UNIVERSITI SAINS MALAYSIA

KAMPUS KEJURUTERAAN TUANKU SYED SIRAJUDDIN
UNIVERSITI SAINS MALAYSIA

USM ICE'26
USM International Conference on Engineering 2026

ICRAIEM 2026

INTERNATIONAL CONFERENCE ON RECENT ADVANCES
IN INDUSTRIAL ENGINEERING AND MANUFACTURING

Programme Book

The 2nd International Conference on Recent Advances in Industrial Engineering and Manufacturing 2026

Smart Manufacturing:
AI and Sustainability in Engineering Innovation

28–29 October 2026

Setia Spice Convention Center, Penang, Malaysia

Co-organisers

MPR Maths Proofread
Malaysia's Leading Proofreading Service Provider

PRINCE OF SONGKLA UNIVERSITY

MESSAGE FROM THE VICE-CHANCELLOR UNIVERSITI SAINS MALAYSIA



Assalamualaikum Warahmatullahi Wabarakatuh.

First of all, with an absolute pleasure and a genuine privilege, I am delighted to extend a warm welcome to all our esteemed and distinguished keynote speakers, delegates, industry partners and participants to this inaugural, premier convergence of international engineering conferences hosted by Universiti Sains Malaysia (USM). As the country's only APEX (Accelerated Program for Excellence) university, USM is committed to leading the sustainability agenda through transformative research, innovation, and education, driving meaningful change for the betterment of the society. Our institutional philosophy stems in the belief that higher education must serve as a catalyst for sustainable development, addressing the urgent needs of today while protecting the future. In a world of rapid technological disruption and environmental issues, the scope of engineering goes far beyond infrastructure and machinery. It is the fundamental engine of all engines for climate resilience, for economic vitality, and for the betterment of humankind.

Ladies and gentlemen,

The global challenges we face cannot be solved in isolation. From climate change and resource scarcity to the complexity of digital transformation, artificial intelligence, and rapid urbanization. What they need are integrated, multi-disciplinary solutions that draw on the combined expertise across all engineering sectors, from advanced manufacturing and electrical systems to resilient civil infrastructure, chemical processes, and aerospace technologies. In addition, our engineering efforts should be closely aligned with Environmental, Social, and Governance (ESG) principles and the spirit of the Malaysia MADANI vision, ensuring that technological progress is coupled with human-centric values and the United Nations' Sustainable Development Goals (SDGs).

The joint conference initiative is a strong indication of USM's grand vision of establishing strong global academic partnerships. We bring together the finest brains from diverse engineering disciplines and countries to create a vital, dynamic center for cross-sector work. These are the partnerships that bring together academia, government and industry that can translate the cutting-edge theoretical research into real world impacts and commercialized innovations.

To conclude, I would like to finally take this opportunity to express my appreciation to all organizing committees of the participating schools for their wonderful synergy in making this grand event possible. To our international guests who have come from afar and to our local participants, I wish you a very engaging, productive, and fruitful conference. May the dialogues initiated here foster lasting partnerships that shape the future of engineering worldwide and inspire the next generation of technology leaders.

Thank you.

Professor Dato' Seri Ir. Dr. Abdul Rahman Mohamed, FASc.
Vice-Chancellor
Universiti Sains Malaysia

WELCOME ADDRESS FROM THE CAMPUS DIRECTOR TUANKU SYED SIRAJUDDIN ENGINEERING CAMPUS



Assalamualaikum Warahmatullahi Wabarakatuh. It is my distinct honour and privilege, on behalf of the USM Engineering Campus, to warmly welcome all delegates to the beautiful state of Penang. You are gathered in a truly dynamic region, a nexus of rich cultural heritage and UNESCO-recognized history, and rapid industrial growth. Strategically located near major industrial corridors such as Batu Kawan, Penang is globally recognised as the "Silicon Valley of the East" and offers an inspiring and highly relevant ecosystem for an engineering conference of this magnitude.

As we convene for this prestigious conference, we are especially honoured to proudly commemorate the 25th anniversary of the USM Engineering Campus. This silver jubilee milestone represents 25 years of commitment to engineering excellence, impactful research, industry collaboration, and human capital development. It is a tribute to the collective efforts of our staff, students, alumni, industry partners and stakeholders who have helped develop the campus into one of the nation's leading engineering education and research centers. This conference is part of our anniversary celebrations and is an ideal opportunity to reflect on what we have achieved and to chart new pathways for innovation and global collaboration in the years ahead.

Our Engineering Campus, home to a variety of specialized engineering schools and world-renowned Centers of Excellence, has always prided itself on fostering a vibrant and holistic research environment. We bridge the gap between rigorous academic research and the critical needs of industry. We are always striving to challenge the limits of multi-disciplinary innovation, ensuring our collective research outcomes contribute directly to the Northern Corridor Economic Region (NCER), national development agendas and the acceleration of global technological progress.

Ladies and gentlemen,

The Fourth Industrial Revolution (IR 4.0) and the transition to a circular economy are driving a paradigm shift in the global engineering landscape. We are breaking down traditional academic silos and leveraging synergies across different branches of engineering combining machine learning with mechanical systems, integrating advanced nanomaterials with structural design, while embedding green technologies into everyday industrial processes to redefine how we approach the world's most complex problems. Academia cannot work in silos anymore; we need to co-create solutions and build future-ready talent with industry leaders and policy makers. I have no doubt that the state-of-the-art facilities, inter-faculty collaborations and the intellectually stimulating environment on our campus will provide the perfect setting for the discussions you will engage in over the coming days.

Finally, I hope all of you will use this unique multi-conference platform to network across disciplines, question the current quo, share new ideas, and explore future collaborations and research grants. Don't forget to also take the time to discover Penang's unique hospitality, rich culture and world-renowned cuisine. I wish you a very productive conference and an inspiring and memorable stay.

Thank you.

Professor Ir. Dr. Mariatti Jaafar@Mustapha
Campus Director, Tuanku Syed Sirajuddin Engineering Campus, Universiti Sains Malaysia

CONFERENCE CHAIR'S FOREWORD



Asalamualaikum Warahmatullahi Wabarakatuh and welcome to the conference, on behalf of the joint organizing and scientific committees, I welcome you to this grand assembly of engineering conferences with a profound sense of pride, gratitude and enthusiasm. The main objective of this mega event is to provide a dynamic, unifying, and high-level platform for researchers, academicians, industry practitioners and policy makers from various fields to converge, and thus, exchange knowledge and foster meaningful collaboration. Over the past year, the overwhelming response to our call for papers, with submission from across the globe, reflects a strong international commitment to knowledge sharing, benchmarking of research advancements, and cross-border collaboration. In the face of the unprecedented global challenges, the focus must be placed on developing the integrated, adaptive, resilient, and forward-looking engineering solutions that are sustainable, robust, and capable of standing the test of time.

During the next two days, we will discuss major breakthroughs in all participating engineering tracks. The well-designed program includes keynote addresses by world-class experts, highly specialized parallel technical sessions, booths in industry exhibitions, and extensive networking opportunities. We are also happy to inform you that the high-quality research presented here will be published in well-reputed indexed proceedings and special issues of journals which will further establish the academic legacy of this event.

Additionally, we also want to show that doing interdisciplinary work is not only valuable, but essential for our future together. The innovations in these rooms will help lay the foundation for tomorrow's smart cities, advanced manufacturing plants, and resilient infrastructures.

An event of this size and complexity is never the work of one person, nor is it the work of a single faculty. My deepest and most sincere gratitude goes to the joint secretariat and the organizing committee. Their vigorous dedication, resilience, and seamless teamwork over the past several months have brought this ambitious, unified vision to life successfully.

Next, I wish to express my sincere gratitude to our distinguished international advisory board and our rigorous panel of peer-reviewers for maintaining the high scientific standards of this conference. We would like to thank our generous sponsors, government agencies and strategic industry partners, as your continued support across all conference tracks has been key to making this event a resounding success.

Finally, we wish to thank our distinguished keynote speakers, authors and all the participants, particularly the young post-graduate researchers and students who are the future of our profession, for sharing their diverse expertise and lively insights with us in this forum. I strongly urge you to look beyond the boundaries of your specific academic domains, engage meaningfully with colleagues across diverse fields, and forge new avenues for interdisciplinary collaboration.

Thank you for your participation and I wish you an inspiring, thought-provoking and highly productive conference.

Associate Professor Dr. Abdullah Aziz Saad
Conference Advisor
Organizing Committee, ICRAIEM/USM ICE 2026

MESSAGE FROM ICRAIEM 2026 CHAIRMAN



First and foremost, on behalf of the Organising Committee of ICRAIEM 2026, I am delighted to extend a warm welcome to all delegates and participants attending this conference. Alhamdulillah, after an eight-year hiatus, ICRAIEM returns with a renewed vision and a timely, forward-looking theme focusing on Artificial Intelligence (AI) and Sustainability. While these topics have become increasingly prominent in contemporary discussions, their practical implications for industrial engineering and manufacturing continue to evolve. Understanding how we can adapt established practices, embrace emerging technologies, and prepare for the changing demands of the manufacturing sector has become more important than ever.

Against this backdrop, ICRAIEM 2026 has been conceived as a platform for academics, researchers, engineers, and industry practitioners to exchange knowledge, present their latest findings, and explore innovative approaches to the challenges and opportunities shaping the future of industrial engineering and manufacturing. Given the multidisciplinary nature of modern manufacturing, the conference sub-themes encompass a broad range of areas, including product design and analysis, automation, plant layout, optimisation and scheduling, quality control, data analytics, and other related fields. Through these diverse perspectives, we hope to foster meaningful discussions on the practical integration of AI and sustainable practices into manufacturing processes, while exploring future directions for a rapidly transforming industry.

Beyond the presentation of the latest research and insights through keynote addresses and technical sessions, we also hope that this conference will serve as a valuable platform for networking, knowledge exchange, and the establishment of new collaborations among participants from academia and industry. We believe that such interactions are essential to strengthening research partnerships and translating innovative ideas into meaningful industrial applications.

As we embark on this exciting journey together, I hope that you will find the conference both intellectually enriching and professionally rewarding. May your participation in ICRAIEM 2026 inspire new ideas, fruitful collaborations, and lasting connections.

Finally, I wish you a productive and memorable conference, and a pleasant stay in Penang.

Thank you.

Associate Professor Ir. Dr. Ahmad Baharddin Abdullah
General Chairman
School of Mechanical Engineering
Tuanku Syed Sirajuddin Engineering Campus, USM

ORGANIZING COMMITTEE

Patron
Professor Ir. Dr. Mariatti Jaafar@Mustapha

Advisor
Associate Professor Dr. Abdullah Aziz Saad
Associate Professor Ts. Dr. Mohd Sharizal Abdul Aziz

Chairman
Associate Professor Ir. Dr. Ahmad Baharuddin Abdullah

Co-chairman
Associate Professor Ir. Dr. Chin Jeng Feng

Secretary
Mrs. Zarirah Karrim Wani

Treasury
Mrs. Aida Hartini Mohd Tajuddin

Sponsorship
Associate Professor Ir. Dr. Yen Kin Sam (Leader)
Associate Professor Dr. Loh Wei Ping

Proceeding publication
Associate Professor Dr. Jamaluddin Abdullah (Leader)
Ir. Ts. Dr. Muhammad Hafiz Hassan
Dr. Md Anwar Ali Anshari

Technical, logistics & venue
Dr. Hasnida Ab Samat (Leader)
Ir. Dr. Nur Amalina Muhammad
Mr. Mohd Idzuan Said
Mr. Akmal Rosli

Conference website, publicity & promotion
Dr. Sareh Aiman Hilmi Abu Seman (Leader)
Dr Norzalilah Mohamad Nor
Ir. Dr. Abdul Haadi Abdul Manap

Conference program & schedule
Dr. Ramdziah Md. Nasir (Leader)
Dr. Siti Nur Hanisah Umar
Mr. Mohzani Mokhtar

INTERNATIONAL ADVISORY COMMITTEE

Professor Paul Wood
Universiti of Derby, United Kingdom.

Associate Professor Dr. Xuan Liang
Nanyang Technological University (NTU), Singapore

Professor Wei Min Huang
Nanyang Technological University (NTU), Singapore

Professor D. Rajamani
Vel Tech Institute of Technology, India

Associate Professor Dr. Nikorn
Prince of Songkla University, Thailand

Professor Ir. Ts. Dr. Yupiter HP Manurung
Universiti Teknologi MARA (UiTM), Malaysia

Associate Professor Dr. Kifayah Amar
Hasanuddin University, Indonesia

Associate Professor Ts. Dr. Pramod
REVA University, India

Professor Ir. Dr. Ahmad Razlan Yusoff
Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), Malaysia

Ir. Dr. Sung Aun Naa
ViTrox College, Malaysia

Mr. Lim Yew Kee
Institution of Engineering and Technology (IET), United Kingdom

Associate Professor Ir. Ts. Dr. Joshua Prakash
Universiti Tunku Abdul Rahman (UTAR), Malaysia

Associate Professor Dr. Shahrul Kamaruddin
Universiti Teknologi PETRONAS (UTP), Malaysia

Dr. Hamidreza Namazi
Monash University, Malaysia

Dr. Boey Kok Hong
Solid Precision Engineering Sdn. Bhd., Malaysia

Mr. Nanthakumaran Muniandy
HICOM Diecastings Sdn. Bhd., Malaysia

CONFERENCE INFORMATION AND PROGRAM

About ICRAIEM 2026

The USM International Conference on Engineering 2026 (USM ICE 2026) marks a milestone event in conjunction with the 25th anniversary of the Tuanku Syed Sirajuddin Engineering Campus. With the theme "Advances AI-Driven and Sustainability-Led Global Impact", the conference highlights cutting-edge research and innovations that address global challenges through engineering excellence. Organized under the umbrella of USM ICE 2026, each School within the Engineering Campus will host its own specialized conference, creating a dynamic platform for knowledge exchange, collaboration, and showcasing impactful research. This inaugural event reflects Universiti Sains Malaysia's commitment to advancing technology, sustainability, and international partnerships. The ICRAIEM 2026 conference, which is organized by the School of Mechanical Engineering, Tuanku Syed Sirajuddin Engineering Campus, Universiti Sains Malaysia (USM), in conjunction with USM ICE 2026 is to provide an excellent platform for industrial players, academicians, researchers, engineers, scientists and others to share their ideas and latest research in the fields of industrial engineering and manufacturing. The scope of the papers to be presented in this conference includes (but not limited to) the following:

- Additive manufacturing
- Applications of artificial intelligence
- Computer integrated manufacturing
- Data mining
- Ergonomics and human factors
- Facility management
- ICT and information system
- IoT in Manufacturing
- Lean manufacturing
- Logistics and materials handling
- Machine learning
- Machine tools technology
- Machine vision and automated inspection
- Machining and forming technology
- Maintenance engineering
- Manufacturing automation and robotics
- Materials joining
- Micro- and nanofabrication
- Modeling and simulation
- Operations research
- Optimization and simulation
- Precision machining
- Precision measurement and metrology
- Production planning and inventory control
- Quality and reliability
- Reverse engineering
- Safety engineering
- Scheduling
- Smart manufacturing
- Supply chain management
- Sustainable and green manufacturing
- Systems engineering
- Tool condition monitoring

Θ The two-day event of ICRAIEM 2026 will cover technical programs including keynote lectures and technical papers presentations.

Θ Technical papers are divided into two tracks namely Manufacturing and Industrial Engineering.

Θ Accepted papers will be published as a book chapter in Springer Book Series - Advanced Structural Materials (SCOPUS Indexed)

ABOUT THE ORGANIZER

SCHOOL OF MECHANICAL ENGINEERING, USM

VISION

- ✓ The School of Mechanical Engineering strive to be the best and leading provider of Mechanical Engineering and Manufacturing Engineering education and research in Malaysia

MISSION

- ✓ To deliver high-quality, innovative education while maintaining full accreditation for all degree programs.
- ✓ To achieve research excellence
- ✓ To establish and enhance the collaboration with industries for education input and research
- ✓ To serve the society and country by providing the latest knowledge and technology

BACKGROUND

The USM School of Mechanical Engineering was established on January 1st, 1989. The initial objective of the establishment of the school was to produce high-quality graduates in Mechanical Engineering and Manufacturing Engineering to fulfill the high demand for professional, specialized workers by the industries in Malaysia. These industries include design, development, manufacturing, production, service and maintenance industry, which are closely related to mechanical and mechatronics engineering involving development of various devices, tools, equipment, machines, components, support systems and infrastructure.

The development of the school is also aimed to be the center for acquiring and dissipating knowledge in the field pertaining to mechanical and manufacturing engineering. The acquisition is through the activities of research, development, project work, and professional networking. The dissemination is through consultancy work, workshops, seminars and professionals writing.

This philosophy is achieved through a curriculum and emphasis on various disciplines involving studies on organization and manufacturing management, manufacturing technology and manufacturing systems. In summary, this program is aimed at educating and training an engineer as a technologist for the manufacturing industry. The application of engineering and manufacturing principles in solving industrial problems is the main theme in this program whilst the management aspect focuses on the study on human, financial and communication factors.

All programs offered by USM School of Mechanical Engineering are tailored to ensure high quality of the School's graduates, aimed towards the achievement of Universiti Sains Malaysia's vision.

For undergraduate level, the programs offered are:

- Bachelor in Mechanical Engineering (Honours)
- Bachelor in Manufacturing Engineering with Management (Honours)

As for postgraduate level, the school offers Master and Ph.D. programs specializing in wide areas of research.

Under the Research Mode, the programs offered are:

- Master of Science (M.Sc.) by Research
- Doctor of Philosophy (Ph.D.) by Research

Under the Coursework Mode, the program offered is:

- Master of Science in Advanced Manufacturing Engineering Management

OVERALL PROGRAM SCHEDULE

DAY 1 (28 OCTOBER 2026) – WEDNESDAY*

TIME	ACTIVITIES
08.15 AM - 08.50 AM	Registration
08.50 AM - 09.00 AM	Arrival of the Guest of Honour and VIPs
09.00 AM – 09.10 AM	Negaraku Welcoming Remarks and Opening Prayer
09.10 AM – 09.20 AM	Welcome Address: **Professor Ir. Dr. Mariatti Jaafar@Mustapha** *Campus Director* *Tuanku Syed Sirajuddin Engineering Campus* *Universiti Sains Malaysia*
09.20 AM - 09.30 AM	Officiating Speech and Official Launch: **Professor Dato' Seri Ir. Dr. Abdul Rahman Mohamed, FASc.** *Vice-Chancellor* *Universiti Sains Malaysia*
09.30 AM - 09.40 AM	Official Launch of: USM International Conference on Engineering 2026 (USM ICE 2026)
09.40 AM - 10.00 AM	**Morning Tea Break** (Refreshment & Networking)
10.00 AM – 10.45 AM	Keynote Speaker 1 **Prof. Paul Wood** *Institute for Innovation in Sustainable Engineering* *University of Derby* *Chairperson: Ir. Ts. Dr. Muhammad Hafiz Hassan* *(Venue: Function Room 9)*
10.45 AM - 11:30 AM	Industrial Talk **Ms. Tan Xiao Wen** *Corporate Communications & Sustainability Manager* *Creative Bliss Sdn Bhd* *Chairperson: Ir. Ts. Dr. Muhammad Hafiz Hassan* *(Venue: Function Room 9)*
11.30 AM – 01.00 PM	Morning Technical Sessions 1 **Manufacturing Track 1** - *Venue: Function Room 9*
01.00 PM - 02.00 PM	**Lunch Break** (Networking Lunch)
02.00 PM - 02.45 PM	Keynote Speaker 2 **Mr Lim Yew Kee, CEng MIET** *Council Member of The Institution of Engineering and Technology (IET), United Kingdom* *Engineering Consultant & Adjunct Lecturer* *Universiti Teknologi PETRONAS (UTP)* *Chairperson: Ir. Dr. Abdul Haadi Abdul Manap* *(Venue: Function Room 9)*

02.45 PM - 03.30 PM	Afternoon Technical Sessions 1 **Industrial Engineering Track 1** - *Venue: Function Room 9*
03.30 PM - 03.45 PM	**Evening Tea Break** (Coffee & Networking)
03.45 PM - 05.00 PM	Afternoon Technical Sessions 1 Continue **Industrial Engineering Track 1** - *Venue: Function Room 9*
05.00 PM	**END OF DAY 1**

DAY 2 (29 OCTOBER 2026) – THURSDAY*

TIME	ACTIVITIES
09.00 AM - 9.40 AM	Keynote Speaker 3 **Dr Boey Kok Hong** *Founder and Managing Director* *SOLID Precision Engineering (SPE) Sdn. Bhd.* *Chairperson: Assoc. Prof. Ir. Dr. Ahmad Baharuddin Abdullah* *(Venue: Function Room 9)*
09.40 AM - 10.00 AM	**Morning Tea Break** (Refreshment & Networking)
10.00 AM - 01.00 PM	Morning Technical Sessions 2 **Manufacturing Track 2** - *Venue: Function Room 9* **Invited Speaker** – Dr. Murshid Imam **Industrial Engineering Track 2** - *Venue: Function Room 3*
01.00 PM - 02.00 PM	**Lunch Break** (Networking Lunch)
02.00 PM - 03.30 PM	Afternoon Technical Sessions 2 **Manufacturing Track 3** - *Venue: Function Room 9* **Industrial Engineering Track 3** - *Venue: Function Room 3*
03.30 PM – 03.45 PM	**Evening Tea Break** (Coffee & Networking)
03.45 PM – 05.00 PM	Afternoon Technical Sessions 2 Continue **Manufacturing Track 3** - *Venue: Function Room 9* **Industrial Engineering Track 3** - *Venue: Function Room 3*
04.30 PM	**CLOSING CEREMONY & END OF CONFERENCE**

All delegates are welcome and dress code is smart casual

TECHNICAL SESSION SCHEDULE

MANUFACTURING TRACK 1

DAY 1: 28 October 2026 (Wednesday)
Venue: Function Room 9

Chairperson: Mr. Nanthakumaran Muniandy
Timekeeper: Dr. Norzalilah Mohamad Nor

TIME	PAPER ID	PAPER TITLE SUB-THEMES: PRODUCT DESIGN, MATERIALS PROCESSING, AND MICRO- AND NANO-FABRICATION.	ABSTRACT PAGE
11.30AM –11.50AM	ICRAIEM2026-0007	1. DESIGN AND DEVELOPMENT OF A SUSTAINABLE SOLAR DRYING APPARATUS UTILIZING SOLAR ENERGY AND SUN DRYING TECHNIQUES.	20
11.50AM –12.10PM	ICRAIEM2026-0027	2. DESIGN AND FABRICATION OF A SMALL-SCALE MICROCONTROLLER-BASED POTENTIOSTAT FOR MULTIPURPOSE APPLICATION	21
12.10PM –12.30PM	ICRAIEM2026-0026	3. COMPARATIVE PRODUCTION-LEVEL ASSESSMENT OF WELD NUGGET DIAMETER VARIATION IN AUTOMOTIVE BODY-IN-WHITE MANUFACTURING	19
12.30PM –12.50PM	ICRAIEM2026-0010	4. EQUILIBRIUM STUDY OF SOLVATED GLUCOSE, GALACTURONIC ACID, AND MIXED GLC/GALA SYSTEMS USING MOLECULAR DYNAMICS	19
01.00pm		**LUNCH BREAK**	

INDUSTRIAL TRACK 1

DAY 1: 28 October 2026 (Wednesday)
Venue: Function Room 9

Chairperson: Assoc. Prof. Ir. Dr. Chin Jeng Feng
Timekeeper: Dr. Anwar Ali Anshari

TIME	PAPER ID	PAPER TITLE SUB-THEMES: QUALITY & RELIABILITY, ERGONOMICS & HUMAN FACTORS, APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN IE, MACHINE LEARNING IN IE, AND OPERATIONAL RESEARCH	ABSTRACT PAGE
02.45PM –03.05PM	ICRAIEM2026-0024	1. ORDER AWARE DMAIC ANALYSIS OF WEAVING REJECTION USING OPEN INDUSTRIAL DATA	23
03.05PM - 03.25PM	ICRAIEM2026-0013	2. THE DEVELOPMENT OF KINAESTHETIC HAPTIC DEVICE FOR EDUCATION APPLICATIONS	22
03.45PM - 04.05PM	ICRAIEM2026-0036	3. ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS IN AEROSPACE SYSTEMS: A COMPREHENSIVE ANALYSIS OF APPLICATIONS, CHALLENGES, AND FUTURE RESEARCH DIRECTIONS	25
04.05PM - 04.25PM	ICRAIEM2026-0037	4. A DATA-DRIVEN PREDICTIVE FRAMEWORK FOR VOLTAGE PROFILE ANALYSIS IN EV-INTEGRATED SMART DISTRIBUTION GRIDS USING RANDOM FOREST AND T-SNE	26
04.25PM - 04.45PM	ICRAIEM2026-0035	5. WHEN IS PRODUCT-SPECIFIC CARBON INFORMATION WORTH COLLECTING? VALUE-OF-INFORMATION THRESHOLDS FOR EMBODIED-CARBON PROCUREMENT UNDER EPD UNCERTAINTY	25
05.00pm		**END OF DAY 1**	

MANUFACTURING TRACK 2

DAY 2: 29 October 2026 (Thursday) *Chairperson: Assoc. Prof. Ir. Dr. Ahmad Baharuddin Abdullah*

Venue: Function Room 9 *Timekeeper: Mr. Mohzani Mokhtar*

TIME	PAPER ID	PAPER TITLE	ABSTRACT PAGE
		SUB-THEMES: ADDITIVE MANUFACTURING	
10.00AM –10.20AM	ICRAIEM2026-0008	**INVITED SPEAKER** 1. OPPORTUNITIES AND FUTURE DIRECTIONS IN POST TREATMENT DRIVEN PROPERTY ENHANCEMENT OF WIRE ARC ADDITIVELY MANUFACTURED INCONEL 625	18
10.20AM –10.40AM	ICRAIEM2026-0004	2. FEASIBILITY INVESTIGATION OF IN718/18NI300 BIMETALLIC STRUCTURE PRODUCED THROUGH CMT-BASED WIRE ARC ADDITIVE MANUFACTURING	18
10.40AM - 11.00AM	ICRAIEM2026-0012	3. TRIBO-SURFACE PERFORMANCE OF HIGH TEMPERATURE HYDROPHOBICITY PDMS-BASED THIN FILMS	18
11.00AM –11.20AM	ICRAIEM2026-0014	4. THE EFFECT OF HONEYCOMB INFILL DENSITY ON THE STRUCTURAL INTEGRITY OF 3D-PRINTED UAV LANDING GEAR	18
11.20AM - 11.40AM	ICRAIEM2026-0023	5. AN EXPERIMENTAL INVESTIGATION ON TOOL WEAR OF UNCOATED TUNGSTEN CARBIDE WHEN MACHINING 316 STAINLESS STEEL	19
11.40AM –12.00PM	ICRAIEM2026-0028	6. PARTIAL MICROSTRUCTURAL RELAXATION AND STRENGTH–DUCTILITY TRADE-OFF IN LMD-FABRICATED NI2.1CRALFE HIGH-ENTROPY ALLOY AFTER INTERMEDIATE-TEMPERATURE ANNEALING	19
01.00pm		**LUNCH BREAK**	

INDUSTRIAL ENGINEERING TRACK 2

DAY 2: 29 October 2026 (Thursday) *Chairperson: Assoc. Prof. Dr. Jamaluddin Abdullah*

Venue: Function Room 3 *Timekeeper: Dr Hasnida Ab Samat*

TIME	PAPER ID	PAPER TITLE	ABSTRACT PAGE
		SUB-THEMES: APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN IE AND OPTIMIZATION IN IE.	
10.00AM –10.20AM	ICRAIEM2026-0015	1. TRANSFORMING AGING BOILERS INTO RELIABLE ASSETS: A RISK-BASED BOILER INTEGRITY PROGRAM FOR AN AGING MULTI-FUEL THERMAL POWER PLANT	22
10.20AM –10.40AM	ICRAIEM2026-0018	2. DUTY-CYCLE-DRIVEN TRADE-OFFS IN PULSED DC PLASMA NITRIDING OF 12CR18NI10TI STAINLESS STEEL	22
10.40AM - 11.00AM	ICRAIEM2026-0021	3. OPERATIONAL IMPACTS OF LOAD CYCLING ON BOILER EFFICIENCY AND TUBE RELIABILITY IN AN AGING MULTI UNIT COAL FIRED POWER PLANT	22
11.00AM –11.20AM	ICRAIEM2026-0030	4. FAILURE ANALYSIS AND RELIABILITY ASSESSMENT OF A SPURIOUS MASTER FUEL TRIP IN A THERMAL POWER PLANT: AN ENGINEERING CASE STUDY	25
11.20AM - 11.40AM	ICRAIEM2026-0033	5. JOB SATISFACTION, LEADERSHIP STYLE, ORGANIZATIONAL CULTURE, AND COMMITMENT AS DETERMINANTS OF TURNOVER INTENTION: AN SEM ANALYSIS IN MAKASSAR'S PRIVATE SECTOR	25
11.20AM - 11.40AM	ICRAIEM2026-0038	6. DELIVERY SEQUENCING HEURISTICS FOR AGV ROUTING OPTIMIZATION	26
01.00pm		**LUNCH BREAK**	

MANUFACTURING TRACK 3

DAY 2: 29 October 2026 (Thursday)
Venue: Function Room 9

Chairperson: Dr. Ramdziah Md. Nasir
Timekeeper: Ir. Dr Nur Amalina Muhammad

TIME	PAPER ID	PAPER TITLE SUB-THEMES: MATERIALS PROCESSING, SUSTAINABLE AND GREEN MANUFACTURING, AND OTHER AREAS RELATED TO MANUFACTURING.	ABSTRACT PAGE
02.00PM - 02.20PM	ICRAIEM2026-0019	1. SELECTION OF HVOF SPRAYING AND UNSM POST TREATMENT CONDITIONS FOR WC–12CO COATINGS	19
02.20PM – 02.40PM	ICRAIEM2026-0031	2. THE EFFECT OF FSP-ASSISTED CYANOACRYLATE INCLUSION ON THE SPRINGBACK AND HARDNESS OF AA5083 ALUMINUM ALLOY	21
02.40PM – 03.00PM	ICRAIEM2026-0011	3. RATE-DEPENDENT MECHANICAL PROPERTIES OF GREEN COMPOSITES: A COMPARATIVE STUDY OF DIFFERENT NATURAL FIBER REINFORCEMENTS	20
03.00PM – 03.20PM	ICRAIEM2026-0034	4. KENAF FIBER COMPOSITES AND FIBER-REINFORCED CONCRETE: A BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS AND EMERGING THEMES FOR SUSTAINABLE MATERIALS AND MANUFACTURING	21
03.45PM - 04.05PM	ICRAIEM2026-0022	5. EXPERIMENTAL INVESTIGATION OF THE FLEXURAL BEHAVIOR OF ASYMMETRIC CARALL LAMINATES.	20
04.30pm		**CLOSING CEREMONY & END OF CONFERENCE**	

INDUSTRIAL ENGINEERING TRACK 3

DAY 2: 29 October 2026 (Thursday)
Venue: Function Room 3

Chairperson: Assoc. Prof. Dr. Loh Wei Ping
Timekeeper: Dr. Siti Nur Hanisah Umar

TIME	PAPER ID	PAPER TITLE SUB-THEMES: LEAN MANUFACTURING, MACHINE LEARNING IN IE, AND OPERATIONAL RESEARCH	ABSTRACT PAGE
02.00PM - 02.20PM	ICRAIEM2026-0006	1. A DMAIC APPROACH TO MITIGATE CAPACITY LOSSES AT FIRST PROCESS IN A PRODUCTION LINE A CASE STUDY IN AN AIR FILTER MANUFACTURING COMPANY	23
02.20PM – 02.40PM	ICRAIEM2026-0017	2. REDUCTION OF DEFECT RATE DURING MATERIAL HANDLING PROCESS IN MASK PRODUCTION LINE USING DEFINE, MEASURE, ANALYSE, IMPROVE AND CONTROL (DMAIC) METHOD	23
02.40PM – 03.00PM	ICRAIEM2026-0020	3. A HYBRID KAIZEN–KAIKAKU MATURITY FRAMEWORK FOR TRANSFORMING COMPLIANCE MONITORING: A CASE STUDY OF DIGITAL PROCESS IMPROVEMENT IN MANUFACTURING	24
03.00PM – 03.20PM	ICRAIEM2026-0016	4. OPERATIONAL FORMALIZATION OF EARLY COAL-MILL INTRODUCTION DURING START-UP OF 500 MW THERMAL UNITS	24
03.45PM – 04.05PM	ICRAIEM2026-0029	5. INTEGRATED MONITORING, COMPLIANCE MARGIN AND OPERATIONAL PERFORMANCE OF AIR EMISSIONS AND INDUSTRIAL EFFLUENT AT A MALAYSIAN LEGACY THERMAL FIRED POWER PLANT	24
04.30pm		**CLOSING CEREMONY & END OF CONFERENCE**	

KEYNOTE SPEAKER ONE



DR. PAUL WOOD, Professor of Advanced Manufacturing and Director of the Institute for Innovation in Sustainable Engineering at the University of Derby. Current research interests focus on additive and subtractive manufacturing of hard alloys and condition monitoring of manufacturing processes. Paul has overseen the delivery of multi-million EU funded research and innovation projects in partnership with business and industry (value £20 M) over 8 years. He has secured and delivered funded R&D and Innovation projects to industry in the transport and nuclear sectors. He has supervised ten PhD completions. Paul has delivered plenary, keynote and invited papers at 54 international conferences and workshops. Paul has 185 works online, published 110 articles, 2 books, 11 book chapters, 38 technical reports and lecture notes.

ADDITIVE AND SUBTRACTIVE MANUFACTURING RESEARCH AT THE UNIVERSITY OF DERBY

SYNOPSIS - The research undertaken by my team at the Institute within the University of Derby focuses on advanced manufacturing of high integrity components covering additive and subtractive processes for transport, healthcare, and the energy power generation sectors. These are regulated sectors and as such the development of products using new materials and manufacturing processes are governed by strict requirements. Underpinning research in additive manufacturing aligned to real applications has focused on the use of laser melting powder bed fusion (LPBF) of high temperature and corrosion resistant alloys (Inconel 718 and stainless steel 316L), and selective laser sintering (SLS) of polyamide (nylon) polymers. In the former under a National Grid funded innovation project, we have conducted extensive low and high cycle fatigue tests on the 3D printed stainless steel 316L material in different build orientations and surface conditions and published the results and findings in numerous journals in recent years.

Our research has demonstrated the new fatigue data can be used to design components in 316L by additive manufacturing in regulated sectors. In the latter under the DECARBONISE grant funded project, we manufactured and conducted high-rate compression and tensile tests on a 3D printed polyamide (nylon) 11 polymer across a range of temperatures and established a constitutive model to predict yield stress behavior that can be used in the design of wearable devices e.g., orthotics, to accelerate patient rehabilitation. Polyamide 11 is a biocompatible and biodegradable structural polymer and conventional moldable grades have been used to make high-performance components in numerous sectors for some decades. Our research had determined the effect of build orientation porosity on yield stress which is a feature of 3D printing polyamide 11 and other polymers and incorporated it in the new yield stress model.

Over the past decade we have developed lab-based manufacturing test beds that are fully instrumented with a variety of sensors to conduct machinability assessments of hard nickel based and titanium alloys in turning, milling, drilling, and tapping. The manufacturing test beds have been developed and used in two ways. First, under a project funded by an aeroengine maker, over fifty different coolant assessments on tool wear rate were performed to compare new to market biobased formulations with fossil-based products with the aim to decarbonize manufacturing. Second, under an industry led grant funded project AI-STREAMS, to develop and demonstrate the potential for low-cost factory instrumented manufacturing using on-machine sensors and an AI framework to optimize production processes and predict a tool failure condition before the event happens.

KEYNOTE SPEAKER TWO



MR LIM YEW KEE is a registered Chartered Engineer (CEng) with the Engineering Council (EC-UK), United Kingdom. He is currently an Engineering Consultant based in Penang, Malaysia. Other than the involvement in industry, he is also the Industry-Community Advisory Panel (ICAP) at Universiti Sains Malaysia (USM); and the adjunct lecturer in Universiti Teknologi PETRONAS (UTP), Tronoh, Perak, Malaysia.

Mr. Lim has been actively serving the Institution of Engineering and Technology (IET), United Kingdom since 2013. He is elected as the Council Member (2023 - 2026). He has been selected as the IET Ambassador for IET China (2016). Currently, he is the International Professional Registration Advisor, IPRA (since 2017-present) for Chartered Engineer (CEng) and Incorporated Engineer (IEng), as well as the Chairman (2018-2020) of IET Internet of Things Network.

In short, the profession and vast experience in the industry and academia of Mr. Lim are worth sharing and learned by many. Mr. Lim Yew Kee has been invited to deliver technical lectures to various universities and professional societies in China, India, Singapore and other countries

BRIDGING THE ANALOG-DIGITAL DIVIDE HANDWRITING TECHNOLOGY IN THE INTERNET OF THINGS (IOT) ECOSYSTEM

SYNOPSIS - Digital technology is no longer just a tool for automation; it is the fundamental fabric of modern society. At the heart of this transformation is the Internet of Things (IoT), a massive network of interconnected devices rewriting the rules of industry, urban living, and human capability.

Moving forward to explore how the convergence of high-speed digital infrastructure, cloud computing, and intelligent edge devices is turning everyday physical objects into data-generating powerhouses.

KEYNOTE SPEAKER THREE



DR. BOEY KOK HOONG has been a key founder and technology driver for SOLID Precision Engineering Sdn Bhd (SPE), the QMS ISO 9001:2016 and EMS ISO 14001:2016 certified company for the past 20 years till date. He is also holding directorship portfolios in other local ventured companies. SPE is located in Sungai Petani, Kedah, Malaysia, and operates with a multi-million-dollar revenue stream each year with a CAGR of around 20% despite in the recent economically turbulent and challenging year. Dr. Boey was graduated from Universiti Sains Malaysia (USM) with a Bachelor of Engineering (Hons) in Mechanical Engineering. In addition, he also possesses a Doctor of Engineering degree in Manufacturing Engineering from Universiti Teknikal Malaysia Melaka (UTeM). Being a various awards recipients such as Malaysia Best Business Excellence Award-2016, Best Service Awards, Best Quality Awards from various reputable organizations and recently in November, 2022, he received a prestigious recognition from our Malaysian government ministry, SME Corporation for the Top 50 SME Award. Dr. Boey, on the other hand, is involved in various corporate social responsibility initiatives by operating a healthcare rehabilitation facilities in Sungai Petani for individuals in need, involving in the Special Interest Group on Industry-Ready Talent (SIGIRT) stakeholder engagement workshop @ Academy of Science Malaysia (ASM) etc. He is also a life membership of Malaysian Invention and Design Society (MINDS) and registered with Malaysia Board of Technologists (MBOT) as a Profesional Technologist. He was also being appointed as Industry-Community Advisory Panel (ICAP) for Mechanical Engineering Faculty @ USM, Industry Advisory Panel (IAP) for DPT Program @ KKTM, as an Associate Research Fellow @ UTeM and as Chairman of Industrial Advisory Panel (IAP) committee for Politeknik Tuanku Sultanah Bahiyah, PTSB. His recent appointment was as CEO @ PolyCC under KPT.

ENGINEERING BEYOND BOUNDARIES: AI, SUSTAINABILITY, AND CROSS-DISCIPLINARY INNOVATION IN SMART MANUFACTURING

SYNOPSIS - As artificial intelligence (AI), the Internet of Things (IoT), and advanced manufacturing technologies continue to transform industrial engineering, cross-disciplinary collaboration has become essential to achieving meaningful and sustainable innovation. This keynote explores how integrating mechanical, industrial, electrical, and computer engineering with non-engineering disciplines can address complex industrial and societal challenges.

The presentation highlights recent advances in smart manufacturing, including AI-driven process optimisation, predictive maintenance, digital twins, human–robot collaboration, and additive manufacturing. It emphasises that true manufacturing intelligence must extend beyond automation and productivity to encompass environmental sustainability, economic viability, worker well-being, and human-centred design.

Drawing on the Parkinson's Disease Deterrence Station project, the keynote illustrates the value of integrating IoT, vibration science and engineering, human physiology, and neuroscience to explore engineering solutions for healthcare-related challenges. This example demonstrates how knowledge sharing across disciplinary boundaries can inspire innovative approaches, encourage adaptive system design, and connect technological development with human needs.

Ultimately, the keynote advocates responsible AI adoption, sustainability-driven engineering, and stronger collaboration among academia, industry, and diverse research communities. It calls for a shift from isolated technical expertise towards integrated knowledge and human-centred innovation, helping shape a smarter, more sustainable, and more inclusive future for manufacturing.

INDUSTRIAL TALK



MS. TAN XIAO WEN is the Corporate Communications & Sustainability Manager at Creative Bliss Sdn Bhd, an HRD Corp Accredited Trainer, and certified in Sustainability & the Green Economy by Singapore Management University.
With over 8 years of experience advancing the United Nations Sustainable Development Goals (SDGs) through JCI and community initiatives, she specialises in corporate sustainability, strategic communications, stakeholder engagement, and people empowerment, connecting business strategies with meaningful social impact.

CREATIVE BLISS SDN BHD, a Malaysia-based precision metal manufacturing company specialising in metal stamping, CNC machining, sheet metal fabrication and integrated manufacturing solutions.
Beyond manufacturing excellence, CBLISS is committed to advancing sustainability through environmental responsibility, workforce development and community empowerment. Guided by its belief that sustainable growth begins with people, CBLISS actively collaborates with industry, educational institutions, and community partners to develop talent, strengthen social impact, and contribute to a more sustainable manufacturing ecosystem.

THE SOCIAL DIMENSION OF SUSTAINABLE MANUFACTURING: FROM WORKFORCE DEVELOPMENT TO COMMUNITY EMPOWERMENT

SYNOPSIS - Sustainable manufacturing is not only about what we produce, but also how we develop people, empower communities and create lasting impact.
This session explores how manufacturers can integrate social sustainability into their business practices, from workforce development and employee well-being to community empowerment. Through CBLISS's sustainability journey and Community Empowerment Project (CCEP), the sharing will highlight how strategic partnerships, people development and community-driven initiatives can create meaningful, long-term social impact while contributing to a more responsible manufacturing ecosystem.

CONFERENCE PAPER ABSTRACT LIST

MANUFACTURING TRACK

Paper ID: ICRAIEM2026-0004
FEASIBILITY INVESTIGATION OF IN718/18NI300 BIMETALLIC STRUCTURE PRODUCED THROUGH CMT-BASED WIRE ARC ADDITIVE MANUFACTURING
Jiang Aimin, Ahmad Baharuddin Abdullah, Wang Hui and Tian Kailai

Cold metal transfer-wire arc additive manufacturing (CMT-WAAM) features a high deposition rate and low heat input, making it suitable for the fabrication of metallic structural components. In this study, the feasibility of depositing IN718 onto 18Ni300 using the CMT-WAAM process was investigated. Microstructural analysis revealed that IN718 primarily exhibited columnar grains, while 18Ni300 was mainly composed of equiaxed grains, and the interface between the two materials showed good metallurgical bonding. Energy-dispersive spectroscopy (EDS) line scans indicated that Ni diffused ~41.2 µm from IN718 side into 18Ni300 side. The tensile strength and yield strength of the interfacial sample reached 772.8 MPa and 448.8 MPa, respectively, while the elongation was 16.29%. Hardness measurements demonstrated a gradual increase in microhardness from IN718 toward 18Ni300, with an interfacial hardness of approximately 315 HV, lying between those of the two adjacent materials. These results confirm the feasibility of using the CMT-WAAM process to fabricate IN718/18Ni300 bimetallic structures without transition layer, providing valuable process references for future research on bimetallic metal fabrication using CMT-WAAM

Paper ID: ICRAIEM2026-0008
OPPORTUNITIES AND FUTURE DIRECTIONS IN POST TREATMENT DRIVEN PROPERTY ENHANCEMENT OF WIRE ARC ADDITIVELY MANUFACTURED INCONEL 625
Rajnish Mishra and Murshid Imam

The fabrication of high value products with large size and complex shape is a challenge in additive manufacturing (AM) for aerospace, marine and energy applications. Wire arc additive manufacturing (WAAM) is one of the AM approaches popularized for the fabrication of metal structures due to its high deposition rate, low cost, excellent material utilization and high efficiency. However, the as-built WAAM IN625 (alloy 625) shows microstructural features of coarse columnar dendritic grains, Nb and Mo segregation, Laves phase formation, resulting in high residual stresses and mechanical anisotropy. These features of as-built WAAM IN625 reduced the corrosion and wear resistance. Post-deposition heat treatment (PDHT) and friction stir processing (FSP) were identified for their efficacy for improving the performance of as-built WAAM IN625. Post-processing techniques such as PDHT and FSP were found to be effective in refining the microstructure, dissolving segregated phases, eliminating the residual stresses and improving the mechanical performance of the as-built WAAM IN625. Furthermore, the optimization of WAAM process parameters such as interlayer dwell time found to have an impact on the efficacy of post processing. Hence, this work presents recent advancements in the post-processing of WAAM-fabricated IN625, with comprehensive discussions on the process–microstructure–property relationships, and provides a conceptual foundation for the future development of intelligent hybrid manufacturing technologies for high value nickel-based superalloy components

Paper ID: ICRAIEM2026-0012
TRIBO-SURFACE PERFORMANCE OF HIGH TEMPERATURE HYDROPHOBICITY PDMS-BASED THIN FILMS
Ramdziah Md Nasir, Riyadh Hassan Hadree, Nur Bayani Muhammad Zahir, Sin Jia Hao

Tribo-surface performance of high hydrophobicity PDMS-based thin films coated on stainless steel under elevated temperature conditions was studied. PDMS coated stainless-steel samples were tested at three various temperatures (40°C, 60°C, and 80°C). The heat-treated coated steels surfaces were evaluated by its hardness, surface roughness, water contact angle, tribological performance using a pin-on-disk, while SEM and EDX analyses were used to observe the surface morphology and elemental composition. The coated surfaces recorded contact angle values above 110°, showing the PDMS coating successfully produced high hydrophobic surfaces. The coating performance is affected by elevated temperature, coating thickness, hardness, and roughness. SEM/EDX analysis showed that surface damage became more obvious as the temperature increased, especially at 80°C. Generally, the study shows that PDMS-based thin films can improve the hydrophobicity of stainless steel and provide surface protection. Further improvement in coating durability and heat resistance may be needed for long-term high temperature tribological applications.

Paper ID: ICRAIEM2026-0014
THE EFFECT OF HONEYCOMB INFILL DENSITY ON THE STRUCTURAL INTEGRITY OF 3D-PRINTED UAV LANDING
Aishah Binti Saafie and Nur Hidayah

Small and lightweight uncrewed aerial vehicles (UAVs) require landing gear that can withstand landing forces while remaining light enough to preserve flight efficiency and battery life. Although fused deposition modelling enables lightweight internal structures, the impact of honeycomb infill density on the mechanical properties of acrylonitrile butadiene styrene (ABS) UAV landing gear remains poorly understood. This paper presents an investigation of the 3d printed UAV landing gear with various infill densities to assess their effects on mechanical structural integrity. The landing gear components were designed in SolidWorks and printed from ABS via fused deposition modelling in controlled printing environments. Mechanical performance was measured using compression and three-point bending tests. The compression and bending assessments were conducted with an Instron 3367 universal testing machine. The results showed that infill density substantially affected mechanical behaviour. The maximum compressive force rose from 32.178 N at 30% infill to 50.321 N at 100% infill. For bending, the specimen with 80% infill achieved a load capacity of 158.483 N, compared with 135.092 N for the filled specimen. Furthermore, the identified critical stress regions matched the locations of cracks observed in the experiments. Generally, higher infill densities enhanced load-bearing ability, although solid infill did not always yield the best performance. The 80% infill resulted in the highest bending strength, whereas the 30% infill was sufficient for the 1.03 N UAV load, while minimising material usage, weight, printing duration, and costs. These results present useful insights for choosing an effective infill density for lightweight UAV landing

Paper ID: ICRAIEM2026-0023
AN EXPERIMENTAL INVESTIGATION ON TOOL WEAR OF UNCOATED TUNGSTEN CARBIDE WHEN MACHINING 316 STAINLESS STEEL
Nurul Hidayah Razak, Muhammad Asyraf Mohammad Yatim

This study investigates flank wear during dry down-milling of 316 stainless steel using uncoated tungsten carbide inserts. The effects of cutting speed, feed rate, and depth of cut were evaluated using a 15-run Box-Behnken design and Response Surface Methodology (RSM). Flank wear was measured using an optical video measuring system, with the tool-life criterion set at VB = 0.30 mm or VBmax = 0.50 mm. The regression model was statistically significant (p = 0.014), while the lack of fit was not significant (p = 0.242). Among the main factors, cutting speed showed the strongest effect, followed by feed rate and depth of cut. RSM optimization predicted a minimum flank wear of approximately 0.1983 mm at a cutting speed of 30 m/min, feed rate of 0.1263 mm/tooth, and depth of cut of 0.8 mm. The observed chip forms also varied with the machining conditions. Overall, the results show that suitable selection of machining parameters can reduce flank wear during dry milling of 316 stainless steel.

Paper ID: ICRAIEM2026-0028
PARTIAL MICROSTRUCTURAL RELAXATION AND STRENGTH–DUCTILITY TRADE-OFF IN LMD-FABRICATED NI2.1CRALFE HIGH-ENTROPY ALLOY AFTER INTERMEDIATE-TEMPERATURE ANNEALING
Wang Hui, Jamaluddin Abdullah, Jiang Aimin

High-entropy alloys (HEAs) fabricated by additive manufacturing (AM) offer tailorable microstructures and properties, yet how the non-equilibrium microstructures produced by laser metal deposition (LMD) evolve under intermediate-temperature annealing, and how this evolution governs mechanical response, remains unclear. Here, Ni2.1CrAlFe HEA was fabricated by LMD and heat-treated at 650 °C for 4 h; the microstructure, elemental distribution, and phase constitution before and after treatment were characterized by optical microscopy, SEM/EDS, XRD, and EBSD, combined with tensile testing, microhardness measurements, and fracture analysis. The as-built alloy exhibited a predominantly FCC, directional columnar/dendritic microstructure with local elemental segregation and lattice distortion. After heat treatment, the FCC matrix remained stable, dendritic interfaces became less distinct, local misorientation decreased, and the elemental distribution homogenized without new-phase formation, indicating partial relaxation via defect recovery and short-range diffusion. Correspondingly, yield strength decreased from 1000 to 724 MPa, ultimate tensile strength from 1060 to 939 MPa, while elongation increased from 2.5% to 4.5% and the microhardness range narrowed from 345-425 to 338-394 HV0.2, with more ductile fracture features. These findings establish a process–structure–property relationship linking LMD-induced non-equilibrium features to annealing-driven strength-ductility tailoring, offering new insight for post-processing design of AM-fabricated HEAs.

Paper ID: ICRAIEM2026-0019
SELECTION OF HVOF SPRAYING AND UNSM POST TREATMENT CONDITIONS FOR WC–12CO COATINGS
N.Magazov, A.Kengesbekov, D.Kakimzhanov, Ye.Molbossynov

The selection of spraying and post-treatment conditions for WC–12Co coatings requires assessment of several responses that may favour different processing regimes. This study investigates the relationship between liquid-fuel high-velocity oxygen-fuel (HVOF) spray conditions and the surface response of WC–12Co coatings to ultrasonic nanocrystal surface modification (UNSM). Coatings deposited at a kerosene-pump frequency of 33 Hz were selected for subsequent UNSM treatment. Four combinations of amplitude (20 and 50 µm) and static load (10 and 40 N) are compared using paired roughness changes, control-normalised hardness and friction, and descriptive two-factor contrasts. The 40 N conditions reduced Ra by approximately 65%, compared with 26–27% at 10 N. Their mean advantage in Ra reduction was 38.6 percentage points. Increasing amplitude had little average effect on Ra reduction, whereas its contribution to Rz reduction depended strongly on load. The maximum Vickers and Martens hardness values occurred under different conditions. All treated specimens exhibited higher mean dry-sliding friction than the untreated control. The results demonstrate that static load controls the Ra response over the investigated parameter range, while the reduction in Rz depends on the combination of load and amplitude. The different hardness and friction responses require property-specific selection of the treatment conditions.

Paper ID: ICRAIEM2026-0026
COMPARATIVE PRODUCTION-LEVEL ASSESSMENT OF WELD NUGGET DIAMETER VARIATION IN AUTOMOTIVE BODY-IN-WHITE MANUFACTURING
Muhamad Hafiz Mohamed Ali, Ahmad Baharudin Abdullah

Resistance spot welding (RSW) is widely used in automotive Body-in-White (BIW) manufacturing, where weld consistency is important for production quality and structural reliability. This study presents a production-data-based comparative assessment of weld nugget diameter for two automotive BIW production populations, Hyundai Santa Fe TM and Kia Carnival KA4. A total of 165 production records were analysed using dimensional compliance, descriptive statistics, BIW layer configuration, station-level stratification and exploratory Pearson correlation. The specified nugget criterion was 5.0 mm with a tolerance of +1.5/−1.0 mm, corresponding to an acceptance range of 4.0–6.5 mm. Both populations achieved 100% dimensional compliance. However, TM exhibited lower variation, with a mean nugget diameter of 4.876 mm and standard deviation of 0.346 mm, whereas KA4 recorded a mean of 5.026 mm and standard deviation of 0.557 mm. The corresponding coefficients of variation were approximately 7.1% and 11.1%, respectively. Layer and station analyses demonstrated within-population variation, while individual recorded process variables showed weak bivariate associations with nugget diameter. The findings indicate that dimensional acceptance and process consistency should be treated as complementary quality dimensions. The study provides a production-level baseline for subsequent development of an integrated RSW quality-control approach for automotive BIW manufacturing.
Surface roughness (Ra) is an important parameter in determining the quality of surface finishing of any products obtained from the machining process. Surface roughness can be affected by several factors such as machining parameters, workpiece material properties, cutting tool parameters and machine tool conditions. In this study, the effects of machining parameters such as feed rate and cutting speed on the surface roughness was investigated for aluminium, mild steel and brass materials during the turning process using CNC Lathe machine. The experimental Ra values obtained were compared with the theoretical values with discrepancy ranging from 1.14 % to 113.71 %. From the study, it can be concluded that the surface roughness of materials will increases as the feed rate increases and decrease when higher cutting speed is applied.

Paper ID: ICRAIEM2026-0010
EQUILIBRIUM STUDY OF SOLVATED GLUCOSE, GALACTURONIC ACID, AND MIXED GLC/GALA SYSTEMS USING MOLECULAR DYNAMICS
Beh En Qi, Abdul Haadi Bin Abdul Manap*, Muhammad Hakimin Shafie

Polysaccharides are renewable biopolymers whose behavior is influenced by molecular composition, functional groups, hydration, and local packing, but these atomic-level processes are difficult to observe directly using conventional experiments. Molecular dynamics (MD) simulation provides a cost-effective computational approach to investigate molecular behavior under controlled conditions. This study investigated solvated glucose (Glc), galacturonic acid (GalA), and mixed Glc/GalA systems using a consistent MD workflow. The systems were prepared using CHARMM-GUI and PACKMOL, solvated with TIP3P water, parameterized with the CHARMM36 carbohydrate force field, and simulated in LAMMPS. The workflow involved energy minimization, NVT equilibration at 298.15 K, and NPT simulation at 1 bar. Thermodynamic properties, final configurations, and oxygen–oxygen radial distribution functions (RDFs) were analyzed to compare equilibrium behavior and local structural arrangement. All systems achieved stable temperature, energy, and density behavior after the initial simulation stage. GalA showed the highest equilibrated density at 1.0465 g/cm³, followed by the mixed system at 1.0373 g/cm³ and Glc at 1.0284 g/cm³. The carbohydrate–water RDF showed the most pronounced hydration-related O–O spatial correlation for GalA, with g(r) = 1.47 at 2.775 Å, while the mixed system showed intermediate behavior. Residue-based RDF decomposition showed that high total carbohydrate–carbohydrate RDF peaks were mainly influenced by intramolecular oxygen–oxygen distances, while the intermolecular RDF peak was highest for Glc. Overall, carbohydrate composition influenced the equilibrium density and local O–O spatial correlation of the solvated carbohydrate systems, supporting MD simulation as a useful approach for atomic-level investigation of polysaccharide-related systems.

Paper ID: ICRAIEM2026-0011
RATE-DEPENDENT MECHANICAL PROPERTIES OF FULLY GREEN COMPOSITES: A COMPARATIVE STUDY OF DIFFERENT NATURAL FIBER REINFORCEMENTS
Anson Shim Wei Lun, Dr. Sareh Aiman Hilmi Abu Seman

This paper quantitatively compares the mechanical properties and failure mechanisms of coconut, pineapple leaf (PALF), and oil palm fiber-reinforced P9509 polyester composites under quasi-static and high-velocity dynamic conditions. Specimens were fabricated using cylindrical compression molding and tested via a Universal Testing Machine (UTM) and a Split-Hopkinson Pressure Bar (SHPB). Results indicate that coconut fiber composites provide the optimal balance of structural efficiency and crack-arresting capabilities under dynamic impacts, mitigating the catastrophic matrix shattering observed in the oil palm and PALF variants.

Paper ID: ICRAIEM2026-0022
EXPERIMENTAL INVESTIGATION OF THE FLEXURAL BEHAVIOR OF ASYMMETRIC CARALL LAMINATES
Afsar Husain, Madni Shifa, Sanan H. Khan, Abdel Hamid I. Mourad

To meet the energy savings targets, materials with high specific strength are needed because structural weight reduction increases efficiency in aerospace, automotive and energy applications. In this study, a fiber-metal laminate (FML) called asymmetric carbon-fiber reinforced aluminum laminate (CARALL) was fabricated by hand lay-up method and the flexural response of the laminate was studied experimentally. The performance was compared to that of an asymmetric carbon fiber reinforced polymer (CFRP) laminate with the same stacking sequence. Specific flexural strength, specific energy absorption and ductility were discussed for lightweight structural applications. The results showed that the specific flexural strength and specific energy absorption of the FML were 12% and 10% higher than those of the CFRP laminate with improved ductility, respectively. Fractographic analysis also revealed failure mechanisms within the FML, such as delamination, fiber failure, matrix cracking, and deformation of the metal layers. These results add to the understanding of the behavior of asymmetric FMLs and support the development of damage tolerant lightweight structures for demanding engineering applications.
The changes in magnitude of cutting force demonstrate the different occurrences in turning. The pattern of cutting force signal illustrates the cutting tool conditions and also corresponds to the changes in the cutting parameters. Obtaining an optimal cutting condition would significantly minimize the cutting force in turning, can reduce respective power consumption and consequently, extent the life of cutting tool. Choosing the optimal cutting parameters in turning would safeguard the cutting tool from catastrophe and could ensure a better surface finish of workpiece. From the orthogonal array and S/N ratio, the cutting speed of 120 m/min, feed rate of 0.32 mm/rev and depth of cut of 1 mm is found to be optimum cutting parameters. The magnitude of cutting force is found to be minimal and the surface finish is seen to be comparatively low at this cutting condition. The tool life at this cutting condition is found to be the longest for that particular tool – workpiece combination.

Paper ID: ICRAIEM2026-0007
DESIGN AND DEVELOPMENT OF A SUSTAINABLE SOLAR DRYING APPARATUS UTILIZING SOLAR ENERGY AND SUN DRYING TECHNIQUES
Zaid Al-Sadi, Osamah Fadhil Fakhri, Hisham H.Jasim, O.Hussein, Faiz.F.Mustafai

Food preservation remains a major challenge in many developing countries due to post-harvest losses, high energy consumption, and the limited availability of affordable drying technologies. Solar drying offers an environmentally friendly and cost-effective alternative to conventional drying methods by utilizing renewable solar energy. This study presents the design, fabrication, and experimental evaluation of a low-cost mixed-mode solar fruit dryer intended for drying various fruit products under natural climatic conditions. The proposed system consists of a solar collector, an insulated drying chamber equipped with multiple trays, a transparent glass cover, a natural convection airflow system, and a chimney to enhance moisture removal. The dryer was constructed using locally available materials to reduce manufacturing costs while maintaining good thermal insulation and structural durability. Experimental tests were conducted using sliced fruits under varying solar radiation conditions, with drying temperatures maintained between 50 and 65°C. Temperature, relative humidity, drying time, and moisture reduction were monitored throughout the drying process to evaluate the system performance. The developed solar dryer successfully reduced drying time to approximately 5–11 hours, depending on the fruit type and environmental conditions, while producing dried products with improved hygiene, color retention, and nutritional quality compared with conventional open-sun drying. The proposed design demonstrates a practical, energy-efficient, and economically viable solution for small-scale agricultural applications and provides a scalable platform for future integration with automatic control systems, Internet of Things (IoT) technologies, and intelligent monitoring for enhanced drying performance

Paper ID: ICRAIEM2026-0027
DESIGN AND FABRICATION OF A SMALL-SCALE MICROCONTROLLER-BASED POTENTIOSTAT FOR MULTIPURPOSE APPLICATIONS
Adriana Shahrul Nizam, Siti Nur Hanisah Umar

This article presents the design, fabrication, and electrical validation of a small-scale microcontroller-based potentiostat intended as a low-cost and adaptable proof-of-concept platform. An Arduino Due was used to generate a triangular digital-to-analog converter waveform, acquire conditioned voltage signals, calculate cell current, and transfer data to Microsoft Excel through PLX-DAQ. The analog front end consisted of unipolar-bipolar and bipolar-unipolar conversion stages, a summing amplifier, voltage follower, transimpedance amplifier, and inverting amplifier. The circuit was first evaluated in LTspice and subsequently fabricated and tested using 4.4 kΩ, 10 kΩ, and 20 kΩ resistive dummy cells. Digital multimeter validation with the 10 kΩ dummy cell showed close agreement between measured and theoretical values, with generally low standard deviation and relative standard deviation. During PLX-DAQ testing, the generated 0.6-2.6 V waveform remained repeatable over three cycles for each load. The measured responses were stable; however, the ADC-derived current reached approximately +250 µA and exceeded the intended ±100 µA measurement range. This systematic deviation was attributed to analog gain and offset errors, resistor tolerance, wiring effects, and ADC scaling. The developed system therefore demonstrates reliable signal generation and repeatability, while requiring calibration before real electrochemical measurements.

Paper ID: ICRAIEM2026-0031
THE EFFECT OF FSP-ASSISTED CYANOACRYLATE INCLUSION ON THE SPRINGBACK AND HARDNESS OF AA5083 ALUMINUM ALLOY
Nur Shahirah Binti Mohd Sanusi, Yusuf Mohammad Chindo and Md Anwar Ali Anshari*

This study investigates the influence of cyanoacrylate (CA) incorporation on the microstructure, hardness, springback effect and bending behavior of AA5083 alloy fabricated through friction stir processing (FSP). AA5083 was processed with CA volume fractions of 0.10, 0.15, and 0.20. FSP significantly refined the coarse primary intermetallic phases and promoted dynamic recrystallization, resulting in a homogeneous ultrafine-grained structure. During processing, thermal decomposition of CA promoted the formation of in-situ Al4C3 and AlN ceramic phases and carbonaceous residues, which contributed to grain refinement and dispersion strengthening. The hardness increased with CA incorporation, reaching 92.5 HV at 0.20 volume fraction; however, excessive CA promoted particle agglomeration, micro-void formation, and microstructural heterogeneity. Notably, 0.10 volume fraction of CA produced the lowest springback of 2.63°, corresponding to a 37% reduction relative to the base material. Bending-surface morphology confirmed improved strain accommodation and reduced deformation localization, demonstrating the potential of CA-assisted FSP for tailoring the forming response of AA5083 sheet.

Paper ID: ICRAIEM2026-0034
KENAF FIBER COMPOSITES AND FIBER-REINFORCED CONCRETE: A BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS AND EMERGING THEMES FOR SUSTAINABLE MATERIALS AND MANUFACTURING
Abdullah O. Baarimah, Madhusudhan Bangalore Ramu, Ahmed Wajeh Mushtaha, Aawag Mohsen Alawag

Kenaf (Hibiscus cannabinus L.) fiber has attracted growing interest as a renewable reinforcement for polymer and cementitious composites. However, the evolution of research across kenaf-based polymer composites and fiber-reinforced concrete, particularly in relation to sustainable materials processing and manufacturing, remains insufficiently mapped. Building on an earlier bibliometric analysis, this study provides an updated bibliometric assessment of the field using Scopus-indexed literature published between 2017 and September 2026. A total of 742 English-language documents were analyzed using performance analysis, author-keyword co-occurrence, Louvain-based clustering, dictionary-assisted theme tracking, and reference-frequency analysis. The results indicate sustained research activity, with polymer-composite studies continuing to dominate the field, while research on kenaf fiber-reinforced concrete has gained increasing attention in recent years. Sustainability-related themes have also become more prominent, whereas research integrating life-cycle assessment, carbon-related metrics, machine learning, and digital manufacturing remains comparatively limited. The thematic structure further reveals a contrast between process-oriented research in polymer composites and laboratory-based characterization in concrete applications. These patterns highlight opportunities to advance kenaf-based cementitious materials through scalable processing, process control, environmental assessment, and digital technologies. The study provides an updated and reproducible research map and identifies emerging directions for the development of sustainable kenaf-based composite and cementitious materials.

CONFERENCE PAPER ABSTRACT LIST

INDUSTRIAL ENGINEERING TRACK

Paper ID: ICRAIEM2026-0015

TRANSFORMING AGING BOILERS INTO RELIABLE ASSETS: A RISK-BASED BOILER INTEGRITY PROGRAM FOR AN AGING MULTI-FUEL THERMAL POWER PLANT

Mohd Khairul Hairi Mamad @ Mohamad & Salmi Samsudin

Thermal power plants operating beyond their original design horizon face increasing integrity risks arising from creep, oxidation, thermal fatigue, erosion, slagging/fouling and other time-dependent degradation mechanisms. This paper presents an industrial case study of a structured Boiler Integrity Program (BIP) implemented at Kapar Energy Ventures (KEV), a 2,200 MW multi-fuel power station in Malaysia with generating fleets commissioned in 1985, 1988 and 2001. The program integrates asset-focused, process-focused and people-focused controls. Core interventions include root-cause analysis, risk-based inspection (RBI), high-energy piping integrity management, advanced non-destructive examination, targeted tube replacement and material upgrades, combustion and sootblower optimization, fuel-selection controls, condition monitoring, fitness-for-service assessment, and workforce competency development. Plant records reported in the source case study show that KEV boiler tube failures decreased from six events in 2020 to two events in 2025, a 66.7% reduction. Capacity-payment loss associated with boiler tube failures decreased from RM10.10 million to RM1.82 million over the same period, an 82.0% reduction. The findings indicate that a governance-based integrity framework can convert aging-related degradation from a predominantly reactive maintenance problem into a more predictable and risk-managed process. The case also highlights the importance of integrating inspection findings with operating parameters, fuel quality, combustion behaviour and competency development. The proposed framework is potentially transferable to other aging coal-fired and multi-fuel generating assets, although further work should quantify unit-level exposure hours, heat-rate effects, inspection probability of detection and remaining-life margins.

Paper ID: ICRAIEM2026-0018

DUTY-CYCLE-DRIVEN TRADE-OFFS IN PULSED DC PLASMA NITRIDING OF 12CR18NI10TI STAINLESS STEEL

Nurtoleu Magazov, Arnur Askhatov, Zarina Aringozhina

Pulsed DC plasma nitriding makes it possible to regulate near-surface properties of austenitic stainless steels through electrical pulse parameters. This conference contribution evaluates how duty cycle changes the balance between nitrided-layer development, mechanical strengthening, friction, wear, and corrosion behavior of 12Cr18Ni10Ti (AISI 321) stainless steel. Disk specimens were treated at 500 °C, 400 Pa, and 700 V for 5 h in dissociated ammonia using duty cycles of 30, 60, and 90%. SEM/EDS, X-ray diffraction, instrumented indentation, ball-on-disk testing, and potentiodynamic polarization were used for characterization. The largest modified-layer thickness, 91.29 µm, was obtained at DC30, while DC60 and DC90 produced layers of approximately 65.07 µm. DC60 showed the highest local nitrogen level (7.7 wt.%), hardness (740.6 HV), elastic modulus (215.9 GPa), the lowest mean coefficient of friction (0.333), and the lowest corrosion current density (0.000665 mA/cm²). The minimum wear rate, 2.276×10^{-5} mm³/(N·m), occurred at DC90. Fe4N and Cr2N phases were detected for all duty cycles. The results demonstrate that duty-cycle optimization is property-dependent rather than monotonic.

Paper ID: ICRAIEM2026-0021

OPERATIONAL IMPACTS OF LOAD CYCLING ON BOILER EFFICIENCY AND TUBE RELIABILITY IN AN AGING MULTI-UNIT COAL-FIRED POWER PLANT A FIVE-YEAR DESKTOP STUDY AT KAPAR ENERGY VENTURES

Mohd Zul Amzar Bin Zulkifli

Increasing renewable-energy penetration requires conventional thermal generating units to operate more flexibly, yet repeated load changes can reduce efficiency and accelerate thermo-mechanical degradation. This study evaluates five years of operating records (2021–2025) from Unit 4 (U4, GF2) and Unit 6 (U6, GF3) at Kapar Energy Ventures, Malaysia, to characterize the relationship between load pattern, boiler efficiency, heat-loss mechanisms and observed boiler-tube failure history. Boiler efficiency was assessed using both the input-output (direct) method and the heat-loss (indirect) method. U4 operated predominantly in a cyclic envelope of 155–295 MW, while U6 cycled mainly between 285 and 475 MW and also experienced near-steady operation at approximately 495 MW. Reported direct-method efficiency was 70–80% for U4, reached up to 90% for U6 during cyclic periods, and was approximately 55% during selected near-steady periods. Indirect-method estimates were substantially more stable at 90–92% for U4 and 90–91% for U6. Dry-flue-gas loss was the largest persistent loss (approximately 4–6%), whereas incomplete-combustion loss was the most variable (approximately 1–3%) and was sensitive to uncertainty in carbon monoxide measurements. Two U6 tube-failure events were recorded in February 2021 and February 2023. The temporal co-occurrence is operationally important but is insufficient to establish load cycling as the sole cause. The study proposes provisional cycling envelopes of 155–295 MW for U4 and 285–475 MW for U6, subject to validated ramp-rate, metal-temperature and condition-monitoring limits. The findings support a risk-based programme integrating performance-data quality, combustion optimization, transient monitoring, targeted inspection and component-life assessment.

Paper ID: ICRAIEM2026-0013
THE DEVELOPMENT OF KINAESTHETIC HAPTIC DEVICE FOR EDUCATION APPLICTIONS
Vrajanat Subramaniam, Muhammad Iftishah Ramdan, Ahmad Syazwan Ahmad Kamal, Ahmad Faizul Hawary, Mohd Azmi Ismail, Jamaluddin Abdullah, Syazwan Aizat Ismail

Building high-fidelity visuo-haptic computing devices for STEM education is challenged by communication latencies and discretization noise. This study presents the development of a 1-Degree-of-Freedom (1-DOF) kinesthetic haptic paddle integrated with a React web dashboard. A deterministic 100 Hz timer scheduler was implemented on an embedded microcontroller, ensuring a stable control loop with minimal execution jitter of ±0.42 ms. An asynchronous multi-threaded data pipeline utilizing the Web Serial API enabled reliable 10 Hz telemetry without browser lag. To mitigate quantization noise during discrete-time numerical differentiation, a recursive first-order Infinite Impulse Response (IIR) filter ($\alpha = 0.97$) was utilized, reducing velocity ripple and yielding a 26.4 dB Signal-to-Noise Ratio (SNR) improvement. The platform successfully simulated Newton's Three Laws of Motion, providing a passive, stable, and responsive kinesthetic learning interface.

Paper ID: ICRAIEM2026-0024
ORDER AWARE DMAIC ANALYSIS OF WEAVING REJECTION USING OPEN INDUSTRIAL DATA
Seyi Ameen Haruna, Sharizal Ahmad Sobri, Sazwan Syafiq Mazlan, Mohd Hisham Nordin

Quality improvement studies depend on whether production records represent independent orders, repeated observations or cumulative totals. This study applies a DMAIC framework to reassess weaving rejection using an open dataset from a Bangladeshi textile manufacturer. A reproducible audit identified 19,828 eligible records but only 945 order identifiers, including 10,317 exact duplicate records. After volume screening, duplicate removal and anomaly exclusions, 8,055 distinct snapshots from 806 identifiers remained. Two representations were compared: all retained snapshots with equal total weight per identifier, and one maximum-output snapshot per identifier. Five-fold validation kept each identifier entirely within one fold, while 1,000 cluster bootstrap samples quantified model and scenario uncertainty. The recorded shrinkage variable was exactly recoverable from machine output and received beam length, indicating that it contains production-state information. Cross-validated linear-model R^2 values were only 0.028 and 0.022. Capping recorded shrinkage at 32.59% produced a conditional rejection reduction of 0.267 percentage points in the snapshot model, but −0.003 percentage points in the representative-record model. These results show that the apparent shrinkage-control benefit is sensitive to the observational unit and cannot justify implementation. The contribution is a reproducible, order-aware DMAIC analysis that distinguishes descriptive associations, conditional scenarios and evidence required for process intervention.

Paper ID: ICRAIEM2026-0006
A DMAIC APPROACH TO MITIGATE CAPACITY LOSSES AT FIRST PROCESS IN A PRODUCTION LINE: A CASE STUDY IN AN AIR FILTER MANUFACTURING COMPANY
Fahmi Hasown, Joshua Prakashi

Capacity loss at the first process of a production line is a persistent constraint in manufacturing systems because its inefficiencies propagate directly and irrecoverably to overall throughput. Prior studies have applied Overall Equipment Effectiveness (OEE), Single-Minute Exchange of Die (SMED), and DMAIC (Define-Measure-Analyze-Improve-Control) individually or in partial combination, but few have integrated upstream-focused bottleneck detection, OEE-based quantification, structured DMAIC root-cause validation, and SMED-based setup optimization into one framework. This study addresses that gap by developing and validating such an integrated DMAIC-SMED framework through a case study at an air filter manufacturing company. The pleating station, the first process of the GigaPleat NXPH production line, was confirmed as the system bottleneck using video-assisted time study across all four stations and OEE decomposition. Root causes of excessive setup time were identified using a fishbone diagram and prioritised with an X-Y matrix, revealing that unseparated internal/external activities, serial task execution, and the absence of a standardized setup procedure were the dominant contributors. SMED principles were then applied to convert internal activities to external ones, enable parallel operator execution, and standardize the procedure through a new Standard Operating Procedure (SOP). Post-implementation data showed that average setup time fell by 85.9%, OEE rose from 85.6% to 95.26%, and daily output increased by 9.07%, The findings confirm that process-based, low-capital interventions at the upstream bottleneck can produce statistically significant meaningful improvements

Paper ID: ICRAIEM2026-0017
REDUCTION OF DEFECT RATE DURING MATERIAL HANDLING PROCESS IN MASK PRODUCTION LINE USING DEFINE, MEASURE, ANALYSE, IMPROVE AND CONTROL (DMAIC) METHOD
Luqman Bin Nasran, Hasnida Ab-Samat, Herry Agung Prabowo, Farida F.

This study addresses the reduction of defect rates during manual material handling in a mask production line at a medical device manufacturing company in Penang, Malaysia. Four major defect categories were identified: damaged masks, foreign material contamination, poor cutting, and out-of-shape defects. The Define, Measure, Analyse, Improve and Control (DMAIC) methodology was applied as a systematic improvement framework. Production and defect data were collected across six working shifts and analysed using Lean Six Sigma tools including SIPOC analysis, a Cause-and-Effect Diagram, and a Weighted Scoring Method. Analysis revealed that out-of-shape defects were the dominant failure mode, accounting for 80.9% of all product rejections. Two improvement solutions were developed: a post-moulding forming jig to stabilise mask geometry during cooling, and a standardised Yellow Bin system to improve storage conditions. SolidWorks was used for bin capacity verification, while Witness Horizon discrete-event simulation software evaluated production performance before and after improvement. Simulation results demonstrated that the defect rate was reduced from 6.78% to 1.00%, with rejected products decreasing from 1,067 to 158 units, representing an 85.19% reduction. Screening machine utilisation remained at 100%, confirming that throughput was unaffected. Estimated cost savings reached RM799.92 per production batch.

Paper ID: ICRAIEM2026-0020

A HYBRID KAIZEN–KAIKAKU MATURITY FRAMEWORK FOR TRANSFORMING COMPLIANCE MONITORING: A CASE STUDY OF DIGITAL PROCESS IMPROVEMENT IN MANUFACTURING

Pei Fang Lee, Nur Amalina Muhammad, Hasnida Ab-Samat, Jeng Feng Chin, Joshua Prakash, Noorhafiza Muhammad, Rosnani Ginting

Compliance monitoring in manufacturing and service-related administrative processes is often constrained by manual document verification, repetitive data matching, and dependence on individual officer judgement. These practices may result in prolonged processing time, inconsistent verification, and limited capability to identify compliance issues. This study aims to develop and evaluate a Hybrid Kaizen–Kaikaku Framework for enhancing compliance monitoring performance through progressive process transformation. A longitudinal single-case quasi-experimental design was employed to evaluate four maturity stages: Manual, Kaizen, Kaikaku, and Hybrid Kaizen–Kaikaku. The framework integrates Kaizen principles through process standardization and structured work practices with Kaikaku principles through workflow redesign, digital matching, and automated compliance monitoring. Six performance indicators were evaluated: average processing time (PTavg), processing-time reduction (PTR), accuracy, detection performance (DP), detection capability (DC), and compliance outcome effectiveness (COE). The findings demonstrate significant improvement across all maturity stages. The Hybrid Kaizen–Kaikaku stage reduced PTavg from 376.08 minutes to 13.50 minutes (a 96.41% reduction) while achieving 100% ACC accuracy, 100% DC, and 100% COE. The proposed Four-Quadrant Improvement Pathway contributes to Lean and digital transformation research by explaining how compliance activities shift from people-led reactive checking to system-led structured monitoring while preserving human judgment for validation and enforcement decisions.

Paper ID: ICRAIEM2026-0016

OPERATIONAL FORMALIZATION OF EARLY COAL-MILL INTRODUCTION DURING START-UP OF 500 MW THERMAL UNITS AN INDUSTRIAL CASE STUDY FROM KAPAR ENERGY VENTURES

Ir. Ts. Kishelsharen A/L Supaya

Start-up of a pulverized-coal thermal unit commonly relies on a comparatively expensive support fuel until the pulverizing and combustion systems are judged ready for coal firing. At the 2 x 500 MW Generation Facility 3 (GF3) units of Kapar Energy Ventures, the legacy sequence delayed coal-mill introduction and prolonged gas firing. This paper presents a practice-based case study in which the gas-to-coal transition was formalized around explicit operating boundaries rather than a conservative fixed-load convention. The revised sequence introduced the first coal mill at approximately 90 MW gross, provided that coal flow was at least 15 t/h, gas-air-heater inlet temperature was at least 330 degrees C, igniter and flame-monitoring systems were available, and mill inlet/outlet-air and gas-air-heater temperatures remained acceptable. The second mill was introduced at approximately 150 MW gross, after which gas firing was progressively reduced and stopped. Existing Boiler Master, fuel, air and automatic plant control functions were retained; no hardware, logic or tuning changes were required. Compared with the reported legacy case, the time to two mills in service and gas burners off decreased from 25 to 20 h, a 20% reduction. Reported commissioning cost decreased from approximately RM478,000 to RM426,000 per start-up, corresponding to a nominal RM52,000 saving (10.9%) after coal, igniter gas and additional mill/primary-air-fan auxiliary electricity were considered. No flameout, mill fire, slagging, burner trip or control disturbance was observed in the reported implementation. The findings show that a boundary-based operating standard can convert tacit operator knowledge into repeatable start-up practice. Because the evidence is derived from a limited operational case, wider adoption should be supported by repeated trials, uncertainty analysis, coal-quality stratification and formal management-of-change review.

Paper ID: ICRAIEM2026-0029

INTEGRATED MONITORING, COMPLIANCE MARGIN AND OPERATIONAL PERFORMANCE OF AIR EMISSIONS AND INDUSTRIAL EFFLUENT AT A MALAYSIAN LEGACY THERMAL FIRED POWER PLANT

Muhammad Irfan Zainal Abidin; Salmi Samsudin

Environmental compliance at an operating coal-fired power plant requires simultaneous control of atmospheric emissions and aqueous discharges. This study evaluates the integrated performance of electrostatic precipitators (ESPs) and an industrial wastewater treatment plant (IWWTP) at a 1,400 MW coastal coal-fired power plant in Peninsular Malaysia using the plant's 2024 monitoring records. The original monthly ESP particulate dataset, wastewater-quality dataset, process diagrams and compliance-assessment workflow are retained. The analysis is expanded beyond binary regulatory compliance by examining monthly patterns, distance from the 50 mg/m³ particulate limit, inter-unit differences, operational hypotheses and implications for maintenance prioritisation. All reported monthly ESP values were below 50 mg/m³. The source manuscript reports annual averages of 24.5791 mg/m³ for Unit A and 34.4722 mg/m³ for Unit B; however, recalculation of the twelve displayed monthly values gives 21.99 and 32.64 mg/m³, respectively, and this discrepancy is retained as a data-quality item requiring verification against the original CEMS export. The IWWTP dataset also shows reported annual-average BOD, COD, TSS, metals, oil and grease, and colour below the stated DOE Standard B limits. The study demonstrates how routine compliance data can be converted into a more useful environmental-performance framework for ageing thermal assets while preserving regulatory traceability and avoiding unsupported causal claims.

Paper ID: ICRAIEM2026-0030

FAILURE ANALYSIS AND RELIABILITY ASSESSMENT OF A SPURIOUS MASTER FUEL TRIP IN A THERMAL POWER PLANT: AN ENGINEERING CASE STUDY

Erman Hardy Mokhtar, Nurhidayah Ahmad, Salmi Samsudin

Spurious actuation of boiler protection can cause forced generation loss even when the protected process remains within a safe operating envelope. This paper presents an engineering failure analysis and qualitative reliability assessment of a Master Fuel Trip (MFT) that occurred on a thermal generating unit on 20 January 2026. At 04:22 h, while the unit was operating at approximately 200 MW, a false Emergency Unit Trip input associated with HIMA MFT control-system card Z7116, Point 1.6.9, initiated MFT Channels 1 and 2 and caused an immediate unit trip. The study integrates sequence-of-events evidence, operating trends, control-card indication, post-maintenance HMI status, Five-Why analysis, qualitative Failure Modes and Effects Analysis (FMEA), and qualitative Fault Tree Analysis (FTA). The evidence supports a faulty input channel as the operational root cause; the MFT logic itself responded to the apparent trip demand as intended. Corrective actions included card replacement, manual emergency-trip functional testing and restoration of spare-card availability. Preventive actions include major-outage interlock testing, enhanced first-out/event traceability, critical-spares management and systematic failure-history review. The case demonstrates the engineering distinction between protection dependability and protection security: a trip system must act reliably on genuine demand while minimizing false demands. The proposed framework is applicable to mature thermal assets where ageing electronic protection hardware can become an availability-critical failure source.

Paper ID: ICRAIEM2026-0033

JOB SATISFACTION, LEADERSHIP STYLE, ORGANIZATIONAL CULTURE, AND COMMITMENT AS DETERMINANTS OF TURNOVER INTENTION: AN SEM ANALYSIS IN MAKASSAR'S PRIVATE SECTOR

Anidya Pramita Sari, Syamsul Bahri, Sapta Asmal

The high rate of permanent employee turnover at Kalla Group, representing the private sector in Makassar, increased from 7% in 2022 to 14% in 2024, mostly due to voluntary resignations. This study aims to evaluate the impact of job satisfaction, leadership style, and organizational culture on employees' intention to leave, both directly and indirectly through organizational commitment as a mediating variable. This study uses an explanatory quantitative approach with Structural Equation Modeling (SEM) assisted by AMOS 26 software. Data were collected using a closed-ended Likert scale questionnaire (1–5) distributed to 431 permanent employees from eleven company entities under Kalla Group with at least one year of service, complemented by limited interviews to strengthen data interpretation. The analysis shows that the structural model meets the goodness of fit criteria (CMIN/DF = 0.948; RMSEA = 0.000; GFI = 0.955; TLI = 1.002; CFI = 1.000; AGFI = 0.927), with findings that leadership style ($\beta = 0.249$; $p < 0.05$) and organizational culture ($\beta = 0.299$; $p < 0.05$) have a positive and significant effect on organizational commitment, job satisfaction has a positive and significant effect on leadership style ($\beta = 0.184$; $p < 0.05$), and organizational commitment has a negative and significant effect on employees' turnover intention ($\beta = -0.384$; $p < 0.05$); however, the direct effects of job satisfaction ($\beta = -0.091$; $p = 0.611$), leadership style ($\beta = 0.038$; $p = 0.520$), and organizational culture ($\beta = 0.240$; $p = 0.598$) on employees' turnover intention were not proven significant, while the Sobel test results indicate that leadership style ($Z = -3.588$; $p < 0.05$) and organizational culture ($Z = -4.407$; $p < 0.05$) have a negative and significant effect on employees' turnover intention through organizational commitment as a mediator. Whereas the mediating role of organizational commitment in the relationship between job satisfaction and employee turnover intention was not significant ($Z = -0.432$; $p = 0.665$). Organizational commitment is the most determining factor in suppressing employee turnover intention in the Kalla Group environment, both as a direct influence and as a mediating pathway from leadership style and organizational culture. Therefore, the company is advised to focus its retention strategy on strengthening organizational commitment through career path certainty, the implementation of a participative leadership style, and the consistent reinforcement of organizational cultural values.

Paper ID: ICRAIEM2026-0035

WHEN IS PRODUCT-SPECIFIC CARBON INFORMATION WORTH COLLECTING? VALUE-OF-INFORMATION THRESHOLDS FOR EMBODIED-CARBON PROCUREMENT UNDER EPD UNCERTAINTY

Abdullah O. Baarimah, Saleem Ahmed Al-Azazi, Aawag Mohsen Alawag, Ahmed Wajeh Mushtaha, Madhusudhan Bangalore Ramu

Environmental product declarations (EPDs) increasingly inform low-carbon procurement, yet procurement decisions lack a quantitative rule for determining when additional product-specific information is worth acquiring. This study formulates embodied-carbon procurement as a Bayesian decision-analysis and value-of-information problem, providing a quantitative framework for optimizing information acquisition under EPD uncertainty. The framework is demonstrated for structural steel using a frozen empirical prior derived from archived EC3 category quantiles. Functionally equivalent supplier candidates are observed through imperfect screening signals, after which product-specific EPD requests are selectively acquired to reduce epistemic uncertainty. Candidates are ranked using posterior expected product-stage global-warming potential, while an information sufficiency rule determines when further acquisition should stop. Across supplier pools of 2, 4, 6 and 10 candidates and screening correlations of 0.3–0.9, targeted information requests consistently outperformed random acquisition. In a six-supplier reference case with $\rho = 0.5$, the expected selected coefficient decreased from 1.354 kg CO_2e/kg without additional EPDs to 0.996 kg CO_2e/kg after two targeted requests. Two requests captured 67.3% of the attainable perfect-information value, while three captured 83.5%. The two-request targeted policy produced an expected information value of 0.358 kg CO_2e/kg, compared with 0.242 kg CO_2e/kg for random acquisition. Results remained directionally stable under alternative priors and 5–30% residual uncertainty in product-specific information. The resulting Information Sufficiency Gate converts EPD uncertainty into an operational procurement stopping rule: an additional EPD should be requested only while its expected decision benefit exceeds its project-specific acquisition cost. The framework demonstrates how Bayesian decision analysis and value-of-information methods can support more efficient information acquisition and low-carbon procurement decisions while complementing technical equivalence screening, structural compliance, and EPD harmonization.

Paper ID: ICRAIEM2026-0036

ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS IN AEROSPACE SYSTEMS: A COMPREHENSIVE ANALYSIS OF APPLICATIONS, CHALLENGES, AND FUTURE RESEARCH DIRECTIONS

Syed Gilani Pasha, Mohammad Ziaullah, Koo Yeong Chin, Mohammad Nishat Akhtar, Elmi Bin Abu Bakar

As aerospace systems become more digital, a huge amount of different data gets produced by aircraft, drones, satellites, and spacecraft. AI and data analytics play crucial roles in ensuring aerospace safety, reliability, efficiency, and autonomous decision-making. This paper offers a systematic investigation of AI and data analytics methods, aerospace data sources and analytics pipelines, and their applications in aircraft design and manufacturing, flight operations and air traffic management, predictive maintenance, UAVs, and space systems. It also discusses core AI and data analytics topics such as machine learning, deep learning, reinforcement learning, explainable AI, digital twins, edge intelligence, and generative AI in the context of aerospace data analytics and applies them to various aerospace applications. This study highlights the state of the art, compares existing approaches, and identifies emerging challenges and gaps, including heterogeneity and limited datasets, interpretability, uncertainty quantification, cybersecurity, real-time implementation, and safety assurance. Future AI and data analytics research directions are proposed, including physics-informed AI, multimodal learning, digital twins, federated intelligence, trustworthy AI, and certification-oriented approaches for developing safe, secure, and operationally capable next-generation autonomous aerospace systems.

Paper ID: ICRAIEM2026-0037

A DATA-DRIVEN PREDICTIVE FRAMEWORK FOR VOLTAGE PROFILE ANALYSIS IN EV-INTEGRATED SMART DISTRIBUTION GRIDS USING RANDOM FOREST AND T-SNE

Wasim Nidgundi, Mohammed Ziaullah, Ravi Hosmani, Vinayaksingh Rajaput, Elmi Bin Abu Bakar, Koo Yeong Chin, Mohammad Nishat Akhtar

This paper presents a novel data-driven predictive framework for analyzing voltage profile variations in electric vehicle (EV)-integrated distribution networks. The escalating deployment of EVs introduces stochastic, time-varying load behavior that conventional deterministic methods cannot adequately model. We propose an integrated methodology combining: (i) Grey Relational Analysis (GRA) for optimal solar distributed generation (DG) and EV placement, (ii) Grey Relational Weight-based EV sizing, (iii) Time-of-Use (ToU) coordinated G2V/V2G charging strategy, (iv) t-Distributed Stochastic Neighbor Embedding (t-SNE) for clustering-based pattern discovery, and (v) a Random Forest Regressor (RFR) for multi-parameter prediction at intermediate EV penetration levels. Experiments are conducted on the IEEE 33-bus distribution test network across seven distinct scenarios spanning 0–100% EV penetration, simulated in ETAP software. The proposed RFR achieves R^2 = 0.9909 and RMSE = 0.1017 for voltage prediction, outperforming SVR (R^2=0.9721), ANN (R^2=0.9793), XGBoost (R^2=0.9887), Decision Tree (R^2=0.9521), and Linear Regression (R^2=0.8812). t-SNE clustering clearly differentiates grid operating states across all scenarios, revealing a critical voltage nadir at 55–60% penetration. Optimized 100% EV integration with solar DG achieves a 41.88% reduction in MW losses and 42.92% reduction in MVAr losses compared to uncoordinated EV deployment.

Paper ID: ICRAIEM2026-0038

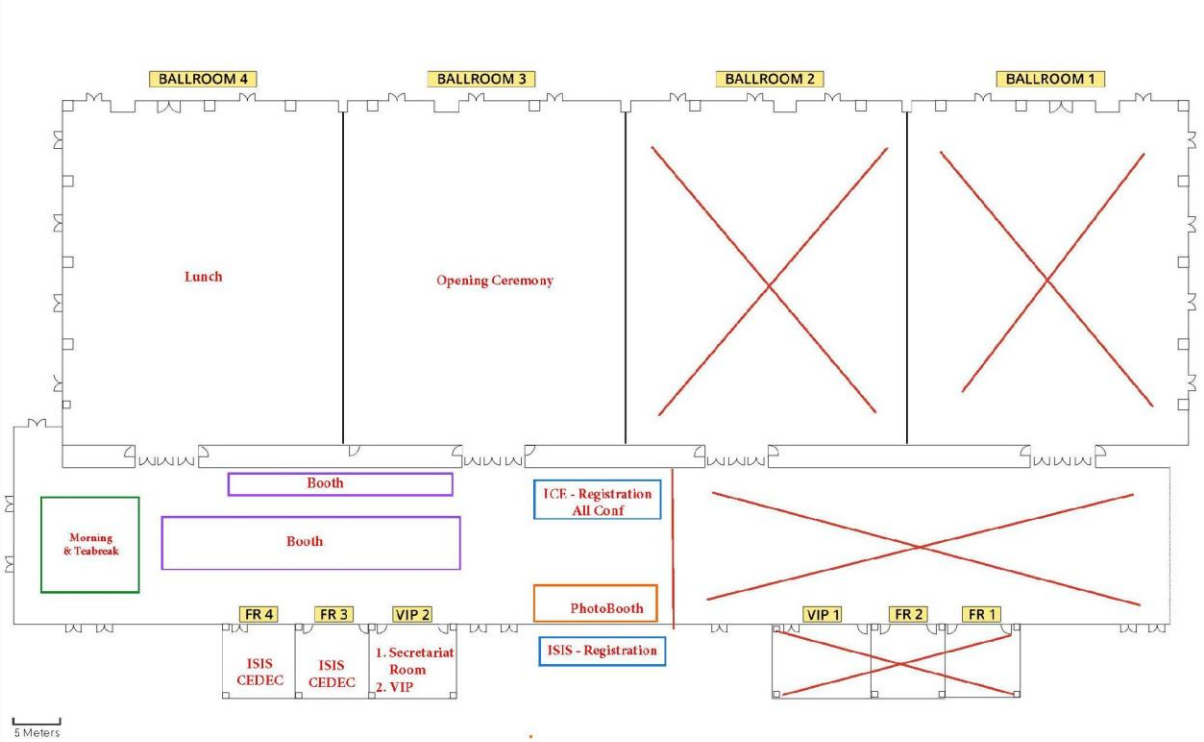
DELIVERY SEQUENCING HEURISTICS FOR AGV ROUTING OPTIMIZATION

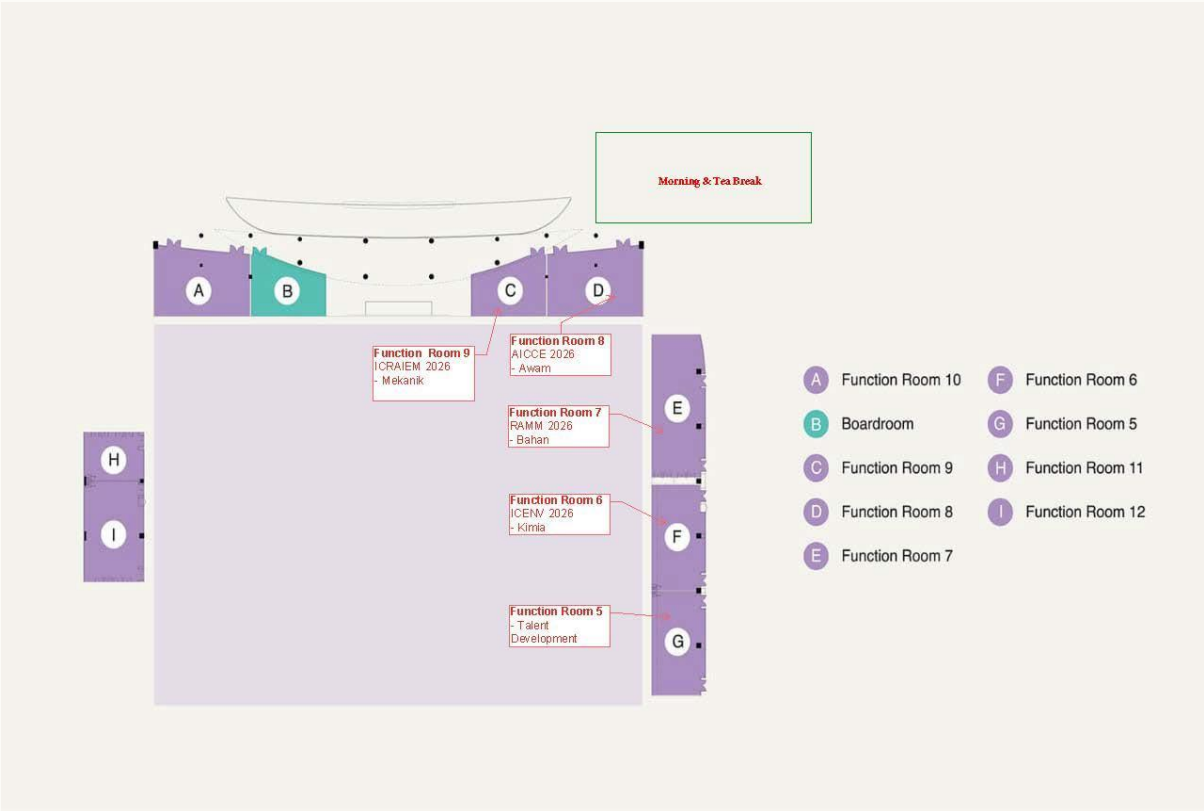
RuoChun Wang, Jeng Feng Chin

This study evaluates five delivery sequencing heuristics and two baseline ordering rules for static, capacitated open routing of automated guided vehicles (AGVs). Each vehicle loads once at a common depot and completes a delivery-only route without returning to the depot. Total travel distance and payload-distance are minimized separately. Thirty independent base instances from three network topologies are partitioned into development and held-out test sets. Sequencing methods are compared on identical task assignments and within discrete artificial bee colony and multi-start local search under equal wall-clock budgets. Cheapest insertion produces the lowest mean fixed-assignment distance, whereas nearest neighbor reduces mean payload-distance by 6.47% relative to the cheapest insertion. Search performance also depends on sequence construction time and the objective feedback supplied to the assignment search. Although different sequencing heuristics perform better on different task assignments, none of their pairwise or three-way combinations outperforms the development-selected best individual in mean test performance under the stated budgets. These results show that heuristic selection requires joint consideration of the routing objective, construction quality and computational cost.

LAYOUT

GRAND BALLROOM & GRAND FOYER & ALL ROOMS






Creative Bliss
trusted precisions
BUILD WITH PRECISION.
BACKED BY TRUST.
Precision Manufacturing. Engineered End to End.
From concept to complieion, Creative Bliss delivers integrated manufacturing solutions built around precision, reliability, and performance.
PEOPLE
PRECISION
POSSIBILITIES
OUR CAPABILITIES
Metal Stamping
CNC Machining
Sheet Metal Fabrication
Die Casting
Mechanical Assembly
Metal Design & Fabrication
INDUSTRIES SERVED
Semiconductor • Medical Devices • Industrial Electronics & Mechatronics • Automotive • Consumer Electronics • Data Centre
LET'S BUILD WHAT'S NEXT.
www.cbliss.my
infor@cbliss.com.my
+604-5085809
No.1482, Lorong Perusahaan Maju 6, Kawasan Perusahaan 4, 13600 Perai, Penang, Malaysia
PRECISION FOR A BRIGHTER TOMORROW

PROUD SPONSOR

iotegrity

Iotegrity Engineering · Iotegrity Sdn Bhd · Malaysia

Pioneering tomorrow's technologies for a sustainable future.

Got a measurement problem?
We build the system that solves it.

Two companies, one team. Iotegrity Engineering and Iotegrity Sdn Bhd design, build and supply custom data acquisition, IoT, AI and digital twin systems, from lab test rigs to smart farms. We also partner with researchers on grant-funded projects and turn prototypes into products.

2021	55+	25+	24/7
Since	Projects delivered	Partners & clients	Client support

WHAT WE DO

DATA & AI — IoT · Data Analytics · Artificial Intelligence (AI) · Digital Twin

MEASUREMENT — Data Acquisition (DAQ) · Custom DAQ Supply · Sound & Vibration · Active Vibration Control (AVC)

INNOVATION — Product Development · Grant Collaboration · Renewable Energy · Smart Farming · STEM Training






RECENT WORK

Spillway PIV and pressure profile measurement system · Motorcycle active vibration control · Rural coffee bean manufacturing development · Galvanostat/potentiostat DAQ · Pyrolysis biochar IoT weighing · Kelulut honey dehydration & monitoring

Trusted by USM · UiTM · UniMAP · UNITEN · MIMOS · MOSTI · TNB Research · MTDC · TERAJU · Yayasan Inovasi · and more

Let's talk about your next project.

Consultation · Design · Fabrication · Installation · Training

WEB www.iotegrity-engineering.com
EMAIL nabil@iotegrity-engineering.com
PHONE +6011-2915 3639

NOTES

Mi Equipment

We seek to deliver value; we innovate for tomorrow.

We are a Leading Semiconductor Equipment Solutions Provider, with world class R&D centers and manufacturing facilities in Malaysia and China as well Sales & Service networks covering Asia, North & Central America and Europe.
The company's commitment to technology advancements and continuous innovation has enabled it to deliver cutting-edge solutions that meet the evolving needs of the semiconductor industry.

OUR SOLUTIONS

- Mobility and Wearables WLCSP Solutions
- Mobility and Wearables EMI Shielding Solutions
- Mobility and Wearables Sensor and Display Solutions
- HPC and Memory Solutions
- Automotive and Renewable Energy Solutions

OUR PRODUCTS

- AI-Enabled Wafer-Level Advanced Packaging and Die Sorting Machines
- Smart Multiple Bin Sorting Platform
- Laser Compression Border (LCB) and Laser Assisted Bonding (LAB)
- High Temperature Known Good Die (KGD) and Packaged Test Handler
- Vision Inspection and Taping Equipment



JOIN US: career@mi-eq.com

https://www.mi-eq.com/careers.html

LinkedIn FOLLOW US

SCAN ME

Thank you to our sponsors

Creative Bliss
trusted precisions

QiQo house

CORTEX ROBOTICS
AOI Equipment & Solutions Provider

iotegrity

Mi Equipment

MPR Maths Proofread

Scan for more details

Programme, abstracts and conference updates

icraiem.eng.usm.my

Organised by

School of Mechanical Engineering
Universiti Sains Malaysia
Engineering Campus,
14300 Nibong Tebal, Pulau Pinang

Conference

28–29 October 2026
Setia Spice Convention Center
Penang, Malaysia

ICRAIEM 2026
INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN INDUSTRIAL ENGINEERING AND MANUFACTURING

USM
UNIVERSITI SAINS MALAYSIA

APEX

USM ICE'26
USM International Conference on Engineering 2026