Souvenir Program

International Conference on Maintenance and Intelligent Asset Management

ICMIAM 2025

Federation University

Berwick campus, Victoria, Australia

Lecture Theatre G43 (Building 901), Room no. 197 and 195 (Building 902)

100 Clyde Road, Berwick, Vic 3806

10 - 12 December 2025

Melbourne, Australia (Australian Eastern Standard Time)

Organised by

Centre for Smart Analytics and Institute of Innovation, Science and Sustainability, Federation University Australia and International Collaboration on Maintenance and Intelligent Asset Management.

Supported by

Asset Management Council Australia, Asset Management Society India, The University of Huddersfield, UK, Luleå University of Technology, Sweden and The University of Johannesburg, South Africa.

Message from Executive Chairs

Dear Esteemed Delegates,

It is our great pleasure to welcome you to the International Conference on Maintenance and Intelligent Asset Management (ICMIAM2025) at Federation University Australia, Berwick Campus. This year's conference, the 6th in this series, brings together a vibrant and diverse community of researchers, practitioners, and industry leaders from Australia, India, Sweden, the United Kingdom, Singapore, Canada, Malaysia, Egypt, South Africa, Brunei and many other regions across the globe. Over the coming days, you will engage with a rich program of presentations and discussions covering a broad spectrum of contemporary themes: making asset management real in practice; values and human assets; systems engineering for maintenance management; intelligent asset management opportunities and challenges; enterprise and asset performance management; standards and risk management; maintenance and reliability engineering; risk-informed investment decision-making; failure analysis; emerging technologies; and asset life-extension strategies. Through these contributions, the conference seeks to showcase both applied practices and cutting-edge research outcomes shaping the future of asset management. We are confident that ICMIAM2025 will stimulate insightful dialogue, inspire collaboration, and support innovation that enhances performance, productivity, resilience, and safety worldwide, ultimately contributing to a more sustainable and liveable planet. We encourage you to take full advantage of the excellent networking opportunities this event provides. We extend our sincere appreciation to our organising partners:

- Institute of Innovation, Science and Sustainability, Federation University Australia
- Centre for Smart Analytics, Federation University Australia
- Asset Management Council, Australia
- Asset Management Society, India

The success of ICMIAM2025 is made possible through the generous support of our industry and professional body sponsors and partners along with collaborating institutions: Federation University Australia; the University of Huddersfield, UK; Luleå University of Technology, Sweden; the University of Johannesburg, South Africa; and the Indian Institute of Technology Kharagpur, India.

We are deeply grateful to all of our sponsors, contributors, and delegates for their commitment of time, expertise, energy, and financial support for making this conference a great success. We warmly acknowledge the dedicated efforts of our organising committee members and their families, whose personal sacrifices have been fundamental to this event. We also thank our keynote and invited speakers, track chairs, reviewers, session chairs and co-chairs, volunteers across multiple committees, as well as administrative staff for their exceptional service in making this conference possible. A special note of appreciation is extended to Prof. Iven Mareels, Prof. Syed Islam, Dr. Anne Gibbs, Prof. Raghuvir Pai, Prof. Uday Kumar, Prof. Rakesh Mishra, Prof. Jan-Harm Pretorius, Dr. Abdul Chowdhury, Dr. Harpreet Kandra, Prof. Gour Karmakar, Mr. Venkata Sudula, Dr. Shantanu Kumar, Ms. Lilly Walker, Mrs. Jo-ann Larkins, Mr. Nik Sharp, Mrs. Kakoli Chattopadhyay, and to all researchers, professionals, students, staff, and sponsors whose contributions have been central to the success of ICMIAM2025. Above all, we extend our deepest gratitude to you, our participants, for enriching this conference with your engagement and presence. We hope you gain significant value from the sessions, reconnect with colleagues, build new relationships, discover fresh insights, and enjoy a memorable and rewarding experience at ICMIAM2025.

Sincerely,
Prof. Gopi Chattopadhyay and Prof. Joarder Kamruzzaman
Federation University Australia

Message from the President, Asset Management Society India

It is my privilege and honour to extend my warmest greetings to all participants, speakers, and stakeholders at the sixth International Conference on Maintenance and Intelligent Asset Management (ICMIAM 2025). It is exciting to witness the growth of this prestigious event, which has time and again served as a premier platform for knowledge exchange, innovation, and collaboration in the field of asset management.

The ICMIAM2025 conference theme focuses on the evolving landscape of Maintenance and Intelligent Asset Management, which is timely and necessary. Worldwide, industries are at a critical juncture of implementing digital transformation and strategic data-driven asset management. The integration of IoT-based solutions, predictive analytics and artificial intelligence is not only enhancing the efficiency of asset lifecycle management but also ensuring sustainability and cost-effectiveness.

Asset Management Society of India (AMSI) firmly believes in collaboration and knowledge-sharing. Our objective is to encourage a community where researchers, professionals and organisations can come together to share insights, discuss challenges, and drive the acceptance of best practices that will outline the future of asset management.
ICMIAM 2025 represents a key moment in this journey. With industry experts, practitioners, and thought leaders from around the globe in attendance, ICMIAM2025 provides a unique opportunity to share experiences and develop solutions that will help businesses not just survive but flourish in today's dynamic environment.

I encourage you to take full advantage of the opportunities ICMIAM2025 presents- engaging with thought-provoking sessions, exploring innovative solutions and networking with peers, that can help drive the success of asset management practices worldwide.

I wish you all a successful and inspiring experience at ICMIAM 2025.

Warm regards,

Professor Raghuvir Pai
President, Asset Management Society of India
Joint Chair, ICMIAM 2025

Message from the Director, Centre for Smart Analytics
Federation University Australia

Industries worldwide are undergoing rapid change as they embrace digital transformation, Industry 4.0, and applied AI. Our cities and businesses are continuously innovating to become smarter and more connected, while governments work to reduce the digital divide between urban and regional communities. In this context, the three-day *International Conference on Maintenance and Intelligent Asset Management (ICMIAM 2025)*, organised by Federation University Australia in collaboration with the Asset Management Council (Australia), Asset Management Society (India), the University of Huddersfield (UK), Luleå University of Technology (Sweden), and the University of Johannesburg (South Africa), is both timely and important. I am confident that the conference outcomes will help address key challenges in maintenance and asset management in the era of Industry 4.0 and beyond.

The conference organisers are members of the Centre for Smart Analytics at Federation University. Part of the research focus of our centre is the Internet of Things, cybersecurity, and artificial intelligence and machine learning, with strong applications in engineering, including intelligent asset management across industry, infrastructure, and business domains. This conference aligns seamlessly with our research priorities, and we are pleased to support and contribute to its organisation.

I wish the conference every success.

Sincerely,

Professor Joarder Kamruzzaman
Director, Centre for Smart Analytics
Federation University Australia

Keynote Speakers

Glenn 'Shoey' Schumacher,
BEng.(Mech.) UTS, Grad. Cert. Man.(Human Resources) USQ, Grad. Cert. Mining Engineering UNSW, MBA.(Tech. Man.) Deakin, MEng.(Power Gen.) UQ, DEng. (*honoris causa*) CQU.
FIEAust., CPEng., EngExec., NER., APEC Engineer, IntPE(Aust), RPEQ, RPEV., FAIE, MAusIMM.

Shoey is currently Engineering Advisor to Delta Electricity and Energy (Delta), Sydney, Australia.
Prior to joining Delta Shoey served as the Head of Engineering, EnergyAustralia (EA) for six years.
Shoey's roles have included as AGL Energy Ltd.'s Chief Engineer from November 2013 to September 2017. In that period, AGL doubled its Generating capacity to over 10,000 MW and covered technologies such as Brown and Black Coal Fired Plant, Brown Coal Mining, Open Cycle Gas Turbines, Hydro, Gas Fired Boilers, Wind and Grid Scale PV Solar, along with developments around Grid Scale Storage technologies. Shoey was heavily involved in the Technical Due Diligence undertaken by AGL into the acquisition of the then Macquarie Generation, and then led the AGL Macquarie Operations Integration Team after the acquisition.

Previously Shoey was the General Manager of NRG Gladstone Power Station (Queensland's largest power station) for six years. He has held several roles in not only the power industry but also across a number of heavy industries and manufacturing in locations from Burnie, Tasmania to Gladstone, Queensland. Those roles have included the fields of maintenance, production and engineering/technical services. Shoey has a particular passion and interest in milling (pulverising) plant and processes on which subjects he is a published author.

Shoey has been involved in the development and deployment of seven (7) Asset Management Programs since the mid-1990s, and the Program developed at Gladstone Power Station (GPS) in the late 2000s won national acclaim for its success in changing the culture and performance of the GPS business.
Through his career, Shoey has held roles in Maintenance, Production / Operations, Engineering / Scientific Services as well as General Management.

Shoey is also Member of the International Advisory Committee of the Asset Management Society of India.

Title: Process Safety a key element of Asset Management.

Abstract: There is a strong and important relationship between Asset Management and Process Safety. At the centre of Asset Management is Asset Integrity and it is here that Process Safety and Asset Management meet. The American Petroleum Institute (API) current definition for Process Safety includes the following : "…A disciplined framework for managing the integrity of hazardous operating systems and processes by applying good design principles, engineering and operating practices. …." And thus, there is a clear alignment with holistic view of Asset Management in terms of considering the total life cycle of Assets from design, through operations and maintenance to end of life. Process Safety is a key element in any good and sustainable Asset Management Program, and this presentation seeks to illustrate these points.

Prof. Jhareswar Maiti,
Indian Institute of Technology Kharagpur, India

Dr Jhareswar Maiti, P C Mahalanobis Distinguished Educator and Suresh & Vidya Nair Chair Professor, is currently Professor, Department of Industrial and Systems Engineering at the Indian Institute of Technology, Kharagpur. He is the founder chairman of the Centre of Excellence on Safety Engineering and Analytics at IIT Kharagpur. He has more than 23 years of experience in teaching, research, and consulting, guided 24 PhD students, executed over 35 funded projects and conducted over 30 training programs for industry. He authored over 220 publications and is on the Editorial Board of Process Safety and Environmental Protection, Safety Science, International Journal of Injury Control and Safety Promotion, and Safety & Health at Work. Prof Maiti's research interests include safety analytics, risk assessment, AI and data science, quality management, and human factors engineering & ergonomics. He authored the textbook "Multivariate Statistical Modeling in Engineering and Management", published by CRC Press. Prof Maiti works with world leading companies like Tata Steel Limited, Adani Group, Coal India, Haldia Petrochemicals, etc. He is a Fellow Member of the Royal Statistical Society, UK and the Institute of Engineers (India). He is also a member of ASQ, INFORMS, IISE, IEEE, etc.

Title: The Safety Bullwhip Effect: Why Small Gaps Create Big Risks

Abstract: Lee et al. (1997, Management Science, 43 (4)) describe the supply chain bullwhip effect (BWE) as a "*phenomenon where orders to the supplier tend to have larger variance than sales to the buyer (i.e., demand distortion), and the distortion propagates upstream in an amplified form (i.e., variance amplification*". In this work, we explore the presence of BWE in plant-level safety management and call it ***Safety-Bull***. Our assumption is that the *safety-bull* underscores how a minor, unreported hazard or delayed response can cascade through departments, magnifying risk and resource strain far beyond the original small gap. The safety-bull may be viewed across the tiers in the organizational hierarchy from frontline operators → shift supervisors → department heads → plant leadership. We aim to demonstrate several research questions: (i) why does safety-bull assumption hold, (ii) what are the causes and consequences of safety-bull, (iii) how do we measure safety-bull (i.e., possible metrics), (iv) what data are required to measure it, (v) what could be the possible models to demonstrate the safety-bull behaviour, and (vi) what activities are needed to counter the safety-bull (i.e., managerial implications). We hope that our roadmap will help asset management by revealing how hazard & risk perception and information distortion frontline escalate across the tiers, enabling earlier risk control actions and reducing unplanned/sudden activities and lifecycle costs.

Keywords*: Safety management, Information distortion, Safety-bull, Asset utilization, Life-cycle costs*

Workshop: Data Analytics for Asset Management.

Raghuvir Pai,
Professor (Retd.), Department of Mechanical and Industrial Engineering,
Manipal Institute of Technology, Manipal 576104, INDIA.

Raghuvir Pai is a Professor in Manipal Institute of Technology, Manipal Academy of Higher Education (MAHE), Manipal, India. He completed his bachelor's in mechanical engineering from Manipal Institute of Technology, Mysore University. Later, he pursued his PhD in Tribology from the Indian Institute of Technology, Kharagpur. Subsequently, he has worked as a Department of Science and Technology, Government of India, BOYSCAST postdoctoral research fellow at Cranfield University, England. He was a research fellow at Queensland University of Technology, Brisbane and an Endeavour Executive Fellow, Australian Government at Federation University Australia. He was the Dr T.M.A. Pai endowment chair in Tribology at MAHE, Manipal. He has held various administrative positions in MAHE, Manipal over the past 20 years. He was the Head of Department, Mechanical and Manufacturing Engineering, Joint Director at Manipal Institute of Technology, Director of International Centre for Applied Sciences and Director Research (Technical), MAHE, Manipal. He was the founder Dean of the School of Engineering at Manipal's Dubai campus. He was also the founder Dean of the School of Science and Engineering at Manipal International University, Malaysia. He has a number of research publications in journals and international and national conferences. His expertise in research is in the field of water lubricated bearings, externally adjustable bearings, tri-taper bearings, tribology of machining metal matrix composites, Nano lubricants in bearings and Biomechanics. Twelve students have completed their PhD dissertations with him and currently, there are 8 other students pursuing their PhD. He is the founder President of the Asset Management Society, India.

Title: Tribology and Artificial Intelligence: Current and Future Prospects

Abstract: Tribology is the science and technology that deals with friction, wear and lubrication of relatively moving surfaces. Friction, wear and lubrication play an important role in the life of machine components. Effective friction and wear control with better lubrication methods can result in improved energy efficiency and extended machinery life. In recent years, there is an increased attention towards the implementation of artificial intelligence (AI) and machine learning (ML) across a number of fields due to several benefits. Friction and wear prediction in tribological contacts can benefit tremendously from these modern tools.

Machine learning can simulate the nonlinear behaviour and complex relationships of tribological systems through simplified models and infer previously unknown relationships. AI algorithms are being increasingly used to predict equipment life and forecast machine part failures, using various machine learning approaches. AI and ML can therefore help determine the tribological behaviour of engineering systems, providing a fundamental insight into the friction, wear, and lubrication mechanisms. The applications of AI and ML tools in tribology show significant potential to provide accurate and extensive predictions than the traditional methods.

Martin Kerr

World Partner in Asset Management and Structured Change

Martin Kerr is a Certified Fellow in Asset Management (CFAM) with the Asset Management Council of Australia, a Certified Asset Management Assessor (CAMA) with WPiAM, and a Certified Maintenance and Reliability Professional (CMRP) with SMRP. He served as Convener of ISO 55001:2024 and is the Technical Director of WPiAM's Global Certification Scheme and CAMA exam. Martin has helped shape global practice and standards as a Project Manager with the GFMAM, AMBoK contributor, and Asset Management Maturity Assessor. He is a co-author of Living Asset Management Maturity (2020) and author of Organizational Change Management for Asset Management (2025).

Title: Asset Management Supporting Maintenance and Reliability

Abstract: "Asset Management Supporting Maintenance and Reliability" explores how asset management principles strengthen maintenance practices to improve reliability at organisational, service, and asset levels. It begins by defining reliability as dependable performance over time and frames assets as enablers of capability and value delivery. Drawing on the GFMAM Asset Management Landscape v3 (2024), it introduces Integrated Reliability (6.3), emphasising alignment of governance, culture, service continuity, and asset performance into a coordinated system.

The slides then detail the benefits of maintenance and reliability in terms of cost savings, risk reduction, and performance gains, noting how preventive maintenance extends asset life, lowers costs, and minimises downtime. Real-world examples highlight challenges—such as poor collaboration between operations and maintenance—and show how improved practices (shared accountability, preventive focus, open communication, and new measures like Emergency Work Ratio) led to better outcomes. Ultimately, it positions maintenance not as a cost, but as an investment in sustaining asset value and organisational success.

Prof. Uday Kumar
Division of Operation and Maintenance Engineering
Luleå University of Technology, SWEDEN

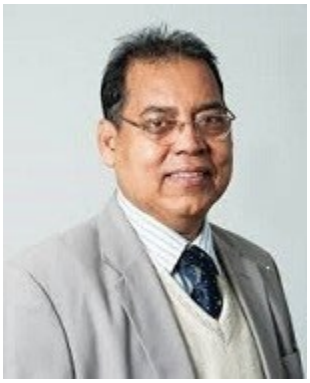
Prof Uday Kumar is the Chair Professor of Operation and Maintenance Engineering and Director of Luleå Railway Research Center at LTU (JVTC). Earlier, he has been a visiting faculty at Imperial College London, Helsinki University of Technology, Helsinki (under European Mining Program), an external Examiner & Program Reviewer for the Graduate Program in Reliability and Maintenance at University of Manchester, UK, a Visiting Guest Professor at National Science Foundation sponsored Center of Excellence for Intelligent Maintenance Systems at University of Cincinnati, Ohio, USA, Distinguished Visiting Professor of Industrial Engineering at Tsinghua University, Beijing, Honorary Professor at Beijing Jiao Tong University, China.
Prof. Kumar was Board member of National Swedish Maintenance Society (2010-2022), Chairman of the Scientific Council of Swedish National Maintenance Society (2006-2016) and was member of the Scientific Advisory Council of RAILENIUM- Invest in Future Program of the Govt of France (2014-2018), Chairman of the Master and Doctoral Thesis Award Committee European Federation of National Maintenance Society, Brussels, Board member of Swedish and Brazil Cooperation Council (CISB).

Title: Next-Generation Asset Maintenance: Integrating Lean Thinking, Digital Transformation and Sustainability

Abstract: This keynote explores how the principles of Lean thinking—traditionally centred on waste elimination, value creation, and continuous improvement—can be used and extended through digital technologies and sustainable practices to implement world-class maintenance leading to excellence in production and asset management.

This keynote traces the evolution of maintenance philosophy—from Taylor's Scientific Management, focused on efficiency and control, to the Toyota Production System, emphasising continuous improvement and people's involvement, to Industry 5.0 and highlights the common thread connecting these paradigms: a human-centric approach.

Furthermore, the talk will emphasise the contribution of effective maintenance to sustainable asset management.



Prof. Gopi Chattopadhyay
Federation University Australia

Gopi has expertise in modeling cost, risk and performance. Professor and Head of engineering programmes, Central Queensland University (CQU), Engineering Management, Qld University of Technology (QUT), Technology Management, University of Qld., overseas projects and deliveries at Lulea University of Technology (LTU), IIT Kharagpur, Calcutta University, Shanghai JT University, University of Indonesia and UNRE, PNG. Supervised 24 research students, 2.5M+ AUD external funds, and authored 200+ international journals and conference papers. Chair of Gippsland, past chair of Gladstone and Brisbane. Asset Management Council (AMC), a technical society of Engineers Australia, past vice president of Maintenance Engineering Society of Australia (MESA Qld), past President of Australian Society for Operations Research (ASOR, Qld), International Chair of Asset Management Society India (AMSI) and founding chair of International Conference on Maintenance and Intelligent Asset Management (ICMIAM). Reviewer of ISO55000 standards, Queensland Govt.'s Total Asset Management Plan (TAMP), and Global Forum on Maintenance and Asset Management (GFMAM)'s Asset Management Landscape.

Title: Issues and challenges in Asset Management.

Abstract: Asset management, in line with ISO55000 standards, encompasses any item, entity, or thing with actual or potential value to an organisation and its communities.
The complexity of assets and asset management has been increasing at ever increasing rate. This talk explores what are the issues and challenges industries, infrastructure owners, and communities have been facing now and might be facing more in the future. It will cover some sectors as illustrative examples and discuss at a high level how to respond to those in a proactive manner for better understanding the current and future needs and how to respond to those in a timely and cost-effective manner for retaining the value of and realising value from capital intensive assets and infrastructure. If applied properly, asset management is able to reduce costs and risks and further enhance performance for making the world a better and safer place to live.

Key Words: Asset Management, Maintenance, Reliability Engineering, Issues and challenges, Cost, Risk, Performance, Value Creation and Improvement, ISO55000.

Hongan Lin
Executive Director · AssetStudio, Singapore

Hongan Lin is the founder of Singapore-based Asset Studio Pte Ltd, where he leverages deep expertise in reliability engineering to help clients analyze asset reliability gaps and their financial impact. His career spans roles as a defence engineer, a lecturer at Temasek Polytechnic, and as Managing Director for ReliaSoft Asia Pacific.

He is a subject matter expert in Life Data Analysis, Accelerated Life Testing, and System Reliability Simulation. His most notable technical achievement was architecting the core simulation engine for AeROS. With over 15 years of training and consulting experience, he is dedicated to equipping engineering teams with the tools and knowledge to solve complex reliability challenges.

Workshop Title: Steps for Reliability, Availability, and Maintainability (RAM) Analysis using a Combined-Cycle Power Plant Example.

Abstract: Reliability, Availability, and Maintainability (RAM) analysis is a critical methodology for quantifying operational performance and identifying improvement opportunities. This presentation outlines a practical framework for conducting a RAM analysis, using a combined-cycle power plant as a case study. We will walk through the essential steps: from data collection and the development of a reliability "digital twin" to modeling failure and downtime distributions. A key focus will be on analyzing how production load acts as a dynamic stressor on asset reliability, supported by empirical evidence from historical data. Finally, we will demonstrate how to integrate these production-dependent failure rates into simulation models to generate more accurate and actionable RAM predictions, enabling proactive maintenance and capacity optimization.

Dr. Narottam Das
Central Queensland University

Dr. Narottam Das (S'97, M'01, SM'05) received his PhD degree in Electrical Engineering from Yamagata University, Japan. His PhD research Project was funded by the Ministry of Education, Sports and Culture, Government of Japan. M.Sc. degree in Electrical and Electronic Engineering from Bangladesh University of Engineering and Technology, Dhaka, Bangladesh; B.Sc. degree (Hons.) in Electrical and Electronic Engineering from Chittagong University of Engineering and Technology, Chittagong, Bangladesh. Dr Das has about 3-decades experience as an academia and industrial Engineer in Australia and overseas.
Currently, he is a Senior Lecturer in Electrical Engineering at the School of Engineering and Technology, Central Queensland University Australia, Melbourne Campus, Victoria. Dr Das is the author/co-author of over 200 peer-reviewed journals and international conference proceedings, including 8 book chapters and 4 edited books: Nnao-structured Solar Cells, Advances in Optical Communication, Optical Communication, and Optical Communication Systems. Currently, he is a Guest Editor of the MDPI Journal "Energies" Special Issue on "Nano-structured Solar Cells", Editorial Board Member of "Energies", Topic Editor of "Solar Energy and Photovoltaic Systems".

Currently, Dr Das is an Executive Committee Member of Electrical College Victoria Branch (ECVB), Engineers Australia, Secretary of the IEEE PES, PHS and IEEE IAS, Victorian Section, USA. Dr Das is a senior member of the IEEE PES and PHS, USA; Fellow of the Institution of Engineers, Australia; CPEng, NER, and Life Fellow of the Institution of Engineers, Bangladesh. His research interests include in Power Systems Communication (Smartgrids) using IEC 61850, Multi-junction Solar (PV) cells, modeling of high efficiency solar cells (renewable energy), and high-speed communication devices.

Title: Optimizing the Operation of Energy Storage Systems for Cost Effective Integration of Solar Power into National Grid.

Professor Rakesh Mishra
The University of Huddersfield.

Professor Rakesh Mishra is Head of Research, Department of Engineering and Technology, University of Huddersfield, UK. 35+ years of expertise in Energy System modelling. Supervised 37 research students, 4M+ Pounds external funds, and authored 300+ international journals and conference papers. Prof. Mishra is an active consultant to many Thermo-fluid industries and has run a number of knowledge transfer partnerships successfully. Prof. Mishra is very active in renewable energy research and is involved with many renewable energy organisations.

Title: Digital Twins in Asset Management.
Key Words: Digital Twin, Condition Monitoring, Asset Management, Maintenance, Valves.

Professor Iven Mareels
Federation University Australia

Since Oct 2022, Iven Mareels has been an Executive Dean at Federation University Australia, leading the disciplines of Business, Engineering, IT and Science. He is a Vice-President of the Australian Academy of Technology and Engineering, and a non-executive Director of Rubicon Water, an ASX listed company focusing on productivity and efficiency in water management. Previously, he was with IBM, as Director of IBM Research in Australia (2018-2021); and Dean of Engineering at the University of Melbourne (2007-2018). Iven received a PhD in Systems Engineering from the Australian National University (1987), and the Master of Engineering (Electromechanical), Gent University (1982). He has received two civil honours for his contributions to engineering and science: the Centennial Medal of Australia and Commander in the Order of the Crown of Belgium. He has published widely in the area of learning systems, and large-scale systems engineering (more than 500 publications).

Title: Systems Engineering for Irrigation System Asset Management
Key Words: Systems engineering, modelling, optimization, asset management, irrigation systems.

Prof. Ramin Karim
Professor of Industrial AI & eMaintenance
Division of Operation and Maintenance Engineering
Director of Centre for Intelligent Asset Management
Luleå University of Technology (LTU), Luleå, Sweden

Ramin Karim received the Ph.D. degree in operation and maintenance engineering from the Luleå University of Technology, Luleå, Sweden, in 2008.,He researched in the area of information and communications technology for over 20 years, as an Architect, a Project Manager, a Software Designer, a Product Owner, and a Developer. He is currently a Professor, responsible for the research area of eMaintenance, with the Division of Operation and Maintenance Engineering, Luleå University of Technology. He has published over 100 refereed journal and conference papers. His current research interests include robotics, feedback control systems, and control theory.

Title: AI-driven digital transformation in Asset management through innovative tools and technologies.

Dr. Anne Gibbs
Asset Management Council, Australia

Dr. Anne Gibbs is the CEO of the Asset Management Council, Australia. She is an executive engineering management professional with a strong focus on infrastructure management to enhance community quality of life. Anne has extensive international experience, having worked with a diverse range of communities in both developing and developed countries. Her projects have spanned aging water and waste assets, transport, and social infrastructure across nations like the UK, Denmark, and Russia. She has also managed the transition of a water authority in Argentina, handled municipal engineering for both remote and urban communities across Australia, and undertaken humanitarian engineering assignments in Tanzanian refugee camps, as a responder to an Indonesian earthquake, and for capacity building in East Timor municipalities. Additionally, Anne provided her expertise as a Disaster Resilient Infrastructure Project Expert to the CDRI Secretariat. She holds a Bachelor of Civil Engineering, a Graduate Diploma in Municipal Engineering and Management, a Masters in Business Administration, and a Doctorate in Business Administration.

Title: Asset Management for Resilience.

Professor Syed Islam, FIEEE
Federation University, Australia.

Professor Syed Mofizul Islam received the B.Sc. degree in electrical engineering from Bangladesh University of Engineering and Technology, Bangladesh in 1979, the M.Sc. and PhD degree in electrical power engineering from the King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, in 1983, and 1988 respectively. He is currently Associate Deputy Vice-Chancellor (Research and Innovation) at Federation University Australia. Prior to joining Federation University, he was the John Curtin Distinguished Professor in Electrical Power Engineering and the Director of Centre for Smart Grid and Sustainable Power Systems at Curtin University, Perth, Australia. He received the Dean's medallion for research at Curtin University in 1999. He received the IEEE T Burke Haye's Faculty Recognition award in 2000. He received the Curtin University inaugural award for Research Development in 2012. He received the Sir John Madsen medal in 2011 and 2014 for best electrical engineering paper in Australia. He has published over 270 technical papers in his area of expertise. His research interests are in Condition Monitoring of Transformers, Wind Energy Conversion, and Smart Power Systems.

He has been a keynote speaker and invited speaker at many international workshops and conferences. He has been a Visiting Professor at Shanghai University of Electrical Power and Xian Jiatong University, China. Prof Islam was also the Dean International for the Faculty of Science and Engineering at Curtin University (2011-2018). He is a member of the steering committee of the Australian Power Institute and a member of the WA EESA board. He is a Fellow of the Engineers Australia, a Senior Member of the IEEE IAS, PES and DEIS, a Fellow of the IET and a chartered engineer in the United Kingdom and a chartered professional Engineer in Australia. He is a founding Editor of the IEEE Transactions on Sustainable Energy and an Associate Editor of the IET Renewable Power Generation. He was the Guest Editor in Chief for the IEEE Transaction on Sustainable Energy special issue on Variable Power Generation Integration into Grid. Professor Islam has extensive experience in international collaboration in both education and research with institutes and researchers in China and other countries.

Title: "Transformer Asset Management" Industry Panel

Professor Tapan Kumar Saha
Electrical Engineering
The University of Queensland

Prof Tapan Saha was born in Bangladesh and immigrated to Australia in 1989. Tapan received his PhD from the University of Queensland in 1994. Previously, Tapan obtained a B. Sc in Electrical & Electronic Engineering from Bangladesh University of Engineering and Technology (BUET), Dhaka in 1982 and a Master of Technology in Electrical Engineering from Indian Institute of Technology, New Delhi in 1985. He has been with the University of Queensland since 1996, where he has been a Professor of Electrical Engineering since 2005. Previously he was an Adjunct Professor of Xi'an Jiaotong University and Hunan University in China. Previously he worked in James Cook University of North Queensland, Townsville for two and a half years and in BUET for three and a half years.

Tapan Saha is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and the Institution of Engineers Australia. He is a Chartered Professional Engineer (CPEng) of Engineers Australia and a Registered Professional Engineer of the State of Queensland (RPEQ). He is on the National Engineering Register (NER). Prof Saha is on the APEC Engineer Register and on the Register of International Professional Engineers.

Dr. Venkat Reddy
Queensland Rail.

Venkat is an Enterprise Asset Management Systems and Digital Engineering Management Leader, dedicated to delivering asset management and digital railway processes. As Queensland Rail focus has shifted towards the process and data-driven decision-making, Venkat is working with Business, Information, Communication and Operational Technology teams to achieve Strategic Asset Management and Digital Railway objectives.
Recently, Venkat have demonstrated leadership skills in introducing the Digital Engineering concepts, integration, tools, systems, and processes. As a key subject matter expert and point of contact for supporting information technology projects, asset management improvement projects, asset data reporting to enable and enhance the asset management practices.
Title: Analysis of Condition data and Process Implementation and its impact on asset management decisions

Prof Joarder Kamruzzaman
Federation University Australia

Joarder Kamruzzaman is currently the Director of the Centre for Smart Analytics and a Professor of Information Technology at the Institute of Innovation, Science and Sustainability at Federation University Australia. Previously, he served Monash University Australia (2004-13) as an Associate Professor and Bangladesh University of Engineering and Technology as a full professor (1999-2003). His research interests include sensor networks, Internet of Things, machine learning and cybersecurity.
He has published over 325 peer-reviewed publications which include 116 journal papers, 194 fully peer-viewed conferences, 15 book chapters and three edited reference books. Kamruzzaman has been listed on the world's top 2% Scientists, 2021-24 by Stanford University. He is the recipient of the Best Paper award in four international conferences: ICICS'15, Singapore; APCC'14, Thailand; IEEE WCNC'10, Sydney, Australia and in the IEEE-ICNNSP'03, Nanjing, China. He was also awarded the Best Researcher award twice in the Faculty of Science & Technology (2021 & 2016) and Graduate Research School Award for Excellence in Graduate Research Supervision (2019) at Federation University. His publications are cited over 9636 times and have h-index 43, g-index 87 and i-10 index 139. He has received over A$6m in competitive research funding, including highly prestigious ARC grant and large CRC (Collaborative Research Centre) grant, and successfully supervised 39 PhDs and 9 Masters to completion.
Title: Engineering Asset Management in the Era of AI.

Prof Gour Karmakar
Federation University Australia

Prof Karmakar received a B.Sc. degree in Computer Science Engineering from CSE, BUET (Bangladesh University of Engineering & Technology) in 1993 and Masters and PhD degrees in Information Technology from the Faculty of Information Technology, Monash University, in 1999 and 2003, respectively. He is currently a professor of Information Technology at Federation University Australia. He has published over 193 peer-reviewed research publications, including 52 international peer-reviewed reputed journal papers and was awarded six best papers in reputed international conferences. His research projects are funded by many industries and competitive funding bodies, including a prestigious ARC linkage grant in 2011. He has successfully supervised 16 PhD and four Masters by research projects from commencement to completion.

Tom Carpenter
CEO and Director, IQ-AM Pty Ltd
Certified Fellow in Asset Management (CFAM),
Certified Asset Management Assessor (CAMA 2),
Graduate Diploma of Asset Management, ME (Systems), BE (Civil)
Awards: Asset Management Council MESA Medallist (2022)

Tom has been involved in asset management for 30 years. He engaged in writing both ISO 55001:2014 and 2024, ISO 55002:2014 and 2018, and ISO 17021-Part 5 Competence requirements for auditing and certification of asset management systems and developed the first JAS-ANZ accreditation specification for conformance assessment and assisted Downer Utilities to obtain the first accredited certification to ISO 55001. As the owner and CEO of IQ-AM he developed the first vocational Graduate Certificate and Graduate Diploma qualifications in Asset Management recognised by the Australian Government and finally the principal developer of the Asset Management Global Certification Scheme for WPiAM.
Tom believes it is critical we ensure that we achieve recognition of Asset Management as a profession as we move on into the future. Not only do we need to gain recognition, but we also need to ensure that Governments, industry and educational institutions embrace Asset Management. A key element in this is our willingness to embrace personal certification – if we are not willing to embrace personal certification we cannot expect others to do so. Tom will outline some of the key aspects of what we need to do.

Title: What does it take to achieve true efficiency and effectiveness in asset-management capability?

Shane Scriven
Advanced Analytics and Asset Management
Accessible, Understandable, and Usable AI for Everyone

Title: The Decentralised Future of Asset Management: Intelligence at the Edge
& “Future Direction of Asset Management”, Industry Panel

Abstract: The asset management profession stands at an inflection point. For decades, we've operated under a centralised paradigm a select cadre of specialists interpreting data, making decisions, and issuing directives from corporate headquarters or regional hubs. This model, whilst serviceable in the industrial age, is increasingly mismatched with the realities of modern asset-intensive operations. The future of asset management isn't centralised; it's distributed, autonomous, and lives at the edge on the assets themselves. The catalyst for this transformation is the

convergence of three enabling technologies: tiny recursive language models, machine learning, and knowledge graphs. Together, these create an environment where assets don't merely generate data they reason, decide, and act.

Consider the breakthrough in small language models optimised for specific domains. These aren't the generalised behemoths requiring cloud infrastructure; they're purpose-built, highly focused models that can execute inference at breakneck speed on edge devices. A tram's predictive maintenance model doesn't need to understand Shakespeare it needs deep expertise in bearing acoustics, brake system thermodynamics, and pantograph wear patterns. This specificity enables deployment directly on the asset, eliminating latency, connectivity dependence, and the computational overhead of general-purpose models.

The implications are profound. Today's asset management suffers from a chronic condition: decision paralysis in the face of uncertainty. When a sensor reading sits ambiguously between acceptable and concerning, we defer to human judgment which varies by shift, by individual, by mood. This inconsistency cascades through organisations as interpretational drift, where identical situations yield different responses based on who's making the call.

Edge-deployed AI eliminates this variability. An asset equipped with domain-specific language models, coupled with machine learning algorithms and underpinned by knowledge graphs; doesn't operate on opinion it operates on encoded expertise, regulatory requirements, and organisational logic. The knowledge graph provides the semantic understanding of asset relationships and dependencies; the ML models detect patterns and anomalies; the language models reason about what those patterns mean and what actions to take. The result is coherent, aligned decision-making across the entire asset portfolio.

This isn't theoretical. The technology exists now. Edge computing hardware is sufficiently powerful and affordable. Model quantisation and pruning techniques can compress sophisticated AI into embedded form factors. The missing piece isn't technical capability it's organisational readiness to relinquish centralised control. The transition will challenge traditional hierarchies. Asset management will evolve from command-and-control to orchestration. Central teams won't disappear, but their role shifts to training models, establishing decision frameworks, and monitoring system-wide performance rather than making individual asset decisions. It's the difference between conducting an orchestra and playing every instrument yourself.

The organisations that embrace this decentralised future will achieve something previously impossible: perfect consistency at scale. Every asset operates with the same expertise, the same decision logic, the same speed of response but contextualised to its specific condition and environment. No opinion. No interpretation drift. Just intelligent, autonomous asset management delivered where it matters most: at the edge.

Venkata Sai Prashanth Sudula

Federation University Australia

Masters by Research with expertise in life extension and modelling for reducing costs and risks and enhancing performance through risk-informed upgrade decisions. Grad IE, Engineers Australia member and Member of the Asset Management Society India. Venkata has worked in various roles in industries and universities in the area of reliability, maintenance, and operational efficiency.

Title: Risk-Informed Life Extension Decisions Using Unstructured Maintenance Data.

Dr. Shantanu Kumar
Lead Electrical Engineer

Dr. Kumar is a subject matter expert in Transmission and Distribution Network with over 35+ years of experience in encompassing design, engineering, testing, commissioning, asset management, reliability engineering & construction of brownfield and new projects related to HV & LV Substations.

As the T&D power engineer, he was responsible for WA's leading mining, utilities and infrastructure industries to design, engineer and commission HV & LV Substations (from 11 kV up to 400 kV AIS & GIS at underground and surface levels.
Title: "Transformer Asset Management." Industry Panel

Charles McInnes
Lecturer and Consultant in the mining, oil, gas, sheet metal, power, defense, maritime, water, civil and construction industries.
VCAT III certified.
Charles McInnes teaches the MREGC5006 course (Machine Condition Monitoring and Fault Diagnosis). He has a PhD in mining robotics and over 25 years' experience in vibration, acoustics, strain, dynamic modelling and feedback control systems. He is the owner of Industrial Vibration Systems and currently works as a consultant when he is not working creating Expert software for noise, vibration and strain data acquisition and analysis.
Title: "Fundamentals of Spectral Analysis."

Indy Sehra
Founder & Principal, City of Assets

With over 20 years in Enterprise Asset Management (EAM) across local government, water, transport, and utilities, Indy Sehra founded City of Assets in 2023, driven by a mission to give back to the asset management community. City of Assets is a boutique, vendor-agnostic, and independent advisory practice supporting asset-intensive industries. Its purpose is simple to help organisations strengthen their asset management capability and bridge the gap between their current and desired future state.

An Electrical & Electronic Engineer with a Master's in Information Technology and a Certified Associate in Asset Management (CAAM), Indy supports councils and utilities in aligning systems, processes, roles, and data with industry standard frameworks to drive long-term, sustainable improvement.

Title: "Future Direction of Asset Management", Industry Panel

Abstract: Enterprise Asset Management Systems – From Complexity to Clarity
Across Australia, organisations continue to invest heavily in Enterprise Asset Management (EAM) systems yet still struggle to realise their full value. The challenge is rarely technology alone; it's the disconnect between Systems, Business Processes, Roles & Responsibilities, and Data.

In response, City of Assets developed a simple framework 'the ABCD Framework' a practical, vendor-agnostic model designed to demystify EAM and create a clear line-of-sight from strategy to street-level delivery:

A. Asset Systems – fit-for-purpose platforms, integrated workflows.
B. Business Processes – end-to-end, cross-functional and outcome-focused.
C. Clear Roles & Responsibilities – clarity of ownership and accountability across lifecycle stages.
D. Data Standards – quality, governance and insight as the foundation for decision-making.

This structured yet simple model helps organisations self-assess their maturity, identify pain points, and design transformation programs that are realistic, measurable and aligned with community outcomes.

The next decade of asset management will be defined by integration and intelligence connecting EAM with digital twins, IoT, AI analytics, and sustainability reporting. However, success will depend on mastering the basics first: understanding your ABCDs before adding the next letter.

Aaron Teo
Managing Director, AVID Group

Aaron is the Managing Director of the Avid Group of Companies, a diversified organisation operating across energy, technology, and engineering. Under his leadership, Avid has evolved into a trusted partner delivering turnkey energy and infrastructure solutions across Australia, Asia, and Africa. With a background in engineering and business, Aaron brings a unique blend of technical insight and strategic foresight. He has spearheaded Avid's expansion into energy storage, modular power systems, and sustainable infrastructure helping industries accelerate their transition to smarter, cleaner, and more reliable energy systems. Aaron's leadership philosophy is grounded in people, innovation, and execution. He is passionate about developing future leaders and driving collaboration that creates enduring value for industries and communities alike.

Title: "The Future needs of asset management of Manufacturing Leadership in Australia."

Abstract: Australia has a great history of innovation and leadership in manufacturing in various sectors including mining, mineral processing, heavy haul transport, agriculture, and livestock. The dominance reduced due to global competition, distances , and price competitiveness. Current dynamics of geopolitical uncertainties and its impact on supply chains, costs, risks, and performance of Australian industries and various sectors shows the need for investing on future of manufacturing in Australia especially how we can continue to innovate and cultivate the next generation of engineers and industries for reducing the risks and costs and further enhancing productivity for making Australia great again in manufacturing sectors and related industries including defence sector.

There are needs for strategic planning, passion, and political will to invest and support in future technologies including advancing robotic technologies useful in welding, mining, manufacturing, for land, underground, underwater and space exploration and next generation of energies, transportation, water, healthcare, and infrastructure.
Case study from Avid group in Australia will cover how to way forward in welding, building high-quality electrical substations and power stations to push the boundaries of efficiency, safety, and sustainability in manufacturing.

It will also cover how to build non–thermal runaway battery systems a safer, more sustainable energy solution to create a cleaner, safer and better world.
Beyond technology, a key question needs to be asked is how do we build passionate leaders who will drive the agenda to build a resilient manufacturing culture in Australia?

Building a resilient culture starts with leadership that values growth over comfort, vision over short-term gains, and teamwork over ego. It's about setting high standards, developing the future generation of professionals, and never losing that focus to build the long lasting and meaningful future whether it's in manufacturing, energy, or shaping the next generation of engineers, managers, professionals, and leaders. This talk will use industrial case study and initiate discussion on looking forward and needs for exchanging ideas and exploring how to shape a stronger, smarter, and more resilient manufacturing future for Australia supported by good practice asset management covering physical assets, human assets, information assets, financial assets, and reputation.

Dr. Kin Yu LAM
Application Engineering Leader
Cargill Asia Pacific Holdings Pte Ltd, Singapore

Dr. Lam is technical and business development professional in the oil and chemical industries with expertise in a wide range of products and applications including lubricants, metalworking fluids, insulation oils, heat transfer fluids, polymers and building materials; and a deep understanding of the different business segments, including customers, quality and regulatory requirements. Well versed in networking with internal and external parties in different job functions and levels, and a proficient presenter to audience of different background and culture, with ability to articulate complex information in a clear, compelling and down to earth manner. Proven track record in developing and implementing strategies and projects to enable business growth and improvement of operational efficiency, and experience in leading, coaching and developing teams with diverse cultural background.

Title: "Lifecycle Cost Benefit Analysis of Natural Ester Transformers Based on Extended Lifespan of Paper Insulation."

A/Prof. Gayan Kahandawa Appuhamillage
Federation University Australia

A/Prof. Gayan Kahandawa Appuhamillage's research expertise includes mechatronic systems, sensors and signal processing, artificial intelligence, mobile robot navigation, instrumentation and structural health monitoring. A/Prof. Appuhamillage's current projects include development of rear wheel steering systems for semitrailers (Regional Scholarship and Innovation Fund grant) and development of active restraining system for wheelchairs in public transport (Victorian Government Grant). He also works on the development of a novel mobile robot navigation algorithm. He currently holds two patents and published an edited book in 2015. He worked with Boeing in his research project, to develop a monitoring system to detect damage in advanced composite structures using embedded fibre optic sensors. He also used fibre optic sensors to monitor West Gate Bridge (VicRoads) and instrumentation and monitoring truck trailers (MaxiTRANS) for performance and structural enhancement.
Title: Intelligent Asset Management of Landfills**.**

Dr. Barun Gorain
Managing Director: Ore2Metal Inc., Toronto, Canada

Dr. Gorain has more than 25 years of experience in the mining and metals industry (gold, copper, zinc, nickel): senior management & technical roles in major global operations, capital projects, investments in critical minerals & metals focusing on transforming project economics leveraging breakthrough technologies; also due diligence for large mining M&A projects.

Experience in Senior Management roles with major mining companies including Director of Technology at Barrick Gold in Toronto, Canada; Chief Technology Officer and Senior Advisor at Hindustan Zinc (Vedanta Resources) in India, and Group Leader at Teck Resources in Canada & the USA.

Dr. Gorain has a Ph.D. in Metallurgical Engineering from the JKMRC, University of Queensland in Australia and a B.Tech. in Mineral Engineering from Indian School of Mines (now IIT, Dhanbad).

Dr. Gorain is now the CEO & managing director of ORE2METAL, based in Toronto Canada.
ORE2METAL is a provider of advanced eco-efficient technologies for the production of critical metals in collaboration with its partners focusing on value chain support from project scoping & feasibility to plant design and commissioning. Ore2Metal specializes in metals recovery from low grade complex ore bodies as well as from mine tailings, smelter residues and electronic waste.
Dr. Gorain's patented AMBS technology has now been implemented by two global operations, one in Chile and another in Saudi Arabia, treating copper and copper-gold ores.

Title: "Transforming Mining Waste into Strategic Assets for Production of Critical Metals."

Rev. Swami Sunishthananda
Vedanta Centre of Melbourne
Rev. Swami Sunishthananda is resident monk in-charge of Vedanta Centre of Melbourne..
Title: "Human aspects of Asset Management."

Title: "Transformer Asset Management" Industry Panel

Professor Ahmed Abu-Siada
Head of Electrical Engineering
Curtin University

Prof. Abu-Siada holds a PhD in Electrical Engineering from Curtin University, with research interests spanning Power Systems, Renewable Energy, Asset Management, and Fault Diagnosis. He has supervised over 40 completed HDR theses and authored 300+ journal articles and conference papers in these research areas.

Title: “Transformer Asset Management” Industry Panel

Yadwinder Singh Hunjan
Head of Asset Planning and Systems, City of Casey

Yad is Qualified professional with a demonstrated history of working experience over a decade in local government and six years in private road construction industry acquired diverse range of skills ranging from Asset Management, Project Management and Construction Management with strong focus on leadership, people development, process improvement, result oriented, customer focused, innovation and new technologies.

Title: From Data to Decision Making – How Asset Management Works at the City of Casey-1

Gayathri Wickramasinghe
Team Leader Asset Data and Systems, City of Casey
Gayathri is Certified Asset Management Assessor (CAMA) who has work experience over a decade in both state and local government bringing extensive expertise in Asset Management Information Systems (AMIS), Asset Management Planning, Infrastructure Financial Management combined with strategic leadership, process improvement, optimising asset lifecycle management and leveraging data-driven insights to enhance service delivery and financial sustainability.
Title: From Data to Decision Making – How Asset Management Works at the City of Casey-2

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Abstracts - Day 1: Technical Sessions (01:45pm-3:30pm)

Technical Session 1A: Parallel Track Room 2

Paper 17: Risk-Informed Life Extension Decisions Using Unstructured Maintenance Data

Venkata Sai Prashanth Sudula, Gopinath Chattopadhyay, and Jo-Ann Larkins
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Life extension (LE) decision of complex, long-life, capital-intensive assets is a challenge due to the availability of structured maintenance data. Data is often unstructured and text-based, making it difficult to perform systematic reliability assessments useful for assessing the remaining useful life (RUL). This study presents a methodology for addressing those challenges by using Natural Language Processing (NLP), NESTOR. Historical maintenance records (2012–2017) from the University of North Dakota (UND) Aviation Academy were analyzed for, three critical engine components: intake gaskets, rocker cover gaskets and baffles in single and twin-engine fleet. Failure Mode and Effect Analysis (FMEA) was conducted for the identification and prioritization of intervention options for failure modes based on likelihood and consequences. The results demonstrate the potential of NLP techniques to support reliability analysis for RUL required for risk informed LE decisions of capital-intensive long life complex assets.

Keywords - Life Extension, Failure Mode and Effects Analysis, Natural Language Processing, Technical Language Processing, Unstructured Maintenance Data, Risk Priority Number.

Paper 2: Lifecycle Cost Benefit Analysis of Natural Ester Transformers Based on Extended Lifespan of Paper Insulation

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With the feasibility of prolonging equipment life and increasing loading capacity, transformers designed with thermally upgraded kraft (TUK) paper in natural ester dielectric fluid is increasingly gaining popularity in the industry. Based on natural ester's unique properties in retarding the degradation of cellulose paper, this paper evaluates how it can deliver quantifiable saving on lifecycle asset cost for utilities and the power industry.
When historical thermal aging test results obtained from various studies on TUK paper were analyzed in accordance with IEEE Standard C57.100, the insulation life in natural ester is about 9.7 times as long as that in mineral oil. With consideration to the longer insulation life and the predicted contribution of natural ester fluid in reducing the relevant modes of transformer failure, the annual failure rate of natural ester transformers is estimated to be about 2.42% as compared to 3.89% for mineral oil transformers. Overall, based on statistics provided by two of the utilities in the USA and the Philippines concerning asset replacement for different reasons, the average transformer lifespan can be extended by 51% and 62% respectively with the use of natural ester fluid in place of mineral oil. With the significantly longer asset life, it is concluded that capital cost saving in the range of 7-12% can be achieved with natural ester transformers based on net present value over the horizon of the transformer life despite its initial cost being 10-16% higher.

Keywords—asset life, dielectric fluid, lifecycle cost, natural ester, transformer, TUK paper insulation

Paper 4: A Bayesian Decision-Making Framework for Life Extension of Long-Life Complex Assets under Data Scarcity

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Life extension decisions are complex due to various issues including costs, risks and limited data. Estimating the Remaining Useful Life (RUL) of long-life, capital-intensive assets is especially challenging for deciding the depth and breadth of the interventions needed for cost and time effective life extensions for assuring expected performance over the extended period of life. Failure records are too sparse in many cases to support conventional models including Weibull analysis or data-intensive approaches like deep learning.
This paper proposes a Bayesian framework designed to take risk informed decisions under such data scarcity. Multimodal failure mechanisms are modelled using Exponential combined with Gamma–Poisson and Beta–Binomial to generate more accurate RUL estimates from limited data. Along with failure data, inspection data is incorporated as additional evidence if available. Subsystem interactions are modeled through Bayesian Belief Networks. The framework links these probabilistic scenarios with expected utility analysis, enabling maintenance strategies based on risks and costs.
A case study of the bogie subsystem of a bucket wheel reclaimer in Alumina refinery, analysing 86 failures across 14 modes, used for illustrative example. The results show cost effective decisions where interventions needed for critical subsystems and recommended deferred maintenance with low-risk areas.

Keywords: Life Extensions, Remaining Useful Life (RUL), Bayesian Framework, Data Scarcity, Risk-Informed Decisions.

Paper 8: A Comparative Analysis of Key Performance Indicators for monitoring and preventive interventions in the Rail Sector.

Dennis Noble, Gopinath Chattopadhyay, Truong Phung
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The global railway industry has been facing unprecedented pressures to retain and further enhance efficiency, ensuring safety, and sustainability. Central to navigating this agenda is the effective use of Key Performance Indicators (KPIs). This paper presents an analysis of the KPIs employed by railway organisations worldwide. Through an extensive review of corporate publications from a diverse passenger rail network, infrastructure managers and operators across Europe, Australasia, the Middle East, and North Africa, this study analyses the key performance indicators and proposes a hierarchical taxonomy. The proposed taxonomy is structured around seven strategic domains: Financial Performance, Service Delivery & Customer Experience, Network Health & Asset Performance, Maintenance & Project Delivery, Safety & Risk Management, Environmental & Social Sustainability, and Governance & Capability. Research finds that while a core set of metrics related to punctuality, reliability, and safety are followed widely, significant regional and organisational divergence exists, reflecting differing ownership models, regulatory environments, and strategic priorities. A comparative analysis of reported performance data reveals a strong correlation between sustained investment in infrastructure and better operational outcomes. This study shows that there is a need for adoption of useful data-driven KPIs, embracing best practice asset management and including safety, Environmental, Social,

and Governance (ESG) metrics into core financial reporting. The proposed framework provides an opportunity for monitoring performance, offering a better understanding and further improvement of rail network performance through the effectiveness of monitoring and timely interventions of adverse trends of KPI of the world's railways.

Keywords— Key Performance Indicators, Railway, Performance, Benchmarking, Rail, Asset Management, Sustainability.

Paper 23: Risk-Based Overall Equipment Effectiveness to Total Productive Maintenance: Translating Measurement into Action in Meat Manufacturing

Vickram Chundhoo, Gopinath Chattopadhyay, Gour Karmakar, and Gayan K. Appuhamillage
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This study advances the concept of risk-based Overall Equipment Effectiveness (RB-OEE) by transforming risk weighted performance metrics into actionable Total Productive Maintenance (TPM) interventions, using live downtime data from a meat manufacturing facility. The proposed framework (i) quantifies loss patterns through a structured, repeatable analysis of run-level downtime logs, (ii) maps dominant downtime categories to corresponding TPM pillars, and (iii) integrates human and organisational factors that influence equipment stability. The approach bridges the measurement–action gap: RB-OEE identifies what matters most, while TPM operationalises who acts and how. Illustrative analysis shows that changeovers (32%), waiting (25%), and people-related delays (15%) constitute the principal loss contributors. The paper concludes with an ISO 55000-aligned implementation roadmap and highlights predictive maintenance extensions to strengthen data-driven decision-making and sustainable operational resilience.

Keywords — Risk-Based OEE, Lean, TPM, Downtime, OEE, ISO 55000, Human Factors, Predictive Maintenance, Food Manufacturing.

Technical Session 1B: Parallel Track Room 3

Paper 29: Fire Risk Mitigation and Reliability Improvement on Conveyor Belts in Mining.

V. Mathew, G. Chattopadhyay, R. Das
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Conveyor belts are one of the most cost effective and reliable modes of bulk material transport with the ability to transport materials that includes natural resources such as Iron Ore, Copper concentrate, limestone etc. Although highly effective in its function to transport bulk materials, the industry events documented in this paper identify conveyor fire as a major risk resulting in significant revenue loss. This study focuses on fire risk due to bearing failures which is one of the major causes of conveyor fires. The current risk mitigation controls are reliant on routine time-based inspections and condition monitoring practices including vibration analysis. The conveyor bearing life cycle analysis completed as a pilot study as part of this paper indicates a strong wear out failure pattern therefore requiring closer monitoring to be able to predict the failure and make decisions as compared to the conventional inspection regime which has its limitations in early detection of a Potential failure. Where there are localised events such as broken grease lines, dirt ingress, etc the resultant defect presents uncertainty of the state of the bearing and can be detrimental to Reliability, Availability,

Maintainability and Safety (RAMS). This study comprises two parts with the first part focusing on understanding the failure modes, life cycle analysis and how it relates to the design life of the bearings. The second part details plan to integrate real time condition monitoring into the asset management database. The cost of implementation of the advanced condition monitoring IIoT system will require determination of trade-off between reliability and risk exposure in maintaining the asset.

Keywords– Conveyor Pulleys, FMECA, Risk based inspections, Cost Benefit Analysis, Risk Management, Condition Monitoring- IIoT

Paper 30: Fault Tree Analysis of Rollingstock Stopping AID System Train Software for improving operational safety.

H. Shi[1], G. Chattopadhyay[2], R. Das[3], F. Gao[4]
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As train software systems grow in complexity, ensuring reliability—especially during maintenance—becomes vital for operational safety. This paper presents a case study from Melbourne's High-Capacity Metro Train (HCMT) project, focusing on unexpected failures in the stopping aid function due to software and operational factors.
Using Fault Tree Analysis (FTA) and Reliability Block Diagram (RBD), the study identifies root causes and evaluates software logic through 12 months of operational data. A cost-benefit and risk analysis support proposed software enhancements, which improve fault tolerance and system robustness. The solution yields a 357% ROI, with cumulative savings surpassing implementation costs within three months.

Keywords- Railway Stopping-aid Function, Railway Software Redundancy, Failure Logic Analysis with FTA, Train Operational Fault Mitigation, Train Software Function Validation.

Paper 34: Failure Mode and Effect Analysis of Power System Monitoring for Control Systems of Alumina Production Plant

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Reliable and uninterrupted power delivery is fundamental to the safe and efficient operation of process industries. In an alumina production plant, the integrity of the Distributed Control System (DCS) is paramount, requiring robust primary and backup power supplies coupled with effective alarm monitoring. This study presents a comprehensive reliability and maintenance analysis of a redundant power supply system for a DCS controlling a critical Multi-Fuel Chamber (MFC) unit. A site audit revealed significant latent failures, including a degraded primary power supply and multiple discharged backup batteries, which had compromised the system's designed redundancy. An integrated reliability assessment methodology was employed, combining Reliability Block Diagrams (RBD) to model system success logic, Fault Tree Analysis (FTA) to deduce failure pathways, and Failure Modes and Effects Analysis (FMEA) to identify and prioritise risks. The analysis confirmed that the reliability of the controller is contingent on the power backbone chassis and the availability of at least one of three parallel power sources. The FMEA identified battery discharge

during plant outages as the highest-risk failure mode, with a correspondingly high-Risk Priority Number (RPN). Based on these findings, a holistic maintenance management strategy is proposed. This strategy incorporates principles of Risk-Based Maintenance (RBM) derived from the FMEA, an integrated local and secure remote condition monitoring architecture, and adherence to ISA/IEC 62443 cybersecurity standards to mitigate risks from Operational Technology (OT) and Information Technology (IT) network convergence. The paper concludes with actionable recommendations to restore system reliability, enhance maintenance practices, and establish a framework for transitioning towards a proactive Prognostics and Health Management (PHM) approach.

Keywords - Reliability, Availability, Maintainability (RAM), Maintenance Management, Distributed Control System (DCS), Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Reliability Block Diagram (RBD), Alumina Refining, Risk- Based Maintenance (RBM), ISA/IEC 62443.

Paper 35: Risk-based Decision Making in Maintenance Intervals of Light Rails in Australia.

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Asset-intensive organisations are seeking to align maintenance practice with Asset Management Systems and risk principles while taking advantage of data-rich operations. This paper presents a standards-aware, analytics-enabled method to rationalise preventive maintenance intervals for an urban light rail fleet of CAF Urbos3 trams. The approach is consistent with ISO 55000 and ISO 31000 governance, railway RAMS practice in EN 50126, and task-level analysis using IEC 60812 style reasoning. It combines a technical review of preventive task scopes, four years of quality-controlled CMMS and FRACAS data, practitioner interviews, and a structured risk assessment to test whether selected tasks can move from fixed time-based cycles to longer kilometre-based triggers.

Results show that all 26 tasks in the 30-day inspection can shift to an 8,750km trigger, and all 38 tasks in the 14,000kminspection can shift to a 17,500km trigger, with risk remaining within tolerable bounds when considered against consequence, detectability and observed likelihood. Corrective history was dominated by non-critical categories such as doors, HVAC and minor interior items, which supports extending intervals without compromising safety or reliability. A cost–benefit analysis using recorded durations and materials estimates savings just under $1.3 million over ten years for the fleet, with expected availability gains due to fewer planned outages.

The study demonstrates a defensible pathway to integrate standards-based governance with data-driven RAM analytics, providing an auditable basis for interval changes that improve whole-of-life performance while maintaining compliance and assurance.

Keywords - Asset management, RAMS, preventive maintenance, condition-based maintenance, FRACAS, CMMS, risk assessment, Light Rails

Paper 45: Reliability-Based Inventory Optimization for Crude Oil Transfer Pumps.

Hongan Lin
Executive Director AssetStudio,
Singapore.

This presentation evaluates spare part inventory strategies for a crude oil transfer pump (COTP) system in a 3x2 configuration. Using reliability simulation that accounts for failure rates, spare costs, and oil prices, the study quantifies the financial effects of different inventory policies. The results compare production outcomes across strategies and provide management with a practical, data-driven framework for maximizing financial performance.

Technical Session 1C: Parallel Track Online

Paper 27: Analysis of Condition data and Process Implementation and its impact on asset management decisions

Venkat Reddy, and Sinda Rebello
Queensland Rail

Queensland Rail implemented Risk Based Decision Framework in 2022 across its entire asset portfolio. From the initial implementation in below rail assets, it has since been extended to above rail, and rollingstock assets. The risk-based decision approach was developed to support and prioritise the investment planning decision making process. This process underpins the development of strategic asset management plans for all assets across Queensland Rail.
By adopting the Risk-Based Decision Framework, the industry aims to make informed asset management decisions based on data related to asset failure, maintenance, and lifecycle management. However, leveraging this data has presented several challenges.
This paper focuses on reviewing critical sub-elements such as Asset Health Index, Deterministic Condition Index and Universal Condition Index across various asset types, considering the entire asset lifecycle management and its application to new assets. Key areas of focus include data accuracy, the development and recording of correct fault codes, and training for end users. The assessment of these condition indices is considered alongside other lifecycle parameters such as criticality, risk, and obsolescence. The paper also highlights the lessons learned and identifies areas where greater process clarity is needed to support future asset management decisions.

Paper 38: Reliability-Based Maintenance Decisions of a Polyol Gear Pump in Foam Manufacturing.

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Reliability plays a critical role in maintaining product consistency and minimizing unplanned downtime in foam manufacturing. This paper presents a reliability-based maintenance study of the polyol gear pump used in the continuous foaming line at Australian Comfort Group. Although the Polyol Metering System accounted for only about 12% of total plant downtime, it contributed nearly 29% of total maintenance costs, identifying it as

a high-impact area for improvement. Three years of maintenance and failure records were analyzed using Pareto analysis, Failure Modes and Effects Analysis (FMEA), and Weibull reliability modeling. The analysis covered 19 recorded failures and 32 maintenance interventions. Results from the Weibull model yielded a shape parameter $\beta = 1.8$ and a characteristic life $\eta = 58.7$ days, indicating wear-out behaviour primarily caused by seal and bearing degradation. A cost-rate optimization model was applied to determine the optimal preventive maintenance interval, which was found to be approximately 27 days. This represents a 10–15% reduction in maintenance costs compared with the previous 50-day schedule. The findings demonstrate how reliability engineering tools can support practical, data-driven decisions that enhance cost efficiency, equipment availability, and foam quality consistency. consistency.

Key Words: Gear pump, Preventive Maintenance, Reliability, Weibull analysis

Paper 46: Fundamentals of Spectral Analysis in Condition Monitoring.

Charles McInnes, Federation University Australia

Why do we typically prefer to analyse vibration data in the frequency domain? This session will attempt to answer this question by giving a live demonstration of data acquisition. The presentation aims to give the audience some familiarity and understanding of how sinusoidal, periodic (but not nonsinusoidal) and broadband data looks in a time waveform and a spectrum.

Paper 13: Review of Differential Protection as Applicable to Conventional and Digital Method Based on IEC 61850

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Traditional large transformers in utilities have differential protection because of their reliability and sensitivity. However, the conventional protection schemes are not straightforward, simple, or economical. Furthermore, the conventional method of copper-based wiring, using CT/PT connections, makes it difficult to diagnose in the event of a fault.

In this paper, a review has been carried out comparing conventional differential protection with the digital schemes based on IEC61850 protocol. Review of the digital protection scheme exhibits faster, reliable, and cost-saving protection of a large utility system. Unlike the conventional differential protection, which is restricted to a single substation and requires point-to-point wiring, this enables line current differential protection to be extended across multiple substations via fibre optic Ethernet, transmitting Sampled Values

and Generic Object Oriented Substation Event Over Wide Area Networks. Additionally, digital substations are immune to electromagnetic interference and scaling errors as the signal processing is done through SV and Merging Units and passes through the Intelligent Electronic Devices. As fault clearance is a significant important part of a substation, this process ensures a fast fault clearance within milliseconds. Recent studies demonstrate that IEC 61850 can cause harmonic blocking using the GOOSE messaging and minimize fault tripping during transformer inrush conditions. Moreover, the evolution of Substation Automation System in the digital model has also enabled Centralized Protection and Control architectures. Whereas the conventional substations use relay-based schemes, digital substations consolidates several protection and control functions into one single device, known as CPC which not only simplifies the configuration but also enhances the cooperation between line, bus bar and transformer protections. One of the major advantages of digital substation includes the protection schemes testing Real Time Digital Simulator before they get tested in Hardware-in-the-Loop with actual relays, IEDs and Ethernet switches. This process ensures safety and saves time for the engineers.

Keywords—Substation Automation System, Protection, Merging Unit, IEC 61850, Hardware-in-the-loop

Paper 43: Asset Management System framework aligned with ISO55001 developed for a Multi Campus University in Australia.

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The ISO55000 series of standards and Asset Management Accountability Framework (AMAF) are aimed at enabling an organisation to obtain value from its assets through effective and efficient management. It offers a structured and well-researched approach to Asset Management (AM) which can be applied to organisations with different levels of maturity in Asset Management System (AMS) Framework.

As a quality vocational education, higher education and research training provider, the Federation University has been working on aligning its strategic and operations management systems to comply with the AMAF and ISO55001 standard requirements and guidelines. This adaptation has helped in developing and embedding a cohesive asset management system framework ensuring that asset management is promoted by leaders, is appropriately resourced with skilled staff and coordinated in a way which helps in continual improvement of operational efficiency using risk informed decision making.

The adoption implementation process is challenging as the University is managing facilities and infrastructure assets in different campuses in Australia with considerably different asset management practices and service delivery models. AMAF and ISO55001 AMS Frameworks have helped the University to align strategic objectives and services to the asset management practices and to ensure that their objectives to realise the best value from facilities and infrastructure assets are addressed well in the service delivery.
This paper outlines key challenges faced by the organisation and how various challenges have been tackled for successful development and adoption of the AMS framework. This paper focus on use of ISO55001 asset management system framework and a state of art Asset Management Information System (AMIS) suite for managing facilities and infrastructure assets, provided assurance to stakeholders that assets have been managed to provide better value from limited resources and assists in fulfilling organisational objectives.

Keywords—asset management, asset management system, asset management accountability framework, ISO55001.

Abstracts Day 1: Technical Sessions (04:00pm-5:30pm)
Technical Session 2A: Parallel Track Room 2

Paper 37: Multi-Head Attention Informer for Predictive Maintenance of Rare Failures in Industry 5.0

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Industry 5.0 systems rely on continuous sensor data to monitor equipment and avoid machine failures that cause production damages and unplanned downtime. Critical faults in these settings, however, are quite rare compared to normal operation, which creates severe class imbalance in monitoring data. Models in charge of detecting these issues therefore learn to predict normal condition overwhelmingly and miss incoming failures. Existing predictive maintenance methods heavily utilize recurrent neural networks (RNNs), which have limitations. Model like long short-term memory (LSTM) scan sequences in local windows, yet they struggle to focus on subtle cross-sensor patterns that precede failures. The remedy, conventional attention applied on top of RNNs, can stay local and yield redundant representations that prevents recognition of minority-class faults. Most methods also do not jointly optimize detection capacity and class balance. As a result, attention concentrates on normal operating conditions. We propose a multi-head Informer tailored for imbalanced fault detection. While the encoder captures longstanding trends, multiple attention heads emphasize temporal signatures of rare faults, including inter-sensor interactions, and evolving shift in sensor data. Class-weighted training values learning the minority class more, making the model more conservative. On the AI4I benchmark dataset, our model attains 85.26% balanced accuracy, outperforming LSTMs and Random Forest while also accumulating the lowest false positive rate (failure predicted as normal). The model provides an early warning system for machine failures, and is non-context specific, allowing application on other systems that require reliable rare failure detection.

Keywords — Informer, Transformer, Attention model, Predictive maintenance, Failures, Industry 5.0.

Paper 6: Automating HAZOP Reports using Clustering-Enhanced Fine-Tuned GPT-2 (CEHRA)

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Traditional Hazard and Operability (HAZOP) studies rely on manual analysis, which is time-consuming, static and prone to errors due to human oversight. These limitations also hinder the dynamic risk identification in complex industrial settings. This present study develops a Clustering-Enhanced Fine-Tuned GPT-2 (CEHRA) framework to automate HAZOP report generation in industrial settings. It integrates the Dirichlet Process Gaussian Mixture Model (DP-GMM) with a fine-tuned GPT-2 model to produce a near accurate, contextually relevant reports, and thereby reducing the dependency on HAZOP experts. The framework takes the historical HAZOP reports as its inputs and addresses data inconsistencies and enhances risk classification reliability. Historical HAZOP reports from a petrochemical plant are used as the dataset. The CEHRA model achieves strong performance with ROUGE scores of 0.36–0.56 and an F1 score of 0.54, ensuring the generation of high-quality, industry-specific reports. The findings enable faster, more reliable hazard analysis, supporting proactive safety measures in the petrochemical operations. Future work could focus on improving model generalization across diverse industrial datasets.

Keywords— Auto-HAZOP, process safety, risk assessment, GPT-2, large language model (LLM)

Paper 44: Building Human Assets: Imperative for Human Capital Management and the mitigation of Childhood Adversity risks

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Abstract

Asset Management in line with ISO 55000 emphasises importance of leadership and culture. Human assets are extremely important in asset management along with physical assets, financial assesses, information assesses and intangible assets including reputation of organisation. The contemporary paradigm of human asset management is increasingly challenged by the pervasive and often hidden impact of psychological childhood trauma. Adverse Childhood Experiences (ACEs) and developmental trauma are significant determinants of human asset outcomes affecting cognitive functioning, emotional regulation, interpersonal skills, and physical health across the entire life. Traditional management approaches, which often pathologize individual behaviour, fail to address the root causes of underperformance, absenteeism, presenteeism, and high staff turnover.

This paper argues that the transition to a Trauma-Informed Society is a critical, strategic imperative for effective human asset management for any human to reach to their highest potential. A trauma-informed framework moves beyond awareness to actively embed principles of safety, trust, transparency, peer support, collaboration, and empowerment into the very fabric of organizational culture and leadership.

By recognizing the widespread prevalence and impact of trauma, society and organizations can shift focus from asking "What is wrong with you?" to "What has happened to you, and how to help in overcoming adverse impacts on your work and well-being?" Inclusive practices are proposed to avoid inadvertently penalising candidates with histories of adversity. In talent development, it is able to promote psychological safety, capability of risk informed decision making and innovation. Leaders need to develop managers to de-escalate conflict, support mental well-being, and build resilient teams. Ultimately, a trauma-informed approach is not a therapeutic intervention but a proactive, human-centric practice that mitigates the long-term societal costs of childhood trauma.

By investing in such a framework, organizations do not merely improve their bottom line; they contribute to a regenerative cycle of healing, productivity, and sustainable human development, transforming a legacy of adversity into a future of realized potential for making the world a safer and better place to live.

Keywords: Human Asset Management, Adverse Childhood Experiences, Trauma-Informed Society

Paper 16: Health as an Asset: Extending Intelligent Asset Management Principles to Smart Homes

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Asset management has traditionally focused on the optimisation and lifecycle of physical infrastructure, equipment, and energy systems. In the context of intelligent buildings, however, the health and wellbeing of occupants can be considered the most valuable and vulnerable asset. This paper proposes a conceptual framework for integrating health into asset management practice, positioning it alongside built and operational assets within smart homes. Drawing on established principles of condition monitoring, preventive maintenance, and lifecycle optimisation, the framework demonstrates how environmental sensing, energy management, and unobtrusive physiological monitoring can be unified under an intelligent asset management approach. Using the University of Huddersfield's Smart House as a case study environment, a set of hypothetical scenarios illustrates how asset management principles can be extended to human health, including air quality monitoring, thermal comfort optimisation, and pressure-related risk detection. The discussion highlights both the benefits of this reframing, such as proactive wellbeing management and alignment with sustainability and healthcare policy, and the challenges, including privacy, interoperability, and the absence of formalised standards. By treating health as a managed asset, the paper establishes a conceptual foundation for future empirical research, technical reviews of sensor modalities, and the development of standards that embed wellbeing within asset management policy and practice.

Keywords—Asset management, smart homes, health monitoring, sustainability, intelligent systems, IoT.

Technical Session 2B: Parallel Track Room 3

Paper 5: Generalisation of Artificial Neural Networks Surrogates for Engine Emission Management

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This paper evaluates single-hidden-layer feed-forward ANNs for predicting NOx, CO, and UHC in a hydrogen-enriched diesel engine. Using a fixed 70/30 split, we vary hidden width from 1 to 15 neurons and compare Levenberg–Marquardt (LM) with Bayesian Regularisation (BR) under the same activation. Results show a clear capacity trend: the largest gain occurs from 1 to 5 neurons, with a smaller but meaningful improvement at 10 and minimal change at 15, indicating a fast-gain and plateau behaviour. Furthermore, the investigations demonstrate that BR consistently yields higher and more stable R2 than LM across widths, with smoother fits and reduced variance. CO remains the limiting target in every case due to its zero-inflated, positively skewed distribution. Overall, a compact BR network with 10–15 neurons offers the best accuracy–complexity trade-off for emissions prediction on the 30% hold-out set.

Keywords— artificial neural networks, emission prediction, engine performance prediction, surrogate modelling

Paper 10: Predictive Asset Management of Gas Cyclone Separators Using an AI-Driven Framework

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Gas cyclone separators are essential components in circulating fluidized bed (CFB) boilers, where their performance and reliability directly impact operational efficiency and maintenance costs. Computational Fluid Dynamics (CFD) simulations using Eulerian–Lagrangian modelling are employed to quantify the effects of inlet velocity, gas temperature, and particle mass flow rate on cyclone performance. This study develops a hybrid CFD–Artificial Neural Network (ANN)–Genetic Algorithm (GA) framework to optimize cyclone performance, focusing on separation efficiency (SE) and pressure drop (ΔP), while translating results into actionable asset-level metrics. High-fidelity CFD simulations provide datasets to train ANN surrogates, which accurately predict SE and ΔP across a wide range of operating conditions. The GA identifies Pareto-optimal configurations that maximize SE while minimizing ΔP, and these optimized solutions are further interpreted in terms of predicted maintenance interval ($\boldsymbol{t_f}$) and lifecycle cost reduction ($\boldsymbol{Cost_{red}}$). Results show that optimized operating conditions can extend maintenance intervals and achieve significant cost savings without compromising separation efficiency. The proposed framework integrates technical performance with asset management, enabling predictive maintenance planning, proactive decision-making, and intelligent lifecycle optimization of gas cyclones in CFB boiler systems. This approach establishes a performance–reliability–economics paradigm, offering practical strategies for sustainable and cost-effective boiler operation.

Keywords— Cyclone separators, Genetic Algorithm, Separation efficiency, Predictive maintenance, Asset management.

Paper 24: Guided Wave based Structural Integrity Assessment of Pipelines used in Hydrogen Transport

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Ensuring the structural reliability of hydrogen transport pipelines is essential for the safe and sustainable operation of emerging hydrogen energy networks. This work presents a structural health monitoring (SHM) framework based on ultrasonic guided waves (UGWs) for early detection and characterization of damage in stainless steel pipelines used for hydrogen transmission. Finite element (FE) modelling using ANSYS was employed to simulate guided wave propagation in both undamaged and defective pipeline sections, considering realistic material and geometric properties. The study examined changes in wave amplitude, phase response, and mode conversion as indicators of internal degradation. Results demonstrate that even subtle internal corrosion or wall thinning produces distinct alterations in received waveforms, enabling effective localization and assessment of hidden defects. The findings validate the strong sensitivity of UGWs to sub-surface anomalies and highlight their suitability for continuous, non-invasive integrity monitoring. The proposed methodology contributes toward developing intelligent, data-driven SHM systems aimed at improving the safety, reliability, and service life of next-generation hydrogen pipeline infrastructures.

Keywords— Ultrasonic guided waves; Structural health monitoring; Hydrogen pipelines; Finite element simulation; Damage detection

Paper 32: The Future of Asset Management: Buildings, Factories & Organisations (Africa & Middle East)

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Asset management is shifting from reactive, paper-based processes to data-driven, predictive, and outcome focused systems. In Africa and the Middle East (AfME), the future will be shaped by affordable IoT, edge computing, AI analytics, cloud platforms, digital twins, and sustainable financing – all adapted to local infrastructure, regulatory and skills realities. Early adopters will gain lower operating costs, longer asset life, improved safety and regulatory compliance, and stronger sustainability credentials.
Asset management in buildings, factories, and organisations is undergoing a profound transformation driven by the Fourth Industrial Revolution (4IR), digitalisation, and sustainability imperatives. Across Africa and the Middle East, the evolution of smart infrastructure, industrial automation, and data-driven decision making is reshaping how assets are monitored, maintained, and optimised. This article examines the future of asset management within these regions, exploring the intersection of technology, governance, and socio-economic development. It highlights digital twin technologies, IoT, and AI-driven predictive maintenance, as well as sustainability, as key enablers of modern asset ecosystems. This study concludes with recommendations for policymakers, institutions, and industries to harness these innovations for sustainable growth and resilience.

Keywords—AfME(Africa and Middle East), AI (Artificial Intelligence), IG (Intellisense Group), SAAMA (South African Asset Management Association), 4IR (Fourth Industrial Revolution), IoT (Internet of Things), Digital Twins, Predictive Maintenance, Smart Infrastructure, DAM (Digital Asset Management).

Technical Session 2C: Parallel Track Online

Paper 22- Bridging Data and Physics: A Novel SINDy-Driven Framework for Modelling Hydrogen-Diesel Dual-Fuel Combustion

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This study introduces a novel application of the Sparse Identification of Nonlinear Dynamics (SINDy) framework for modelling hydrogen–diesel dual-fuel (H_2–DF) combustion in a compression-ignition engine. A four-cylinder engine, modelled in Ricardo WAVE to replicate a JCB engine, was simulated under varying hydrogen energy shares (HES), compression ratios (CR), injection timings, durations, and speeds. Seven functional bases such as constant, linear, polynomial, trigonometric, exponential, interaction, and reciprocal were used to identify governing relationships between inputs and outputs. The sparsity parameter ($\lambda = 0.01$–2) was varied to examine model stability and accuracy. At $\lambda = 0.01$, the SINDy model achieved high accuracy ($R^2 > 0.99$) for key performance and emission indicators, while $\lambda = 0.5$ provided smoother generalisation. Overall, SINDy proved effective for capturing nonlinear combustion behaviour and offers a transparent, data-driven alternative to conventional black-box models.

Keywords— *Sparse Identification of Nonlinear Dynamics, emission prediction, Combustion dynamics, surrogate modelling*

Paper 31- Development of Machine Learning based Inverse Design for 2D Aerofoil

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This research exemplifies initial stages of the development of an inverse design process for an ultra-large horizontal axis wind turbine (HAWT) blade. The full-scale HAWT blades are complex as twist angles and chord lengths at different radial sections are varied along the length of the blade. Therefore, the design procedure has been reorganized into a modular evolution. The present stage focuses on the development of 2D simulation data that is subsequently applied to train predictive models of inverse design. Simple 2D cases of NACA 2412 aerofoil were considered for controlled validation, data generation and refinement of the Machine Learning (ML) framework. A step-by-step strategy has been adopted to ensure detailed design complexities are considered with proven data and design principles to form trusted baselines for 3D analysis leading to the development of future complex aerofoil designs. In this research, the generated data from 2D simulations was used to train the Levenberg-Marquardt (ML) learning algorithm model to develop a baseline inverse design methodology to estimate geometric parameters of the aerofoil from desired lift (Cl) to drag (Cd) coefficient ratios. The prediction level of the ML algorithm showed 0.998 of R2 followed by minimal errors of the ratio being 0.00955 at highest frequency of occurrences and mean squared error of 0.1197 that confirms the modelling approach while establishes trust for its future scalability.

Keywords— Inverse design, HAWT blade, aerodynamic forces, machine learning, simulation data

Paper 7- Post-Processed Hybrid Deep Learning Framework for Remaining Useful Life Estimation on NASA C-MAPSS FD001

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Accurate estimation of the Remaining Useful Life (RUL) of engineering systems is central to the development of predictive maintenance strategies, particularly for safety critical assets such as aero-engines. Despite extensive research on deep and hybrid neural architectures for RUL prediction, challenges persist in ensuring temporal stability and robustness against sensor noise. This study presents a comprehensive benchmarking and refinement of classical, deep, and hybrid learning models on the NASA C-MAPSS FD001 dataset, introducing post-processing mechanisms that enhance predictive reliability. Established models including LSTM and CNN-LSTM were replicated under standardized preprocessing protocols, followed by integration of adaptive signal-level filters—Kalman, Gaussian, and LOESS—to smooth degradation trends and suppress stochastic fluctuations. Comparative evaluation based on RMSE, MAE, and R2 demonstrates that post-processing substantially improves model stability, with the Kalman-based refinement achieving the best overall performance (RMSE = 14.02, R2 = 0.827). The findings affirm that incorporating lightweight, model-agnostic filtering techniques can meaningfully enhance prognostic accuracy without altering network architectures. The proposed framework offers a reproducible, computationally efficient pathway toward reliable, interpretable, and deployable RUL prediction in intelligent maintenance systems.

Key words—Remaining Useful Life (RUL), Predictive Maintenance, C-MAPSS, CNN-LSTM, Kalman Filter, Deep Learning

Paper 9: Physics Informed Neural Network for Fatigue Modelling and Prediction

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Worker fatigue modeling helps in providing intervention to avoid potential occupational health problems. Although a model for forecasting worker fatigue has been previously established, task-specific modeling remains poorly addressed. The major limitation of the traditional approach is the lack of task-specific data. The Physics-Informed Neural Network (PINN) is acknowledged for its quicker training relative to traditional neural network models, dependent upon the accessibility of model information. This paper proposes a PINN-based approach for feature extraction to predict worker fatigue using an inertial motion capture unit (IMU). A publicly accessible dataset, Pamap2, is used for this purpose, including 3D acceleration, gyroscope, and magnetometer data. The dataset also contains task category labels and labelled for 25 different activities. The traditional neural network is structured to use body kinematics data to enhance PINN capabilities. The method provides a framework for improved task-specific worker fatigue prediction with relatively less IMU data by combining neural network models with body kinematics information. In the future, a sensor fusion strategy should be used to integrate IMU device data with other physiological sensors to enhance output robustness.

Keywords—Physics Informed Neural Network (PINN), Fatigue Modelling, Body Kinematics, Human Factors Engineering, Occupational Health.

Abstracts - Day 2: Technical Sessions (11:00am-12:45pm)

Technical Session 3A: Parallel Track Room 2

Paper 20: Motor Current-based Vibration Pattern Recognition in Electric Systems using Deep Learning

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This study proposes a robust vibration analysis technique that leverages motor current signals as the sole input for identifying distinct vibration patterns, providing a cost-effective and sensor-minimal alternative to traditional vibration monitoring methods. Four reproducible vibration conditions (Pattern 1 to Pattern 4) were generated using a motor-driven test bench, and exactly 3000 motor current data points were recorded for each pattern at a sampling rate of 20 Hz. An adaptive windowing algorithm was employed to segment continuous current signals into complete vibration cycles, which were then used to train a recurrent convolutional neural network (RCNN). The trained model achieved a peak validation accuracy of 98.6% with a stable validation loss of 0.258. It successfully classified Patterns 1–3 with 100% accuracy and Pattern 4 with 94% accuracy, while feature space visualisation demonstrated clear class separation. These findings demonstrate that motor current-based vibration classification offers a reliable, scalable, and low-cost solution with significant potential for deployment in diverse applications, including autonomous navigation, predictive maintenance, and condition monitoring of electrically driven systems.

Keywords — Vibration classification, motor current sensing RCNN, predictive maintenance, condition monitoring.

Paper 36: Predicting Maintenance Actions through Retraining of Pretrained Large Language Models.

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Effective maintenance is critical to ensuring aircraft safety, reliability, and operational efficiency. However, identifying the correct maintenance actions from data remains a challenging and time-consuming task. To address this, we apply a large language model (LLM) to predict maintenance actions directly from problem descriptions and operational data. The Mistral AI model was retrained using a supervised learning approach on an annotated dataset containing aircraft fault records and corresponding corrective actions. Instruction-based prompts were incorporated during training to help the model understand maintenance contexts and generate appropriate recommendations. The performance of the retrained model was compared with an instruction only baseline, showing improved results. The results show that the retrained LLM improved by 5% compared with the model without retraining. This improvement makes decision making faster and supports the development of smart, predictive maintenance systems.

Keywords—Maintenance actions, prediction, retrain, large language models, aircraft

Paper 12: Enhancing Operational Safety of Legacy Assets Leveraging on Artificial Intelligence.

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Aging electrical assets, such as transformers, CT, VT, CB, LA, switchgears, and busbars in power systems, are prone to failure owing to insulation degradation, corrosion, increased heat dissipation contact resistance, and thermomechanical fatigue. Infrared thermography, particularly hotspot thermography, is a non-contact, real-time diagnostic technique for visualizing surface temperature fields, enabling the early detection of localized anomalies that precede catastrophic failures. This paper outlines the role of Infrared thermography in predictive condition monitoring strategies for aging power assets, emphasizing practical implementation steps, including emissivity calibration, environmental correction, and baseline trending under operational loads. It further elaborates on the integration of IRT data streams with Supervisory Control and Data Acquisition systems to enable continuous asset health monitoring with automated thermal anomaly detection. Current challenges inherent in legacy infrastructure, such as emissivity variability, environmental interference, load dependency, and lack of baselines, that are discussed with industrial case examples demonstrating practical applications and remediation strategies. Leveraging recent advancements, this study highlights how artificial intelligence, particularly deep learning architectures such as convolutional neural networks (CNNs) and generative adversarial networks (GANs), enhance detection sensitivity and reduce false positives by analyzing thermal image datasets. Time-series data acquisition and predictive analytics combined with AI-supported diagnostics promise higher reliability in maintenance programming. A comparative theoretical analysis illustrated the statistical and operational gains over conventional methods. These methods improve maintenance efficiency and operational safety, extend asset life, and reduce unplanned outages, thereby demonstrating a pragmatic and scalable framework for managing aging power-station assets in modern grid environments.

Keywords- Infrared Thermography, Hotspot Thermography, Predictive Condition Monitoring, Electrical Asset Management, Power System Maintenance, Transformer Monitoring, SCADA Integration, Artificial Intelligence in Maintenance, Convolutional Neural Networks, Generative Adversarial Networks, Thermal Anomaly Detection, Aging Assets Diagnostics, Non-contact Temperature Measurement, Fault Detection in Power Systems, Data Fusion in Predictive Maintenance.

Paper 19: Digital Drops: IoT-Driven Smart Water Asset Intelligence.

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In the recent time water utilities around the globe is facing a range of complex challenges – from maintaining ageing infrastructure spread across geographically vast and located in difficult terrain, to rising operational cost, limited visibility of the assets, reactive maintenance practices due to asset failure, fragmented data systems, and increasing risk around compliance, workforce efficiency, and cyber security. Traditional practices in the water utilities in asset monitoring and management have been mostly manual and reactive. This review paper explores how the Internet of Things (IoT) intelligent technologies could offer a smarter, more strategic path forward. By deploying smart sensors and edge devices across the critical infrastructure of the water distribution network, and combining it with AI-driven analytics, utilities could get access to real-time insights of asset health, performance and environmental conditions. These capabilities enables early

fault detection at the asset level, predictive maintenance scheduling, and better resource allocation that shifting operation from reactive to proactive approach. The proposed IoT-enabled solution integrates seamlessly with the enterprise application, combining sensor networks, edge computing, cloud analytics, and robust cyber security protocol to ensure scalability, security and interoperability. Additionally, this paper also highlights the importance of organizational readiness, strong data governance, and workforce transformation as the key factors for the success of the solution. Ultimately this approach demonstrates how IoT can help water utilities move towards intelligent asset management, improving operational efficiency, reducing downtime, and building long-term sustainability deploying smart tools.

Keywords; IoT; Smart meters; AI, Analytics, NB-IoT, LTE CAT M1, LoRa WAN, Wize, MITM, DoS, IDS, TLS, VPN

Paper 33: Intelligent Asset Management of Landfills Using UAV-Based 3D Terrain Modeling and AI-Driven Geospatial Analysis

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Accurate volume estimation and terrain analysis of landfill sites are critical for effective waste management operations, regulatory compliance, and capacity planning. Traditional surveying methods provide limited temporal resolution and face safety challenges in active disposal areas. This paper presents a comprehensive methodology using Unmanned Aerial Vehicles (UAVs) and photogrammetry to generate high-resolution 3D digital elevation models for landfill volume calculations and terrain characterization. We demonstrate a complete workflow from UAV image acquisition to quantitative analysis, utilizing Open Drone Map (ODM) software for photogrammetric and AI processing. The methodology produces five key analytical outputs: (1) detailed elevation mapping with profiles, (2) slope gradient analysis for stability assessment, (3) fill volume calculations with spatial distribution, (4) stormwater flow path modeling for drainage management, and (5) contour mapping for operational planning. The approach is validated through a case study at the Highland Highway Landfill at Loy Yang in the Latrobe city, where we able to successfully calculate the total fill volume to the nearest cubic meters and identified critical slopes up to 37.22:1. Results demonstrate that UAV-based photogrammetry provides superior spatial resolution and accuracy compared to traditional methods, with elevation measurements achieving precision within ±7.1 cm RMSE. The integration of these analytical outputs into a unified GIS framework enables data-driven decision making for landfill operations, supporting capacity planning, stability monitoring, and stormwater management within ISO 55001 asset management principles. This standard establishes best practices for managing physical assets throughout their lifecycle, ensuring decisions are informed by data-driven insights and aligned with long-term operational and sustainability goals.

Keywords—asset management, photogrammetry, landfill monitoring, volume estimation, terrain analysis, slope stability, digital elevation model, Open Drone Map

Technical Session 3B: Parallel Track Room 3

Paper 41: The Asset-Attack Surface: A Survey of Cyber-Physical Vulnerabilities and Mitigation Frameworks for Industry 4.0-Enabled Intelligent Asset Management

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This paper presents a systematic survey of the cybersecurity challenges inherent in Industry 4.0-enabled Intelligent Asset Management Systems (IAMS). Drawing on a structured review of academic, technical, and industry literature, it analyses the vulnerabilities introduced by IAMS-enabling technologies, categorises the resulting cyber-physical threat landscape, and evaluates the suitability of dominant security frameworks. The convergence of the Industrial Internet of Things (IIoT), Digital Twins, and Artificial Intelligence (AI) in IAMS creates a new cyber-physical attack surface, in which the primary risk shifts from data confidentiality to operational safety. The most significant challenges are not purely technical (for example ransomware and Denial of Service) but are dominated by socio-technical skill gaps and resistance to change, together with systemic supply chain vulnerabilities. The analysis indicates that traditional IT security standards (for example ISO 27001) are inadequate for this cyber-safety domain. The paper argues that a layered framework stack is required to achieve resilience. In this model, the National Institute of Standards and Technology (NIST) Cybersecurity Framework provides high-level governance and asset management (ID.AM), while the ISA/IEC 62443 standard is applied for the technical, engineering-led design of secure industrial control systems.

Keywords — Industry 4.0, Cybersecurity, Intelligent Asset Management, Risk Management, ISA/IEC 62443, NIST

Paper42: Optimizing the Operation of Energy Storage Systems for Cost Effective Integration of Solar Power into National Grid

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This paper presents a simulation-based study on the integration of a Battery Energy Storage System (BESS) with a solar photovoltaic (PV) system for a grid-connected household application. This research aims to optimise energy management, reduce operational costs, and enhance grid stability through a rule-based control algorithm developed in MATLAB/Simulink. Two scenarios were evaluated: one without the BESS and another one is with the BESS integration. These results demonstrate that the inclusion of the BESS significantly improves system self-sufficiency, particularly during low solar irradiance periods, and reduces reliance on grid power. Key performance indicators such as, export variability, ramp rate, and energy cost were analysed, showing enhanced system stability and financial viability in the BESS-integrated scenario. These findings confirm that an optimised BESS operation strategy can effectively support the transition to renewable energy by improving energy efficiency and ensuring smoother grid integration.

Keywords— Battery Energy Storage System, Energy Management, Export Variability, Grid Stability, Optimisation Algorithm, Ramp Rate, Renewable Energy Integration, Self-Sufficiency, Solar Photovoltaic.

Paper 15: Uncovering Latent Failure Signatures : A Graph-feature based analysis of Critical Component Interactions in Technical Event Logs

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Substantial volumes of rich, tacit knowledge regarding asset condition is locked within event descriptions and maintenance reports archived in enterprise repositories. The size and amorphous nature of the content hinder the extraction of insights from this data source. This paper introduces a novel framework that leverages graph-based feature extraction to automate the identification and grouping of failure signatures from these technical narratives. Our approach modelled events belonging to one group of assets as knowledge graphs, preserving the structural relationships between critical components. We extracted features from these graph representations, applied dimensionality reduction and employed clustering to group similar entities. When applied to a large corpus of technical event logs, this human-in-the-loop workflow proved highly effective in the fast processing of substantial volumes of text from the context of identifying and interpreting precursors to failures. The graph-feature-based analysis transforms dormant historical records into actionable intelligence, offering a scalable, data-driven methodology to improve predictive maintenance and reliability.

Keywords—Technical Text, Fault Detection, Critical Components, Co-occurrence Network, Graph Features, Dimensionality Reduction, Clustering, Visualisation.

Paper 47: Transforming Mining Waste into Strategic Assets for Production of Critical Metals

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Global asset management increasingly depends on securing the supply of critical raw materials essential for renewable energy, digital infrastructure, defense, and advanced manufacturing. Yet many of these strategic metals—Cobalt, Gallium, Indium, Lithium, and Rare Earths—are not mined directly but lost as by-products in the production of base metals such as copper, zinc, lead, and aluminium.

Emerging technologies now enable the recovery of these critical elements from tailings, residues, and metallurgical by-products, transforming environmental liabilities into valuable assets. At Ore2Metal, our ReCLAIM™ technology and tailored process flowsheets unlock this hidden value, turning waste into new revenue streams while advancing circular-economy goals.

For mining corporations and investors, this approach represents a new frontier in asset optimization and value creation—monetizing existing waste inventories, enhancing ESG performance, and improving project economics without the risks of greenfield development. By reclassifying waste as a strategic resource, Ore2Metal is redefining how asset managers, miners, and investors capture long-term value from the global energy transition.

Keywords: Asset Optimization, Critical Minerals, Circular Economy, Waste Valorization, ESG, Strategic Metals

Technical Session 3C: Parallel Track Online

Paper 14: Leveraging Transformers for Workplace Safety: Insights from OSHA Accident Data.

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Accidents at work present serious hazards to employee safety and a loss of productivity for organizations, which makes a proactive analysis of accident data of paramount importance. The Occupational Safety and Health Administration (OSHA) has provided a rich dataset of accidents, which has a variety of structured (organized) fields and unstructured (narrative) text that describe circumstances, hazards, and consequences. While the structured data will accommodate some basic statistical analysis, the narrative text has not been analyzed, simply because it was not usable. Thus, this study demonstrates how to employ transformer-based natural language processing (NLP) models (BERT and RoBERTa) to analyze OSHA accident reports and process their information. We fine-tune each of the transformer models to automatically classify accident types, identify contributory factors, and discover recurring patterns in hazard types across different industries. In addition, while attempting to examine the narrative data collectively, we employ clustering techniques and semantic similarity to create clusters of related incidents. We also analyzed a text summarization approach to condense the length of reports into concise safety notes, facilitating a quicker review process. Our analysis practices have uncovered high-risk industries, frequent factors that could lead to an accident, and common scenarios that could lead to an accident occurring, which we view as valuable input for safety managers and policy makers. Our study speaks well to the ability of transformer models when examining and transforming raw narrative data into knowledge in a structured manner and identifying entangled evidence-based interventions and prioritizing hazards to mitigate risk. This study provides evidence that deep learning has enhanced our analysis capacity through a framework with the potential to support change that reduces the incidence of workplace accidents and sustainable change to safer workplaces.

Keywords: Workplace accidents, OSHA accident reports, Transformer-based NLP, BERT and RoBERTa, Hazard analysis Safety management.

Paper 18: IEC 61850-Based Digital Protection for a Weak Grid at a Mine Site: A Review.

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In several mining areas in Western Australia, there are conventional substations both underground and on the surface that have been in operation for over 40 years. A significant section of assets in these substations, have outlived its design life. However, due to operational and financial constraints, the ageing electrical network is difficult to substitute due to production requirement. Usually, these assets are maintained to meet basic operational requirement from production perspective as long as there are no major faults or safety hazards. Additionally, the increasing penetration of DERs (Distributed Energy Resources) such as solar, wind, hydrogen, and batteries have introduced instability in the grid, leading to oscillations, degraded power quality, and issues such as maloperation or failure of the protection system.

Considering the network instability, introduction of a digital protection system based on IEC 61850, could not only extend the operational life of a weak grid and enhance the reliability of protection, but also provide more flexible protection and control, as well as improved monitoring and diagnostic capabilities.
This paper maps a weak-grid constraints due to conventional protection by leaning on to IEC 61850 capabilities. Finally, this paper summarises recent deployments and lessons learned in IEC 61850-based digital protection, and discusses practical engineering applications at a mine sites, including topology, KPIs, and functional testing. It further outlines emerging directions for IEC 61850-based protection. The aim is to extract actionable patterns and upgrade pathways for migrating ageing distribution systems at remote mine sites to digital substations under weak-grid constraints, thereby shortening project cycles, reducing risk, and improving reliability.

Keywords—IEC 61850; digital protection; digital substation; weak grids; mine sites.

Paper 1: Off-Grid Solar System Performance for Critical Medical Instruments in Isolated Regions,

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In remote areas with limited electricity or frequent outages, maintaining a reliable power supply for critical medical instruments is a major challenge. Power disruptions can lead to serious medical risks and fatalities. Off-grid solar systems offer a promising solution by providing a stable, renewable power source for remote medical facilities. This study assesses the feasibility, benefits, and limitations of integrating such systems through a combination of literature reviews, expert interviews, and user surveys. Findings indicate that off-grid solar power can provide a consistent and reliable energy supply, even during adverse weather conditions, while being cost-effective, low-maintenance, and environmentally friendly. However, cost and implementation feasibility remain key concerns. The study concludes with practical recommendations to enhance device performance during outages and improve system reliability in remote healthcare settings.

Keywords—Off-grid solar systems, Reliability and Availability, Remote areas, Critical medical equipment, Cost effectiveness

Paper 26: Simulation-Based Lean Production Control in Steel Manufacturing: Evidence from Tyre Bead Wire.

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This study investigates the application of Lean Production Control in steel manufacturing, focusing on the tyre bead wire segment—a resource-intensive yet underexplored domain in Lean literature. The goal of this research is to create and verify a simulation-based Lean Production Control framework for increasing efficiency and profitability in tyre bead wire production. Employing Value Stream Mapping (VSM) , 5S, Just-In-Time (JIT), Single minute exchange of die (SMED), Kanban, and Total Productive Maintenance (TPM), the research identified inefficiencies including scheduling conflicts, excessive work-in-progress, and bottlenecks. A future-state model integrating hybrid push–pull scheduling, takt time alignment, and supermarket buffers was developed, supported by SMED and TPM practices. Simulation in OpenModelica, combined with statistical analysis, validated significant improvements: a 27.6% lead time reduction ($p = 0.0001$) and a

significant increase of net profit. Beyond operational and financial gains, the work advances Lean scholarship by introducing a simulation-based optimisation framework tailored to resource-heavy industries. Recommendations include adopting IoT-enabled Lean 4.0 monitoring and extending the framework to cement, paper, and chemical sectors, positioning the study as a scalable roadmap for sustainable efficiency in complex industrial environments.

Keywords—Lean production, Steel manufacturing, Tyre bead wire

Paper 39: A Modified Total Cost of Ownership Framework for Fatigue Testing Equipment in Academic Laboratories.

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Universities often prioritise acquisition of testing equipment, while underestimating long-term operational and maintenance costs. Due to their educational use and relatively low utilisation, fatigue testing equipment in research labs tend to have longer life spans than their manufacturing and industrial counterparts. In the long term, yearly operations and maintenance cost have far reaching impact on operational budgets.
Amid rising financial pressure from capped international enrolments and domestic competition, universities must reduce operation costs to remain competitive. This paper presents a case study on fatigue testing machines in university research testing laboratory, estimating the Total Cost of Ownership (TCO) over a six-year period (2019 – 2024). Using historical data from SAP, CMMS, and testing software, the study analyses acquisition, operations and maintenance cost components. Notably, it introduces the cost of safety, Cst, for assets used beyond their accounting end-of-life, providing strategic insights for maintenance planning and capital investments.
A modified version of the Landscheidt model is proposed, introducing an additional component – Cost of safety, (Cst) to account for residual risk in operating ageing equipment. The study found that labour and calibration alone accounted for 54.1% of the total cost of ownership of the testing equipment. A Net Present Value (NPV) forecasting tool was developed to enable informed data-driven decision-making for capital investment in equipment. This study contributes to existing literature by adapting existing frameworks to educational settings tailored to non-commercial environments.

Keywords – TCO; fatigue testing; calibration; cost of safety; NPV model

Paper 49: Reliability-Centred Digital Modernisation Framework for CNC and Metal-Forming Assets: A Case from an Australian Manufacturing SME.

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Small- and medium-sized manufacturing enterprises (SMEs) frequently operate ageing computer numerical control (CNC) machining and metal-forming equipment without comprehensive maintenance histories or sensor-based monitoring. These limitations make it difficult to justify modernisation or targeted reliability improvements using conventional analytical methods. This study presents a data-lean reliability-centred maintenance (RCM) framework suitable for such environments, supported by representative benchmark information and synthesised failure-mode characteristics developed from generic CNC maintenance examples and case scenarios. These inputs were used to establish defensible failure frequencies and downtime assumptions in the absence of complete computerised maintenance management system (CMMS) records.

The framework integrates failure analysis, Failure Mode and Effects Analysis (FMEA)-based risk prioritisation, and scenario-based annual economic comparison of three alternatives: continuing reactive maintenance, implementing targeted improvements for high-risk failure modes, and partially modernising aging equipment with newer CNC systems. Results show that targeted improvements reduce failures and downtime by roughly one-third, while partial modernisation achieves reductions of about one-half relative to the baseline. The study demonstrates that meaningful reliability and cost insights can be generated under limited-data conditions by combining benchmark information, synthesised failure characteristics, and structured scenario modelling. The proposed method offers a practical and repeatable approach for SMEs to support maintenance planning and asset-renewal decisions.

Keywords—Reliability-centered maintenance, Failure Mode and Effects Analysis, Ageing CNC machinery, Data-limited maintenance environments, SME manufacturing systems, Risk-based maintenance planning, Asset modernisation decision-making

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