UTEP
INDUSTRIAL, MANUFACTURING
AND SYSTEMS ENGINEERING

THE NEXT FRONTIER: DIGITAL TWINS FOR INNOVATION

IMSE DAY 2025

El PASO NATURAL GAS CONFERENCE CENTER
APRIL 17, 2025
8:00 AM To 5:00 PM
Open to all students and faculty

WELCOME TO THE IMSE DAY 2025, CELEBRATED AT UTEP!

The Department of Industrial, Manufacturing, and Systems Engineering at The University of Texas at El Paso is excited to welcome all participants to IMSE Day 2025! This year, we are thrilled to focus on "The Next Frontier: Digital Twins for Innovation." Our event will explore the potential and applications of Digital Twins (DTs) across various engineering disciplines.

At UTEP's IMSE Department, we strongly emphasize interdisciplinary research and collaboration among students, researchers, industry leaders, and practitioners. Our aim is to foster an environment where innovative ideas can be shared and developed into practical solutions with significant real-world impact. This event is a perfect opportunity for the IMSE community to come together, exchange knowledge, and drive advancements in fields such as manufacturing, complex systems, healthcare, transportation, and more.

We have organized a series of engaging sessions, workshops, poster presentations, and discussions designed to demonstrate the transformative role of DTs in modern engineering systems. We invite all attendees to fully engage—network, share your insights, and contribute to discussions that enhance our understanding of DTs.

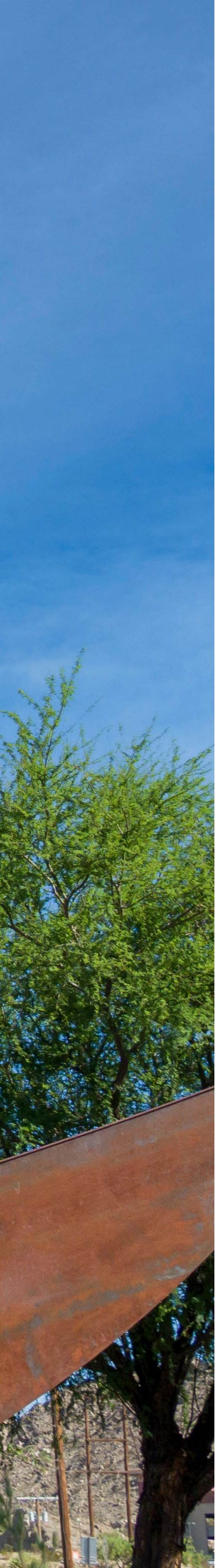
Thank you for joining us. Your participation is crucial to the success of IMSE Day 2025, and we look forward to seeing the innovative collaborations that emerge. Together, let's embrace this opportunity to shape the future of engineering and science with Digital Twins."

Md Fashiar Rahman, Ph.D.
Assistant Professor, IMSE

IMSE DAY 2025 | THE NEXT FRONTIER: DIGITAL TWINS FOR INNOVATION

CONTENT


UTEP



MESSAGE FROM IMSE DEPARTMENT CHAIR

Welcome to the Industrial, Manufacturing and Systems Engineering (IMSE) Day in the Next Frontier: Digital Twins for Innovation

It is my pleasure to welcome you all to our annual IMSE Day event. The event brings together industry leaders and subject-matter expert panelists to share their valuable insights on Digital Twin technologies, Digital Transformation, Smart Manufacturing, Logistics, Robotic Systems, and active collaborations needed among industry leaders, researchers from academia, and workforce development institutes for broader Digital Twin adoption.

As we witness the continuous growth and advancement in Digital Twin technologies, we can see that many applications are being enabled in various fields such as aerospace, healthcare, transportation, automotive, and military. The manufacturing industry has seen a lot of advancement over the years, and this calls for even more innovation and development in Digital Twin technologies. At UTEP, our academic work emphasizes experiential learning for students from the El Paso-Cd. Juarez region. Events like IMSE Day provide students with an opportunity to develop leadership and networking abilities, which will be critical in their future careers.

I would like to thank all the speakers, presenters, and most importantly, all the students and staff who have participated in making this annual event a success. I encourage all the student community and those attending this event to see this as a networking opportunity and build professional relationships that will enhance your personal, networking, and professional growth. I invite you to also send us your valuable suggestions and feedback on the event to help us organize a better event in the future.

Dr. Tzu-Liang (Bill) Tseng
CHAIR- DEPARTMENT OF INDUSTRIAL, MANUFACTURING & SYSTEMS ENGINEERING (IMSE)
DIRECTOR- RESEARCH INSTITUTE OF MANUFACTURING AND ENGINEERING SYSTEMS (RIMES)

INDUSTRIAL, MANUFACTURING & SYSTEMS ENGINEERING

The IMSE Department at The University of Texas at El Paso plays a vital role in providing innovative solutions to complex problems across industries such as manufacturing, transportation, technology, healthcare, agriculture, aerospace, and supply chain management. With a mission to advance the field of engineering and address pressing societal challenges, the department offers cutting-edge research and educational opportunities to its students.

The IMSE Department offers a bachelor's degree in industrial & systems engineering (ISE) and three Master of Science (MS) programs in Industrial Engineering, Manufacturing Engineering, and Systems Engineering. The curriculum is designed to provide a strong foundation in mathematics, science, and technology, along with practical skills in problem-solving, analysis, and design. An online MS in Systems Engineering is also available to offer greater flexibility. Besides the regular degree programs, the department also offers graduate certificates in Smart Manufacturing and Systems Engineering, as well as degree concentrations in Systems Modeling and Simulation (SMS).

The department is also home to the Research Institute for Manufacturing and Engineering Systems (RIMES), Texas Manufacturing Assistance Center (TMAC), and two research centers and four research labs supporting collaborative, interdisciplinary work and cutting-edge discoveries in systems, manufacturing, design, and more. These facilities provide students with opportunities to engage in impactful research alongside faculty and industry partners, further enhancing their academic experience. The Department also leads various federal and non-federal funded research projects for technological advancements and workforce development to support the needs of the industries of today and the future.

In addition to academic and research programs, the department is committed to experiential learning through internships, co-op programs, and student research projects. IMSE also hosts seminars, workshops, and conferences, giving students direct access to industry leaders and academic experts.

Overall, IMSE is a driving force in advancing engineering and society. Its focus on interdisciplinary collaboration, innovation, and real-world experience prepares students to thrive in diverse careers and make a meaningful impact on the world.

CENTERS AND ACTIVE RESEARCH LABS ASSOCIATED WITH THE DEPARTMENT

RESEARCH INSTITUTE FOR MANUFACTURING & ENGINEERING SYSTEMS (RIMES)

RIMES was created in 1995 as the Institute for Manufacturing and Materials Management (IM3). We have recently renamed the Institute while maintaining its focus on Manufacturing and Materials Management. The institute has also evolved and taken the lead in focusing on the research of new knowledge of systems and its applications to Manufacturing and Engineering Systems.

TEXAS MANUFACTURING ASSISTANCE CENTER (TMAC)

TMAC's mission is to enhance the global competitiveness of Texas's manufacturing economy by helping companies improve performance, drive innovation, and grow sustainably. Through tailored, hands-on solutions, TMAC partners with businesses to address challenges in areas such as energy efficiency, quality management, and supply chain optimization. By focusing on each company's unique needs, TMAC empowers manufacturers to gain a competitive edge, uncover financial opportunities, and achieve long-term growth.

SMART MANUFACTURING LAB

The Smart Manufacturing Lab is a dynamic research hub dedicated to advancing next-generation manufacturing through the integration of cutting-edge technologies. The lab focuses on optimizing production processes, enhancing operational efficiency, and implementing advanced automation, data analytics, and intelligent systems to support agile, responsive, and sustainable manufacturing solutions.

PHYSICAL, INFORMATION AND COGNITIVE HUMAN FACTORS ENGINEERING RESEARCH LAB (PIC-HFE)

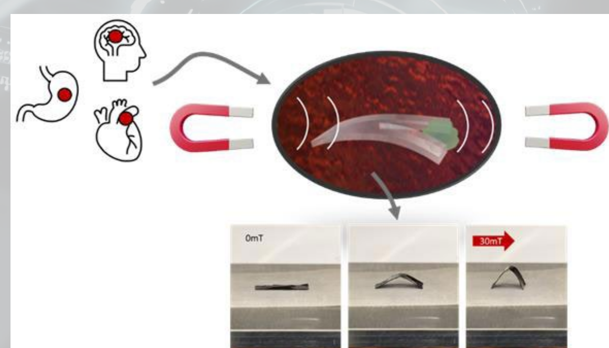
The Physical, Information and Cognitive Human Factors Engineering Research Lab (PIC-HFE) conducts research focused on supporting workers in high-stress occupations—such as construction and healthcare—that are prone to both physical injuries and significant cognitive demands, including workload, stress, and burnout. Students in the lab actively address these challenges through innovative human factors engineering research.

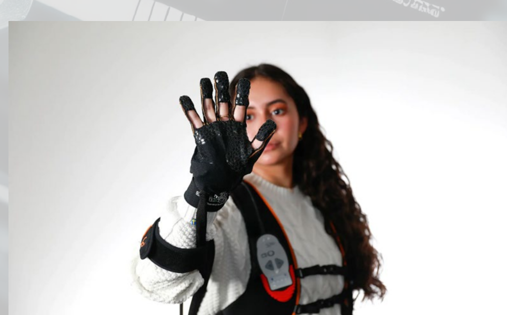
SYSTEMS INNOVATION WITH MODELING AND SIMULATION (SIMS) LAB

The Systems Innovation with Modeling and Simulation (SIMS) Lab in UTEP's Department of Industrial, Manufacturing, and Systems Engineering (IMSE) is designed to spark student interest and innovation through immersive, hands-on experiences. The lab focuses on developing and simulating real-world systems to expose students to cutting-edge research and equip them with practical skills highly sought after in today's workforce. Through projects involving big data analysis, simulation model development, 3D-model design, and augmented/virtual reality (AR/VR) application development, students gain valuable technical expertise in a controlled, scalable environment—capabilities that are often difficult to acquire due to the safety, cost, and scale constraints of traditional training settings.

SOFT ROBOTICS DESIGN LAB

The Soft Robotics Design Lab aims to enhance people's lives by developing innovative robotic capabilities, focusing on small scale robotics and humanoid robots. In small scale robotics, the team designs and tests millimeter scale flexible robots controlled by magnetic principles, eliminating the need for batteries or motors. These robots have potential applications in minimally invasive medicine, such as performing tiny surgical procedures or targeted drug delivery. For humanoid robots, the research explores how to teach companion robots to handle repetitive tasks in homes, clinics, factories, and restaurants such as food preparation and cleaning, requiring dexterity and precision. By leveraging machine learning and advanced sensing technologies, the lab is pushing the boundaries of robotic innovation.





PROGRAM COMMITTEE

Dr. Tzu-Liang (Bill) Tseng

Dr. Sergio Luna
SE Graduate Program Director/Advisor

Dr. Md Fashiar Rahman
Assistant Professor

Dr. Amanda Oliveira
Assistant Professor

Dr. Honglun Xu
Research Assistant Professor

Pablo Machado, MBA
Sr. Coordinator

Gabriel Valadez
Student Graphic Designer

Jeeva Senthilkumar
TMAC - Engineer

Solayman Emon
Doctoral Student

Tenzin Lhaden
Doctoral Student

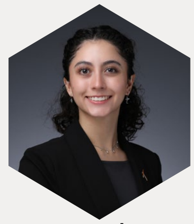
Mustafizur Rahman
Doctoral Student

S M Atikur Rahman
Doctoral Student

Sofya Sellak
Doctoral Student

Ana Sofia
Masters Student

Carlos N. Maiti Rivera
Undergraduate Student



Myrna Ochoa
Undergraduate Student & IMSE Student Leader

Sergio Palacios
Undergraduate Student & IMSE Student Leader

UTEP

INDUSTRIAL, MANUFACTURING AND SYSTEMS ENGINEERING

DATA FACT SHEET

FALL 2024

316 STUDENT ENROLLMENT

90 TOTAL DEGREES AWARDED

10 FACULTY

DEGREES AWARDED AY 2023-24

(FALL 23, SP 24 & SU 24)

Bachelor of Science (B.S.)	**40**
Industrial and Systems Engineering	40
Master of Science (M.S.)	**50**
Industrial Engineering	11
Manufacturing Engineering	3
Systems Engineering	34
Systems Engineering - AT&T	2

ENROLLMENT FALL 2024

Undergraduate	**187**
Industrial and Systems Engineering	152
Industrial Engineering	4
Lower Division Industrial Engineering	31
Master's	***129**
Industrial Engineering	8
Manufacturing Engineering	20
Systems Engineering	92
Systems Engineering – AT&T	9

*These numbers do not include certificates, only actual degrees.

FACULTY AS OF FALL 2024

Total	**10**
Tenured	6
Tenure-track	3
Non Tenure-track	1
Faculty Rank (T/TT)	**9**
Assistant	3
Associate	5
Professor	1
Faculty Rank (Non Tenure-Track Faculty)	**1**
Assistant Professor of Research	1
Gender (T/TT Faculty)	**9**
Female	2
Male	7
Gender (Non Tenure-Track Faculty)	**1**
Female	0
Male	1

STUDENT BODY PROFILE - DEGREES AWARDED AY 2023-24

Ethnicity (UG)	**40**
Black Non-Hispanic	5%
Hispanic	70%
Mexican National	10%
Native American	5%
Other International	2.5%
Unknown	2.5%
White Non-Hispanic	5%

Gender (UG)
Female = 32.5% Male = 67.5%

Ethnicity (MS)	**50**
Asian American	2%
Black Non-Hispanic	10%
Hispanic	56%
Mexican National	14%
Other International	6%
Unknown	2%
White Non-Hispanic	10%

Gender (MS)
Female = 40% Male = 60%

STUDENT BODY PROFILE - FALL 2024 ENROLLMENT

Ethnicity (UG)	**187**
Hispanic	82.35%
Mexican International	12.83%
Other International	2.67%
Two or more races	0.54%
Unknown	1.07%
White Non-Hispanic	0.54%

Gender (UG)
Female = 33% Male = 67%

Ethnicity (MS)	**129**
Asian American	1.55%
Black Non-Hispanic	10.85%
Hispanic	51.17%
Mexican International	17.05%
Other International	4.65%
Two or more races	1.55%
Unknown	3.88%
White Non-Hispanic	9.30%

Gender (MS)
Female = 31% Male = 69%

Comment: Demographics for enrollment and degrees conferred were rounded to the nearest decimal point.

PROGRAM AGENDA: DIGITAL TWINS FOR INNOVATION IMSE DAY 2025

8:00 AM to 9:00 AM | COFFEE AND REGISTRATION

9:00 AM to 9:10 AM | OPENING REMARKS: KENITH E. MEISSNER II, PH.D.

DEAN OF THE UNIVERSITY OF TEXAS AT EL PASO - COLLEGE OF ENGINEERING

9:10 AM to 10:00 AM | SOHEIL SABRI, PH.D.

ASSISTANT PROFESSOR AND DIRECTOR OF URBAN DIGITAL TWIN LAB

DISCUSSION TOPIC: Next Generation of Modeling and Simulation - Digital Twin Fundamentals, Applications, and Challenges

10:00 AM to 10:50 AM | JOHN LIU, PH.D.

DIRECTOR AND PRINCIPAL INVESTIGATOR OF THE MIT LEARNING ENGINEERING AND PRACTICE (LEAP) GROUP

DISCUSSION TOPIC: XR Experiences to Scale and Enhance Learning Manufacturing and Analysis and Skills

10:50 AM to 11:40 PM | CHRISTOPHER COLAW

LOCKHEED MARTIN FELLOW AND EXECUTIVE DIRECTOR OF INDUSTRIAL PARTNERSHIPS FOR THE SMU CENTER FOR DIGITAL AND HUMAN-AUGMENTED MANUFACTURING

DISCUSSION TOPIC: Human Digital Twin for Quality Assurance in the Aerospace Manufacturing Domain

11:40 PM to 12:50 PM | POSTER EXHIBITION AND LUNCH

Lunch, the Student Poster Presentation, and the Research Exhibition will be held simultaneously.

12:50 PM to 1:40 PM | JESUS JIMENEZ, PH.D

DIRECTOR OF TEXAS STATE UNIVERSITY'S INGRAM SCHOOL OF ENGINEERING

DISCUSSION TOPIC: Using Human Digital Twins to Model Human Labor in Smart Material Handling Systems

1:40 PM to 2:30 PM | IMSE ALUMNI DISCUSSION SESSION

Students Will Get the Chance to Interact with the IMSE Alumni for Career Opportunity and Preparation.

Jorge Mena, Entrepreneur: Supply Chain & Operations Consultant | ***EP&O***

Oscar E. Martinez Gonzalez, Senior Manufacturing Engineer | ***Eaton Corp.***

Jesus Reverol, Administrative Director, Performance Excellence | ***University Medical Center of El Paso***

David Mendoza Hernandez, Sr. Product Engineer | ***Cardinal Health***

Abisai Ramirez, Sr. Product Engineer | ***Cardinal Health***

2:30 PM to 3:20 PM | ABIEL CARRILLO

CEO, IMPULSE 4.0

DISCUSSION TOPIC: AI in Every Function – Dream, Test, Fail, Repeat

3:20 PM to 4.10 PM | CHIN-YI LIN, PH.D.

IMSE POSTDOCTORAL RESEARCH ASSOCIATE

DISCUSSION TOPIC: AI-Driven Digital Twin for Process Optimization in Semiconductor Manufacturing

4:10 PM -4:50 PM | STUDENT RESEARCHERS' PRESENTATIONS

Three Student Groups Will Present Their Work on Virtual Reality, Electric Vehicles Charging Systems, and Senior Design of Project.

Mustafizur Rahman
Research Topic: Augmented Reality-Based Visualization of Orbital Systems and Space Debris for Enhanced Space Situational Awareness

Tenzin Lhaden
Research topic: Development of Electric Vehicle Charging Station Microgrid with Hybrid Simulation Modeling

Juan Ortiz & Irvyn Hernandez
Research Topic: Heat Dissipation from a Nuclear Microreactor in Space

4:50 PM - 5:00 PM | Closing Remarks by Tzu-Liang (Bill) Tseng, Ph.D., IMSE Chair & Professor, The University of Texas at El Paso

SEMINARS & PRESENTERS

Next Generation of Modeling and Simulation – Digital Twin Fundamentals, Applications, and Challenges

SEMINAR 1

SOHEIL SABRI, PH.D.

ASSISTANT PROFESSOR AND DIRECTOR OF URBAN DIGITAL TWIN LAB

This presentation delves into the concept of digital twins and highlights their three main components: physical environment, virtual environment, and infrastructure for tailoring the two. Furthermore, the presentation discusses the evolution of digital twins. It emphasizes the significance of digital twin development approaches, including the model-driven engineering perspective and the digital twin system of systems (SoSDT) approach, which aim to enhance decision-making, interoperability, and autonomy. Additionally, the presentation explores digital twin application areas, such as smart cities, healthcare, supply chains, and transportation, showcasing the transformative potential of digital twins in these domains. The presentation also addresses the need for developing digital twin skillsets and education, outlining collaboration opportunities between universities, colleges, and digital twin solution providers. The challenges associated with implementing digital twin education are also highlighted, including the lack of expertise in universities and potential pushback from students. Lastly, the presentation discusses digital twin technologies' integrative and transformative role, emphasizing the need for a paradigm shift in digital systems engineering and application. It underscores the significance of whole life-cycle management and the convergence of expertise and technology in shaping the future of digital twins. The presentation also recognizes the pivotal role of industry collective efforts, such as the Digital Twin Consortium, in guiding technological integration and professional expertise across various domain applications.

Dr. Soheil Sabri is an Assistant Professor and Director of Urban Digital Twin Lab, at the School of Modeling, Simulation, and Training, at the University of Central Florida. He holds the titles of Urban Planner and Geospatial Scientist, with a primary focus on advancing the field through his research, practical work, and educational pursuits. His core interests revolve around developing Urban Digital Twins, Multi-dimensional (3D/4D) Planning Support Systems, and analytical tools tailored to empower planners and decision-makers with evidence-based, data-driven insights for future urban development. He is an Honorary senior research fellow at the Centre for Spatial Data Infrastructure and Land Administration (CSDILA) at The University of Melbourne, Australia, where he received two Post-Doctorate Fellowships that centered on Geosimulation, Urban Analytics Data Infrastructure (UADI), and 3D Geospatial techniques for Landscape Design during 2014 - 2023. He is the co-chair of the Academia and Research Working Group within the Digital Twin Consortium, and he has contributed substantially to the IEEE Digital Twin and Parallel Intelligence, IEEE Systems, Man, and Cybernetics Society, Urban Digital Twin working group of Open Geospatial Consortium, and the Digital Twin Task Force at the Smart Cities Council in the USA and Australia. He is the lead editor of the recent Book: "Digital Twin Fundamentals and Applications".

UCF

MODELING, SIMULATION AND TRAINING

Human Digital Twin for Quality Assurance in the Aerospace Manufacturing Domain

SEMINAR 3

CHRISTOPHER COLAW

LOCKHEED MARTIN FELLOW AND EXECUTIVE DIRECTOR OF INDUSTRIAL PARTNERSHIPS FOR THE SMU CENTER FOR DIGITAL AND HUMAN-AUGMENTED MANUFACTURING

Quality assurance programs in the manufacturing sector have a traditional foundation built upon human dependency. While some special inspection equipment, tools, or processes may exist, the common denominator between the performance of audits, evaluation of performance and process capability, supply chain management, and execution of inspection, is in fact human labor. According to some studies in the manufacturing sector, as much as 80 percent of all quality assessments are made subjectively by humans. With such reliance on human performance, quality organizations become driven by human labor cost, and due to finite budgets for manpower, therefore constrain the reach and frequency of quality assurance activities based on what is affordable. Recent global trends with Industry 4.0, which sought to automate processes and eliminate humans from the equation, have shown that human presence is a critical enabler for certain types of work such as quality assurance. The expectations, variation, and potential failure modes are vast and too complicated for full automation of all quality assurance activities. Based on this understanding a new focus on Industry 5.0 has emerged which aims to keep the human centered in the process and build their capability of performance through digital and technological teaming. By enabling the human quality assurance practitioner to utilize and rely on technology for certain things, then their time and attention can be focused on other things simultaneously that are better suited for humans. This approach packs more quality assurance activities into the same hourly labor cost than a focus solely based on the human alone. This abstract proposes a cutting-edge approach that combines human tradecraft, Mixed Reality (MR), Artificial Intelligence (AI), and Digital Twin technologies to provide an immersive and hands-on quality assurance platform tailored specifically for the enhancement of effectiveness of quality assurance practices in aerospace.

Christopher "Chris" Colaw is a Lockheed Martin Fellow with expertise in digital transformation, inspection technology, autonomation, 3D modeling, and quality management systems. In this role he is responsible for a quality and digital transformation portfolio valued at over $200M in cost savings for Lockheed Martin. This savings performance is complimented with two patents, one trade secret, and receipt of a 2022 Environmental Safety & Health Excellence Award for application of Artificial Intelligence and Internet of Things solutions to reduce injuries and lost time associated with elevated space workplace hazards. Additionally, Chris was selected in 2021 as one of the "Top 100 Visionaries in Education" by the Global Forum for Education and Learning for his contributions to development of global university talent. Chris also serves as the Executive Director of Industrial Partnerships for the SMU Center for Digital and Human-Augmented Manufacturing, Chairman of the SMU Mechanical Engineering Industrial Advisory Board, Chairman of the UTEP Industrial, Manufacturing, and Systems Engineering Advisory Board, and is currently pursuing a PhD in Aerospace and Mechanical Engineering from UTEP.

LOCKHEED MARTIN

SMU

SEMINAR 2

JOHN LIU, PH.D.
DIRECTOR AND PRINCIPAL INVESTIGATOR OF THE MIT LEARNING ENGINEERING AND PRACTICE (LEAP) GROUP

XR Experiences to Scale and Enhance Learning Manufacturing and Analysis and Skills

The economy and national security of nations depend on its ability to innovate and produce. STEM skills are in the critical path to compete in this technologically-dependent, post-COVID world. Digital learning environments such as those offered in extended reality (XR) can scale learning, but they often facilitate lower-level cognitive thinking, script the learning pathway, or are disconnected from authentic assessment. In this talk, I will first highlight the potential impact effective workforce solutions can have on individuals and companies. I will then explore crafting extended reality experiences for learning analysis and hands-on skills within manufacturing contexts.

Dr. John Liu is the Director and Principal Investigator of the MIT Learning Engineering and Practice (LEAP) Group, which investigates the intersection of learning technologies, STEM workforce and education, and digital learning and MOOCs. He is a Lecturer in MIT's Mechanical Engineering department and a Scientist in the MIT Digital Learning Lab. He leads education and workforce development efforts for MIT's new campus-wide Initiative for New Manufacturing. He was the Director of the Principles of Manufacturing MicroMasters program, an online certificate program that has now enrolled over 160,000 learners across the globe. He has received several Best Paper Awards from ASEE and IEEE DEMOCon. He has co-authored dozens of publications and currently serves as an executive guest editor for Manufacturing Letters. His research is supported by the Department of Commerce, Department of Defense, Massachusetts Technology Collaborative, Schmidt Futures, National Science Foundation, NAMTECH, and industry partners.

MIT LEAP GROUP

SEMINAR 4

JESUS JIMENEZ, PH.D
DIRECTOR OF TEXAS STATE UNIVERSITY'S INGRAM SCHOOL OF ENGINEERING

Using Human Digital Twins to Model Human Labor in Smart Material Handling Systems

A Human Digital Twin (HDT) is a digital replica of a human worker that evaluates, analyzes, and improves worker productivity and human factors in real-world manual material handling applications. This research has successfully demonstrated using a digital twin to evaluate motion and physiological responses collected from lab-based simulations of simple manual material handling (MMH) tasks and predict fatigue in the operator. The team has developed and applied non-invasive motion capture technology and physiological reading sensors in simulated manufacturing workstations. By employing Principal Component Analysis (PCA) and human action recognition (HAR) techniques, we aim to further our research. Our efforts are focused on addressing the existing research gap in AI development for MMH. We are now testing the technology in an industrial partner's manufacturing site. These advancements will enhance our capability to create accurate and reliable digital twins, ultimately improving worker productivity and safety in industrial applications.

This project received funding from Toyota Material Handling North America (TMHNA) through the University Research Program (URP) grant, as well as multiple internal research grants from Texas State University, including the Formosa Innovation Award. Dr. Jesus A. Jimenez is a dedicated leader and educator in Industrial Engineering. As the Director of Texas State University's Ingram School of Engineering, he is shaping the school's future with innovative undergraduate and graduate programs centered around disruptive technologies, such as digital twins. These programs align with the university's ambition to achieve R1 status by 2027. He earned his Ph.D. from Arizona State University and both his B.S. and M.S. from The University of Texas at El Paso. Dr. Jimenez has over 20 years of experience in the modeling and analysis of manufacturing systems through computer simulations and digital twins. His research group is pioneering the concept of Human Digital Twins (HDT) for manufacturing operators, integrating advanced computer-vision technology, biometric sensors, and artificial intelligence to collect and provide real-time feedback. HDT technologies can enhance efficiency and productivity while prioritizing the safety and ergonomics of the most valuable asset of a company: its workforce.

Aside from his research, Dr. Jimenez actively collaborates with industry leaders to ensure his work is practical and applicable in real-world environments. He is involved in multiple projects that bridge the gap between academia and industry, aiming to translate theoretical advancements into tangible engineering solutions. Beyond research, Dr. Jimenez is deeply committed to mentoring the next generation of engineers, influenced by his background as a first-generation and minority student. His team is dedicated to using research to help individuals reach their full potential, guided by three pillars: Mentorship, Skill Development, and Collaboration. They mentor numerous students, primarily from underrepresented minorities, measuring their impact through co-authoring publications and inventor disclosures and sending students to conferences to present their work. For those interested in collaboration or wishing to learn more about his work, Dr. Jimenez invites you to connect via email at jesus.jimenez@txstate.edu.

TEXAS STATE UNIVERSITY

IMSE ALUMNI EXPERIENCES: HOW DID IT GET HERE?

PANELIST

OSCAR E. MARTINEZ GONZALEZ
Senior Manufacturing Engineer
Eaton Corp.

Abisai Ramirez
Sr. Product Engineer
Cardinal Health

Jesus Reverol
Administrative Director,
Performance Excellence
University Medical Center of El Paso

Oscar E. Martinez Gonzalez is a Senior Manufacturing Engineer at Eaton Corporation, working at El Paso Site 2 (ELP2), where he provides engineering solutions for the Electrical Sector. He specializes in the development and optimization of power distribution units, load centers, and Busway solutions, critical products that ensure safe and efficient power distribution for data centers worldwide.

With over 12 years of experience in the maquiladora industry across Juarez, MX, and El Paso, TX, Oscar has held key roles at Foxconn, Eagle Ottawa, Jabil, Valeo, Technimark, and Eaton, working across electronics, automotive, medical, and food transportation industries. His expertise includes process optimization, industrialization strategies, new product introductions, and cross functional team leadership, helping companies improve efficiency, reduce costs, and enhance production capabilities.

Oscar earned a Master of Science in Industrial Engineering from The University of Texas at El Paso (UTEP), where he participated in Lean Six Sigma, DOE, IMSE, INCOSE, and Data Mining initiatives. He has also obtained numerous certifications, further strengthening his technical and leadership expertise in manufacturing and industrial engineering.

Abisai Ramirez has a passion for cycling and a constant drive to pursue new challenges and goals. His professional journey began as a contractor at Cardinal Health, where he discovered a strong interest in health care products and project management.

Now serving as a Senior Product Engineer, Abisai Ramirez manages projects ranging from product development and market research to customer interaction and service. His responsibilities include new product introductions, product line transfers, and cost-saving initiatives. He defines project scopes, allocates resources, sets timelines, and aligns project goals with stakeholders to ensure successful outcomes. Abisai Ramirez leads cross-functional teams across manufacturing, finance, and marketing to launch products effectively, while also overseeing product development, maintenance, and planning to meet customer needs. With a strong focus on problem-solving, strategic planning, and logistics, Abisai Ramirez works to develop solutions for global challenges in the health care industry.

Prior to this role, Abisai Ramirez completed an internship with Ingine Logistics at Amazon in Austin, where he developed goals and key performance indicators aimed at improving operational efficiency and package delivery. He also analyzed production limitations and created standards for drivers to enhance both customer service and overall experience.

Jesus Reverol has led performance improvement efforts at UMC El Paso since 2017. Prior to his current role, he served as Performance Improvement Director and later Plant Manager at Lucchese Bootmaker.

Before that, he worked as a Business Improvement Advisor with the Texas MEP, TMAC. In his role at UMC El Paso, Jesus supports the organization with initiatives focused on patient throughput improvement, revenue enhancement, and cost optimization. He has led efforts that have been instrumental in improving organizational performance indicators.

Additionally, he has been a key leader in the implementation of the Malcolm Baldrige framework, helping UMC El Paso earn the Texas Award for Performance Excellence and currently leading the organization's application for the National Baldrige Award.

Born and raised in Maracaibo, Venezuela, Jesus holds a Bachelor's degree in Industrial Engineering, a Master of Business Administration, and a Master's degree in Industrial Engineering.

JORGE MENA
Entrepreneur Supply Chain & Operations Consultant
EP&O

Jorge Mena is a seasoned leader and entrepreneur with expertise in supply chain, manufacturing, and operations management. As a founding member of EP&O, he consults small and medium-sized businesses, optimizing logistics, inventory management, and operational strategies to improve efficiency and reduce costs.

Before launching his entrepreneurial venture, Jorge held leadership roles at Eaton and Schneider Electric, managing multi-million-dollar operations, leading high-performance teams, and driving improvements in supply chain and production management. His expertise spans plant operations, procurement, and global logistics, establishing him as a key figure in industrial management.

Beyond his corporate and consulting work, Jorge serves as a Board Member at TMAC, where he contributes to initiatives that advance manufacturing excellence and business transformation. Passionate about mentorship and leadership development, he is committed to fostering innovation in engineering and operations.

Jorge holds a Master of Science in Manufacturing Engineering and a Bachelor's Degree in Industrial Engineering from The University of Texas at El Paso. His core expertise includes supply chain strategy, logistics, business process optimization, and team leadership.

David Mendoza Hernández
Sr. Product Engineer
Cardinal Health

David Mendoza Hernandez serves as a Senior Product Engineer at Cardinal Health, where he leads a variety of projects ranging from process improvements to design modifications. He is responsible for driving cost-saving initiatives, maintenance efforts, and sustaining projects that support the company's annual financial and service level goals. His work primarily supports the Surgical Drapes & Gowns and Facial Protection product portfolios.

The role of Product Engineer has been an enriching experience for David Mendoza Hernandez. Based at a technical design center, he provides support to three Cardinal Health manufacturing facilities in Mexico and one in the Dominican Republic. This position has enabled him to apply the engineering expertise he developed at the University of Texas at El Paso (UTEP) to qualify new raw materials and build strong relationships with suppliers and internal manufacturing teams.

While attending UTEP, David Mendoza Hernandez worked in the Memberships department at the Student Recreation Center, assisting students, faculty, staff, and alumni with fitness programs, membership services, and general enrollment support.

Originally from Ciudad Juárez, Chihuahua, David Mendoza Hernandez earned a Bachelor of Science in Industrial & Systems Engineering in Fall 2019, followed by a Master of Science in Manufacturing Engineering in Spring 2021.

SEMINARS & PRESENTERS

SEMINAR 5

AI in Every Function – Dream, Test, Fail, Repeat

AI is everywhere—but the truth is, we're all still figuring it out. The technology is new, and so is our understanding of it. At Impulse4.0, we don't have all the answers, but we believe in dreaming, testing, failing, and repeating as the only way forward. This isn't about AI theory; it's about real-world experiments—where it works, where it doesn't, and what we've learned. We'll explore AI everywhere by testing it across functions, from supply chain to HR. We'll highlight the power of experimentation by making space for failure and iteration. We'll look at AI as a tool, not a solution—one that augments, not replaces, human intelligence. And we'll embrace the continuous learning loop, recognizing that AI is an ongoing journey, not a one-time fix. We don't know everything, and we're okay with that—because progress isn't about certainty, it's about the willingness to keep learning.

ABIEL CARRILLO
CO-FOUNDER, IMPULSE4.0

Abiel Carrillo is an industrial engineer from Nuevo León University in Monterrey, Mexico, with a career spanning banking, industrial development, and supply chain management. He spent 17 years in banking, with the last five leading the department at the Industrial Development Bank of Mexico (NAFIN) responsible for the bank's nationwide response to the maquila industry. In 2001, Abiel co-founded Impulse4.0 with a vision to create fully integrated, efficient supply chains. Today, Impulse4.0 operates in the U.S., Mexico, and Europe, serving Fortune 1000 companies and their suppliers. The company is built on two core KPIs: 100% inventory accuracy and 100% OTIF (On-Time, In-Full) performance. Abiel is passionate about our community seizing the opportunities that come with having a $60 billion maquila industry operating across our binational region, as well as the potential Fort Bliss brings to local manufacturing, design, and innovation. He actively advocates for better jobs, a stronger STEM culture, and industrial transformation to ensure the community thrives in the era of AI-driven supply chains. As part of this mission, Impulse4.0 actively shares knowledge through university and industry collaborations. The company recently hosted the second TechAI Tacos & Tequila event, bringing together 240 participants from 60 maquila plants for discussions with industry, association, and government leaders. The company has also developed its own Master Agentic AI platform, currently training 53 employees worldwide in AI-driven supply chain management. Based in El Paso, Texas, Abiel enjoys skiing, jazz, scuba diving—and is arguably the worst golfer in the world.

impulse4.0
SUPPLY CHAIN EMPOWERED

SEMINAR 6

AI-Driven Digital Twin for Process Optimization in Semiconductor Manufacturing

In semiconductor manufacturing, process optimization faces mounting challenges amid complex multi-machine and multi-product scenarios. This presentation outlines the evolution of our AI-driven digital twin frameworks that enhance process control and yield. We begin with an approach that integrates digital twins, deep learning, and Multi-Restart Bayesian Optimization to improve parameter control in epitaxial silicon carbide processes. Building on this, we developed MOODFG—a framework that simultaneously adjusts multi-conflicting objectives like thickness control and uniform doping via deep-feature extraction and Gaussian Process Regression. To overcome data scarcity and adapt seamlessly to new machines without manual intervention, we further integrated meta-learning and transfer learning for robust, automated adaptation. Our latest ADEPT framework leverages reinforcement learning, multi-stage learning, Gaussian Processes, and dynamic deep feature extraction to enable continuous real-time updates in process predictions and control, achieving scalable, data-efficient optimization even in wide-bandgap applications such as SiC and GaN. This talk will also share our implementation experience at the Infineon plant in Germany, highlighting the transformative potential of AI-driven digital twins for process optimization in semiconductor manufacturing.

CHIN-YI LIN, PH.D
POSTDOCTORAL RESEARCH ASSOCIATE

Chin-Yi Lin is a Postdoctoral Research Associate at the University of Texas at El Paso (UTEP), USA, where his work focuses on semiconductor manufacturing—specifically in intelligent yield management, predictive maintenance, and generative AI applications. Previously, he served as a Staff Specialist at Infineon Technologies in Germany and as a Research Specialist at National Cheng Kung University in Taiwan. He has published extensively in high-dimensional data analysis and machine learning, and in 2024, a report by Scopus, Elsevier, and SciVal ranked him 3rd in Taiwan and 8th globally for academic Performance in Semiconductor Device Manufacturing, Neural Networks, and Process Control (2014–2023). In recognition of his innovative contributions, he was awarded the 2025 Taiwan National Invention Award (Silver Medal) for his invention, "Virtual Metrology Method Using Convolutional Neural Network and Computer Program Product Thereof."

NATIONAL CHENG KUNG UNIVERSITY 1931

APPLIED RESEARCH

NORTHROP GRUMMAN

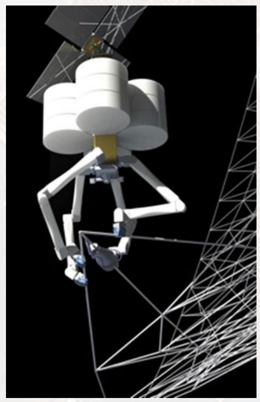
1994 marked the massive consolidation of a heritage over 90 years old which became known as Northrop Grumman Corporation (NGC). Its acquisitions diversity allowed NGC to explore and refine their work at 4 main sectors: Aeronautics, Defense, Mission, and Space Systems amounting to $36.6 Billions in sales in 2022, employing over 95k.

In recent conversations with IMSE, Aerospace and Mechanical Engineering leaders, Dr. Bill Tseng, and Dr. Yirong Lin respectively, NGC decided to formalize a relationship with UTEP - College of Engineering (COE) under the direction of Dr. Andrew Kwas. This marked the first time NGC Collaborated with IMSE, offering a new set of opportunities for the students in the Industrial and Systems Engineering BS Program. The agreement materialized into a set of four projects all involving the creation of innovative solutions to real life problems in the aerospace industry.

These projects objective can be summarized in the following descriptions:

1. Delivery Systems

Taking a logistics approach, how do we deliver payload packages safely to the moon that then get replaced/installed by robotics onto lunar assets, such as the Lunar Terrain Vehicle Service (LTVS)? Other than replacing/installing cargo consider disassembling the cargo and then assembling it in a different location. How do we get robotics to do that?



4. Space 3D Printing

If a team has some Additive manufacturing experience, they can help determine what and how we can replicate space environments on Earth for testing AM effectively. Maybe even do some rudimentary testing in a vacuum. Not easy since most printing systems are pressurized which will complicate holding proper vacuum conditions. How do you handle microgravity conditions, or at least what are the implications of testing in one g vs what we will see in space? This will be a continuation from Fall 2024.

2. Orbit MMOD Protection

Research and develop a concept for MMOD protection for satellites in LEO. As LEO becomes more crowded with massive constellations of small satellites the risk of impact from a man made or natural object will continue to increase. Students could research current methods of protection and identify new approaches including different low-mass materials or incorporating MMOD features into 3-D printed structures.

3. Heat Rejection

Whether it be a need for a manufacturing system in space or a deep space satellite mission that can't rely on solar power generation, eventually we will put a small nuclear reactor in orbit. The reactor is one problem. But the complexity comes in when we have to dissipate heat from the reactor. This project will identify radiation shielding ideas for space (low mass) for something that would be applicable to a spacecraft design.

These four will set the sediment to a fruitful and long-lasting relation in which both COE students and NGC will benefit, overall providing NGC fresh ideas and results in research and practical techniques. Strengthening problem solving and critical thinking skills in systems that currently populate space.

DIGITAL TWIN FOR SMART MANUFACTURING

DIGITAL TWIN FOR REAL-TIME MONITORING AND CONTROL OF CONVEYOR SYSTEMS USING FLEXSIM, AI AND PLC INTEGRATION

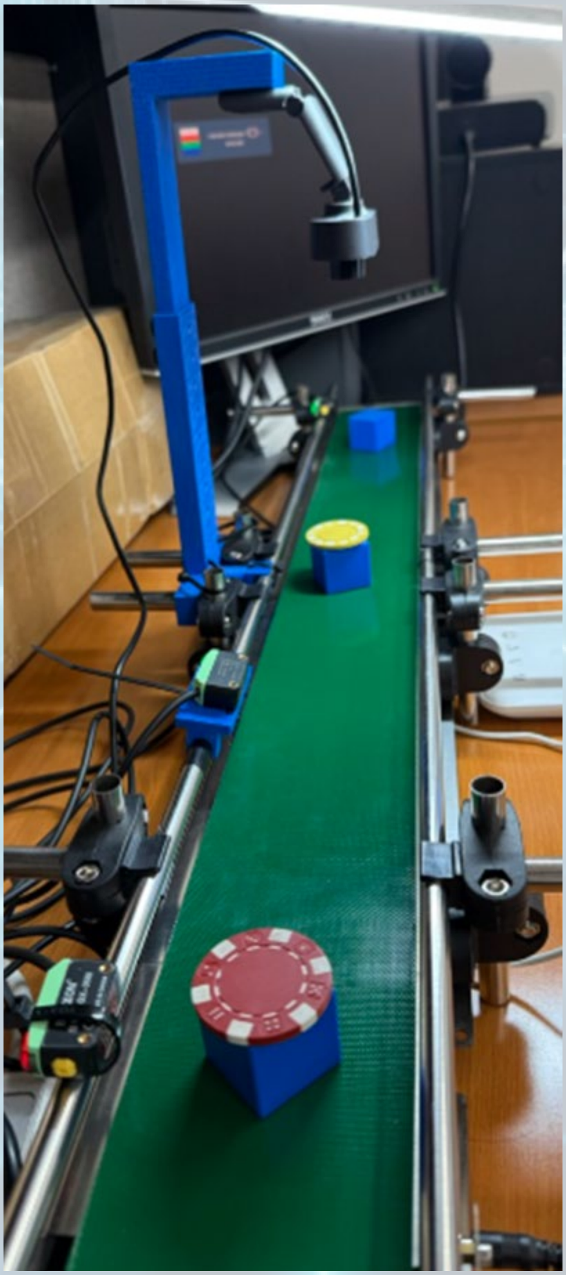


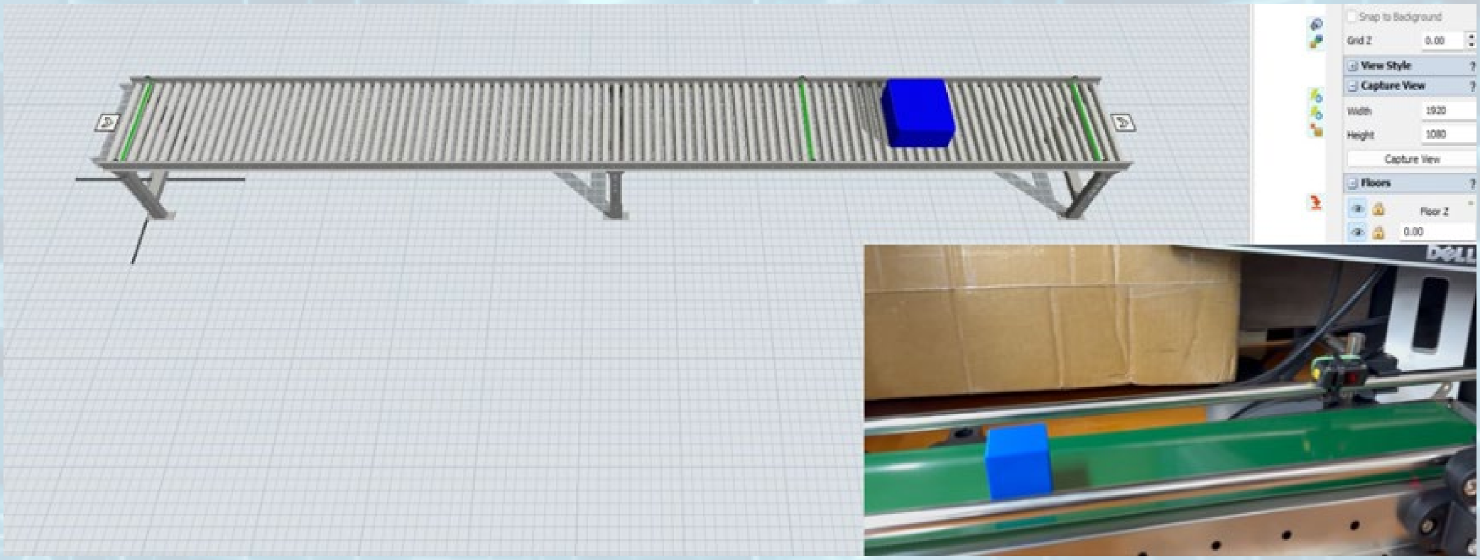
Figure 1. Physical system of the conveyor

Modern manufacturing ecosystems are increasingly complex, integrating real-time software and automation. Digital Twins (DT) are transforming the industry, enabling enhanced monitoring and control. This article showcases a project currently being done in the Systems Innovation with Modeling and Simulation (SIMS) laboratory under the supervision of Dr. Md Fashiar Rahman. In this project, Mr. José Arvizu, a master's student, is developing a real-time Digital Twin of a physical system with a conveyor belt equipped with a vision system for object detection and classification using Artificial Intelligence (AI). The vision system can identify and classify objects moving along the conveyor, ensuring accurate synchronization between the real-world setup and its Digital Twin.

This project utilizes FlexSim simulation software, the FlexSim Emulation module, and a Programmable Logic Controller (PLC). FlexSim specializes in manufacturing systems. With real-time analysis tools, one can track performance, utilization times, and overall system efficiency. The emulation tool, crucial for this project, links FlexSim with external hardware, like the PLC and vision system. As shown in Figure 1, the physical system consists of a conveyor belt with three photoelectric sensors connected to a PLC, which powers and manages them. The PLC communicates with the system via Ethernet. The vision system, programmed with PyTorch, identifies the object's color and sends the detection to the real-time simulation, updating the object's color accordingly.

Events on the physical conveyor, such as object movement, are detected and transmitted to the virtual model, where the object's external features (such as color) are identified and updated dynamically and in real time. The DT can also adjust conveyor operations via the PLC in response to unexpected events. A mini-scale prototype was built as a testbed, as shown in Figure 2, demonstrating real-time monitoring, remote oversight, and improved system control. The DT framework is highly scalable, offering significant potential for expanding automation and intelligence in manufacturing. Such a DT

Figure 2. Digital Twin of the conveyor with real-time object recognition and classification functionalities.



framework can create infinite scenarios to design better systems and troubleshoot problems virtually risk-free and without making real-world changes that could disrupt operations. It works with hardware like sensors, robots, and conveyors to optimize operations, create predictive models, analyze performance, and predict failures.

In today's rapidly evolving industrial landscape, the demand for intelligent, interconnected manufacturing systems is more critical than ever. As the United States and other nations prioritize reshoring manufacturing and investing in advanced production technologies, integrating Digital Twin systems has emerged as a cornerstone for digital transformation. DTs enable manufacturers to mirror physical assets in a virtual environment, allowing seamless monitoring, simulation, and control. This capability is essential for improving operational efficiency, reducing downtime, and fostering innovation in predictive maintenance, process optimization, and supply chain resilience.

Aligned with this national priority, academic institutions are vital in driving innovation and preparing the workforce for next-generation manufacturing. Universities are increasingly engaging in applied research that explores theoretical advancements and builds hands-on experience with real-world systems. The Systems Innovation with Modeling and Simulation (SIMS) laboratory at The University of Texas at El Paso exemplifies this effort, where students and researchers collaborate to implement cutting-edge technologies in practical settings. By focusing on real-time data integration, machine learning, and automation, these initiatives contribute to building a future-ready workforce and advancing the field of intelligent manufacturing.

Jose Arvizu, Master's Student
Supervised by
Md Fashiar Rahman, Ph.D.
Assistant professor, IMSE Department

Augmented Reality-Based Visualization of Orbital Systems and Space Debris for Enhanced Space Situational Awareness

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Industrial, Manufacturing & Systems Engineering, The University of Texas at El Paso

Industrial, Manufacturing & Systems Engineering

Abstract

This project focuses on the development of an advanced Augmented Reality (AR) application for visualizing orbital systems—Geosynchronous Earth Orbit (GEO), Medium Earth Orbit (MEO), and Low Earth Orbit (LEO)—along with dynamic debris formations. The core objective is to create an immersive and interactive tool that provides detailed insights into orbital regimes and the growing concern of space debris. Using Autodesk Maya, we have designed 3D models of Earth, GEO, MEO, LEO, and various debris objects with different sizes, shapes, and masses. These models were successfully integrated into Unity and configured for deployment on HoloLens 2, enabling users to visualize the orbital system in real time.

The application allows users to explore and interact with orbital data and debris formations, offering detailed information about their location and properties. Debris objects are accurately placed within their respective orbits using geospatial coordinates (longitude and latitude). This provides a clear understanding of the debris environment and its potential impact on satellite operations. The AR-based visualization enhances situational awareness by offering a dynamic and intuitive experience that static models cannot achieve.

In future iterations, real-time data integration will be incorporated, enabling live updates of debris positions and characteristics. This will further improve the application's utility for training, analysis, and operational planning in space domain awareness. By visualizing and interacting with complex orbital systems through AR, this project provides an innovative solution to the challenges of space operations, improving decision-making and risk assessment for both commercial and military satellite operators.

Introduction

The exponential increase in the number of satellites and orbital missions has led to an alarming growth in space debris, particularly in critical orbital zones such as Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geosynchronous Earth Orbit (GEO). Traditional methods of monitoring and modeling these regions rely heavily on 2D visualization tools and tabular data, which limit spatial comprehension and real-time interaction. Understanding the complex behavior of space debris and its influence on orbital mechanics is vital for ensuring satellite safety and mission continuity. This project addresses that need by introducing an Augmented Reality (AR)-based application that allows users to visualize, interact with, and analyze orbital systems and debris formations in a 3D immersive environment..

The primary goal is to leverage AR technology to enhance space situational awareness by developing a dynamic visualization system that simulates Earth's orbital belts and space debris in real-time. Specifically, the project aims to:

i. Visualize LEO, MEO, and GEO with accurate scale and orientation.
ii. Simulate debris clusters with diverse physical properties and orbital behaviors.
iii. Provide interactive capabilities for users to inspect debris data and assess spatial relationships.
iv. Offer a functional tool for analysts, students, and space operators to study collision risks and orbital congestion.

Methodology

3D Modeling: High-resolution 3D models of the Earth, orbital rings, and space debris were created using Autodesk Maya. Emphasis was placed on scientific realism, varying object shapes and sizes, and physical characteristics including velocity, density, and material type to simulate differing real-world debris behaviors.

Unity Integration: The models were imported into Unity where the application framework was developed using MRTK (Mixed Reality Toolkit) and AR Foundation. Custom interaction scripts were implemented to enable spatial mapping, head-gaze targeting, air-tap gestures, and gesture-driven manipulation, offering users full control within the mixed reality environment.

AR Deployment: The application is deployed on Microsoft HoloLens 2, transforming real-world surroundings into immersive orbital environments. The Earth model and orbits are anchored in space, and users can physically navigate around them, zoom in on regions of interest, and interact with objects using natural hand movements.

Dynamic Simulation: Simulated debris were programmed with variable mass, velocity, and orbit altitude to reflect space dynamics. The use of geographic coordinates (longitude, latitude, and altitude) enables precise object placement. The architecture supports future updates using real-time Two-Line Element (TLE) datasets for live satellite and debris tracking.

System Architecture: A modular system design ensures flexibility for scaling features. Components such as object metadata rendering, orbit color-coding, and interaction control are decoupled, allowing for easy integration of new functionalities like data overlays, UI updates, and telemetry display.

Planned Extensions: The next stages of development aim to integrate AI-based anomaly detection, risk prediction algorithms, and probabilistic collision modeling. Additionally, the inclusion of space weather data visualization and API integration with live space object databases (e.g., CelesTrak or Space-Track.org) are planned.

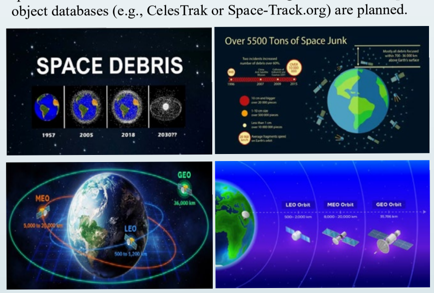

Fig-1: The problems and future predictions associated to debris/space junks on LEO, MEO and GEO orbits.

Results

The developed AR application was successfully deployed on the Microsoft HoloLens 2, delivering an intuitive user interface and immersive visualization of Earth's orbital regions. Users could navigate around dynamic, color-coded orbital belts—LEO, MEO, and GEO—that realistically represented altitude and spatial positioning. The simulation effectively showcased space debris behavior, varying in speed, size, and trajectory, thereby enhancing the realism and training value of the experience. Interactive features allowed users to select individual debris particles and access associated metadata, including orbital parameters and object characteristics, directly within the AR environment. This interactivity significantly improved user understanding of space congestion and highlighted high-risk zones with dense debris clusters. The tool proved particularly effective for training, education, and satellite operations planning, demonstrating its potential for both technical analysis and public outreach applications.

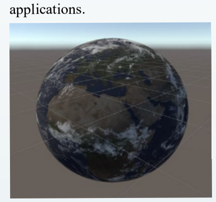

Fig-2: 3D model of the Earth designed in Autodesk Maya and imported to Unity

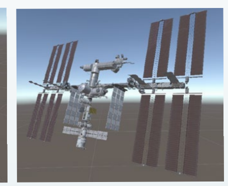

Fig-3: 3D model of the Satellite designed in Autodesk Maya and imported to Unity

Fig-4: Demonstration of Earth model and Satellite in Unity

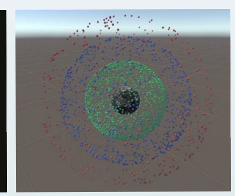

Fig-5: Visualization of catalogued and simulated space debris objects with earth model.

- Debris on LEO Orbit (Green)
- Debris on MEO Orbit (Blue)
- Debris on GEO Orbit (Red)

N.B: Due to data sensitivity, we are not representing the associated data of this project in this poster. However, authors are open to discuss in detail for interested students, analysts and researchers.

Conclusion

This project demonstrates the potential of AR to serve as a powerful tool for visualizing complex orbital systems and space debris interactions. By merging scientific accuracy with immersive technology, the application creates a rich user experience that improves spatial understanding and decision-making capabilities. The system's modular architecture supports future integration of live orbital datasets, making it a scalable solution for space operators and educators. This project not only supports operational training but also promotes safer and more sustainable practices in space domain awareness.

Acknowledgements

We extend our gratitude to The Intelligent Systems Engineering Laboratory (ISEL) and the Department of Industrial, Manufacturing and Systems Engineering at The University of Texas at El Paso. Special thanks to Dr. Tzu-Liang (Bill) Tseng for providing mentorship, technical resources, and guidance throughout the development of this project.

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THE UNIVERSITY OF TEXAS AT EL PASO

Integrating Machine Learning with 3D Geometry for Feasibility Prediction in Manufacturing Design

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Department of Industrial, Manufacturing & Systems Engineering
University of Texas at El Paso

Industrial, Manufacturing & Systems Engineering

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Abstract

In modern manufacturing, evaluating the feasibility of design concepts is essential for optimizing production efficiency and reducing costs. Traditional methods rely on expert judgment and computational simulations, which can be time-consuming and resource-intensive. This study introduces a machine learning approach that integrates scalar parameters and 3D geometric features from design models to automate feasibility prediction. The methodology includes preprocessing scalar and 3D design data, feature engineering through geometric analysis, and predictive modelling using various machine learning classifiers like Logistic Regression, Decision Tree, SVM, and Random Forest. Feature selection techniques identify the most influential design parameters, improving model interpretability and efficiency. Comprehensive evaluation, including cross-validation, shows the Random Forest model achieving the highest accuracy and F1-score. SHAP (Shapley Additive Explanations) is used to provide insights into feature importance, enhancing model explainability. Integrating 3D geometric features with traditional scalar data significantly improves prediction performance, offering a more robust and automated feasibility assessment framework. This approach aids manufacturing engineers in making data-driven design decisions, reducing iteration cycles, and streamlining the product development process.

Introduction

Manufacturing feasibility assessment ensures cost efficiency and structural integrity but is often time-consuming. This study automates feasibility prediction using machine learning, integrating **scalar design parameters** and **3D geometric features**.

Figure-1: Sample Feasible Designs

The dataset includes 1000 design samples (500 feasible, 500 infeasible) with six scalar predictors and 3D representations. ML models like Random Forest, SVM, and Logistic Regression predict feasibility, with SHAP analysis ensuring interpretability.

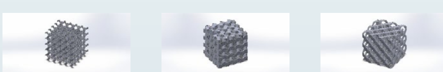

Figure-2: Sample Infeasible Designs

This poster presents the data workflow, model evaluation, and the impact of 3D geometric features on accuracy, with visual demos highlighting manufacturability differences.

Methodology

This study integrates **machine learning** and 3D geometric analysis to classify designs as **feasible or infeasible**. The methodology follows a structured pipeline based on CRISP-DM, enhanced with feature engineering techniques for 3D designs..

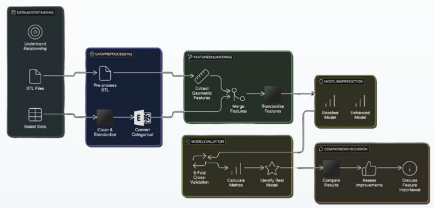

Figure-3: Proposed Methodology for Feasibility Prediction in Manufacturing Design

The **correlation matrix** identifies relationships between scalar predictors, geometric features, and feasibility. This helps in selecting the most relevant features for classification.

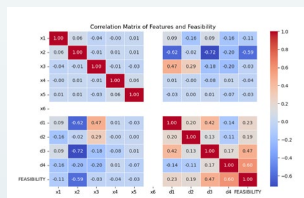

Figure-4: Correlation Matrix

The **3D scatter plot** visualizes feature distribution, revealing patterns that distinguish feasible from infeasible designs.

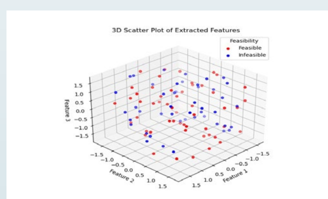

Figure-5: 3D Scatter Plot of Extracted Features

Results

Model Performance Evaluation:

To assess the classification performance, we trained multiple models, including Logistic Regression, Decision Tree, Support Vector Machine (SVM), and Random Forest. **The Random Forest model** achieved the highest accuracy of 93.62%, with an F1-score of 0.9437, outperforming other models in predicting feasibility.

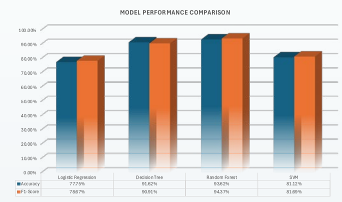

Figure-6: Model Performance Evaluation

Feature Importance Analysis:

To interpret the model's decision-making process, we analysed **feature importance** using Random Forest feature importance scores (Fig. 7). The most influential features were:x2 (31.1%): A primary determinant of feasibility. STL Aspect Ratio (25.6%): Critical geometric feature extracted from STL files.x3 and STL Volume: Contributed moderately to feasibility classification.

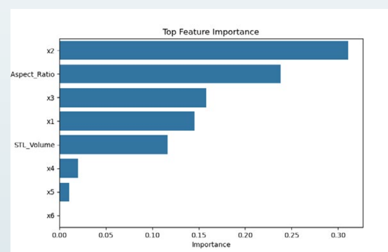

Figure-7: Top Feature Importance Analysis

To ensure feature relevance, T-tests and ANOVA (F-test) were applied. The results confirmed that the top features had the lowest p-values (< 0.001), indicating strong statistical significance.

Conclusion

This study successfully developed a machine learning-based feasibility classification framework for 3D-designed components using both scalar and STL-extracted geometric features. The Random Forest model achieved the highest accuracy of **93.6%**, outperforming other models in feasibility prediction.

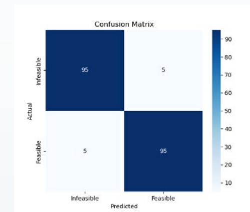

Figure-8: Confusion Matrix

The confusion matrix (shown in Figure 8) illustrates the classification performance, with **95% correct predictions** for both feasible and infeasible designs. The minimal misclassification indicates the robustness of the model in distinguishing between manufacturable and non-manufacturable designs. The low false positive and false negative rates further confirm its reliability in assisting design engineers.

Feature importance analysis revealed that STL-based geometric features strongly influence feasibility outcomes. T-tests and F-tests validated their significance, ensuring effective model performance. By integrating 3D design attributes with machine learning, this approach enhances feasibility assessment, reducing design iterations and improving manufacturing efficiency. Future work will explore deep learning, STL feature expansion, and explainable AI (e.g., SHAP) for better interpretability and robustness. Material characteristics simulation results can be compared to this design variables for better results. These findings highlight the potential for automated design feasibility assessment, aiding engineers in optimizing manufacturing processes.

Acknowledgements

I sincerely thank my advisor, Dr. Amit J. Lopes, for his invaluable guidance, support, and insightful feedback. His expertise was instrumental in shaping this study. I also appreciate the Department of Industrial, Manufacturing & Systems Engineering, UTEP, for providing essential resources, as well as my colleagues for their collaboration and constructive discussions.

I am especially grateful to Hamilton Metal Corporation Limited for generously providing the dataset and 3D designs used in this study. Their contribution was crucial in facilitating the research and enhancing the understanding of manufacturing feasibility. This work would not have been possible without the collective support and contributions of all those involved, and I deeply appreciate their efforts.

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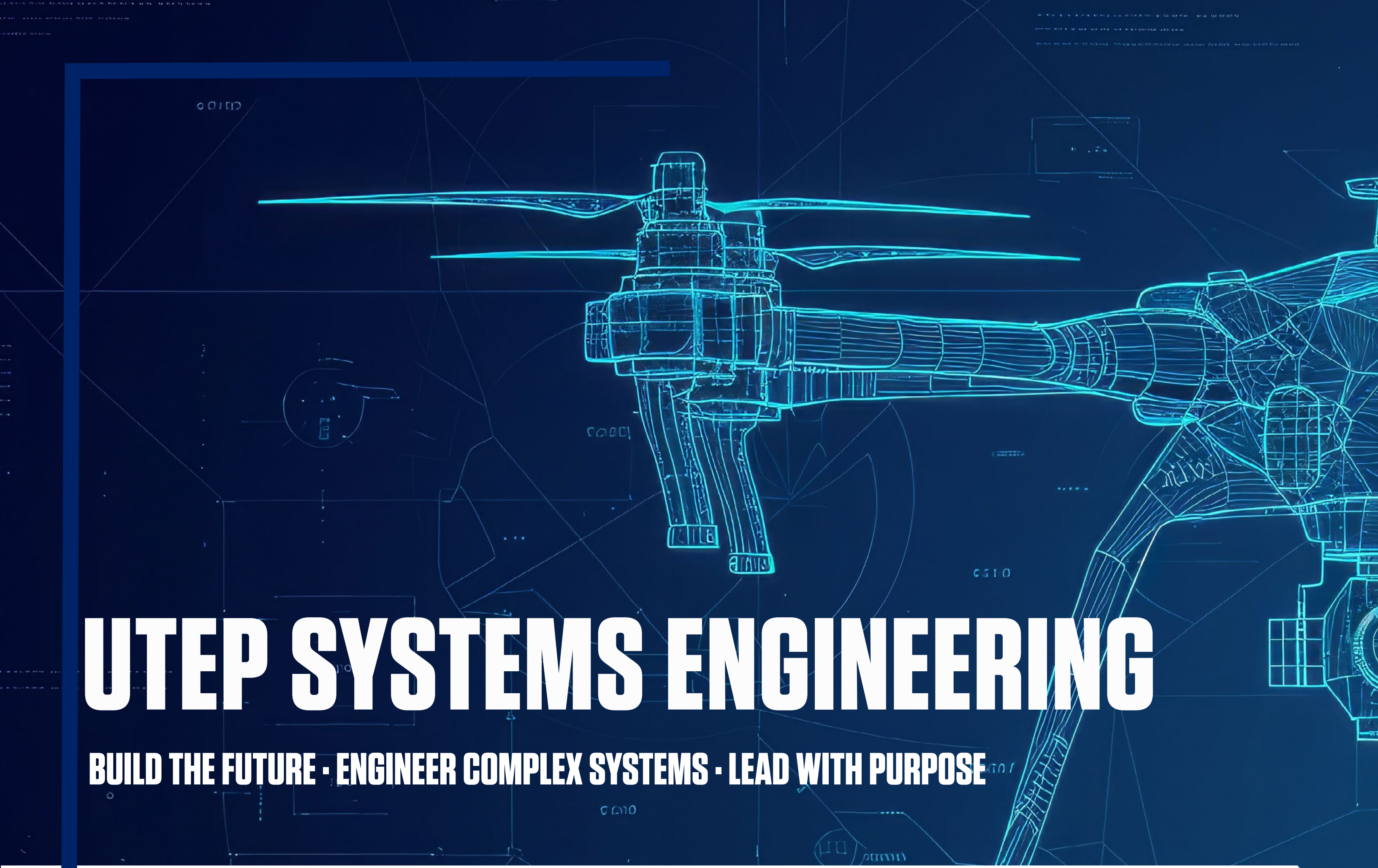

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- Industry guest lectures and networking

Projects Developed

- Digitalization of legacy systems (MBSE)
- AI for artifact development
- Automated Verification and Validation
- Industry training of MBSE
- Small Satellite Modularity
- Lunar Terrain Vehicle MBSE
- Image recognition

Heat Dissipation from a Nuclear Microreactor in Space

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UTEP Industrial, Manufacturing & Systems Engineering

Project Objective

The goal of this project is to explore heat rejection methods used on Earth, analyze trends in space-based heat rejection, and assess the feasibility of adapting these methods for a spacecraft equipped with a nuclear reactor.

Introduction

- The heat dissipation is a critical component of the spacecraft's power infrastructure and responsible for managing excess thermal energy generated.
- In the vacuum of space, traditional convective cooling methods are ineffective, necessitating advanced radiation-based heat rejection technologies.
- The system leverages radiators, heat pipes, and thermal control coatings to effectively transfer and radiate heat away from the spacecraft.

Background

- Designing a heat rejection model to reject a minimum of 60kWth of waste heat generated by the power conversion system,
- Energy coming out of the reactor will be used to feed up a satellite for a space mission that needs to last a total of 15 years.
- The newest microreactor technology will allow for longer and more successful space missions.

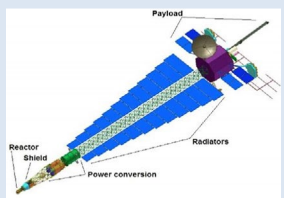
Methodology

1. Literature Review: Researched NASA sources and Kilopower project for heat rejection strategies.
2. Analytical Calculations in CAMEO: Determining radiator count based on waste heat and material selection.
3. System Design: Heat pipes + radiators stored in Falcon Heavy by Space X, deploying in orbit.
4. Software: Considering Fusion 360 for design

Setup

Westinghouse Electric Company. (n.d.). *eVinci™ Microreactor* [Images]. Westinghouse Electric Company

Heat Dissipation System: Connected to the reactor via heat pipes, transferring waste heat to deployable radiators.
Environmental Considerations: Designed to withstand temperature extremes and operate efficiently in space.



NASA. (2012). *Jupiter Icy Moons Orbiter (JIMO)* [Image]. NASA

Microreactor Placement: Located at the front/top of the satellite for power generation.

Deployment Mechanism:

- Stowed compactly during launch.
- Radiators unfold/extend after satellite separation.

Northrop Grumman Corporation. (2020). *GEOStar-3* [Images]. Northrop Grumman.

FMEA For Heat Rejection System

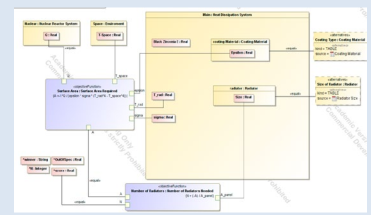
Part/Process	Potential Failure Mod	Potential Failure Effects	S (Severity)	Potential Causes	Occu	Current Controls	D (Detection)	RPN (Risk Priority Number)
Radiator Panel (Material Failure)	Emissivity loss	Reduced radiative cooling efficiency	7	Degradation of high-emissivity coatings over time	5	Use SiC or ZrO2 coatings, perform pre-launch durability tests	6	210
Heat Pipe Failure	Loss of thermal transport	Localized overheating of reactor, thermal runaway	10	Micro-meteroid impact, manufacturing defects	3	Use redundant heat pipe loops, employ whipple shielding for impact protection	5	150
Radiator Panel (Material Failure)	Thermal degradation	Reduced heat dissipation, overheating of reactor	9	Long-term exposure to radiation and space conditions	4	Molybdenum or Niobium Alloys with SiC coating for thermal stability and oxidations resista	4	144
Solar Radiation-Induced Degradation	Loss of materrial strength	Weakened structure, loss of emissivity	7	Constant exposure to UV and solar wind	5	Use UV-resistant coatings(SiC, ZrO2), design with radiation-hardened materials	4	140
Oxidation in High-Temp Components	Material degradation	Reduced lifespan, potential failure	6	Long-term exposure to residual oxygen in launch phase	4	Apply Iridium of Hafnium Carbide coatings, bake out oxygen before launch	5	120
Structural Failure (Fatigue/Cracking)	Loss of mechanical integrity	Structural breakage, loss of function	8	Cyclic thermal stress, launch vibrations	3	Use Carbon-Carbon composites or Niobium Alloys, stress test under vaccuum conditions	4	96
Connectors Failure (Heat Pipe to Radiator Interface)	Poor thermal contact	Ineficcient heat transfer, overheating	8	Manufacturing defects, material expansion mismatch	3	Use high-reliability brazing or diffusion bonding tecniques, tests for long term durabilty	4	96
Cold-Induced Brittle Fracture	Structural damage	Cracking, loss of radiator function	8	Prolonged exposure to deep-space cold (3K)	2	Use high-temperature-resistant alloys (Mo-30W, Nb-1Zr) with low thermal expansion	4	64
Micrometeroid Impact	Surface damage	Punctures, loss of heat transport efficiency	9	High-speed particle collisions in	2	Use Whipple shielding, design redundant heat transport pathways	3	54

FMEA for Heat Dissipation System

Results

#	Name	OutOfSpec : Real	N : Integer	score : Real	winner : String
1	radiator Size Trade Study	0	6	0	
2	radiator Size Trade Study1	0	6	-17.4035	Coating Type : black Zirconia, Size of Radiator : big Radiator
3	radiator Size Trade Study2	0	9	0	
4	radiator Size Trade Study3	0	20	29.0058	Coating Type : black Zirconia, Size of Radiator : small Radiator
5	radiator Size Trade Study4	0	8	30.6172	Coating Type : silicone Carbide, Size of Radiator : small Radiator

Trade Study Results



Panel Size (m²)	Emissivity	# Panels	Total Area (m²)	Total Mass (kg @7.5 kg/m²)	Deployment Fit	Complexity
1.5	0.95	29	43.5	326	✅	Medium
2	0.95	22	44	330	✅	Low
2.5	0.95	18	45	337.5	❌	High

Conclusion

A heat rejection model is essential to dissipate the high levels of heat generated by the EVinci Microreactor, which will power a satellite on a 15-year space mission. The deployable system will be transported aboard a SpaceX Falcon Heavy, requiring a compact design to fit within payload constraints while ensuring efficient heat dissipation in space.

Acknowledgments

This research was funded through a Northrup Grumman and UTEP partnership.

Digital Twin for Real-Time Monitoring and Control of Conveyor Systems Using FlexSim, AI and PLC Integration

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[2]Department of Industrial, Manufacturing and Systems Engineering
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Industrial, Manufacturing & Systems Engineering

Abstract

Modern manufacturing ecosystems are increasingly complex, integrating real-time software and automation. Digital Twins (DT) are transforming the industry, enabling enhanced monitoring and control.

This project developed a DT of a conveyor system using FlexSim simulation software, the FlexSim Emulation module, and a Programmable Logic Controller (PLC). The system incorporates multiple sensors, including a vision sensor, to capture real-time data. Events on the physical conveyor, such as object movement, are detected and transmitted to the virtual model, where object color is identified and updated dynamically. The DT can also adjust conveyor operations via the PLC in response to unexpected events.

A mini-scale prototype was built as a testbed, demonstrating real-time monitoring, remote oversight, and improved system control. The DT framework is highly scalable, offering significant potential for expanding automation and intelligence in manufacturing.

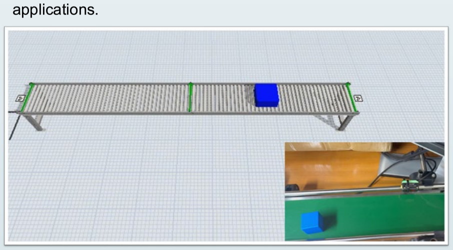
Introduction

The rapid evolution of manufacturing ecosystems has been driven by the integration of advanced technologies, enabling real-time data transmission and automation. As industries transition from manual operations to fully automated systems, the concept of Digital Twins (DT) is becoming increasingly prominent. A Digital Twin is a virtual representation of a physical system that mirrors its real-world counterpart in real time, allowing for enhanced monitoring, control, and predictive analysis. In this project, we developed a Digital Twin of a conveyor system utilizing FlexSim simulation software, the FlexSim Emulation module, and a Programmable Logic Controller (PLC). The DT integrates multiple sensors, including a vision sensor, to capture and transmit data between the physical and virtual environments. When an object enters or exits the conveyor, the sensors detect the event, and the data is processed within the digital replica. A vision sensor identifies the object's color, updating the simulation in real time. Additionally, in the event of an anomaly, the DT can send corrective signals to the physical system via the PLC. This study demonstrates the potential of Digital Twins for real-time monitoring and control in manufacturing. While implemented as a mini-scale prototype, the system is highly scalable for broader industrial applications.

Methodology

The real-time Digital Twin project simulates a conveyor system integrated with an advanced vision system, accurately replicating real-world operations. Using specialized manufacturing simulation software, the system includes three strategically placed sensors: entry, midpoint (triggering the vision system), and exit. A Programmable Logic Controller (PLC) operating on 12-24 VDC, managed via TIA Portal, controls these sensors.
The vision system, developed in Python with TorchVision, features an AI-driven image classifier that detects object color and material, improving classification accuracy and speed. Additionally, it incorporates a quality control mechanism to identify defective or unexpected objects, optimizing scrap management and process reliability.

FlexSim software is used to simulate the conveyor and sensor operations. Through its Emulation tool, the system communicates in real time with external systems like the PLC via Ethernet. An OPC UA server enables integration with the vision system, updating object status when detected at the midpoint sensor. The AI then classifies objects and transmits results back to FlexSim, ensuring real-time synchronization. Beyond color detection, the AI model can be trained to identify anomalies in material, color, or shape, making the system scalable for industrial automation and quality control applications.



Results

•Developed a real-time digital twin for optimizing operations, generating predictive models, and analyzing performance.

•Simulation closely mirrors real-world operations, accurately representing object movement.

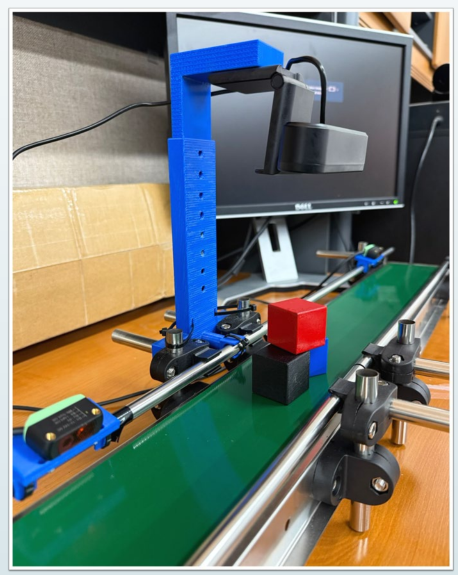
•AI-driven image classifier enhances vision system performance, improving object recognition and classification.

•Ensures precise synchronization—objects disappear from the simulation when the last sensor stops detecting them.

•Vision system includes a quality control mechanism to detect defective or incorrect objects.

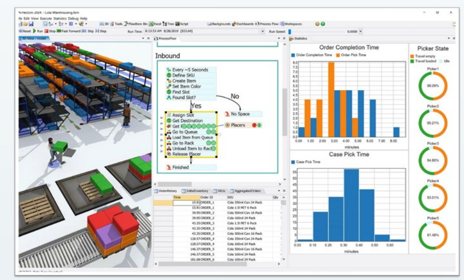
•Enhances operational efficiency by preventing errors and maintaining product integrity.

•Demonstrates potential for streamlining processes and improving decision-making in automated systems.



Conclusion

Digital Twin (DT) technology optimizes modern manufacturing by integrating real-time data, enabling engineers to simulate scenarios, predict failures, and troubleshoot without physical risks. This improves efficiency while reducing downtime and costs. Beyond manufacturing, DT is used in healthcare, smart cities, aerospace, and logistics. Companies like Walmart, Nissan, Amazon, and Michelin leverage DT to monitor performance, optimize resources, and enhance system efficiency. By integrating AI-driven vision systems and real-time communication, DT ensures precise synchronization between physical and virtual environments, improving automation and quality control. As industries shift toward data-driven decision-making, DT's role will expand, driving innovation and efficiency across multiple sectors. Its predictive capabilities and process optimization make it a crucial tool for businesses in an increasingly automated world.



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I would like to express my sincere gratitude to **Dr. Md Fashiar Rahman**, Assistant Professor in Industrial, Manufacturing and System Engineering (IMSE) Department at The University of Texas at El Paso (UTEP). I appreciate his mentorship, which has been key in this project.

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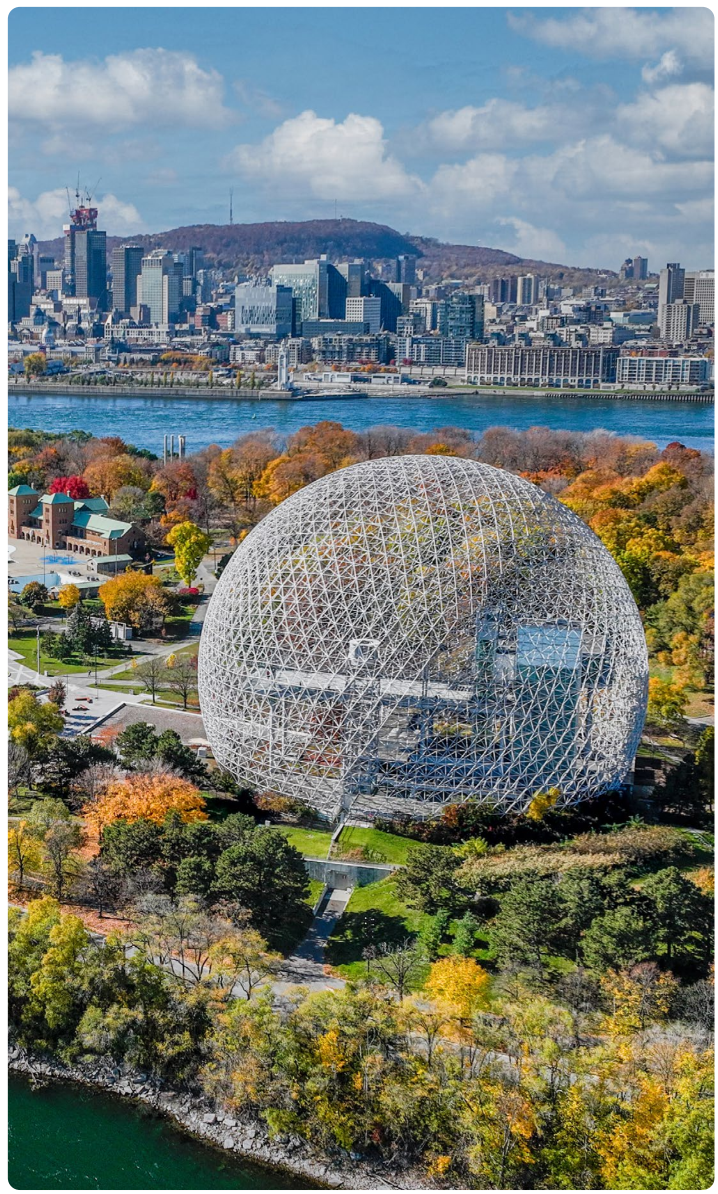
DEPARTMENT HIGHLIGHT

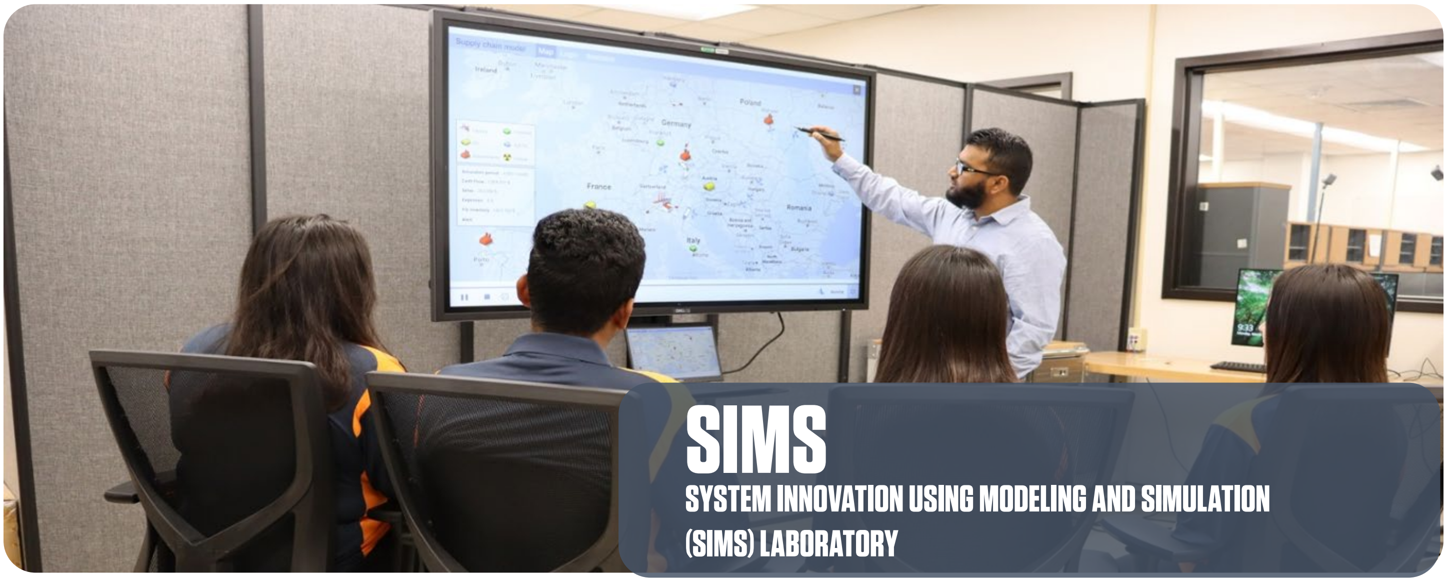


The Industrial, Manufacturing and Systems Engineering (IMSE) Department has a proud tradition of participating in the IISE (Institute of Industrial and Systems Engineers) Annual Conferences for 17 years! In 2024, faculty and students traveled to Montreal, Canada, to present cutting-edge research and represent IMSE-UTEP on an international stage. Each year, students whose research papers are accepted receive sponsorship to attend.

This ongoing support reflects IMSE's commitment to research excellence and professional development. Attending IISE conferences allows students to:

1. Present their work to a global audience
2. Network with industry professionals and fellow researchers
3. Gain insights into emerging trends in industrial and systems engineering

Our community continues to grow stronger through innovation, collaboration, and shared success.



SIMS

SYSTEM INNOVATION USING MODELING AND SIMULATION (SIMS) LABORATORY

The Research Institute of Manufacturing and Systems Science (RIMES) is the house of the SIMS laboratory, which was established in 2023 through the collaborative efforts of Dr. Rahman and Dr. Tseng, with partial funding from the U.S. Department of Education's FIPSE program. The SIMS Laboratory is committed to pioneering innovative solutions for complex ecosystems, particularly in manufacturing and healthcare, by harnessing advanced computational techniques.

Our research integrates Applied Artificial Intelligence, Deep Learning, Computer Modeling and Simulation, Smart Manufacturing, Digital Twins, Healthcare Systems, and Big Data Analytics to enhance decision-making, optimize processes, and drive innovation. By bridging theoretical advancements with practical applications, we strive to address real-world challenges, improve system efficiency, and develop the next generation of intelligent, data-driven solutions. Through interdisciplinary collaboration and state-of-the-art technologies, the SIMS Laboratory remains at the forefront of transforming industrial and healthcare systems for a smarter, more efficient future.

Available Resources

- Computer Simulation Software: AnyLogic University Research Version and FlexSim capable of discrete event simulation, agent-based simulation, and system dynamics for any complex systems
- FlexSim PLC Emulation license for Digital Twins
- Additive Manufacturing Resources: One Stratasys F370 and Two MakerBot Sketch 3D printers
- High computing facilities: Two Alienware GPU workstations and One Lambda Server
- Five student workstations with standard software combability for student research.
- Interactive screen for project demonstration and training
- Other Software: AnSys and Computer Aided Design Software (SolidWorks and Blender) for prototyping and modeling

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Empowering the Next Generation of Design Influencers to Holistically Design for the Future.

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By participating in this program, students will:

· Engage in transdisciplinary, real-world projects that address pressing societal challenges.

· Learn to design solutions that align with the United Nations Sustainable Development Goals.

· Gain experience working with communities to solve complex, interconnected problems that span global, cultural, and economic contexts.

· Receive specialized training in holistic design and inclusion in every phase of the design process.

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Join us in building a more inclusive, sustainable world—one design at a time. Apply and become a part of a transformative movement shaping the future of design.

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01 Coursework

Five course certificate on holistic design including a research seminar and community engagement capstone

02 Research

Engage in research with faculty mentors in one of the 5Ps - in Engineering, Education, Sicences, Health Sciences or Liberal Arts

03 Funding

Selected trainees receive stipend and tuition support. Eligibility for funding: US Citizens or Permanent Residents

04 Community Engagement

Address challenging societal problems like homelessness, poverty, and disability through holistic design and community engagement

05 Professional Development

Trainees receive profesisonal development opportunities based on their career path

Focus: Holistic Design of 5Ps

Holistic Design is essential to ensure all individuals can access and use products, services,and systems effectively.

Eligibility

Any graduate student in good standing interested in holistic design of 5Ps from any discipline. Should be admitted to UTEP Graduate School to be considered for NRT program admission.

Visit us to learn more

Contact Ms. Namburi or Dr. Pennathur to learn more.
Email: **epicnrt@utep.edu**

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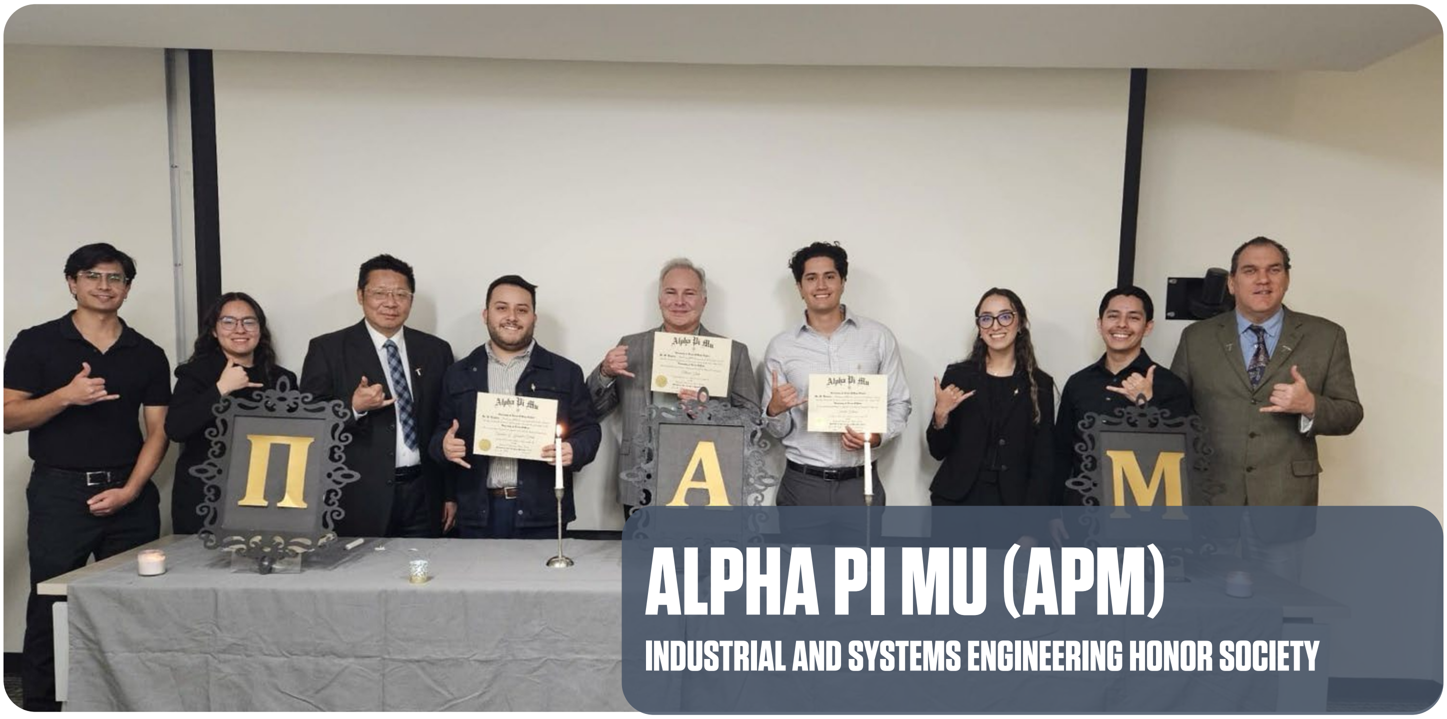

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