THE ATHENS INSTITUTE FOR EDUCATION AND RESEARCH

Abstract Book

12th Annual International Conference on Industrial, Systems and Design Engineering
24-27 June 2024, Athens, Greece

Edited by
Theodore Trafalis & Olga Gkounta

2024

Abstracts
12th Annual International Conference on Industrial, Systems and Design Engineering

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(In Alphabetical Order by Author's Family Name)

Preface

This book includes the abstracts of all the papers presented at the *12th Annual International Conference on Industrial, Systems and Design Engineering* (24-27 June 2024), organized by the Athens Institute for Education and Research (ATINER).

A full conference program can be found before the relevant abstracts. In accordance with ATINER's Publication Policy, the papers presented during this conference will be considered for inclusion in one of ATINER's many publications only after a blind peer review process.

The purpose of this abstract book is to provide members of ATINER and other academics around the world with a resource through which they can discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. ATINER was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world can meet to exchange ideas on their research and consider the future developments of their fields of study.

To facilitate the communication, a new references section includes all the abstract books published as part of this conference (Table 1). I invite the readers to access these abstract books –these are available for free– and compare how the themes of the conference have evolved over the years. According to ATINER's mission, the presenters in these conferences are coming from many different countries, presenting various topics.

Table 1. *Publication of Books of Abtracts of Proceedings, 2013-2024*

Year	Papers	Countries	References
2024	27	14	Trafalis and Gkounta (2024)
2023	28	19	Trafalis and Gkounta (2023)
2022	26	15	Trafalis and Gkounta (2022)
2021	12	5	Papanikos (2021)
2020	15	9	Papanikos (2020)
2019	20	13	Papanikos (2019)
2018	29	19	Papanikos (2018)
2017	29	15	Papanikos (2017)
2016	47	21	Papanikos (2016)
2015	46	25	Papanikos (2015)
2014	33	11	Papanikos (2014)
2013	20	14	Papanikos (2013)

It is our hope that through ATINER's conferences and publications, Athens will become a place where academics and researchers from all over the world can regularly meet to discuss the developments of their disciplines and present their work. Since 1995, ATINER has organized more than 400 international conferences and has published over 200 books. Academically, the institute is organized into 6 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of ATINER for putting this conference and its subsequent publications together.

Gregory T. Papanikos
President

Editors' Note

These abstracts provide a vital means to the dissemination of scholarly inquiry in the field of Industrial, Systems and Design Engineering. The breadth and depth of research approaches and topics represented in this book underscores the diversity of the conference.

ATINER's mission is to bring together academics from all corners of the world in order to engage with each other, brainstorm, exchange ideas, be inspired by one another, and once they are back in their institutions and countries to implement what they have acquired. The 12th Annual International Conference on Industrial, Systems and Design Engineering accomplished this goal by bringing together academics and scholars from 14 different countries (Albania, Australia, Brazil, Canada, China, Jordan, Malaysia, Poland, Qatar, South Africa, Taiwan, UAE, UK, USA), which brought in the conference the perspectives of many different country approaches and realities in the field.

Publishing this book can help that spirit of engaged scholarship continue into the future. With our joint efforts, the next editions of this conference will be even better. We hope that this abstract book as a whole will be both of interest and of value to the reading audience.

Theodore Trafalis & Olga Gkounta
Editors

12th Annual International Conference on Industrial, Systems and Design Engineering, 24-27 June 2024, Athens, Greece

Organizing & Scientific Committee

All ATINER's conferences are organized by the Academic Council. This conference has been organized with the assistance of the following academic members of ATINER, who contributed by reviewing the submitted abstracts and papers.

1. Gregory T. Papanikos, President, ATINER & Honorary Professor, University of Stirling, U.K.
2. Theodore Trafalis, Head, Industrial Engineering Unit, ATINER, Professor of Industrial & Systems Engineering and Director, Optimization & Intelligent Systems Laboratory, The University of Oklahoma, USA.
3. Timothy M. Young, Director, Center for Data Science, ATINER & Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA

FINAL CONFERENCE PROGRAM

12th Annual International Conference on Industrial, Systems and Design Engineering, 24-27 June 2024, Athens, Greece

PROGRAM

Monday 24 June 2024

08.45-09.30
Registration
09:30-09:45
Opening and Welcoming Remarks:

- **Gregory T. Papanikos**, President, ATINER.

09:45-11:30 Session 1
Moderator: Theodore Trafalis, Head, Industrial Engineering Unit, Athens Institute, Professor of Industrial & Systems Engineering and Director, Optimization & Intelligent Systems Laboratory, The University of Oklahoma, USA.

1. **Pavel Ikonomov**, Professor, Western Michigan University, USA.
   ***Title**: Hybrid 3D Metal Printing Process Optimization Using ML and AI.*
2. **Zhijian Pei**, Professor, Texas A&M University, USA.
   ***Title**: 3D Printing of Biomass-fungi Composite Materials.*
3. **Glen Bright**, Dean, Head of the School of Engineering, University of KwaZulu-Natal, South Africa.
   Tyrone Antonio Swanepoel, Engineer, University of KwaZulu-Natal, South Africa.
   ***Title**: Development of a Low-Cost 3D Printed Bilaterally Teleoperated Surgical System with Haptic Feedback for Minimally Invasive Surgery in Africa.*

11:30-13:00 Session 2
Moderator: Glen Bright, Dean, Head of the School of Engineering, University of KwaZulu-Natal, South Africa.

1. **Jacek Pietraszek**, Professor, Cracow University of Technology, Poland.
   Norbert Radek, Professor, Kielce University of Technology, Poland.
   Aneta Gądek-Moszczak, Professor, Cracow University of Technology, Poland.
   Renata Dwornicka, Professor, Cracow University of Technology, Poland.
   ***Title**: Optimizing Technological Parameters for Laser Processing of Special Coatings Applied by ESD: A DOE Approach to Prediction.*
2. **Chien-Wei Wu**, Distinguished Professor and Chair, Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Taiwan.
   Zih-Huei Wang, Associate Professor, Feng Chia University, Taiwan.
   ***Title**: An Innovative Approach for Evaluating Process Performance under Asymmetric Tolerances.*
3. **Shih-Wen Liu**, Associate Professor, National Chin-Yi University, Taiwan.
   ***Title**: A Flexible Mechanism for Lot Determination Based on Process Yield.*

13:00-14:30 Session 3
Moderator: Pavel Ikonomov, Professor, Western Michigan University, USA.

1. **Shengyuan Chen**, Professor, York University, Canada.
   Suzy Zhang, PhD Candidate, York University, Canada.
   ***Title**: High Speed Craft Peak Acceleration Prediction Using Machine Learning Models.*
2. **Andres Gonzalez**, Associate Professor, University of Oklahoma, USA.
   ***Title:** Quantifying and Enhancing the Resilience of Supply-Demand Networks.*
3. **Maher Maalouf**, Associate Professor, Khalifa University, UAE.
   Symeon Savvopoulos, PhD Student, Khalifa University, UAE.
   Abdulrahman Ali, Professor, Mohammed Bin Rashid University of Medicine and Health

Sciences, UAE.
Dirar Homouz, Associate Professor, Khalifa University, UAE.
Theodore Trafalis, Professor, University of Oklahoma, USA.
***Title**: Robust Kernel Ridge Regression with Bayesian Estimator.*

4. **Karen Roberts-Licklider**, PhD Student, University of Oklahoma, USA.
   Theodore Trafalis, Professor, University of Oklahoma, USA.
   ***Title**: Machine Learning Techniques with Fairness for Prediction of Completion of Drug and Alcohol Rehabilitation.*

14:30-15:30 Lunch

16:00-17:30 Session 4
Moderator: Dillip Das, Associate Professor, University of KwaZulu-Natal, South Africa.

1. **John Smallwood**, Professor, Nelson Mandela University, South Africa.
   Mauritz Van Rooyen, Graduate Student, Nelson Mandela University, South Africa.
   ***Title**: The Impact of Climate Change on the Built Environment: Built Environment Professionals' Perceptions and Practices.*
2. **Yasameen Al-Ameen**, Senior Lecturer, Nottingham Trent University, UK.
   ***Title**: Underground Thermal Energy Storage Systems.*
3. **Mohammad Shbool**, Associate Professor, The University of Jordan, Jordan.
   Yara Altarawneh, Research Assistant, The University of Jordan, Jordan.
   Raghad Bani Hamad, Industrial Engineering Graduate, The University of Jordan, Jordan.
   Rand Alqa'aydeh, Industrial Engineering Graduate, The University of Jordan, Jordan.
   Ammar Al-Bazi, Senior Lecturer in Operations and Supply Chain Simulation (Associate Professor equivalent), Aston Business School – Aston University, UK
   Mohammad Al-Tahat, Professor, Industrial Engineering, The University of Jordan, Jordan
   Thahabia Abedeljawad, Assistant Director of Quality Department, Jordan University Hospital, Jordan
   Mohammed Bashir, Professor & Department Head of Environmental Engineering, Universiti Tunku Abdul Rahman, Malaysia.
   ***Title**: Predictive Modelling of Chemical Waste Generation in Healthcare Facilities: Enhancing Waste Management Strategies.*

17:30-19:00 Session 5 – A Round-Table Discussion on The Future of Sciences and Engineering Education & Research
Moderator: Gregory T. Papanikos, President, Athens Institute

1. **Glen Bright**, Dean, Head of the School of Engineering, University of KwaZulu-Natal, South Africa.
   ***Title:** The Impact of Disruptive Technologies on Science and Engineering.*
2. **Timothy Young**, Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.
   ***Title**: The Future of Human Activity in Work as The Application of Innovation and Artificial Intelligence Research Accelerates.*
3. **Theodore Trafalis**, Professor, The University of Oklahoma, USA.
   ***Title**: Artificial Intelligence in Sciences and Engineering Education & Research.*
4. **Dimitrios Goulias**, Associate Professor, University of Maryland, USA.
   ***Title**: Integrating Sustainability and Resilience in Engineering & Sciences through Experiential Learning.*
5. **George Zahariadis**, Associate Professor, Faculty of Medicine, Memorial University of Newfoundland, Canada.
   ***Title**: Why Are Educational Institutions Suing Social Media Providers?*
6. **Evangelos Kaisar**, Professor, Florida Atlantic University, USA.
   ***Title**: Integrating Research and Teaching in the Classroom: Benefits for Instructors and Student.*

20:30-22:30
Athenian Early Evening Symposium (includes in order of appearance: continuous academic discussions, dinner, wine/water, music)

Tuesday 25 June 2024

08:45-10:30 Session 6
Moderator: Quan Yuan, Professor, Tsinghua University, China.

1. **Praveen Edara**, Professor, University of Missouri, USA.
   ***Title**: Advanced Data Analytics and Visualization Platform for Freight Data.*
2. **Xiaomin Lu**, Associate Professor, Lanzhou Jiaotong University, China.
   ***Title**: Pattern Recognition of Map Cluster Targets Based on Directional Entropy.*
3. **Weifang Yang**, Professor, Lanzhou Jiaotong University, China.
   Xiangrong Yan, Master Student, Lanzhou Jiaotong University, China.
   ***Title**: Research on GNSS-PWV Retrieval and Its Application in Rainfall Forecasting Based on Deep Learning.*
4. **Yunlong Zhang**, Professor, Texas A&M University, USA.
   ***Title**: Ranking the Operational Impact of Incoming Tropical Cyclones on Ports: A Recommendation Algorithm.*
5. **Cicero Rodrigues De Melo Filho**, Economist, Infra S.A., Brazil.
   Raul Sandoval Cerqueira, Engineer, Infra S.A., Brazil.
   ***Title**: Modeling The Effects of Fuel Cost Shocks on Airline Competition: A Case Study from Brazil.*

10:30-12:00 Session 7
Moderator: Zhijian Pei, Professor, Texas A&M University, USA.

1. **Tolga Benli**, Assistant Professor, Wenzhou-Kean University, China.
   ***Title**: Utilizing Natural Fibers and Bio-Composites in Industrial Design within the Framework of Sustainability.*
2. **Tyrone Bright**, Lecturer, Durban University of Technology, South Africa.
   Sarp Adali, Senior Professor, University of KwaZulu-Natal, South Africa.
   Cristina Trois, Director, Centre for Renewable and Sustainable Energy Studies, Stellenbosch University, South Africa.
   ***Title**: Systematic Review and Meta-analysis: The Application of Drone and Robotic Technology in Waste Management.*

12:00-13:30 Session 8
Moderator: Praveen Edara, Professor, University of Missouri, USA.

1. **Nabil Al-Omaishi**, Professor, The College of New Jersey, USA.
   ***Title**: Proposed Formulas for Lump-Sum Prestress Losses.*
2. **Issa Ramaji**, Associate Professor, Roger Williams University, USA.
   ***Title**: Advancing Building Management: Digital Twins for Sustainable HVAC Efficiency.*
3. **Arli Llabani**, Assistant Lecturer, Polytechnic University of Tirana, Albania.
   ***Title**: Combination of the Mobile Terrestrial Laser Scanning and UAV for the 3D Modelling of Bridges.*

13:30-14:30 Lunch

14:30-16:00 Session 9
Moderator: John Smallwood, Professor, Nelson Mandela University, South Africa.

1. **Faris Tarlochan**, Professor, Qatar University, Qatar.
   ***Title**: A Conceptual Framework for Inquiry Based Learning in Engineering Laboratories.*
2. **Izabela Stroe**, Associate Professor, Worcester Polytechnic Institute, USA.
   ***Title**: Integrating Entrepreneurial Mindset and Value Creation in Teaching Physics to Engineering Students for Innovation and Impact.*
3. **Nicholas Haritos**, Academic Associate/Director, Honorary Principal Fellow, The University of Melbourne & Adjunct Professor, Swinburne University of Technology, Australia.

***Title**: Experiential Learning in Engineering Courses is not just from Work Placements.*

4. **John Paul Tharakan**, Professor, Howard University, USA.
***Title**: Creating the 21st Century Engineer for Sustainable Development and Social Justice.*

17:00-20:00 Session 10
Old and New-An Educational Urban Walk

The urban walk ticket is not included as part of your registration fee. It includes transportation costs and the cost to enter the Parthenon and the other monuments on the Acropolis Hill. The urban walk tour includes the broader area of Athens. Among other sites, it includes: Zappion, Syntagma Square, Temple of Olympian Zeus, Ancient Roman Agora and on Acropolis Hill: the Propylaea, the Temple of Athena Nike, the Erechtheion, and the Parthenon. The program of the tour may be adjusted, if there is a need beyond our control. This is a private event organized by ATINER exclusively for the conference participants.

20:30-22:00
Dinner

Wednesday 26 June 2024
An Educational Visit to Selected Islands
or Mycenae Visit

Thursday 27 June 2024
Visiting the Oracle of Delphi

Friday 28 June 2024
Visiting the Ancient Corinth and Cape Sounion

Yasameen Al-Ameen
Senior Lecturer, Nottingham Trent University, UK

Underground Thermal Energy Storage Systems

This presentation presents an experimental and numerical investigation into recycling building waste materials to use as alternative backfills to improve the thermal performance of underground horizontal ground heat exchanger (HGHE) systems. The examined categories of backfill material include various soils and recycled enhancers. Waste arising from CD&E (construction, demolition, and excavation) and C&I (commercial and industrial) wastes were studied. These waste materials are sent directly to landfills without finding other pathways for reuse and recycle. During this study, multiple tests were conducted on these waste materials to obtain their thermal and physical properties. Then, an experimental HGHE model was designed, constructed and tested with several backfill materials to assess the model charging (thermal energy storage) and model discharging (thermal energy extraction) trends. Charging and discharging trends using various backfill materials were compared to that of sand. The discharging process was quantified by the duration and quantity of hot fluid produced and the energy extracted from the model for space heating. Several circulating heat transfer fluid (HTF) flow rates were tested in the model ranging between 0.04 to 0.26m/s. Results show that the rate of thermal extraction from the model was dependent on the HTF flow rate, and thermal properties of backfill materials.

Additionally, two transient three-dimensional numerical models were developed using the ANSYS Fluent software to simulate (i) the experimental model for validation purposes and (ii) a larger full-scale working model of the HGHE. The numerical solution was developed to assess the temperature distributions and heat transfer inside the HGHE. The models were used to approximate the required time to heat the HGHE, the hot water output and energy extracted from the HGHE model. The initial and boundary conditions for the simulation were investigated for the inlet HTF flow rates and backfill material thermal and physical properties. When considering the quantity and duration of hot fluid produced from the experimental and numerical models, results show that utilizing selected alternative materials, improved the thermal performance of the HGHE, in terms of heating time and extracted energy, by up to 70%. In addition, mixtures composed of recycled waste blended with soil, improved the HGHE's thermal performance. Further results showed that placing backfill material in

mixes was better than putting the backfill material in layer form inside the HGHE. Overall, design guidance has been provided based on the thermal output results obtained in this study from both experimental and numerical testing.

Nabil Al-Omaishi
Professor, The College of New Jersey, USA

Proposed Formulas for Lump-Sum Prestress Losses

The current *AASHTO LRFD Approximate formula* for estimating long-term prestress losses is the outcome of the research work presented in the *NCHRP Report 496*. It is produced by simplifying the detailed method and taking into account the variability of concrete properties and the interaction between precast girder and cast-in-place deck. Two detailed parametric studies, presented in this paper that are based on the average conditions for the design and construction of commonly used bridge girders. The girders examined are *Bulb Tee BT-54, Bulb Tee BT-72, I-Girder NU1100, I-Girder NU1600, I-Girder NU2000, Box Beam BI-48, Box Beam BIII-48, Inverted Tee IT600*, and *Slab Beam SIV-48*. Three spans and consequently three levels of prestressing for each section have been considered. The first study establishes the creep multiplier, N_c, while the second study evaluates the shrinkage multiplier, N_s. Both multipliers are used in the lump-sum formulas for estimating long-term prestress losses for different bridge girders. The multipliers produced by these studies are compared with that of the current *AASHTO LRFD* approximate method, and new lump-sum formulas for long-term prestress losses are proposed.

The significance of these two parametric studies is to increase the accuracy and use of the current *AASHTO LRFD Approximate formula*[1] in estimating the long-term prestress losses for commonly used pretensioned sections. The author believes that the values produced by the two studies can be a tremendous help to designers during the preliminary design stage. The variables used for these two parametric studies include type of beam cross-section, span and spacing of beams, concrete strengths at release and final times, and levels of prestressing.

Tolga Benli
Assistant Professor, Wenzhou-Kean University, China

Utilizing Natural Fibers and Bio-Composites in Industrial Design within the Framework of Sustainability

In the contemporary landscape of industrial design, the emphasis on sustainability and environmental conscientiousness has taken precedence. This research delves deep into the adoption and integration of natural fibers and bio-composites in the realm of industrial design, aiming to shed light on their implications for a more sustainable future. Natural fibers, being derived from renewable sources, present a dual advantage: they not only reduce the carbon footprint but also serve as a testament to the circular economy model, ensuring that resources are recycled and reused efficiently.

Bio-composites amalgamate the strengths of these natural fibers, offering durability and lightweight characteristics, with the environmentally friendly attributes of bio-based resins. This potent combination ensures that these materials can be robust contenders against traditional, more pollutive counterparts in industrial applications.

This research conducts a comprehensive analysis of the properties, advantages, and potential applications of both natural fibers and bio-composites. It further presents industrial design examples developed using these materials during the research phase, offering tangible insights into their practical applications and implications. For example, Furniture Industry. Additionally, one of the salient discussions in this study revolves around the potential advantages these materials bring to companies, examining how the novel designs can facilitate and streamline operations.

We methodically explore how these materials can be seamlessly integrated into the current industrial design practice and the broader logistics industry. Furthermore, the discourse extends to discuss the broader implications of material innovation, postulating how such advancements can redefine and shape the future trajectories of sustainable design methodologies.

It is the hope of this research to not only provide a foundational understanding of these materials but also to instigate further exploration, fostering an environment where design harmoniously coexists with nature, ensuring a brighter, more sustainable future for all.

Glen Bright
Dean, Head of the School of Engineering, University of KwaZulu-Natal, South Africa
&
Tyrone Antonio Swanepoel
Engineer, University of KwaZulu-Natal, South Africa

Development of a Low-Cost 3D Printed Bilaterally Teleoperated Surgical System with Haptic Feedback for Minimally Invasive Surgery in Africa

There is a dire need for medical services in Africa especially rural communities, the need to provide timely access to these services is the greatest challenge especially surgical procedures such as appendectomy and hernia repair. However, the number of qualified surgeons and healthcare professionals per capita is extremely low. To address the lack of access to these services, more surgeons and healthcare professionals need to be trained. Due to the limited resources and infrastructure available, developing training centers and the facilities necessary locally is almost impossible. The solution that this paper will discuss is the use of a low-cost 3D printed bilaterally teleoperated surgical system with haptic feedback for minimally invasive surgery. This system will enable trainees to remotely control and practice with the same surgical system they would use locally, in training centers located in more developed areas. Providing the necessary access to trained professionals and the ability to transport surgeons remotely from other regions to where their skills are required. However, such robotically assisted minimally invasive surgical (RAMIS) systems currently available are extremely expensive such as the Da Vinci System from Intuitive currently costing approximately $2,000,000. These systems typically have four robotic arms, three of which are fitted with surgical instruments and the fourth a HD stereoscopic camera providing depth perception. Along with a surgeon console which captures the surgeons hand movements. Therefore, a proof-of-concept low-cost prototype with a single robotic arm, similarly featured system was developed using easily accessible manufacturing methods such as 3D printing and off-the-shelf components.

To enable remote bilateral teleoperation while streaming HD video and audio given the operating environment and location various long range, high bandwidth and low latency communication technologies were investigated. These being optical communication using fiber optic cables and laser communication, 5G and Low-Earth Orbit (LEO)

satellite internet using Starlink. Satellite internet being the most promising due to the minimal local infrastructure required. Various control schemes were investigated such as the Time Domain Passivity Approach (TDPA) which compensates for latency effects by reducing the energy or error so that interactions with the environment do not cause the system to become unstable even under varying time delay. The Perceived Deadband Approach (PDB) was also investigated which utilizes the limited positional resolution with which humans can perceive to reduce bandwidth requirements of the network by only sending new commands to the slave manipulator when a bound is breached. Less complicated control schemes were also investigated which also add functionality to the system such as position scaling. Allowing for more ergonomic movements for the surgeon and the ability to conduct micro surgical movements not capable by a human while minimizing latency effects.

The 4DOF (Degree-of-freedom) serial robotic arm is manufactured using PLA+ filament due to its mechanical properties, ease of printing, cost, and the 3D printers accessible. The actuators used to manipulate the joints utilize compound planetary cycloidal gearboxes with reduction ratios of 1:50 for the wrist, 1:80 for the elbow and 1:100 in the shoulder and base joints. The planetary gearboxes incorporate a scissor gear mechanism using torsional springs to preload the planetary gears eliminating backlash when changing direction, also compensating for the inherent inaccuracies of the manufacturing process. The use of two cycloidal disks which are 180 degrees out of phase eliminate vibration caused from the eccentricity of the cam shaft and provide high shock loading capacity and rolling contact with zero backlash. Brushless Direct Current (BLDC) motors and AS5048A absolute magnetic encoders are used in each of the actuators controlled by ODrive v3.6 motor drivers with integrated PID controllers. The master tool manipulator used by the surgeon utilizes MX-12W Dynamixel servos to track joint angles and provide force feedback. The MX-12W servos are also used in the slave tool manipulator to track joint angles and actuate the capstone pully cable drive system to articulate the wristed Da Vinci surgical instrument.

Haptic feedback was also incorporated into the prototype, which isn’t currently implemented on commercial systems, using bilateral teleoperation allowing the surgeon to feel a pseudo realistic reaction force generated using a spring-damper model using position and velocity error between the master and slave instruments. This model was chosen to eliminate the use of a 6DOF force/torque sensor which would drive up the cost and add unnecessary complexity. A kinesthetic

feedback approach was also investigated which utilizes voice coils also know as vibration motors mounted on the surgeon's instrument manipulator and an IMU (Inertial Measurement Unit) mounted on the surgical tool itself. Capturing the vibrations experienced by the tools contact with the patient which are then relayed to the surgeon and generated using the vibration motors. Allowing the surgeon to feel through vibration the texture of the tissue and the ability to feel various anatomy.

The Master and Slave Manipulator kinematics and coordinate mapping homogeneous transformation matrix were calculated utilizing the Denavit-Hartenberg method along with their Jacobian matrices to calculate joint velocity, acceleration and torques for a 3kg payload and a maximum joint velocity of 180°/s. These specifications for the 3D printed serial robot were taken from the xArm5 serial robotic arm used as the master manipulator. The Computer Aided Design (CAD) 3D models of both the master and slave manipulators were imported into MATLAB using the Simscape Multibody Link allowing for the designed hardware to be simulated and the discussed control schemes implemented and tested.

Tyrone Bright
Lecturer, Durban University of Technology, South Africa
Sarp Adali
Senior Professor, University of KwaZulu-Natal, South Africa
&
Cristina Trois
Director, Centre for Renewable and Sustainable Energy Studies,
Stellenbosch University, South Africa

Systematic Review and Meta-analysis: The Application of Drone and Robotic Technology in Waste Management

This systematic review and meta-analysis aims to evaluate the application of robotic and drone technology in waste management, with a specific focus on the use of image recognition and deep learning for waste identification and categorisation. Due to urbanisation and the rapid growth of modern cities, ecosystems face challenges such as waste management. Therefore, there is a growing trend to develop innovative, efficient and environmentally sustainable solutions. These solutions include the integration of advanced technologies such as robotic and drone technologies. Coupled with artificial intelligence (AI), particularly image recognition and deep learning algorithms, which have emerged as promising tools to enhance waste management processes.

The methodology of this review involves a comprehensive search of databases such as PubMed, IEEE Xplore, and Scopus for studies published up to June 2023. The inclusion criteria are studies that describe the use of robotics and drones equipped with image recognition and deep learning capabilities in waste management settings. The primary outcomes assessed include the accuracy of waste identification, the efficiency of waste categorisation, and the overall impact on waste management practices.

The results of this meta-analysis reveal significant advancements in the accuracy and efficiency of waste management processes facilitated by robotic and drone technologies. Image recognition and deep learning algorithms have shown high efficacy in identifying and categorising various types of waste, thereby optimising the sorting and recycling process. Furthermore, the application of these technologies has demonstrated potential in reducing human exposure to hazardous waste, improving the speed of waste processing, and enhancing the precision of waste data collection for better environmental management.

This review discusses the implications of these findings for developing intelligent waste management systems. It highlights the role of robotic and drone technology in advancing sustainable waste management practices, addressing challenges such as waste segregation and recycling rates. Additionally, the review identifies gaps in current research. It suggests directions for future studies, emphasising the need for scalable solutions and integrating these technologies into existing waste management frameworks. Through this analysis, the review contributes to the understanding of how emerging technologies can be leveraged to improve environmental sustainability and waste management efficiency.

Shengyuan Chen
Professor, York University, Canada
&
Suzy Zhang
PhD Candidate, York University, Canada

High Speed Craft Peak Acceleration Prediction using Machine Learning Models

The capability to measure the impact of slams, which occur during high-speed motion of planing watercraft, is critical for the safety of passengers and equipment aboard. Previous studies have employed acceleration data from high-speed crafts to quantify the amplitude and duration of wave impact loads. This research considers several parameters for individual wave impacts: peak acceleration, impact duration, and velocity change. Mathematical models have been developed based on these parameters. This paper focuses on analyzing the characteristics separately in the freefall and impact regions for each wave to predict peak acceleration before the occurrence of a slam. To achieve this, two machine learning methods, Random Forest, and Convolutional Neural Networks, are utilized. The paper presents results from classification and regression models, demonstrating the accuracy of these predictions.

Cicero Rodrigues De Melo Filho
Economist, Infra S.A., Brazil
Davi Prado Novais Moura
Student, Pontificia Universidade Católica de São Paulo, Brazil
Raul Sandoval Cerqueira
Engineer, Infra S.A., Brazil
Cristiano Della Giustina
Director, Infra S.A., Brazil
&
Elaine Radel
Specialist, Infra S.A., Brazil

Modeling the Effects of Fuel Cost Shocks on Airline Competition: A Case Study from Brazil

This paper investigates the effects of exogenous cost shocks on the competition between Full Service Carriers (FSC) and Low Fare Carriers (LFC) in the airline industry. We develop an oligopoly model of airline competition with exogenous fuel costs and simulate increases in total costs. We apply the model to the case of the most important Brazilian domestic route, using airline/route-specific demand and costs data. The contribution of this paper relies on the empirical model of asymmetric economies of density for the competing business models applied to fuel cost shocks. Results show that LFC's Airlines suffer greater losses of markup and demand in comparison with their rival (FSC), however they also increase the price proportionally more than their rivals. We find that, on account of the airlines have similar sizes, less changes were observed which gives a more predictable environmental to consumers. The results are attenuated by higher economies of density, but amplified by higher price-elasticities of demand and lower economic growth.

Praveen Edara
Professor, University of Missouri, USA
Yaw Adu-Gyamfi
University of Missouri, USA
Evangelos Kaisar
Professor, Florida Atlantic University, USA
Carlos Sun
University of Missouri, USA
&
Luckson Kamisa
Florida Atlantic University, USA

Advanced Data Analytics and Visualization Platform for Freight Data

An exponential growth in freight data streams has brought new opportunities and challenges in the realm of data warehousing. Increased data enables improved planning, monitoring, prediction, and management of freight transportation systems, but only if the manipulation of such large datasets could be efficiently automated. With the increasing demand for modern data warehousing, there has been a significant growth in commercial and open-source tools. This research seeks to develop a user-friendly, interactive, web-based prototype platform that leverages recent advances in spatial data analysis, big data, and user-centered visualization to integrate freight data across different private and public databases for the purpose of improving freight planning and data driven decision making. The methodology includes a spatial-temporal conflation framework that enables seamless integration of three key freight data sources including: weigh-in-motion (WIM), freight facility, and traffic flow data. A massively parallel database is subsequently designed to store the integrated data on a cluster of servers enabled with Graphical Processing Units (GPUs). We leverage the immense computational power of the GPUs to carry out analytics and visual rendering on-the-fly via a Structured Query Language (SQL) which interacts with the underlying database. A web interface is designed for an unprecedented near-instant rendering of queries on simple charts and maps to enable decision makers to drill down insights quickly.

Andres Gonzalez
Associate Professor, University of Oklahoma, USA

Quantifying and Enhancing the Resilience of Supply-Demand Networks

Proper functioning of supply demand networks is critical for adequate societal operations, governance, safety, and well-being. However, these networks are subject to diverse types of hazards, including natural (e.g., hurricanes, earthquakes, tsunamis) and anthropogenic (e.g., physical attacks, cyberattacks, disinformation). Thus, it is imperative to develop effective ways of both quantifying and enhancing the resilience of supply-demand networks, in order to better withstand, recover, and adapt them, so that their performance is adequate before, during, and after disruptive events. In this work, I will present recent advances in mathematical models to describe the dynamics of supply-demand networks, that can be used to evaluate and enhance their performance in pre- and post-event time-horizons.

Nicholas Haritos
Academic Associate/Director, Honorary Principal Fellow, The University of Melbourne & Adjunct Professor, Swinburne University of Technology, Australia

Experiential Learning in Engineering Courses is not just from Work Placements

Experiential learning, widely acknowledged as the most effective method for knowledge and skill transfer, is particularly crucial in practical fields like Engineering. Ancient wisdom, such as Aristotle's "For the things we need to learn before we can do them, we learn by doing them," and Confucius' "I hear and I forget. I see and I remember. I do and I understand," remains relevant today. Experiential learning, often referred to as "Learning by Doing," serves as a vital tool for apprentices, proteges, and disciples to gain knowledge and skills. In modern times, the traditional one-to-one learning from a master to a learner has evolved into more structured educational systems, from Kindergarten to Post-Graduate levels, aiming to achieve structured recognition of proficiency levels or even professional qualifications.

In the context of professional engineering courses, traditional face-to-face teaching methods have given way to changes driven by budget constraints and the widespread availability of digital devices. Computer Labs and online platforms now dominate over physical labs and in-person lectures at many Engineering Schools, leading to a reduction in hands-on learning opportunities. Recognizing this shift, several engineering schools incorporate industry placements into their degree programs to provide some semblance of credible practical experience.

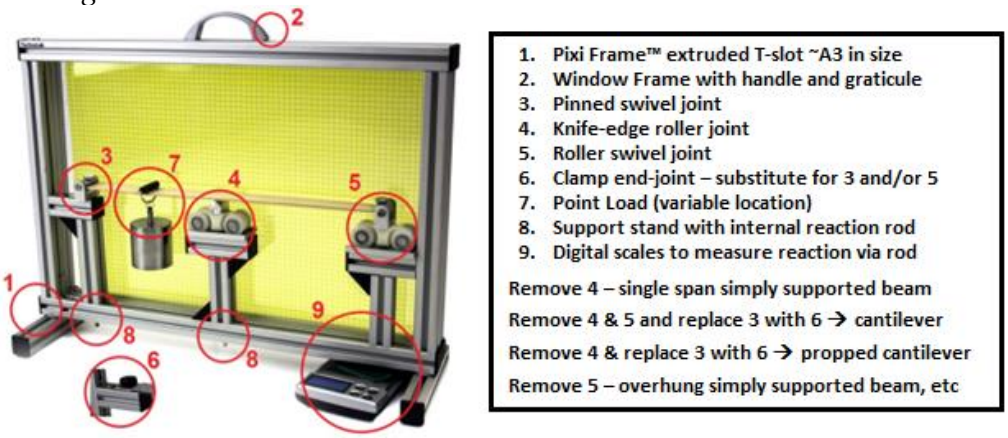
This paper proposes a proactive solution to this challenge: the development of a physical Experiential Learning Platform named TechnoLab™. Unlike traditional laboratories, TechnoLab™ does not require dedicated space and can be utilized in existing classroom settings or even in computer labs. It offers truly hands-on learning experiences for basic and complex engineering concepts at much more affordable pricing compared to demonstration units from other suppliers. The platform concentrates on experiment test rigs pertinent to material covered in Statics, Mechanics of Solids/Materials/Structures, subjects that underpin the knowledge and skill base of most Engineering disciplines and sub-disciplines such as Civil, Mechanical, Structural, Mechatronics, Robotics, Aeronautical, Aerospace, etc. (See example in Figure 1 of setups for Flexure).

TechnoLab™ incorporates thematic experiment test rigs fitted within replicates of (typically) 12 Pixi™ test frames in a classroom. Students work in pairs on experiment conditions specific to their Pixi frame, utilizing a patented photogrammetric mensuration approach for obtaining deflections/reactions. This deep learning experience eliminates the need for complex transducers and wiring, relying instead on a highly visual technique of analyzing digital photos from personal smartphones.

Another significant advantage of the platform lies in its diverse range of experiment test rigs and test conditions, inhibiting plagiarism between student groups. Additionally, the photographic nature of the raw and processed data, stored on the university's intranet, safeguards against artificially generated results by Artificial Intelligence engines.

In a world where AI can produce quality reports of substance, TechnoLab™ not only limits such opportunities through its design but also offers a genuine hands-on fundamental learning experience to students in most engineering disciplines.

Figure 1. *Pixi Frame™ Setup Supporting a Variety of Basic Flexure Experiment Investigations*



Pavel Ikonomov
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Hybrid 3D Metal Printing Process Optimization using ML and AI

Metal additive manufacturing (AM) technologies, also called metal 3D printing, are based on a typical additive process for creating parts layer by layer; furthermore, some use support material. Since the quality parameters, including tolerance and surface finish after the AM process, are not sufficient, the subtractive process (CNC machining) is performed later on a separate machine. 3D Hybrid metal printer developed at Western Michigan University combines two manufacturing methods - additive manufacturing and Computer Numeric Control (CNC) machining. The additive process uses the gas metal arc welding (GMAW) method to deposit each metal layer along a path controlled with CNC. The subtractive machining process is performed on the same CNC-controlled machine. The 3D Hybrid metal printer iterates between these two processes, adding material with welding and then using CNC machining to refine the surface. These additive/subtractive processes are repeated until the final 3D object is complete to achieve the essential geometrical and quality requirements, the same as machining with a typical CNC machine.

Traditional manufacturing processes have been refined for many years to guarantee defect-free parts, while 3D printing often requires manual intervention and might produce imperfect layers. To address these issues, we developed an automated 3D metal printing process using sensors for feedback during the printing process and machine learning/artificial intelligence (ML/AI) algorithms to optimize the printing. This process aims to reduce costs, printing time, and waste while achieving first-time printing success with the same quality as traditional methods.

3D printing provides numerous advantages over traditional methods like complex geometrical designs, on-demand manufacturing, new materials, and reduced material usage. 3D metal printing faces challenges like slow printing speed and inconsistent material structure that prevent broader adoption in the industry. Our research addresses the slow speed and inconsistent material structure limitations of 3D metal printing with smart software based on ML/AI-based optimization techniques.

To improve 3D metal printing quality and prevent defects, a real-time monitoring and control system using multi-sensor fusion (vision,

3D scanning) and ML/AI algorithms. This system aims to identify and correct defects in-process during printing, leading to defect-free layers with optimal properties. Initial experiments using ML/AI were successful, and further refinement is in progress to increase the accuracy. Ultimately, this approach's goal is to reduce costs by preventing the need for reprints due to defects while speeding up production at the same time.

The final product, ready for industrial application, is an integrated 3D metal printing system with three features. First, an automated control system optimizes 3D printing and CNC machining processes. Second, a software optimizer determines the most efficient way to create parts based on their geometry. Finally, an in-process quality inspection system uses 3D scanning and cameras to automatically check parts during printing, ensuring they meet accuracy and finish requirements. Overall, this product aims to streamline and ensure quality control in 3D metal printing for the industry.

Shih-Wen Liu
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A Flexible Mechanism for Lot Determination Based on Process Yield

Continuous Sampling Plans (CSP) were originally developed to evaluate production efficiency by sampling batches rather than inspecting each unit individually, a method known as "item-to-item" inspection. This approach was later adapted for the continuous receipt of lots from trusted suppliers, with only a fraction of the lots being inspected. This method can enhance the level of protection per sampled unit. In 1955, Dodge introduced the Skip-Lot Sampling Plan (SkSP-1) to assess the quality of raw materials from a common source. This plan was further developed by Dodge and Perry into SkSP-2, which included a "reference" plan for batch inspections. SkSP-2 is widely used in situations with a consistent history of high-quality products, mainly for cost reduction. To improve SkSP-2, Perry introduced a two-level SkSP, creating three scenarios (SkSP-2L.1, SkSP-2L.2, and SkSP-2L.3) with two fraction parameters. These versions offered greater discriminatory power in the Operating Characteristic (OC) curve. Murugeswari, Jeyadurga, and Balamurali later added resampling to improve SkSP-2L plans, but their focus was on attributes inspection, which often requires more samples. This paper proposes a variables SkSP-2Ls based on the process capability index, a common measure for evaluating processes or products. The goal is to provide a more reliable and cost-effective method for lot sentencing. We use the Markov chain approach to derive the operating characteristic function and the average sample number. Plan parameters are determined by solving a minimization problem that accounts for two acceptable sampling risks and corresponding quality levels. Our computational results indicate that our method outperforms existing variables SkSP-2 plans.

Arli Llabani
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Combination of the Mobile Terrestrial Laser Scanning and UAV for the 3D Modelling of Bridges

Bridges play a crucial role in modern infrastructure, serving as vital transportation links. The accurate assessment and maintenance of these structures are essential for public safety and cost-effective operation. This abstract explores the innovative fusion of Mobile Terrestrial Laser Scanning (MTLS) and Unmanned Aerial Vehicles (UAVs) to create comprehensive 3D models of bridges, providing valuable insights into their condition, safety, and structural health.

Mobile Terrestrial Laser Scanning (MTLS) is a ground-based technology that employs high-precision LiDAR (Light Detection and Ranging) sensors to capture precise 3D data points of the surrounding environment. However, traditional MTLS systems face challenges in capturing the entirety of a bridge structure, especially its hard-to-reach and elevated components. Unmanned Aerial Vehicles (UAVs), commonly known as drones, have emerged as an efficient and versatile platform for remote sensing and aerial surveying. UAVs equipped with LiDAR and photogrammetry systems can capture detailed data from elevated perspectives, making them well-suited for bridge inspections. The combination of MTLS and UAV technology offers a powerful solution to bridge modeling and inspection. By integrating data from these two sources, engineers and researchers can create holistic 3D representations of bridge structures, overcoming the limitations of each technology. MTLS provides precise ground-level data, while UAVs capture aerial views and hard-to-reach areas, resulting in a more complete bridge model. The benefits of this hybrid approach are manifold. First, it enhances safety by reducing the need for personnel to access hazardous areas, such as the underside of bridges or steep embankments. Second, it accelerates the inspection process, allowing for more frequent and cost-effective assessments. Third, the comprehensive 3D models generated can be used for structural analysis, deformation monitoring, and damage detection. Detailed 3D models offer an accurate baseline for assessing structural changes over time, helping bridge authorities make informed decisions about repairs and rehabilitation. Moreover, these models can be used for public awareness and education, showcasing the complexity and importance of these engineering marvels. This paper highlights the potential of combining Mobile Terrestrial Laser Scanning and UAV technology for

3D modeling of bridges. The synergy between these two methods addresses the limitations of each technology, offering a more complete, efficient, and safer approach to bridge inspection and maintenance.

Xiaomin Lu
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Pattern Recognition of Map Cluster Targets based on Directional Entropy

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Symeon Savvopoulos
PhD Student, Khalifa University, UAE
Abdulrahman Ali
Professor, Mohammed Bin Rashid University of Medicine and Health Sciences, UAE
Dirar Homouz
Associate Professor, Khalifa University, UAE
&
Theodore Trafalis
Professor, University of Oklahoma, USA

Robust Kernel Ridge Regression with Bayesian Estimator

Regression methods, whether linear or nonlinear, kernel or non-kernel, usually analyze data with the assumption that the errors are normally, identically, and independently distributed. However, as the last two assumptions have proved to be frequently inappropriate, research has been focusing on finding estimators that are insensitive to extreme values. Robust regression is an important tool in the analysis and prediction of data that are contaminated with outliers or noise. In this study, we extend the successful implementation of the truncated regularized Newton algorithm, which was effectively applied to kernel ridge regression, to two well-known robust regression models. The first model is based on the M-estimator method and the second is based on the Bayesian estimator method. The proposed methods are compared and the findings indicate that the model with a Bayesian estimator outperforms the M-estimator in terms of R-squared and the mean squared error (MSE).

Zhijian Pei
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3D Printing of Biomass-fungi Composite Materials

This presentation is about a 3D-printing based method to manufacture environmentally friendly products using biomass-fungi composite materials. In the biomass-fungi composite materials, the biomass (from agricultural wastes such as wheat straw and switchgrass) serves as a nutrition source for fungi, and the fungi grow through and bind the biomass particles together. Products manufactured using this method can substitute those currently made from petroleum-based plastics. Initial targeted applications of these manufactured products will be in packaging, furniture, and construction. The presentation will cover several experimental studies on feasibility of this new method, the relationship between the composition of the mixture (prepared for 3D printing) and print quality, and the effects of waiting time (from the time when the mixture is prepared till the time 3D printing is performed) and mixing on properties of the prepared mixture. The presentation will conclude by discussing research challenges and future research topics for this new manufacturing method.

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Optimizing Technological Parameters for Laser Processing of Special Coatings Applied by ESD: A DOE Approach to Prediction

Promoting sustainable development, environmental stewardship, and economic imperatives exert pressure on companies to enhance the quality of their products and services, particularly emphasizing reliability. Within the machinery industry, this pursuit entails continually improving machine components, enhancing machining precision, and augmenting resilience against wear and corrosion. One viable approach involves the application of specialized coatings, such as carbides, utilizing the ESD technique, followed by refinement of the resultant surface layer through laser processing. Given the multifaceted nature of this phenomenon, which encompasses material, chemical, thermodynamic, and mechanical considerations, modeling the technological process poses significant challenges.

This article presents an illustrative example of modeling selected technological parameters using the DOE methodology in the laser processing a carbide surface layer obtained by applying a specialized layer using ESD technology. Both the benefits and difficulties of using the DOE methodology are shown and discussed.

Issa Ramaji
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Advancing Building Management: Digital Twins for Sustainable HVAC Efficiency

The evolution of Industry 4.0 technologies has catalyzed the transformation of traditional buildings into intelligent infrastructures, integrating sophisticated control systems for enhanced data analytics, optimization, and fault detection in heating, ventilation, and air conditioning (HVAC) systems. Given the critical role of HVAC systems in the global energy footprint, this paper explores the adoption of Digital Twin (DT) technology as a forward-looking strategy for eco-efficient building management across their lifecycle and in predictive maintenance scenarios. Through a meticulously curated analysis of 200 scholarly articles from leading databases such as Scopus, Web of Science, and Google Scholar, this research delves into the spectrum of fault detection and diagnosis methodologies, highlighting the emerging preference for data-driven strategies. These strategies, particularly unsupervised and semi-supervised learning, are underscored for their robustness in managing vast datasets, enhancing diagnostic precision, and ensuring system adaptability without the need for labeled data. The paper advocates for the pursuit of interpretable models to demystify AI-driven decision processes and suggests that hybrid and deep learning models, capable of dissecting complex, voluminous data, represent fertile ground for future investigative endeavors. This study not only charts the current landscape of DT application in building efficiency but also sets the agenda for upcoming research pathways aimed at sustainable, intelligent building operations.

Karen Roberts-Licklider
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&
Theodore Trafalis
Professor, University of Oklahoma, USA

Machine Learning Techniques with Fairness for Prediction of Completion of Drug and Alcohol Rehabilitation

The aim of this study is to look at predicting whether a person will complete a drug and alcohol rehabilitation program and the number of times a person attends. The study is based on demographic data obtained from Substance Abuse and Mental Health Services Administration (SAMHSA) from both admissions and discharge data from drug and alcohol rehabilitation centers in Oklahoma. Demographic data is highly categorical which led to binary encoding being used and various fairness measures being utilized to mitigate bias of nine demographic variables. Kernel methods such as linear, polynomial, sigmoid, and radial basis functions were compared using support vector machines at various parameter ranges to find the optimal values. These were then compared to methods such as decision trees, random forests, and neural networks. Synthetic Minority Oversampling Technique Nominal (SMOTEN) for categorical data was used to balance the data with imputation for missing data. The nine bias variables were then intersectionalized to mitigate bias and the dual and triple interactions were integrated to use the probabilities to look at worst case ratio fairness mitigation. Disparate Impact, Statistical Parity difference, Conditional Statistical Parity Ratio, Demographic Parity, Demographic Parity Ratio, Equalized Odds, Equalized Odds Ratio, Equal Opportunity, and Equalized Opportunity Ratio were all explored at both the binary and multiclass scenarios.

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&
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Predictive Modelling of Chemical Waste Generation in Healthcare Facilities: Enhancing Waste Management Strategies

The accumulation of chemical waste in healthcare facilities is a critical issue that necessitates effective management strategies. This manuscript presents a system dynamics modeling approach to forecast chemical waste generation rates within hospitals supply chain. The model incorporates diverse variables to mitigating environmental impact and enhancing public health outcomes. Various factors, including patient flow rates, are integrated into the model to create a holistic understanding of the waste generation process. A comprehensive case study at a healthcare facility validates and illustrates the proposed model's practical application. Through this methodology, the research identifies key departments, such as Main Operations, Obstetrics, Catheter, and Tissue, as significant contributors to healthcare chemical-waste generation. The study's findings underscore the pivotal role played by specific hospital departments in influencing chemical waste generation rates. Notably, the Main Operations, Obstetrics, Catheter, and Tissue departments emerge as substantial contributors. This insight into department-specific contributions provides a nuanced understanding of the dynamics of waste generation within healthcare facilities, allowing for targeted interventions.

The study further emphasizes the importance of capacity planning, scheduling, and resource allocation for waste management departments to effectively address the identified areas of concern. This research carries dual significance. Firstly, it unravels the intricate factors influencing chemical waste generation in healthcare facilities, pinpointing the departments contributing to the problem. This information is invaluable for hospitals seeking to optimize waste management practices. Secondly, the study equips waste management departments with actionable insights, facilitating better planning and resource allocation. Hospitals can bolster environmental sustainability and improve public health by enhancing waste management practices. The study's predictive capabilities and identification of key departments offer a foundation for developing comprehensive, long-term waste management programs.

John Smallwood
Professor, Nelson Mandela University, South Africa
&
Mauritz Van Rooyen
Graduate Student, Nelson Mandela University, South Africa

The Impact of Climate Change on the Built Environment: Built Environment Professionals' Perceptions and Practices

Literature indicates the built environment contributes to GHG emissions, the increase in the earth's surface temperature has resulted in forced climate change, and climate change has been linked to the increase, severity, and frequency of natural disasters.

The aim of the study reported on was to investigate the effects of climate change on the built environment, the objectives being to determine built environment professionals' (BEPs') knowledge, perceptions, and practices relative to climate change and the built environment.

The quantitative method was adopted, which entailed the distribution of a self-administered questionnaire to a sample stratum of BEPs in the form of architects, architectural technologists, electrical and mechanical engineers, and construction project managers.

The salient findings include: respondents' hardly attended three climate change courses / seminars; the internet predominates among respondents' source of climate change information; respondents rate themselves marginally above average in terms of knowledge relative to climate change; respondents rate themselves below average in terms of knowledge relative to climate change future predictions, current global processes to reduce greenhouse gas emissions, and current climate change related research, and respondents understand and appreciate the extent to which activities/processes contribute to GHG emissions, the extent to which manifestations are caused by climate change, the extent to which climate change impacts on the built environment, and the extent to which eight interventions seek to reduce GHG emissions.

Conclusions include: climate change has been linked to the increase, severity, and frequency of natural disasters; increasing urbanisation contributes to the built environment's contribution to GHG emissions; climate change has impacted on the built environment in several ways, and South African designers' climate change knowledge is inadequate.

Recommendations include: green transition strategies must be accelerated, and new investments must be focused on the

decarbonisation of all sectors of the economy; new construction projects should be designed to minimise artificial heating and cooling and promote passive heating and cooling; the use of renewable energy must be incorporated into new structures and existing buildings must adapt and be retrofitted to reduce energy usage; strategies are required to better communicate climate change strategies to BEPs; climate change information should be easily accessible, and tertiary education should educate BEPs in terms of sustainable design and construction processes.

Izabela Stroe
Associate Professor, Worcester Polytechnic Institute, USA

Integrating Entrepreneurial Mindset and Value Creation in Teaching Physics to Engineering Students for Innovation and Impact

Worcester Polytechnic Institute is committed to the education and training of engineers for the needs of the 21st century by connecting science content to issues of critical local, national, and global importance. Recent survey done by Kettering University of industry employers shows that a large gap exists between what employers consider the "most essential competencies" for workforce readiness and graduates' proficiency. For example, engineering students were competent in some key scientific and technological areas and were strong at continued learning; however, they lacked key skills, knowledge, and mindset to be successful in innovation with impact. To close the gap, we redesign the physics curriculum to integrate Entrepreneurial Mindset (EM) and Value Creation Framework (VCF) as a tool that empowers each student to connect physics topics to real-world societal problems and to innovate with impact. The integration of EM and VCF as a tool in teaching Physics courses proved to be impactful not only in the upper-level courses, but also in the large introductory physics courses. This is particularly important, as it shows that undergraduate students can learn to innovate with impact from day one in college. Therefore, engineering students better understand the critical needs of society, they are more motivated to learn and innovate, and they are overall more ready to successfully contribute to global partnerships.

Faris Tarlochan
Professor, Qatar University, Qatar

A Conceptual Framework for Inquiry Based Learning in Engineering Laboratories

A thorough conceptual framework for improving the efficacy of inquiry-based learning (IBL) in engineering labs is presented in this paper. Because inquiry-based learning encourages students to actively explore and analyze real-world situations, it is known to build critical thinking, problem-solving abilities, and a deeper comprehension of the subject matter. Laboratories are essential for converting theoretical ideas into real-world applications in engineering education. However, a clear framework is necessary for the best possible integration of IBL principles into engineering laboratory environments. Important elements including curriculum design, teaching methodologies, assessment techniques, and the application of cutting-edge technology are all included in the suggested conceptual framework. Itplaces a strong emphasis on how laboratory exercises relate to actual engineering problems, supporting a student-centered approach that fosters curiosity and independent study. The framework also discusses the facilitator role that teachers have in helping students through the process of inquiry while fostering their independence and creativity. Additionally, the framework investigates the integration of contemporary technologies to enhancethe educational process and provide students a more comprehensive understanding of engineering methods. These technologies include data analytics, virtual laboratories, and simulation tools. The framework's adaptation to different engineering disciplines is taken into account, guaranteeing its relevance in a range of educational settings. This conceptual framework provides an organized method for implementing and evaluating inquiry-based learning in engineering laboratories through a detailed analysis of the body of existing research, educational theories, and real-world experiences. The suggested framework is a useful tool for instructors, curriculum designers, and organizations looking to improve engineering education by encouraging a culture of creativity and inquiry in lab environments. In the end, using this frameworkcould foster the development of a new generation of engineers who possess the essential abilities required to take on challenging, real-world engineering problems.

John Paul Tharakan
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Creating the 21st Century Engineer for Sustainable Development and Social Justice

Engineering educators bear a profound ethical responsibility as the stewards of the next generation of critical and innovative thinkers. It is imperative that we equip our engineering graduates not only to confront the monumental challenges facing humanity but to be the architects of innovative technologies, products, and processes that directly contribute to achieving sustainable development goals. This entails more than the traditional role of problem solvers; it requires a fundamental shift in the paradigm of engineering education.

The conventional approach, often characterized by chalk-and-talk lectures and limited assessment methods like problem sets and exams, must evolve to meet the demands of the 21st century. In this presentation, we endeavor to showcase tangible strategies for implementing transformative changes within engineering programs. Our goal is to guide educators in updating and upgrading curricular and programmatic approaches, ensuring that their graduates emerge as transformative thinkers and adept problem solvers, well-equipped to navigate the complex landscape of contemporary engineering challenges.

Central to this transformation is a departure from traditional teaching methods. Project-Based Learning (PBL) stands out as a pedagogical approach that immerses students in real-world, open-ended projects, fostering the development of critical thinking, collaboration, and problem-solving skills. PBL not only bridges the gap between theory and practice but also instills a sense of purpose by directly addressing real-world challenges.

Service Learning (SL) is another pivotal element that can be seamlessly integrated into engineering curricula. By engaging students in community-based projects, SL not only enriches their educational experience but also underscores the social responsibility inherent in engineering practice. These projects, ranging from sustainable energy solutions in rural communities to water treatment initiatives, not only provide practical learning experiences but also contribute to the betterment of society.

Open-ended design (OED) thinking is an essential aspect that encourages students to approach problems with creativity and flexibility. OED projects allow students to explore multiple solutions, fostering innovation and adaptability. By incorporating OED thinking, engineering

programs can cultivate a mindset that is attuned to the dynamic and evolving nature of the engineering profession.

Moreover, an integral aspect of this presentation will be an exploration of the ethical dimensions of engineering. Recognizing the profound impact of engineering projects on society, we will emphasize the importance of ethics and social justice considerations. Engineers must be cognizant of the broader implications of their work, ensuring that their solutions are not only technically sound but also ethically and socially responsible.

In conclusion, this paper seeks to be a catalyst for change in engineering education, advocating for a paradigmatic shift that aligns with the needs of the 21st century. Through the integration of PBL, SL, OED thinking, and a heightened awareness of ethics and social justice, we aim to empower engineering educators to nurture a new generation of professionals who will not merely solve problems but transform the world for the better.

Chien-Wei Wu
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An Innovative Approach for Evaluating Process Performance under Asymmetric Tolerances

Process capability analysis (PCA) aims to quantify whether a manufacturing process consistently meets quality standards. However, existing research in the field of PCA primarily concentrates on processes with symmetric tolerances, overlooking the common occurrence of asymmetric tolerances in the manufacturing industry. Asymmetric tolerances indicate that deviations from the desired outcome are less tolerable in one direction compared to the other, from the customer's perspective. Several generalizations of the capability index C_{pk}, such as C_{pk}* and C_{pk}', have been developed to address asymmetric tolerance scenarios. However, these generalizations often either underestimate or overestimate process capability. To tackle this, a new generalized index, denoted as C_{pk}", has been introduced, which outperforms other existing generalizations in evaluating processes with asymmetric tolerances. Despite its effectiveness, constructing exact confidence intervals for C_{pk}" is challenging due to the complexity of the sampling distribution of its estimator. This article suggests an innovative approach, generalized confidence intervals (GCI), to compute the lower confidence bound (LCB) for C_{pk}". The calculated LCB not only provides insight into the minimum level of the process' actual performance but also assists in decision-making regarding capability testing. To examine the performance of the suggested GCI approach, a simulation study with diverse process parameters was conducted. The findings demonstrate that the GCI approach can provide accurate and reliable information on evaluating process performance under asymmetric tolerances. Thus, practitioners can employ this approach along with the provided step-by-step procedure to determine whether a process with asymmetric tolerance is capable or not.

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Xiangrong Yan
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Research on GNSS-PWV Retrieval and its Application in Rainfall Forecasting Based on Deep Learning

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Ranking the Operational Impact of Incoming Tropical Cyclones on Ports: A Recommendation Algorithm

Maritime transportation is essential for the U.S. economy, handling over 69% of its trade and facilitating the movement of approximately $11.4 trillion worth of goods annually through its ports. These ports, however, are vulnerable to disruptions caused by tropical cyclones, which can lead to significant economic losses. Predicting the impact of incoming tropical cyclones on ports, in terms of days underperforming, is crucial for the effective management of ports. However, existing methods often fall short due to limited data and the inherent uncertainties associated with forecasting the trajectory of cyclones. This study addresses these challenges by applying a recommendation algorithm that shifts the focus from predicting the precise duration of port impacts to ranking port impact.

Initially, we collected comprehensive data on port characteristics and historical tropical cyclone activity in the Gulf of Mexico. In total, data from 37 ports and 31 tropical cyclones between 2017 and 2022 (except for 2020) were collected. A modular time-series regression model was employed to estimate the duration of port impacts based on vessel count data from the Automatic Identification System (AIS). Drawing inspiration from recommendation systems, we redefined tropical cyclones and ports as "users" and "items," respectively, with the duration of port impacts serving as their "interaction." This approach allowed for an innovative way to model and analyze the effects of cyclones on ports.

The recommendation system encompasses two phases following data preparation: retrieval and ranking. In the retrieval phase, we identify ten ports likely affected, based on their proximity to each cyclone's predicted landfall location. The ranking phase employs a Factorization Machine (FM) to analyze relationships between port infrastructure features, historical cyclone data, and their interactions, enabling precise impact rankings. Additionally, the model enhances resilience to forecast uncertainty of cyclone trajectory by incorporating ten forecasted trajectories for each incoming cyclone to augment the training dataset. We assessed the system's performance using precision, recall, and Rank-Biased Overlap (RBO) metrics, testing on the 2022 tropical cyclones—Alex, Ian, and Nicole. Results indicate that the FM-based algorithm substantially outperforms traditional distance-based

methods, achieving higher precision and recall rates. The RBO metric confirmed its consistent ranking under varying conditions. The algorithm's superior performance, attributable to its capacity to integrate and analyze diverse data dimensions and adapt to different forecasting trajectories, significantly reduces ranking errors. These findings not only are statistically significant but also offer practical benefits, enhancing disaster preparedness and response strategies.

By providing a trustworthy and reliable ranking of port impacts for incoming cyclones, this study equips port authorities and other stakeholders with a powerful tool for informed disaster management and planning. The significance of this research lies in its potential to enhance port resilience by delivering more accurate, advanced information on cyclone impacts, thereby aiding in the strategic development of port infrastructures against increasing threats from natural disasters.

References

Trafalis T, Gkounta O (2024) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 12th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Trafalis T, Gkounta O (2023) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 11th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Trafalis T, Gkounta O (2022) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 10th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2021) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 9th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2020) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 8th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2019) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 7th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2018) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 6th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2017) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 5th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2016) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 4th Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2015) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 3rd Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2014) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 2nd Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).

Papanikos GT (2013) *Industrial, Systems and Design Engineering. Abstract Proceedings of the 1st Annual International Conference.* Athens: Athens Institute for Education and Research (ATINER).