortable and well supported. A hand-held 3D scanner was used to accurately capture the shape of the child's head and be the basis of a 3D printed shell to support the child's head. A custom gel-cushion "honeycomb" structure was implemented in the shell. The compliance of the cushion was tailored by varying the gel-cushion structural element dimensions. The enclosing fabric was chosen to be comfortable in both humid and dry conditions and be easily removed and cleaned. The Graphic Design students met with the Engineering students periodically during the project to discuss ways to make the rotating-head-support more visually appealing to the child, using for example, color schemes, illustrated fabrics, and accessories such as flags with age-specific themes and images. During the final

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presentation of the visual identities and branding campaigns, the Engineering students participated as judges for the Graphic Design students.

This collaborative, interdisciplinary approach to project-based learning ensured that the creative process was experiential - principles and skills were employed first-hand with a primary emphasis on learning by doing, including trial and error. Students learned an array of vital skills while adding a unique cross-disciplinary collaborative experience to their education, making them better equipped for future classroom success and professional opportunities.

** Best Paper Nominee

Enhancing Understanding of Mechanics Courses using FEA Active Learning Modules

Dr. AHM E. Rahman, Pennsylvania State University, Harrisburg, The Capital College
Anil Chandra Attaluri, Pennsylvania State University, Harrisburg, The Capital College
Dr. Amit Banerjee
Dr. Brian A. Maicke, Pennsylvania State University, Harrisburg, The Capital College

Finite Element Analysis has become an important simulation tool in academia and industries. To take full advantage of this incredible engineering tool, FEA has been integrated in lower-level mechanics courses such as statics, mechanics of materials, machine design etc. It should be noted that most mechanical engineering undergraduate programs offer FEA as an upper-level technical elective or required course. Although the integration of FEA in mechanics and/or design courses is an existing concept, the practice is limited to the use of FEA software package such as how to create a CAD model, how to set up a problem, and obtain a simulation. Simulation of stress analysis of 2D truss bridge, 2D beam frame using a simulation software can be mentioned as examples. On the other hand, the class-room instructions of mechanics courses are primarily limited to solving problems from different textbooks. The authors propose that the FEA simulation software can be used effectively to enhance the understanding some of the concepts of lower-level mechanics courses. This paper discusses the introduction of FEA active learning modules on combined loading, beam deflection, and critical buckling in mechanics of materials course, a sophomore-level course, and shaft deflection in Machine Design course, a junior-level course. The learning outcomes were discussed in class for each module. The learning outcomes were assessed using following two different ways: 1) conceptual understanding of the content be- fore and after introducing the FEA module was assessed by the assignment grades, and 2) student response on survey questionnaire obtained towards the end of semester. The focus of the assessment and student survey were to determine how effective the integration of FEA package was to understand the concept of any topic in Mechanics of Materials and Machine Design courses.

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Use of Generative Design and Shape Optimization Tools for Advanced Engineering Design

Dr. Nadir Yilmaz P.E., Howard University
Dr. Hyung D. Bae , Howard University

The fast-paced development of high power computing hardware and user-friendly interfaces, along with increasing capabilities of commercial software, are leading to the earlier exposure of students to advanced levels of engineering graphics, design, and analysis tools in undergraduate curricula. Specifically, easy-use of computer aided design packages allow students to practice with engineering analysis aspects beyond solid modeling or engineering graphics. This paper will give details about shape optimization and Generative Design, which are revolutionary techniques for optimization of engineering parts for complex design scenarios and advanced engineering analysis. Surveying of students have indicated overwhelmingly positive feedback for the course and group projects, which appears to have increased their hands-on knowledge and skills with respect to advanced design and engineering analysis software.

The relationship between persistence, effort, and achievement in a spatial skills training program

Dr. Maxine Fontaine, Stevens Institute of Technology (School of Engineering and Science)

The importance of strong spatial visualization skills (SVS) in engineering is well established. Since SVS are rarely specifically taught in the K-12 curriculum, many first-year engineering programs have implemented a spatial skills training program aimed at identifying first-year engineering students with low SVS and giving them the opportunity to gain these critical skills through focused practice. A variety of different implementations of these spatial skills training programs have proven effective in improving spatial ability, ranging from a total training time of 8 hours to over 20 hours.

This objective of this study was to determine whether different amounts of training should be prescribed for students based on initial spatial ability, as measured by the Purdue Spatial Visualization Test of Rotations (PSVT:R). Another objective was to determine the minimum level of persistence required during the training to effectively im- prove spatial visualization skills (SVS). Training amount is measured by the number of problems completed in the

Spatial Vis software by eGrove Education, and persistence level is measured by the average stars per problem. Participants are divided into three groups based on initial test score: novices (test score below 60%), intermediates (test score between 60% and 69%) and masters (test score 70% and above). A correlational analysis between training persistence and gains in spatial ability was performed for each group. A weak positive correlation was found for the novice group only. A correlational analysis between training amount and gains in spatial ability was also performed for each group. Strangely, a weak negative correlation was found for the novice group. These results indicate a need to more closely examine the effects of persistence and training amount in smaller, more similar subgroups or more carefully consider how to quantify improvement in spatial ability.

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Technical Session 2: Saturday April 23, 9:45 - 11:15 AM	Location
2-C Innovative Curriculum: AI, Machine Learning and Games	CKB 217

Preservice Teachers' Mechanistic Reasoning about Machine Learning and Artificial Intelligence[++]

Dr. Amy Voss Farris, Pennsylvania State University
Ms. Anna Eunji Kim, Pennsylvania State University

Modern humans are frequently embedded in contexts in which machines learn from their everyday actions. Examples include encountering predictive text when texting a friend and facial recognition in personal digital photographs. However, explanations that account for the underlying causal mechanisms of machine learning systems require learners to consider parts of the system and the relationships among the parts of that system. While mechanistic reasoning [3] is a foundational body of abilities germane to engineering, children and many adults rarely conceptualize their interactions with machines in ways that are consistent with the complex and dynamic nature of machine learning systems.

We investigated how undergraduate teacher candidates (TCs) explained an example of machine learning, Google Quick, Draw! [13] after playing the game and participating in a series of machine learning investigations. We found that even among an elite group of non-science major undergraduate students, initial explanations of how the computer recognized images rarely focused on how events that lead to a correct guess are linked to one another. In contrast, given opportunities to read and think together about the mechanisms of machine learning, TCs' descriptions of how Quick, Draw! works became more sophisticated in terms of the sense of mechanism and the chaining [3] of events that lead to a correct guess. For example, in students' final explanations at the end of our activities, 12 of 22 (54.5%) described the importance of the beginning "stroke" in their doodles or described patterns of key features of doodles as important to how image recognition is accomplished.

Secondly, we explored how building basic understanding of machine learning can support engineering across disciplinary boundaries in K12 contexts. We asked the same preservice teachers to think about how machine learning could be relevant to the content and practices in their area of disciplinary specialization and to create an initial lesson design that could be used with middle school students (U.S. Grades 4 – 8). The participating preservice teachers' disciplinary specializations were Social Studies (n = 3), English Language Arts (n = 8), and Mathematics (n = 12). We found that all students portrayed that learning goals about artificial intelligence (in general) and machine learning (in particular) were relevant to their focal disciplinary areas and their understanding of literate participation in society. Additionally, some TCs focused on students' understandings of the social and ethical dimensions of artificial intelligence technologies. This included perceptions of the ethical dimensions of AI and the diverse cultural contexts in which machine learning operates. We report the connections they saw and discuss the relevance of machine learning
as an example of reasoning about complex engineered systems for young students and for teachers.

[++] Best Paper Winner

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Evaluation of an AI-assisted Adaptive Educational Game System

Dr. Ying Tang, Rowan University
Mr. Ryan Hare, Rowan University

As education continues to expand, both in outreach and in content, so too does the need for automated systems that can augment a student's educational process. This work builds on prior developments of a gamified adaptive tutoring system that automates and personalizes a student's learning process without instructor intervention. Our personalized learning system uses an augmented petri net graph structure to track student progress through the game, allowing us to enable or disable paths based on a student's performance. As an intelligent component, our system uses reinforcement learning agents to adaptively adjust system behavior based on student performance with the goal of optimizing student learning. The end result is a fully integrated game system that can measure student performance using integrated tests, leveraging that information to adjust game content, address learner misconceptions, and lead to a faster and more effective learning session. As part of continued research, we present data from pilot and comparison testing of our implemented game system.

With our comparison testing, we show that the game provides greater educational utility for students compared to a standard lab. To verify improved educational utility, we present results from content tests given pre- and post intervention. We further verify the game system's educational utility through an example case of the game adaptation, showing the full process of adapting to a student and providing educational assistance. By sharing our testing and verification, we demonstrate the effectiveness of our intelligent educational game system. In addition, we provide developmental insights for other researchers in this area who seek to implement or improve their own systems.

Mixed Reality Game for Active Geotechnical Engineering Learning

Dr. Ying Tang, Rowan University
Prof. Cheng Zhu, Rowan University
Mr. Ryan Hare, Rowan University
Tyler Ziesse
Conor Peterson
Mr. Chenchen Huang

Our fully-integrated mixed reality game system, called multiphysics enriched mixed reality for integrated geotechnical education (MERGE), focuses on improving student education in the context of geotechnical engineering. This work allows students to participate in online learning in a more inclusive way while playing a game. The game is meant as an ”integrated geotechnical learning experience”. By providing students visualization, collaboration, and simulation tools, we hope to promote problem-solving and improved learning. A big part of that is leveraging mixed reality technology to improve student access to lab equipment. By gamifying the learning, we also focus on improving student interest in geotechnical engineering. Due to the virtual nature of the game, everyone will have access to the same lab equipment and the same opportunity to experience the material. They are also able to progress through the game at their own pace, which helps keep the interest of the students while they are learning. Learning by playing games is not a new concept, but the potential has not been reached yet. Our goal is to provide a fulfilling learning experience while keeping the students engaged in a fun game.
The MERGE platform is inspired by popular mixed reality games, allowing students to see computer-generated models superimposed into the world through the camera on their mobile device. Building on

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recent advancements in cyberinfrastructure, MERGE is meant to provide an attractive and motivating environment to support students' geotechnical engineering skills. Throughout gameplay, students' strategic thinking will be tested through carefully designed games that relate to geotechnical problems. Additionally, the game uses their GPS to create a map of the real world around them, giving players the ability to explore their local environment to advance their game progress. Initial gameplay mainly focuses on a lab assignment involved with the study, construction, and implementation of geothermal piles, which are special foundations that utilize the earth's temperature to heat and cool the associated building. The main contribution of this work is a discussion of the educational technology and processes behind implementing a mixed reality educational game. We provide developmental insights and educational background as well as results from preliminary game testing to inform researchers who seek to develop similar games.

Absorption and distribution of Arsenic by plants & role of soil conditions

Dr. Sunil Dehipawala, City University of New York, Queensborough Community College
Dr. Harsha Rajapakse, Medgar Evers College, CUNY
Breeya Evans
Prof. Tak Cheung

Arsenic poisoning is a major health hazard affecting millions of people worldwide. Major contribution to arsenic contamination of soil is due to repeated use of fertilizers and pesticides. This results in higher amounts of arsenic in plants. We explored arsenic absorption by several different types of plants under different soil conditions such as presence of Fe2+ and Fe3+ ions in the soil. X-ray florescence spectroscopy (XFS) utilized to determine distribution of arsenic within a plant in different areas such as leaves, stem, and trunk. Chemical nature and association and possible association with iron ions were studied X-ray Absorption Near Edge Structure (XANES). Arsenic K edges employed to study microstructure such as bonding properties of iron and arsenic within plants. Results indicate that presence of more Fe3+ in the soil facilitate arsenic absorption by plants.

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Technical Session 3: Saturday April 23, 2:45 - 4:00 PM	Location
3-A Innovation in an Online/Remote Classroom	CKB 116

Remote Professional Development Opportunities for K-12 Teachers during a Pandemic

Dr. Howard S. Kimmel, New Jersey Institute of Technology
Dr. John D. Carpinelli, New Jersey Institute of Technology
Dr. Ronald H Rockland, New Jersey Institute of Technology
Dr. Mark R O'Shea, California State University Monterey Bay

This paper will explore pathways for providing professional development for K-12 teachers during the time of a pandemic which requires the utilization of a mode of remote education. While K-12 and post-secondary education have shifted from the face-to-face learning to a virtual or distance learning setting for student learning, teacher training and professional development for K-12 teachers have also been affected. The pandemic caused learning loss not only for the students, but also for the teachers. With schools closed and most everyone in "lockdown", professional development opportunities for teachers became almost non-existent. While their undergraduate degrees and teacher certification provides teachers with the foundation of knowledge and skills necessary to begin classroom instruction, it should also be recognized that continuous professional development for teachers is necessary to ensure that their content knowledge and instructional practices keeps up with the changing base of knowledge and practices required in order to maintain effective classroom instructional practices regardless of the mode of instruction. In addition, teachers need to be prepared to provide effective, engaging learning by using available technology in meaningful ways. Our experience with providing web-based professional development programs for teachers can serve as a model for distance learning programs for teachers, where they can enhance their content knowledge and instructional practices, and also network with others. Two professional development programs are described that can be described as forerunners for present and future mixed modes programs.

The first program was implemented in the mid-1980s, when electronic conferencing was being utilized mostly for communications among academic researchers. A computer conferencing network was created to overcome the seriously limited dissemination of educational materials for K-12 educators, which allowed for communication between individuals, group discussions with a permanent transcript of the proceedings, a repository of educational materials,and an area for group preparation of educational materials. The initial program involved a series of in-person workshops and an electronic network of participants for planning and communications among the participants. In 1990, this became an international network involving teachers and students in other states, and other countries in Europe and Asia, which included joint projects that shared environmental data. The other distance learning program, entitled Virtual Medibotics, was designed to expand the reach of a face-to-face program for NJ teachers, to teachers outside our immediate geographical area by creating a web-based version of the original professional development program, Medibotics. The program, reaching teachers in the mid-Atlantic and Northeastern states, included the creation and implementation of a web-based program that teachers accessed remotely and, as a result of the training, were able to implement, in their classroom. Medibotics involved the application of robotics and information technology to solve biomedical problems.

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Lessons learned from these two professional development programs can serve as a framework for the implementation of programs for teachers utilizing different modes of remote learning as well as face-2-face programs.

Excel optimization pedagogy using Van Hiele learning model of spatial abilities with Force Concept Inventory Test MRI and haptic learner data for COVID-19 online challenge

Dr. Sunil Dehipawala, City University of New York, Queensborough Community College
Dr. Dimitrios S. Kokkinos, City University of New York, Queensborough Community College
Dr. Rex Taibu
Mr. George Tremberger Jr
Prof. Tak Cheung

The van Hiele learning model of spatial abilities has been shown to effectively assess the preparedness of students learning geometry. Moreover, Force Concept Inventory (FCI) Test MRI data compiled on the neural networks of engineering students showed activation beyond the neural networks associated with regular math operations. The recently reported qualitative study of students' verbal responses to problems on the FCI in the framework of the van Hiele learning model and Redish cognitive resources model has been expanded by our group to include a quantitative study of students' math responses. The use of Excel Solver optimization pedagogy in introductory physics courses for engineering and algebra-proficient students during the COVID lockdown and reopening challenge was performed by our group. The selection of the optimization applications was designed to be consistent with the activation of the neural networks reported in MRI studies on engineering students, physics professors and haptic learners. The effectiveness of the optimization approach would confirm the assertion put forth in an ASEE previous presentation that engineering physics is a universal donor degree. It would also provide a means by which to implement the recommendation presented in another previous ASEE paper in which the engineering students' conclusion was " the learning of physics being irrelevant in their third semester after completing introductory physics". The contrast between the van Hiele learning model and Bloom's taxonomy model on educational learning objectives in the learning of physics is discussed. The use of the spatial-numeric tool provided by Excel in terms of the plagiarism prevention and equity issues is discussed.

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Optimization of Student Learning Outcomes Using an Hours of Instructional Activity Tool

Mrs. Tracey Carbonetto, Pennsylvania State University, Allentown

The transition from in-person to online classes prompted universities to provide guidance and compliance policies in planning for required hours of instructional activity (HIA). The U.S. Department of Education defines one credit hour as one hour of direct faculty instruction, equivalent teaching instruction (EIA), and a minimum of two hours of out-of-class student work, equivalent learning activity (ELA). For a typical three-credit course, the sum of EIA and ELA hours must amount to 135 HIA in order to meet most university policies. Instructors are mandated to the EIA per university requirements and guide, suggest, and assign the work associated with ELA. It is the latter that can be complex in determining whether the perceived ELA satisfies a stated requirement.

In order to support faculty in navigating these guidelines, time equivalencies of activities and assignments have been disseminated by a number of organizations. From this information, compliance tools such as the HIA Estimator provided by [name omitted for blind review] can be utilized by instructors when planning a course. While prior research on HIA tools has focused largely on compliance and accountability, this study aims to explore other ways in which an HIA estimator tool can be used to support student learning.

The study first seeks to determine the accuracy of the time estimates used in the tool, as many of these were determined prior to the shift to remote learning under COVID-19. Students will determine and input their actual time equivalencies for a particular assessment. Instructors will offer their perspective as well either based on a published time equivalency or their own estimation. The median and standard deviation among students will serve as insight into the distribution of competency among the students and the difference between the students' averages and the instructor's estimation on time will demonstrate the effectiveness of the tool. The researcher aims at demonstrating student participation in the planning of a course will optimize the metacognitive, cognitive, and affective learning. Students will provide insight through data collected as to what an ideal course would look like including an optimal balance of assignments and assessments applicable to each type of modality. The HIA Estimator can be considered a student-driven pedagogical tool that may increase student learning in an innovative manner.

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Through the Looking Glass: STEM Students' Changing Relationships with Time Across the COVID-19 Pandemic

Bradley J. Sottile, Pennsylvania State University
Laura E Cruz, Penn State
Prof. Kris McLain, Pennsylvania State University

Recent research has emphasized that the collective experiences of the pandemic have influenced not only how students spend their time but have also impacted students' fundamental relationship with time itself. The present study is based on a large-scale survey, distributed to students (n=396) enrolled in two introductory engineering courses at a large, public research-intensive university, The Pennsylvania State University, in the northeastern United States during the Fall 2021 semester. Students were asked to respond to a series of open-ended questions asking them to articulate changes in how they spent their time compared to before, during, and (approaching) the end of the global COVID-19 pandemic. A team of coders then reviewed the students' responses and coded them for review.

The present study results suggest that many students have experienced fundamental shifts in their use, perception, and orientation towards social, academic, and personal time. Furthermore, the results from this study also suggest that these effects were neither universally experienced nor evenly distributed by all students. Our findings provide support for the notion that student time management is best framed as an optimization problem that students and faculty inherently view differently. By reconceptualizing the student time management question in this new light, new avenues for improving engineering education practice open, particularly with respect to the development of more inclusive and equitable teaching practices.

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Technical Session 3: Saturday April 23, 2:45 - 4:00 PM	Location
3-B Innovative Curriculum: Electrical and Computer Engineering	CKB 204

Designing Electrical and Computer Engineering Capstone Projects to meet ABET Outcomes

Dr. Pritpal ”Pali” Singh, Villanova University

Senior design projects are now expected to meet multiple dimensions of student outcomes. For example, ABET criterion 3, student outcome (2) requires students to have ”an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.” Furthermore, ABET criterion 5 d requires ”a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.” Designing appropriate senior capstone projects in electrical and computer engineering (ECE) that satisfy these ABET requirements can sometimes be a challenge. To ensure that faculty and student-proposed senior capstone projects meet these criteria, the ECE faculty at XXX University recently developed a screening tool to ensure that projects meet these criteria. This paper will present this screening tool and show a wide range of ECE project examples to illustrate how student project descriptions may be developed and refined to meet the required ABET outcomes.

Recommendation Engine using Adamic Adar Measure

Mr. Sourabh Dadapure, Sacred Heart University

In recent years, recommendation engines have gained a lot of success on many online giant commerce and entertainment platforms. Recommending similar products that users will like using the user’s past behavior is a challenging problem especially because of the unpredictable nature of people’s likes and dislikes. It also involves a guess about the future based on something that the user has never seen which makes it that much harder to predict mainly because people’s tastes change all the time. What we can do is try to estimate those values as best as we can using the Adamic Adar measure by creating nodes and finding similarities between those nodes. Unlike most of the existing recommendation systems that use either collaborative filtering or content-based filtering to generate recommendations, this paper explores a slightly different approach by creating node pairs consisting of common neighbors but with a lower degree and calculating the Adamic Adar Coefficient of those two nodes. Adamic Adar Coefficient is a measure that is used to calculate the closeness of two nodes based on their common neighbor. This paper describes a recommendation engine built that can be used to predict similar items when a user is browsing an eCommerce, music or movie platform based on the user’s behavior. It takes in the item’s features such as description, price, title, ratings, etc., and creates nodes for each word to find commonalities between those nodes. It then generates nodes with the highest Adamic Adar Coefficient which will result in the items that are close in characteristics to the currently viewed item by the user.

Adamic Adar Coefficient:
If I and J are two nodes, the Adamic Adar Coefficient of I and J would be calculated as
Whereas N(node) is a function that returns the set of neighboring nodes

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VLSI Design, Verification and Fabrication of an Arithmetic Logic Unit (ALU) Using the Cadence Virtuoso: A Case Study

Dr. Nian Zhang
Dr. Wagdy H Mahmoud P.E., University of the District of Columbia
Mr. Tewodros Mekbib Mamo, University of the District of Columbia

VLSI Design, Verification and Fabrication of an Arithmetic Logic Unit (ALU) Using the Cadence Virtuoso: A Case Study Abstract Although the Cadence Virtuoso has been widely used in many universities, there is lack of a shareable publication, document, or tutoring video on the very large-scale integration (VLSI) design, verification and fabrication. Few online tutorials or tutoring video are quite outdated. They either cannot be used for step-by-step guideline, or they only cover part of the entire design flow, which doesn't meet designer's need. The lack of up to date publication or document has caused a huge barrier for universities to teach a VLSI lab. Due to a severe discrepancy in procedure and parameter setting, instructors have to report technical cases to the Cadence technical support center, and then spend significant time troubleshooting problems with the remote assistance from the Cadence engineers. This has greatly affected the progress of lab teaching and student learning. In addition, there is very few sources of educational tutorials of adding pad frame, which is a complex but extremely important component before fabrication. Therefore, there is an urgent need to create and disseminate a shareable publication or document on VLSI design, verification and fabrication with the latest version of Cadence Virtuoso. This paper promotes the needs of a comprehensive study on the newest version of Cadence Virtuoso, a state-of-the-art CAD tool for VLSI design. An 8-bit arithmetic logic unit (ALU) is used as a proof-of-concept example to go through the major VLSI design flow, including schematic capture, pre-layout simulation, physical layout, extract, design rule check (DRC), and layout vs. schematic (LVS). In addition, since this specific ALU is designed to perform three logical operations (i.e. AND, OR, and XOR) and two arithmetic operations (i.e. addition and subtraction), their respective schematic, symbol, testbench, pre-layout simulation, physical layout, post-layout simulation results are demonstrated with detailed snapshots. Moreover, the design layout is wired to a 40-pin MOSIS Tiny Chip pad frame. The ALU circuit is then simulated along with the pad frame and the simulation results are analyzed. Universities and designers around the world will find it an invaluable document, which ensures an efficient and fast VLSI design, verification and fabrication using the latest Cadence Virtuoso software.

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A Feasibility Study on Building a Stand-Alone Community Microgrid in the United States

Ms. Salma Alami Yadri
Ruby W. Burgess, Wheaton College, IL

In recent years, the U.S. and countries across the globe have seen a major rise in the development of microgrids. Microgrids represent a great opportunity for integrating renewable energies and thus, vital tools in the fight against climate change. The increased occurrence of natural disasters has made delivering constant and reliable power to critical facilities a major problem especially in remote areas, which is where microgrids excel. This study analyses the costs-benefits of building a self-sufficient community microgrid infrastructure that uses 100% Distributed Renewable Energy (DER) resources. The proposed systems also incorporate energy storage solutions to serve a 1000 households with the total capacity of 8 MW. The study employs NREL's System Advisor Model (SAM) to model performance and financial metrics by using a time-based modeling approach, based on installation and operation cost of the project and the system design parameters. Insights obtained from the model are used to guide planning strategies which in turn, could be used to sell homes at attractive prices and encourage the switch from conventional energy to clean renewable energy.

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Technical Session 3: Saturday April 23, 2:45 - 4:00 PM	Location
3-C Innovative Design Projects	CKB 217

Deadlift Energy Absorption and Dissipation Device for Athletic Weight Room

Mr. Henry Alan Freligh, Raritan Valley Community College
Mr. Christian Anthony Ambrico, Raritan Valley Community College
Ange Mendez, RVCC
Dr. Peter Raymond Stupak, Main Engine Start a NJ Non-Profit Corporation

The Raritan Valley Community College (RVCC) project-based-learning ”Authentic Engineering Experience” tasks groups of 2 to 4 students to solve a real problem for a real customer in one semester. All project activity is hands-on and ”live” – without classroom lectures or Labs. Principles and skills are experienced first-hand. The student Team members are treated as Professional Engineers– not as students. The focus is for the student team to learn by doing. The practical objectives are to expose students, early in their careers to methods and techniques used in industry and give students authentic hands-on product development and teamwork experience to relate to potential internship and professional employers. Working as part of RVCC’s Authentic Engineering Experience, a three-student team was tasked by the College’s Facilities Department to solve the practical problem at hand: the unacceptable level of noise created by students ”deadlifting” in the College’s ”Weight Room”. The impact of the deadlift weights on the floor made it difficult for the Facility Department staff to conduct work in their offices, which are located directly below the weight room. The student team designed, fabricated, and demonstrated a fully functional prototype that ”caught” the falling weight, absorbed the weight’s kinetic energy as elastic strain-energy stored in the twisting of a torsion bar that performed as a spring, and dissipated the stored energy using commercial shock-absorbers. The students worked to overcome multiple technical challenges including designing a ”cradle” to capture the 200- 400lb barbell weight without fracturing, calculating the optimum torsion bar dimensions to absorb and store the kinetic energy of the falling weight as elastic strain-energy, maintaining rigidity of the system to prevent warping of the device during the impact of the weight, rapid dissipation of the elastic strain-energy to allow the user to maintain their normal weight-lifting rhythm, and limiting the design dimensions to fit into in a highly constrained device footprint required by the ”Deadlift” station within the College’s ”Weight Room”. The resulting fully functional prototype effectively eliminated the unacceptable noise to the Facilities’ office, to the delight of the Facilities’ Staff, and to the Exercise Science Staff, who’s Weightlifting program had been shifted to after 5pm evenings. Throughout the project, the overwhelming emphasis was for the student Team to reach their own designs, experience their own failures and successes in earning their own know-how, resolve their own communications and scheduling conflicts, and to respond to customer critical comments of prototype product performance.

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Design Analysis of Rocket Tail Fins Aimed at Higher Apogee by Computer Simulation

Mr. Justyn Allen Bunkley, University of Maryland, Baltimore County
Mr. Marc J Louise O. Caballes, Morgan State University
Miss Margaret Ajuwon, Morgan State University
Dr. Guangming Chen, Morgan State University

The rocketry team at a mid-size University is developing a single-stage liquid-propellant rocket (LPR) with a targeted apogee of 13,000 feet. Due to the complexity of the LPR, each component of the rocket must be studied to optimize parameters that play a role in achieving the design apogee. These parameters do so either directly or by affecting other parameters in the optimization space. A wide variety of research papers and peer-reviewed journals that deal with the rocket nose cone and the characteristics of its airframe are already publicly accessible. However, only a few in-depth studies specifically address the design of the rocket's tail fins. Thus, this paper focuses on how different factors, such as the planform shape of the fins – clipped delta and trapezoidal; fin materials – carbon fiber, aluminum, and fiberglass; and its geometric dimensions – root chord and sweep angle, will affect the estimated apogee of a rocket and what is an ideal combination of design parameters. The simulation results collected using the software OpenRocket Simulator shows the possible outcomes of the rocket's apogee. Furthermore, a factorial design methodology was employed using the collected data and the Minitab software to perform statistical analysis to determine the significant factors and generate surface and contour plots. From the data in the study, the best rocket tail fin design for apogee was determined to be three clipped delta-shaped tail fins made of fiberglass.

Parametric Analysis of a Stirling Engine Using Engineering Equation Solver

Kaitlyn Kreider, State University of New York at New Paltz
Dr. Kevin T. Shanley, State University of New York at New Paltz

The Stirling engine is a clean energy source that converts heat into work efficiently with a theoretical thermal efficiency equal to that of the Carnot engine. As an external combustion engine, there is no limitation on the type of fuel source chosen to power the Stirling engine—so a wide range of unusual fuel sources may be used. This paper describes a program created in Engineering Equation Solver (EES) that is designed to create a power output matrix and a parametric analysis for any Stirling engine—whether alpha, beta, or gamma configuration—and is developed as a tool for use in a Senior Design project at SUNY New Paltz. Upon successful completion of this code, EES will compute a resulting power output matrix and P-v and T-s diagrams. The resulting power output matrix is two-dimensional: one dimension is an array of Revolutions Per Minute (RPM) values from 100 rpm to 1,000 rpm; the second dimension is an array of compression ratios. This power output matrix is created by utilizing the Parametric tables in EES. The Nasa Ideal Gas Library within the EES program contains 1,262 ideal gases to be chosen as the working fluid. The thermodynamic properties of these gases were recorded in 2002 at the Glenn Research Center. The thermophysical property functions in EES calculate the thermophysical property values at each state using the ideal gas assumption. The purpose of this program is that the user will input the length and bore of any chosen cylinder, as well as the hot and cold temperature values, to determine a power output matrix that varies with compression ratio and RPM, and then perform a parametric analysis for the Stirling engine. To prove the effectiveness of EES in designing and analyzing thermal systems, there is survey data completed by undergraduate mechanical engineering students who are using EES in their Thermal System Design course at SUNY New Paltz.

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Pure Circular Motion with Non-Angular Variables in One-Dimensional Motion Physics Problems

Prof. Daniel Blessner, Pennsylvania State University, Wilkes-Barre Campus

Pure Circular Motion with Non-Angular Variables in One-Dimensional Motion Physics Problems

In standard algebra and calculus-based college physics textbooks, chapter two normally introduces one-dimensional motion for a particle with the following equations v = dx/dt and a = dv/dt. The kinematic equations with constant acceleration are then derived for motion along the x-axis. Then a second section is introduced for motion along the y-axis for freely falling objects in which the constant acceleration is ay = g = 9.81 m/s2. This pedagogical paper suggests that a third section be included for a particle travelling in pure circular motion. With the introduction of one new formula for Radial Acceleration, the standard kinematic equations can be used. The standard kinematic equations will be defined with tangential velocity and acceleration. This paper proposes to model particles travelling along the circumference of a circle with radius R relating displacement x as multiples of n Straight-Line segments of length C = 2R along a horizontal axis with markings of 0C, 1C, 2C, 3C etc. Once the formula for radial acceleration is derived, the following axes will also be defined. The positive x and positive Tangential Velocity axes. For these problems we simplify things and will consider only counterclockwise motion. This direction will be considered positive. In addition, a moving particle will not come to rest and reverse direction. The positive x-axis can then be related to the positive circumference axis through the equation x = nC in which n is the number of circumference lengths travelled by the particle or the number of times the particle travelled around its circular path. Lastly, the tangential acceleration axis which will have both positive and negative acceleration values and perpendicular to that axis, the positive radial acceleration axis will be introduced. The positive radial acceleration axis will point to the center of the circle. Both uniform and non-uniform circular motion will be discussed. The difference in these pure circular motion problems versus one-dimensional motion along the x or y axes is that the resultant acceleration vector will have two components. In addition, an angle will need to be calculated between these two acceleration components. There will be no formulas that contain standard rotational variables such as and . Also, a new notation for the introduction of time will be introduced. For example, with an initial velocity of 1 m/s and a given tangential acceleration how long will it take to reach a final velocity of 4m/s? The notation will be as follows (1m/s, 0s) and (4m/s,?s) This alternative method eliminates the need for plotting variables in a two-dimensional graph with time on the horizontal axis. This third introduced section of pure simple circular motion expressed as straight-line motion with the particle travelling along the positive n-axis can greatly help students visualize the more difficult general curvilinear motion seen in their sophomore year dynamics course. Except for the derivation of radial acceleration this paper will contain the full written section needed to be included in a standard Physics textbook with the appropriate number of fully worked example problems.

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Investigation of Dominant Daily Uptake Factors on Gut Health from Samples in the Database of National Health and Nutrition Examination Survey

Margaret Dugoni, Villanova University
Ms. Nicola Iris Kaye, Villanova University
Dr. Zuyi (Jacky) Huang, Villanova University

Abstract: The diversity of healthy gut bacteria in the human digestive system are linked to positive health effects. For example, the intestinal microbiome, including but not limited to, Firmicutes, Bacteroidetes, Actinobacteria, Proteobacteria, Verrucomicrobia, and Fusobacteria, can aid in the immune system, improve digestion, and support mental health. Since caffeine, sugars, and alcohol are among common daily intakes and they may upset the environment of the gut microbiota, it is important to investigate how these daily update factors influence gut health. An unhealthy gut can in turn lead to several negative effects on health, such as indigestion issue, low sleep quality, and poor mental health. The hypothesis that drives this research is that individuals who consume higher than the recommended volume of sugar, alcohol, and caffeine will experience negative effects on their gut health, which can then impact an individual's digestion, mental health, and quality of sleep. In order to investigate this hypothesis, data from the database of National Health and Nutrition Examination Survey (NHANES) was thoroughly screened for samples containing all factors studied in this work, including the daily consumption of sugar, alcohol, and caffeine, and the examined levels of C-Reactive Protein and Tissue Transglutaminase IgA, two variables indicating the gut health as they are involved in gut inflammation. The NHANES data was imported into the R programming platform, which was followed by a dominance analysis on all factors to examine the largest influence on gut inflammation. Principal component analysis and hierarchical clustering were then performed to examine the variance of the variables as well as the grouping. Finally, a t-test was conducted to see if the consumption of a higher than the recommended value of caffeine, sugars, or alcohol has a significantly different effect on each of the parameters than a recommended value. The t-test was able to further validate the significance of the identified dominant factor. The dominance analysis demonstrated that the total amount of consumed sugar has the greatest impact on C-Reactive Protein, while consuming more caffeine had the largest impact on Tissue Transglutaminase IgA. The average amount of alcohol also appeared to impact C-Reactive Protein. To further emphasize the importance of gut health, the same analysis was performed while examining the effects of C-Reactive Protein and Tissue Transglutaminase IgA on other factors sampled from NHANES, including indigestion, poor sleep quality, and mental health. The dominant impacting variable on sleep quality in referenced to diagnosed sleep disorders was gut inflammation, and this same pattern follows for variables of depression, suicidal thoughts, and overall health. Therefore, not only does consuming more than the recommended daily intake of caffeine, alcohol, and sugar effect gut health, but the impact of poor gut health extends to overall health, sleep quality, and even mental health. This work initiates the effort to examine overall gut health, which requires analysis on more variables including nutrients, diet and human bowel health.

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2022 Fall Conference at Pennsylvania State University, Harrisburg

Dates: TBD