Souvenir Program

International Conference on Maintenance and Intelligent Asset Management - ICMIAM 2021
Federation University Australia, Ballarat, Victoria, Australia

12 - 15 December, 2021
Melbourne, Australia (AEST) times
Conference Registration Link

Organised by

School of Engineering, Information Technology and Physical Sciences, Federation University Australia
Centre of Excellence in Safety Engineering and Analytics, Indian Institute of Technology, Kharagpur, India
Department of Mechanical and Manufacturing Engineering, Manipal Academy of Higher Education, Manipal

Technical co-sponsors

IEEE Victorian Section (Australia) and Victorian Section PES Chapter

Message from Conference Chairs

International Conference on Maintenance and Intelligent Asset Management
(ICMIAM2021)

We warmly welcome you to the International Conference on Maintenance and Intelligent Asset Management (ICMIAM2021) in Federation University Australia Mt Helen Campus, Ballarat, near Melbourne. The conference is built upon a long history of Conference on Asset Management and Maintenance which was held in Gladstone since 2009 to 2012, 2013 in Brisbane and 2014 along with 27th international conference COMADEM2014 in Brisbane Convention and Exhibition Centre, Workshops from Australia, Endeavour Executive Fellowship award in 2018, Research and Industry Day (RAID 2020 and 2021) events showcasing projects from Maintenance and Reliability Engineering (MRE) Postgraduate Programmes in Federation University and ICMIAM2020 conference in Bangalore, India. Maintenance, Reliability and Asset Management events continued being held in Churchill campus of Federation University Australia and also online events from 2016 to 2021. We are excited about the outstanding sessions, and wide variety of ideas that scholars and practitioners from Australia, New Zealand, India, Sweden, UK, Bangladesh, Canada, Ireland, Indonesia, Kuwait, South Africa, Ecuador, USA, Philippines, Taiwan, Portugal and many other parts of the world will present. There will be fantastic networking opportunities. Speakers will address topics such as: to standards, risk management as the basis of an asset management plan, whole-life-approach investment decisions, failure modes, existing and emerging technologies, and extending an asset's lifecycle. The conference will highlight the practices and research outcomes to improve and enhance asset management through systems, standards, and technologies for balancing costs, risk and performance covered in major areas of this field:

- Track 1 Asset Management (AM) and Systems (AMS)
- Track 2 Reliability, Availability and Maintainability (RAM) and Maintenance Management (MM)
- Track 3 Safety Engineering and Analytics (SEA), Security, Risk Management and Human Factors (SRM-HF)
- Workshop: Rural Assets for Sustainable Development

ICMIAM2021 aims to:
- Make people aware of the possibilities in Maintenance, Reliability and Asset Management.
- Showcase best practice and achievements in this field along with high quality applications in industry.
- Foster networking across all disciplines.
- Identify future needs for professional development and opportunities for research.
- Establish platform for Universities, Industries and professional bodies for collaborations.

We hope that this conference will allow the participants a productive discourse not only in informed decision making in maintenance, reliability and asset management but also in improving performance and productivity. We are also particularly excited about the upcoming presentations from our keynote and invited speakers. Our speaking panel will consist of respected, senior representatives from within 'asset management and maintenance' industries, government entities, universities and professional bodies. There will be fantastic networking opportunities. We greatly appreciate their valuable contributions. This conference would not be possible without generous help from them and a large number of other people.

We thank the conference organising partners
- School of Engineering, Information Technology and Physical Sciences, Federation University, Australia
- Centre of Excellence in Safety Engineering and Analytics, Indian Institute of Technology, Kharagpur, India

- Department of Mechanical and Manufacturing Engineering, Manipal Academy of Higher Education, Manipal

Technical co-sponsorship by:
- IEEE Victorian Section (Australia) and Victorian Section PES Chapter

ICMIAM2021 is supported by:
- Asset Management Council, Australia
- City of Ballarat, Australia
- Sovereign Hill, Australia
- University of Huddersfield, UK
- Lulea University of Technology, Sweden
- Institute of Rural Management, Anand (IRMA), India

We thank all those partners, contributors, delegates and communities for the time, energy and thought that they have invested in organizing the conference and preconference workshop. We thank all the organizing committee members and their families for their sacrifice of personal times, the keynote and invited speakers, track chairs, the reviewers, the session chairs and co-chairs, and the numerous volunteers in various committees, without whose generous contributions this conference would not have set record number of high quality papers, presentations and number of outstanding participants.

Special thanks to Federation University Australia: Prof. Duncan Bentley, Vice Chancellor, Prof. Syed Islam, Acting DVCRI and Dean Engineering IT and Physical Sciences, Cr Daniel Moloney, Mayor, City of Ballarat, Honourable Jason Wood, Assistant Minister for Customs, Community Safety and Multicultural Affairs, Honourable Mr Raj Kumar, Indian Consul General, Melbourne, Prof. Joarder Kamruzzaman Director, Centre for Smart Analytics, Federation University Australia and technical chair, Assoc Prof Sam Henson, Kathy Racunica, Leigh Kennedy, A/Professor Geoffrey Lord, campus heads, Dr. Harpreet Kandra, organisation and track chair, A/Prof. Gour Karmakar, track chair, Dr. Abdul Chowdhury, Liz River, Louise Drohan, Katrina Southurst and Bec Davis, Evan Dekker, Cindy McKenzie, Jacinta Leppik, and Peter Litras, Ean Ooi, Ibrahim Sultan, Truong Phung, Ayon Chakraborty, Jo-ann Larkins, Manoj Khandelwal, Vickram Chundhoo, Kui Lu , Lennard Peters, Katrina Beer, Stephanie Charalambous, Tom Laurie and Pavan Bhuravarjela. Asset Management Council Australia: Dr. Anne Gibbs, CEO, John Hardwick, Kai Dong, Heidi Robinson and Jacqui Bates. IIT Kharagpur, India: Prof V. K. Tewari, Director, A/Prof. Sayak Roychowdhury, track chair; Prof. OB Krishna, A/Prof. Sunita Mishra and A/Prof. B G Menon. Manipal Academy of Higher Education: Dr Ramdas M Pai, President and Chancellor, Manipal Academy of Higher Education, Dr Ranjan Pai, Chairman Manipal Education and Medical Group, Dr H S Ballal, Pro-Chancellor, Lt Gen (Dr) M D Venkatesh, Vice Chancellor, Dr Anil Rana, Director and A/Prof. Nitesh Kumar, track chair. Institute of Rural Management Anand (IRMA): Prof. Umakant Dash, Director and Prof. Harekrishna Misra and contributors in the workshop. Lulea University of Technology (LTU) Sweden: Prof. Uday Kumar Head of Division Operation, Maintenance and Acoustic, and Prof. Aditya Parida. The University of Huddersfield, UK: Prof. Artur Jaworski, Head of Department, Department of Engineering and Technology and Prof. Rakesh Mishra. City of Ballarat, Joel Chadwick, Sovereign Hill, Chris Hutton, Victorian Section (Australia) and Victorian Section PES of IEEE, Dr. Enamul Haque, Dr. Mehrnaz Shoushtarian, Dr. Greg Adamson and Catherine Tuxen, Swami Sunishthananda from Vedanta Centre Melbourne and many others who kindly supported and contributed to this conference. We also appreciate the sponsors supporting this conference for making it happen.

Most of all, we thank you, the participants, for enriching this conferences by your presence. We hope you will enjoy the content, renew old friendships, make new friends, get new ideas, and above all, have a good time.

Dr. Gopinath (Gopi) Chattopadhyay, Federation University, Australia (General Chair, ICMIAM2021)

Prof. Raghuvir Pai, Manipal Academy of Higher Education, India (Joint-Chair, ICMIAM2021
Mr. Dave Daines, Asset Management Council, Australia, (Joint-Chair, ICMIAM2021)
Prof. Jhareswar Maiti, IIT Kharagpur, India, (Joint-Chair, ICMIAM2021)
12 Dec 2021, Ballarat, Australia

Centre of Excellence in Safety Engineering and Analytics (CoE-SEA)
Indian Institute of Technology Kharagpur

Chairman, CoE-SEA, IIT Kharagpur

It gives me immense pleasure to welcome you to the International Conference on Maintenance and Intelligent Asset Management 2021 (ICMIAM2021) from December 12-15, 2021. Today's products and production processes are more technology oriented, the people are more and more focused and versatile, and the mother Earth, needless to say, is more tolerable. 'No maintenance or zero maintenance' is the order of the present day requirement. Under this backdrop, the ICMIAM2021 conference is very timely and well planned. The inclusion of three tracks namely (i) Asset Management (AM) and Systems (AMS), (ii) Reliability, Availability and Maintainability (RAM) and Maintenance Management (MM), and (iii) Safety Engineering and Analytics (SEA), Security, Risk Management and Human Factors (SRM-HF) targeted to products, processes and people is noteworthy. The collaboration of several world-known institutions and organizations and participation of experts, researchers and practioners from academia, industries, and professional societies/bodies for disseminating the knowledgebase, practices and experiences in the three broad domains will make the conference a grant success.

I am pleased to inform you that Centre of Excellence in Safety Engineering and Analytics (CoE-SEA), Indian Institute of Technology Kharagpur is one of the organizing units of ICMIAM2021. The Indian Institute of Technology Kharagpur, established in 1951, is the oldest "IIT" in India, and is engaged in nation building through dissemination of technical knowledge. Presently, IIT Kharagpur has more than 50 academic units and is a destination of faculty, scientists, researchers, and industry professionals across the globe. In the field of asset management, safety, security and reliability, IIT Kharagpur has emerged as a leader in teaching, research and outreach. In addition to the various departments/centres /schools, the Safety, Quality, Reliability and Analytics (SQRA) vertical has been created in the IIT Kharagpur to promote interdisciplinary research in the related fields and to promote industry academia interactions. The CoE-SEA is created to migrate the concept of Prevention through Design, right from the educational institutes to industries.

I am sure that with the keynote speeches, the oral presentations and the workshops in the three different tracks, each with multiple themes, ICMIAM2021 will provide an excellent opportunity for the participants and the authors to interact, showcase and learn from the leaders and experts. It will also highlight useful solutions, research directions, and collaboration framework with adoption of new technologies.

I wish a mega success of this conference.

(Jhareswar Maiti)
Chairman, CoE-SEA, IIT Kharagpur, India

Lt Gen (Dr) M. D. Venkatesh, VSM (Retd)
Vice Chancellor

MESSAGE

I am pleased that Federation University, Australia, is organizing an "International Conference on Maintenance and Intelligent Asset Management (ICMIAM2021)" in association with Department of Mechanical & Manufacturing Engineering, Manipal Institute of Technology, Manipal, Asset Management Council, Australia and Indian Institute of Technology, Kharagpur. I am also happy to note that a large number of partners are supporting the conference- Lulea University of Technology, Sweden, Institute of Rural Management, Anand, University of Huddersfield, UK, IEEE, Asset Management Society, India, Sovereign Hill Museums and the City of Ballarat.

Maintenance and asset management is of utmost importance for reliable operation of industrial systems to reduce production costs and life cycle costs. Artificial intelligence, big data analytics and machine learning are changing our lives in every sphere. These technologies and analytic tools, I presume will have a significant impact on maintenance and asset management. I am sure that ICMIAM2021 will provide an opportunity to asset management professionals to share their knowledge and experience for a better tomorrow.

My greetings and best wishes to all the delegates.

Lt. Gen. (Dr) M D Venkatesh
Vice-Chancellor

Dr. Umakant Dash
Director, Institute of Rural Management Anand (IRMA)

Dear fellow delegates of the ICMIAM2021, ladies and gentlemen,

I am pleased to be here with you, representing the Institute of Rural Management (IRMA), as its Director and part of the advisory board, ICMIAM, 2021. You will be glad to know that IRMA is a supporting partner of the conference.

I take this opportunity to introduce IRMA, a national institution founded in 1979, with the support of the Swiss Agency for Development Cooperation (SDC), the Government of India, the Government of Gujarat, and the National Dairy Development Board (NDDB). The Institute is driven by the dream of serving under-served segments of the economy through professional management. It focuses on creating management professionals who can bring about sustainable, ecologically-friendly and equitable growth by applying their management acumen at the grassroots level and influencing the public policy narrative at the national and global levels. It also pursues the highest standards of excellence and relevance in all our activities, namely teaching, research, consulting, and mid-career/ continuing education, and to remain transparent and accountable in our core functions through processes of self-evaluation, reflection, and continuous improvement.

To introduce the role of IRMA at ICMIAM2021, I am glad to share that we have arranged a workshop on "Rural Assets for Sustainable Development Goals : Exploring Leveraging Pathways". I invite you all to participate in the workshop and contribute your views to enrich the outcome of the deliberations.

I conclude by thanking the organizers of ICMIAM2021 and the Federation University for associating IRMA with this conference on asset management, and we look forward to furthering fruitful collaboration in the future.

Luleå Railway Research Center

MESSAGE

In today's competitive environment, there are unmistakable signs that human beings, organizations, cities and various assets are increasingly becoming interconnected, instrumented and intelligent to improve the quality of services, resource utilization, cost effectiveness and realising value from the assets. International Conference on Maintenance and Intelligent Asset Management (ICMIA2021), provides us opportunity and platform to look back in time, review and reflect what we wanted to achieve and what have we achieved. It also gives us an opportunity to peer into the future - what we would like to achieve, develop action plan and draw road map for the future.

The organizers of the conference have been able to bring asset management experts, industry-leading speakers , academic experts and professional body leaders to discuss the best practices in asset management, its relevance in the era of Industry 4.0 and digital transformation of business practices.

I am sure that the keynotes and the oral presentations during ICMIAM 2021 on various themes and issues related to asset management and maintenance will provide an opportunity for the participants including the younger delegates to learn and interact with leaders and experts from the field. It will also give an opportunity for the delegates to show case their works, share their experiences, and reflect on different issues and challenges being encountered and how to implement potential solutions. It will also provide discussion on the integration of new technologies in asset management practices and its impact on industry and society.

I am hopeful that ICMIAM 2021 will resolve some of the existing complex issues associated with intelligent asset management. It will also provide guidelines to address the future challenges especially those associated with technology empowered new business and governance models.

It gives us immense pleasure to be associated with and supporting ICMIAM 2021. I convey my best wishes for the grand success of this event.

(Uday Kumar)
Chair Professor and Director

Message from the Director, Centre for Smart Analytics

Federation University Australia

Industries are going through significant transformation and gearing towards Industry 4.0 and digital transformation. In general, our cities and businesses are continuously innovating themselves to become smarter and connected, and governments are trying to reduce the digital divide between urban and regions. In this context the three-day International Conference on Maintenance and Intelligent Asset Management (ICMIAM'2021) that Federation University Australia is organizing in collaboration with Asset Management Council, Australia; Manipal Academy of Higher Education, India; and Indian Institute of Technology, Kharagpur, India is very timely. I am sure the outcome of the conference will contribute to solving the challenges in maintenance and asset management in Industry 4.0.

The organizers of the conference Federation University are part of the Centre of Smart Analytic of the university. Part of the research focus of our centre is the Internet of Things, cybersecurity, and AI & ML and their applications in engineering problems including intelligent management of assets in industries, infrastructure, and businesses. In that sense, this conference aligns perfectly with the research focus of our centre and we are very glad to support this conference and assist in organizing it.

I wish the conference every success.

Professor Joarder Kamruzzaman

Director
Centre for Smart Analytics

Federation University Australia

Day 1, Sunday 12th Dec: Workshop on Rural Assets for Sustainable Development (2pm – 4pm)

Join via: LIVE stream link will be provided

Session chair: Prof Harekrishna Misra, IRMA; Session Co-chair: Mr. Amar Singh, ANA, Australia and New Zealand	
2:00pm-2:10pm	Opening remarks and Introduction to the Workshop *Prof Harekrishna Misra, IT and Systems, IRMA, India*
2:10pm – 2:30pm	Leveraging Assets to support SDGs- Global Perspectives *Prof. Luis Barbosa, Deputy Head- UNU- Portugal*
2:30pm – 2:45pm	Economic assets and related policies towards sustainable livelihoods and SDGs: Learning from Indian context *Prof. Umakanta Dash, IRMA*
2:45am – 3:00pm	Effects of rural social networks and their contributions *Prof. Shyam Singh, IRMA*
3:00pm-3:15pm	Financial assets and related policies in rural areas *Prof. Rakesh Arrawatia, IRMA*
3:15pm – 3:30pm	Understanding the role of social media data in decision making *Prof. Sehl Mellouli, Deputy Vice-Rector, University of Laval, Quebec, Canada*
3:30pm – 3:45pm	Understanding global policies related to Rural Digital infrastructure and services *Prof. Ojo Gboyega, Central University of Maynooth, Ireland*
3:45pm – 4:00pm	Understanding Rural Digital policies of India and its contributions to SDGs *Prof. Harekrishna Misra, IRMA*

Day 1, Sunday 12th Dec: Workshop on Rural Assets for Sustainable Development – panel discussion (4:30pm – 5:30pm)

Join via: LIVE stream link will be provided

Session chair: Prof Harekrishna Misra, IRMA; Session Co-chair: Mr. Amar Singh, ANA, Australia and New Zealand	
4:30 pm - 4:45pm	Discussion session: Preparing pathway charters for rural assets classification and contributions to SDGs *Panellists and Audience*
4:45pm – 5:15pm	Way forward *Panellists and Audience*
5:15pm – 5:30pm	Wrap up and Vote of thanks *Prof Harekrishna Misra, IRMA*

Day 2, Monday, 13th December 2021: Inauguration and welcome Session (9:00am – 10:00am)
Join via: personalized link & password will be emailed to registrant

Master of Ceremony Dr Gopi Chattopadhyay, General Chair of ICMIAM2021 conference
Acknowledgement of the Country and welcome message *Prof Syed Islam, Acting DVC Research and Innovation, and Dean School of Engineering, IT and Physical Sciences, Federation University Australia*
Ceremony: Acknowledgement of the country *Katrina Beer, Manager Aboriginal Education Centre, Federation University Australia*
Inauguration and welcome speech *Prof Duncan Bentley, Vice Chancellor, Federation University Australia* *Cr Daniel Moloney, Mayor, City of Ballarat* *Honourable Jason Wood, Assistant Minister for Customs, Community Safety and Multicultural Affairs*
Opening words *Mr Dave Daines, National Chair, Asset Management Council*
Welcome to Mt Helen Campus *Assoc Prof Sam Henson, Campus Head, Federation University Australia*
About the conference *Dr Gopi Chattopadhyay, General Chair of ICMIAM2021 conference*
Video messages from collaborators *Prof Virendra Kumar Tewari, Director, IIT Kharagpur* *Lt Gen (Dr) M D Venkatesh, VSM (Retd), Vice Chancellor, Manipal Academy of Higher Education* *Prof Umakant Dash, Director, IRMA*
An IEEE Supported conference *Dr Enamul Haque, Institute of Electrical and Electronics Engineers (IEEE) Power and Engineering Society, Victoria Chapter, Australia*
Welcome to delegates from the Centre for Smart Analytics, Federation University Australia *Prof Joarder Kamruzzaman, School of Engineering, IT and Physical Sciences, Federation University Australia*
Thanks *Dr Harpreet S Kandra*

Day 2: Keynote speeches Session 1 (10:15am – 11:15am)

Join via: personalized link & password will be emailed to registrant

Session chair: Mr John Hardwick, Asset Management Council (AMC) Australia
Introductions by the Session Chair
10:15am-10:45am: Keynote 1: Dr Gopi Chattopadhyay: Capability building of Industries and Professionals through Asset Management, Maintenance and Reliability Engineering (MRE) Programmes *General Chair of ICMIAM2021 conference and Program Coordinator MRE program*
10:45am-11:15am: Keynote 2: Swami Sunishthananda: Positive influencing factors of Spiritual paradigm that may be adopted to human aspects of Asset Management *Resident Monk in-charge, Vedanta Centre of Melbourne*

Day 2: Technical Session 1 (11:30am – 1:15pm)

Join via: personalized link & password will be emailed to registrant

Technical Session 1: *Track 1*	
Session Chair: Mr. Amar Singh, ANA, Australia and New Zealand; Session co-chair: Dr Harpreet S Kandra, Federation University	
11:30am – 11:35 am	Introductions by the Session Chairs
11:35am – 11:55 am	**Paper#54**: A data-driven approach for gravel road maintenance *Keegan Mbiyana, Mirka Kans and Jaime Campos*
11:55am – 12:15 pm	**Paper#24**: A novel database model for gravel road maintenance *Mirka Kans and Jaime Campos*
12:15pm – 12:35 pm	**Paper#75**: Digital Twins and their significance in Engineering Asset Management *Madhumenon Krishnamenon, Rabin Tuladhar, Mostafa Rahimi Azghadi, Govinda Pandey and Jeffrey Loughran*
12:35pm – 12:55 pm	**Paper#57**: Multi-Classifier Predictive Maintenance Strategy for a Manufacturing Plant *Prashant Singh, Sunil Agrawal and Ayon Chakraborty*
12:55pm – 1:15 pm	**Paper#19**: Circular Economy adoption in Critical Mineral Supply Chain *Ayon Chakraborty, Manoj Khandelwal and Gopinath Chattopadhyay*

Day 2: Technical Session 1 (11:30am – 1:15pm) contd..

Join via: personalized link & password will be emailed to registrant

Technical Session 1: *Track 2*	
Session Chair: Prof Raghuvir Pai, Manipal Academy of Higher Education, India; Session Co-chair: Dr Gopi Chattopadhyay, Federation University	
11:30am – 11:35 am	Introductions by the Session Chairs
11:35am – 11:55 am	**Paper#56**: Conceptual modelling of railway infrastructure cost- A system dynamics approach *Jan-Harm Pretorius, Katleho Mafokosi and Gopi Chattopadhyay*
11:55am – 12:15 pm	**Paper#17**: Reliability analysis of Rotary unions used on Balanced machines *Selvakumar Lakshminarayanan*
12:15pm – 12:35 pm	**Paper#68**: Decision-making in complex asset life extension *Stephen Morey, Gopinath Chattopadhyay and Jo-Ann Larkins*
12:35pm – 12:55 pm	**Paper#107**: Informative Bayesian Survival Methods to Handle Heavy Censoring in Lifetime Data *R. Leadbetter and A. Phatak*
12:55pm – 1:15 pm	**Paper#113**: Winder Maintenance Strategy of paper Mill *Sakila Tennakoon*

Technical Session 1: *Track 3*	
Session Chair: Assoc Prof Gour Karmakar, Federation University; Session Co-chair: Dr Sunita Mishra (IIT Kharagpur, Assistant Professor, Dept. of Mining Engineering	
11:30am – 11:35 am	Introductions by the Session Chairs
11:35am – 11:55 am	**Paper#4**: Assessing public sentiment and disaster impacts using social media data: A case study of Vizag gas leak *Rajan Kumar Gangadhari, Vivek Khanzode and Shankar Murty*
11:55am – 12:15 pm	**Paper#23**: Adaptive neuro fuzzy-based prediction of safety participation from the personal factors of the workers *Tiju Baby, G Madhu and V R Renjith*
12:15pm – 12:35 pm	**Paper#36**: Prevention through Design (PtD) in major construction projects – Case study from Tata Steel *Neeraj Kumar Sinha, Surya Bhusan Kumar Sinha, Ranadip Das, Kumari Shalini and Souvik Das*
12:35pm – 12:55 pm	**Paper#40**: Risk assessment in the calibration of medical equipment *Saptarshi Das, Sayak Roychowdhury and Jhareswar Maiti*
12:55pm – 1:15 pm	**Paper#53**: Human Factors Associated with Self-reported Aberrant Behavior-A Study of Different Indian Autorickshaw Driver Age Group *Mukesh Kumar Kamti and Rauf Iqbal*

Day 2: Technical Session 2 (1:45pm – 3:30pm)
Join via: personalized link & password will be emailed to registrant

Technical Session 2: *Track 1*	
Session Chair: Assoc Prof Ayon Chakraborty, Federation University; Session co-chair: Assoc Prof Nitesh Kumar, Manipal University, India	
1:45pm – 1:50 pm	Introductions by the Session Chairs
1:50 pm – 2:10 pm	**Paper#92:** Studies on the impact of carbon offsetting in the road transport industry: issues and challenges of meeting the objectives *Lennard Peters, Gopinath Chattopadhyay and Harpreet S Kandra*
2:10 pm – 2:30 pm	**Paper#41**: Management of fuel consumption and emissions of heavy goods trucks *Muhammad Atif, Aliyu Aliyu and Rakesh Mishra*
2:30 pm – 2:50 pm	**Paper#49**: Asset Management System Framework Implementation in align with ISO55001 and AMAF- University Sector Case Study *Amar Singh*
2:50 pm – 3:10 pm	**Paper#83**: Cyber-physical System Management for Digital Twin Application of a Control Valve *Mubarak Tolani Aderibigbe, Rakesh Mishra and Aliyu Aliyu*
3:10 pm – 3:30 pm	**Paper#34**: Cognitive Engineering Approaches to Assess Control Room Operator *Aatif Shahab, Babji Srinivasan and Rajagopalan Srinivasan*

Technical Session 2: *Track 2*	
Session Chair: Prof Khanindra Pathak, IIT Kharagpur, India; Session co-chair: Mr Sean Reeves, Asset Management Council (AMC) Aust.	
1:45pm – 1:50 pm	Introductions by the Session Chairs
1:50 pm – 2:10 pm	**Paper#108**: Data Driven Risk Based Decision Making Ability – Attainable or not? *Venkat Reddy*
2:10 pm – 2:30 pm	**Paper#109**: Failure Analysis of a Large Motor Grader Engine *Nik Sharpe*
2:30 pm – 2:50 pm	**Paper#111**: Reliability Centred Maintenance (RCM) in Liquefied Natural Gas (LNG) loading *Erik Vandenberg*
2:50 pm – 3:10 pm	**Paper#110**: Development and implementation of Asset Management System Framework for Federation University Australia – University Perspective *Anandh Ravi*
3:10 pm – 3:30 pm	**Paper#65**: Sensitivity Analysis of Minimum Film Thickness on the Controllable Bearing Adjustments of a Multi-Pad Active Fluid Film Bearing Using DOE Technique *Ganesha A, Raghuvir Pai, S M Abdul Khader and Girish H*

Day 2: Technical Session 2 (1:45pm – 3:30pm) contd …
Join via: personalized link & password will be emailed to registrant

Technical Session 2: *Track 3*	
Session chair: Prof Jhareswar Maiti, IIT Kharagpur, India; Session co-chair: Prof Joarder Kamruzzaman, Federation University Australia	
1:45pm – 1:50 pm	Introductions by the Session Chairs
1:50 pm – 2:10 pm	**Paper#8**: A Simple Data-Driven Risk Management Framework for Decentralized Industry 4.0 Quality and Safety Monitoring *Theodore Allen, John McCarty, Shih-Hsien Tseng and Tu Feng*
2:10 pm – 2:30 pm	**Paper#39**: Network Intrusion Detection using Principal Component - Mahalanobis Taguchi (PC-MTS) System Approach *Tanmay Bhalavi, Sayak Roychowdhury, Akshay Bhosale and Arnav Tiwari*
2:30 pm – 2:50 pm	**Paper#45**: Data Security Management Framework for Digital Twins of Industrial Pipeline *Ilyasu Anda, Rakesh Mishra and Aliyu M. Aliyu*
2:50 pm – 3:10 pm	**Paper#9**: Identifying Product Safety Concerns from Amazon Reviews Using Text Mining Approaches *Chirag Bhawnani and Gaurav Nanda*
3:10 pm – 3:30 pm	**Paper#95**: Cybersecurity Risks in Meat Processing Plant and Impacts on Total Productive Maintenance *Vickram Chundhoo, Gopinath Chattopadhyay, Gour Karmakar and Gayan Kahandawa*

Day 2: Keynote speeches Session 2 (4:00 – 5:30pm)
Join via: personalized link & password will be emailed to registrant

Session chair: Assoc Prof Ean Ooi, Federation University; Session co-chair: Prof Pradip K. Ray, IIT Kharagpur, India
Introductions by the Session Chair
4:00pm-4:30pm: **Keynote 3: Mr John Hardwick:** How Asset Management creates value for organisations especially during turbulent times? *Asset Management Council*
4:30pm-5:00pm: **Keynote 4: Ms Wendy McPate:** Challenges in the Energy industry as we transition to a lower Carbon future *Board Member, Asset Management Council*
5:00pm-5:30pm: Keynote 5: Prof Jhareswar Maiti: Safety and Risk Analytics – Issues, Challenges and Future Directions *CoE in Safety Engg. and Analytics, Department of Industrial and Systems Engineering, IIT Kharagpur*

Day 3: Keynote speeches Session 3 (9:00am – 10:30am)
Join via: personalized link & password will be emailed to registrant

Session chair: Assoc Prof Ibrahim Sultan, Federation University; Session co-chair: Dr Gopi Chattopadhyay
Introductions by the Session Chair
9:00am-9:30am: **Keynote 6: Mr Dave Daines:** Global Certification in Asset Management *National Chair, Asset Management Council, Australia*
9:30am-10:00am: **Keynote 7: Prof Uday Kumar:** New Technology Empowered Asset Management- Issues, Challenges and Future Directions *Chair Professor, Division of Operation and Maintenance Engineering, Luleå University of Technology (LTU), Luleå, Sweden*
10:00am-10:30am: **Keynote 8: Prof. Melinda Hodkiewicz:** AI on maintenance data – Challenges to value delivery *School of Engineering, University of Western Australia*

Day 3: Technical Session 3 (11:15am-1:00pm)
Join via: personalized link & password will be emailed to registrant

Technical Session 3: *Track 1*	
Session chair: Dr Truong Phung, Federation University Australia; Session co-chair: Prof Harekrishna Misra, IRMA, India	
11:15am – 11:20 am	Introductions by the Session Chairs
11:20am – 11:40 am	**Paper#12**: Let's talk about Computer Audit Quality. A systematic literature review *Imbaquingo Daisy, Lorena San Pedro, Javier Diaz, Tatyana Saltos-Echeverria and Silvia Arciniega*
11:40am – 12:00 pm	**Paper#50**: Managing Sustainable Asset Networks using Advanced Information Systems *David Thorpe*
12:00pm – 12:20 pm	**Paper#51**: Maintenance Management Conceptual Model: System Dynamics Approach *Mpho Manenzhe and Arnesh Telukdarie*
12:20pm – 12:40 pm	**Paper#98**: Integration of ISM and System Dynamics to portray the antecedents and consequences of implementation of IoT in manufacturing firms *Vasanth Kamath V P, Giridhar Kamath, Kevin Amith Mathias and D. Srikanth Rao*
12:40pm – 1:00 pm	**Paper#93**: Experimental Investigation on Axial Groove Water Lubricated Journal Bearing *Ravindra Mallya, Girish H, Satish Shenoy and Raghuvir Pai*

Day 3: Technical Session 3 (11:15am-1:00pm) contd…

Join via: personalized link & password will be emailed to registrant

Technical Session 3: *Track 2*	
Session Chair: Assoc Prof Indra Gunawan, University of Adelaide; Session co-chair: Dr Manoj Khandelwal, Federation University Australia	
11:15am – 11:20 am	Introductions by the Session Chairs
11:20am – 11:40 am	**Paper#42**: Air Quality Management in Railways Coaches *Musa Ilemona Alhassan, Prof. Rakesh Mishra, Aliyu M. Aliyu and Naeem S. Mian*
11:40am – 12:00 pm	**Paper#38**: Reliability Block Diagram what-if scenarios helped to identify extra redundancy and resulted in over a few millions of dollars saving for a data centre design *Maine Wong*
12:00pm – 12:20 pm	**Paper#55**: Biogas Blower Troubleshoot, Repair and Improved Reliability *Ahmad S Kidwai and George Zimmermann*
12:20pm – 12:40 pm	**Paper#61**: Viscosity and Thermal conductivity studies on developed vegetable oil in water emulsions for metal working purpose. *Vishal Shenoy P, B Raghuvir Pai, M Vijay Kini and Prajwin Amanna*
12:40pm – 1:00 pm	**Paper#105**: Remaining useful life prediction using hybrid neural network and genetic algorithm approaches *Neha Kumari, Ranjan Kumar, Amiya R Mohanty, Satyendra K Singh, Sujit K Mandal and Prabhat K Mandal*

Technical Session 3: *Track 3*	
Session Chair: Assoc Prof Gour Karmakar, Federation University; Session co-chair: Prof Gayan K Appuhamillage, Federation University	
11:15am – 11:20 am	Introductions by the Session Chairs
11:20am – 11:40 am	**Paper#52**: Systemic improvements in safety management system through near miss capturing: A Case of a manufacturing unit of steel industry *Mom Mitra, Souvik Das and O Bala Krishna*
11:40am – 12:00 pm	**Paper#59**: Estimating the remaining useful life of process piping using Bayesian methods *Gabriel Gonzalez, Aloke Phatak and Adriano Polpo*
12:00pm – 12:20 pm	**Paper#96**: Safety, Health and Environment culture transformation in 400 KV Transmission Assets *Kevinkumar Chothani*
12:20pm – 12:40 pm	**Paper#103**: An IoT-based Smart Grid Technology: Bidirectional Power Flow, Smart Energy Metering, and Home Automation *Sowmik Sarker, Md. Abdur Rakib, Sayemul Islam and Shakib Shahriar Shafin*
12:40pm – 1:00 pm	**Paper#73**: Internal leakage detection in a hydraulic pump using exhaustive feature selection and ensemble learning *Jatin Prakash, P. K. Kankar and Ankur Miglani*

Day 3: Technical Session 4 (1:45pm – 3:30pm)
Join via: personalized link & password will be emailed to registrant

Technical Session 4: *Track 1*	
Session Chair: Mr Dave Daines, Asset Management Council (AMC) Australia; Session Co-chair: Dr Abdul Chowdhury, University of Adelaide	
1:45pm – 1:50 pm	Introductions by the Session Chairs
1:50 pm – 2:10 pm	**Paper #89**: Minimizing uncertainties in roof rock reinforcement design for stable mine roadways *Ranjan Kumar, Prabhat Kumar Mandal, Arka Jyoti Das, Kumar Gaurav, Rana Bhattacharjee and Subhashish Tewary*
2:10 pm – 2:30 pm	**Paper #106**: 30 Years of EAM *Phil Williams*
2:30 pm – 2:50 pm	**Paper #74**: Viscosity Analysis of ZnO enriched Neem Oil Biolubricant at Sub Zero Temperatures *Ganesha A, Girish H, Shilpa Mp, Gurumurthy S C, Raghuvir Pai and Nitesh Kumar*
2:50 pm – 3:10 pm	
3:10 pm – 3:30 pm	

Technical Session 4: *Track 2*	
Session Chair: Dr Umakant Dash, IRMA, India; Session co-chair: Ms Jo-ann Larkins, Federation University	
1:45pm – 1:50 pm	Introductions by the Session Chairs
1:50 pm – 2:10 pm	**Paper#43**: Local flow analysis and management for digital twins of control valves *Qingyun Bu, Aliyu Aliyu and Rakesh Mishra*
2:10 pm – 2:30 pm	**Paper#91**: Using Data for Effective and Reliable Maintenance Optimisation *Kaylyn Chandran and Kevin Tan*
2:30 pm – 2:50 pm	**Paper#112**: Reliability Analysis of a Large Mining Dump Truck Engine *Nik Sharpe*
2:50 pm – 3:10 pm	**Paper#104**: A study on the use of machine learning methods to improve reciprocating compressor reliability via torque tailoring *A Kui Lu, Ibrahim Sultan and Truong Phung*
3:10 pm – 3:30 pm	**Paper#31**: Asset replacement forecasting based on asset criticality and life *Martin Boettcher*

Day 3: Keynote speaker Session 4 (4:00pm – 5:00pm)
Join via: personalized link & password will be emailed to registrant

Session Chair: Prof Uday Kumar, Lulea University Sweden; Session Co-chair: Dr Gopi Chattopadhyay, Federation University	
4:00pm – 4:05 pm	Introductions by the Session Chairs
4:05 pm – 4:20 pm	**Keynote address:** Prof Theodore T. Allen: Cybersecurity "Super-Critical" Vulnerabilities and Control Policies *Integrated Systems Engineering, The Ohio State University*
4:20 pm – 4:35 pm	**Keynote address:** Dr. O.B. Krishna: Analytics Based Integrated Safety Management System *CoE in Safety Engg. and Analytics, Department of Industrial and Systems Engineering, IIT Kharagpur*
4:35 pm – 4:50 pm	**Keynote address:** Prof Raghuvir Pai: Role of Tribology In maintenance and Asset Management *Manipal Institute of Technology, Manipal Academy of Higher Education (MAHE), Manipal, India.*
4:50 pm – 5:00 pm	Question Answer session

Day 3: Keynote speaker Session 5 (4:00pm – 5:00pm)

Join via: personalized link & password will be emailed to registrant

Session Chair: Mr Andrew Sarah, Asset Management Council Australia; Session co-chair: Prof J Kamruzzaman, Federation University	
4:00pm – 4:05 pm	Introductions by the Session Chairs
4:05 pm – 4:20 pm	**Keynote address:** Prof Rakesh Mishra: Asset Management through Multi-layer Digital Twins *Energy, Emissions and the Environment Research Group Leader, University of Huddersfield, Huddersfield, U.K.*
4:20 pm – 4:35 pm	**Keynote address:** Prof Harekrishna Misra: Do Digital Assets Matter to meet SDGs? An Exploration *IT & Systems Group, Institute of Rural Management*
4:35 pm – 4:50 pm	**Keynote address:** Prof P K Ray: Ergonomic Design of Human-Product Interface in Healthcare Systems: Assurance of Risk-free Environment with Automation for Improved Performance *Emeritus Professor Industrial and Systems Engineering, IIT Kharagpur*
4:50 pm – 5:00 pm	Question Answer session

Day 3, Tuesday, 14th December 2021: Closing Session (5:15pm – 6:00pm)

Join via: personalized link & password will be emailed to registrant

Master of Ceremony: Dr Gopi Chattopadhyay, General Chair of ICMIAM2021 conference
Address by Indian Consulate General Melbourne *Honourable Mr Raj Kumar, Indian Consul General, Melbourne*
Thanks from Campus Heads *Ms Kathy Racunica, Campus Head, Berwick campus, Federation University Australia* *Ms Leigh Kennedy, Campus Head, Churchill campus, Federation University Australia* *Associate Professor Geoffrey Lord, Wimmera Campus, Federation University Australia*
Thanks from Technical Program Committee *Associate Professor Gour Karmakar, TCP of ICMIAM2021*
Thanks from Conference Organisation team *Mr Dave Daines, National Chair, Asset Management Council* *Dr Harpreet S Kandra, Organising Chair of ICMIAM2021* *Prof Jhareswar Maiti, Chairman, Centre of Excellence on Safety Engineering & Analytics*
Welcome on behalf of the Organising Team ICMIAM 2022 *Prof Raghuvir Pai, Manipal Academy of Higher Education, India and Asset Management Society India* *Prof Harekrishna Misra, IRMA, India and Asset Management Society India* *Dr Gopi Chattopadhyay, Federation University Australia*
Closing *Dr Gopi Chattopadhyay, General Chair of ICMIAM2021 conference*

Abstracts Day 1, Sunday 12th Dec: Workshop on Rural Assets for Sustainable Development (2pm – 4pm)

Rural Economic Assets and Localizing SDGs

Dr. Umakant Dash
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Gujarat, India

Local governance and space play a major role in achieving SDGs as these are ultimately the sites of delivery and development. Localizing SDGs is therefore important in a country like India, which is predominantly a rural economy. This paper presents a conceptual framework to elucidate the economic assets and related policies in rural areas. An attempt will be also be made to how the economics assets be efficiently used for sustainable livelihoods and thereby enhance the performance of local economies in the context of global competition.

Unless the local governments have a sense of ownership of the economic assets and understand the roles and responsibilities they have in maintaining these assets, their involvement in implementation will be limited.

(Rural) Social Assets and Localizing SDGs: A Conceptual Framework and An Action Agenda

Shyam Singh
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Achieving SDGs is still an unfinished agenda. One of the major challenges is that SDGs are understood as national-level goals that are decided internationally. Hence, the realization of the development process that is oriented towards achieving the SDGs is missing at the local level. Localizing SDGs is becoming a prominent call for action in a country like India, which is predominantly rural (69 percent rural population). This paper presents a conceptual framework to orient local institutions of rural India in using social assets to achieve SDGs. The paper also works out an action agenda by proposing the pathways through which local institutions can use social assets efficiently, which ultimately would help realize the SDGs at the local level. We construe, in this paper, social assets in three different forms: 1) individuals (with definite skills and values), 2) community organizations (common goals and cohesion), and 3) collective behaviour (social networks, social capital, reciprocity, etc.). We base the conceptual framework on the premises of 'solidarity economy' that promotes a collective values-based economy through collective action and cooperation. The action agenda will reflect the fostering of bonding and bridging social capital by the local institutions and community organizations, which would calibrate the collective efforts to achieve contextually relevant SDGs.

Rural Financial Assets and Sustainable Development Goals

Dr. Rakesh Arrawatia
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Access to credit hinders the execution of Sustainable Development Goals (SDGs). Creation of rural financial assets by financial institutions can help nations achieve the SDGs, esp., SDG 1, 2 and 12. Rural finance through financial institutions provide access to assets required by the poor. These assets can increase their productivity and help them to reach a scale where the poor can have higher incomes and come out of poverty. Rural households' access to finance through microfinance and financial institutions can help them in getting access to credit for supporting small enterprises, dairy ad agriculture farming and education. This paper presents a conceptual framework on how financial asset creation by financial institutions can promote SDGs.

ICTs as an Asset for the Sustainable Development Goals

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Information technologies are playing a key role as an asset to capture and manage data of different forms. One of the forms of this data is text. Textual data can be exploited to for example better inform decision-makers. There

are many sources of textual data such as reports, emails, books, memories, or social media. So, one of the questions that need to be tackled is how social media textual data can be exploited to better inform decision-makers. In this research, we looked at on how this social media data can be used to better inform policymakers in the context of the sustainable development goals.

In early September 2015, The United Nations (UN) adopted the seventeen "Sustainable Development Goals" (SDGs) to come with new international strategies to resolve many challenges across the globe such as poverty, unemployment and pollution. In this context, the goal thirteen (i.e. SDG-13) refers to "climate action", which aims to reduce one of the major atmospheric and environmental threats. Governments at national and international level are facing significant challenges to implement this goal and align with its targets. On the other hand, significant discussions are disseminated in social media by people and organizations that are involved and/or interested in SDG-13. This research emphasizes on Twitter, as an IT asset, to explore the climate change and the climate action related discussions in the context of SDG-13. We collected tweets between 2015 and 2020 that refer to that goal, and then we applied qualitative and quantitative analysis to explore trends and potential insights that could help decision and policy makers in implementing and monitoring the SDG-13. Our results show that users are increasingly posting content related to climate change to express their concerns and suggest alternatives to mitigate climate change. Policymakers should be aware of this content that may help them build their policies to build their climate change strategies.

Digital Infrastructure and Services for Smart Rural - A Scientometric Analysis

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Rural regions in different parts of the worlds require digital infrastructure like broadband and digital government services for meaningful social-economic development. Consequently, governments over the years have as part of their regional development strategy the intensified initiatives to provide these digital assets to its rural residents with the support or participation of private sectors and civil society organisations. This study examines the trend in the provision of these digital assets, including the extant models, management frameworks and related challenges. The study concludes with plausible future pathways in development digital infrastructure and services in realising smart rural regions and development.

Digital Rural Assets and SDGs: Polices and Outcomes

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The United Nations (UN) Sustainable Development Goals (SDG) adequately recognized the role of information and communication technologies (ICT) as part of the implementation strategies. Digital infrastructure (DI) policies and implementation strategies globally or nationally have focus on not only address still prevalent digital divides, but also have come up with various services to reach out to the populace, especially in in rural areas. This paper aims to discuss global digital infrastructure polices and examines the Indian strategies dealing with the digital divides and opportunities for the rural populace.

Digital India policies have support of policy makers and each pillar of its policies has the scope for examining the rural element. Each pillar of the digital India provides opportunity and scope to set of digital infrastructure assets for the rural populace to use for their livelihoods. This paper aims to critically examine this relationship and outcomes.

Abstracts Day 2: Technical Session 1 (11:30am – 1:15pm) Track 1

Paper #54 A data-driven approach for gravel road maintenance

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Gravel roads are important assets for geographically sparse countries, but the maintenance of these roads is costly and inefficient. In addition, as failure development is highly affected by environmental factors, the planning should be dynamic for reaching efficiency and effectiveness, which is achieved by data-driven maintenance approaches. This paper proposes applying a data-driven approach in gravel road maintenance following the steps of the OSA-CBM specifications. The conceptual approach is developed and illustrated based on the findings of an extensive literature review. The approach thus contextualises OSA-CBM in gravel road maintenance and points out further development and research areas. It was found that the research has mainly focused on data acquisition techniques, road condition classification, diagnostics, and deterioration models, while data manipulation methods and prognostic models for gravel roads are rather unresearched areas. In addition, a holistic approach towards data-driven maintenance of gravel roads is currently lacking. In this perspective, the approach presented in this paper could serve as a base for the further development of data-driven methods to reach efficient and effective gravel road maintenance practices.

Keywords — Data-driven methods, Decision Making, Gravel road maintenance, OSA-CBM.

Paper #24 A novel database model for gravel road maintenance

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This paper reports on an empirical investigation of functionality and information requirements for gravel road maintenance following a stakeholder-based requirement elicitation process. Results in the form of use case diagrams, prototypes, as well as a database model describing information needs for gravel road maintenance are presented. The novelty of the database is highlighted by describing new features that are enabled by the database, such as predictive maintenance management using road condition information or the coordination of maintenance tasks between the contractor and the customer.

Keywords— database model, gravel road maintenance, requirements elicitation, stakeholder's approach.

Paper #75 Digital Twins and their significance in Engineering Asset Management

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Developing digital replica of complex systems for the purpose of decision making is an emerging concept in various subject domains. This paper surveys the history, state of development, characteristics and key features from multiple domains and their suitability for life cycle decision making of engineered assets. The review also explores the current state of knowledge, level of abstraction and precision, limitations, benefits and future opportunities in a service-oriented application for prognostic decision making.

Keywords—Asset Management, Digital Twin, Industry 4.0, PHM.

Paper #57 Multi-Classifier Predictive Maintenance Strategy for a Manufacturing Plant

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Predictive Maintenance Management in an industry can play a pivotal role in asset management and revenue generation. This work proposes a data-driven-based multi classifier model for implementing predictive maintenance to simultaneously reduce both downtime and idle time of the machines in a manufacturing plant. A case study of the plant comprising of 100 machines has been done to identify the early prediction of failure, its nature, and the attributing cause. Gradient Boosting Tree Classifier and Random Forest Classifier machine learning algorithms have been used to develop the models for fault prediction. A comparative analysis of results obtained using these methods has also been done. Random Forest Classifier outperforms Gradient Boost tree classifier in all evaluation parameters - accuracy, precision, and recall.

Keywords—Classifier, Data Driven Method, Diagnostics, Predictive Maintenance, Prognostics.

Paper #19 Circular Economy adoption in Critical Mineral Supply Chain

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In today's world, there is a major push for the transition of global energy system to clean energy. Many of these clean energy technologies rely on critical minerals such as copper, lithium, nickel, cobalt, and rare earth elements. These critical minerals are utilised in clean energy technologies such as solar panels, wind, turbines, and electric cars. The shift to clean energy system will lead to increasing demand for critical minerals thus showing that the energy sector is going to be a major force in minerals markets. This growing need of critical minerals can lead to price volatility, geopolitical influence, and supply disruptions. Although CE principles have been applied in critical minerals supply chains to achieve resource efficiency and waste reduction across supply chains, there is little effort to measure the circularity and adopt CE holistically across the critical minerals supply chain.

Track 2

Paper #56 Conceptual modelling of railway infrastructure cost- A system dynamics approach

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The investment decision making in railway infrastructure plays a vital role in safe and reliable utilization of the infrastructure. There is a considerable contribution to the country's economy from railway transport infrastructure, which requires continuous investment in the railway infrastructure. The infrastructure investment in maintenance, renewal and construction increases the availability and capacity of the railway infrastructure. Economic indicators are used to analyze and evaluate the infrastructure life cycle cost in order to justify the investment decisions. System dynamics modelling is used to outline the feedback structure of railway infrastructure life cycle cost. The system structure, system component relationships, and system behavior are defined using systems thinking in order to analyze the causality between different variables. System dynamic modelling shows how different variables influence the railway infrastructure life cycle cost and investment decision making. The understanding of how the system works enables well-informed decision making. The application of the system dynamics approach in the conceptual modelling of the railway infrastructure cost will enable past system behavior or occurrences to be explained and the future ones to be predicted.

Paper #17 Reliability analysis of rotary unions used on balanced machines

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Material handling equipment like stackers, reclaimers and ship loaders are grouped as 'balanced machines'. These equipment need a continuous water supply, which is provided through a hose, at the end of which there is a 'rotary union' fitting, containing an interface between stationary and rotating parts, which is used to connect the hose to the distribution piping on the equipment. Frequent failures of the rotary unions across the various plants of Rio Tinto Iron Ore operations in the Pilbara, prompted a review of the maintenance strategy for these fittings. A study was done to collect the failure data of the rotary unions on all balanced machines across all plants, followed by a reliability analysis. Machine downtime data was extracted to study the impact of downtime to operations. Costs working for various maintenance strategy scenarios were performed to arrive at the optimum maintenance strategy for the rotary unions.

Paper #68 Decision-making in complex asset life extension

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Complex, long-life assets present challenges for life cycle management, particularly decisions about life extension at the end of the asset life. Multiple interlinked risk factors drive the decision-making process. Compounding the difficulty, few ready-to-use life extension methods exist in literature. Complex decision analysis processes which are technically superior, but difficult to follow, may have the effect of alienating decision-makers who do not understand them. A method developed for NASA for risk informed decision making appears more suitable for guiding decision-making in life extension problems. This paper proposes a framework for decision-making in life extension of complex, long-life, capital-intensive assets, addressing some of the important challenges in life extension decision-making.

Paper #107 Informative Bayesian Survival Analysis to Handle Heavy Censoring in Lifetime Data

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Developing a fixed time replacement policy requires reliable estimates of the lifetime of an asset. Estimation of the lifetime is conventionally performed by fitting a Weibull distribution to historical lifetime data using maximum likelihood. However, in industries such as mining and mineral processing, data are often heavily censored. This censoring results in biased parameter estimates that can mislead a replacement policy which the analysis informs. In this paper, we demonstrate for practitioners how high levels of censoring in lifetime data affect inference about the Weibull parameters and how a Bayesian approach can be used to constrain the parameter estimates to more sensible values by using domain expert knowledge. Furthermore, we elaborate on a previous method from the literature which elicits domain expert knowledge on the outcome space in order to construct a joint prior for the Weibull distribution; we also show how this method is more effective at reducing

bias caused by high levels of censoring compared to other informative Bayesian approaches in the reliability literature. Finally, we present a small simulation study to show that the bias reducing effect of the informative joint prior is reproducible.

Keywords— Bayesian, domain expert knowledge, Prior elicitation, and Survival analysis.

Paper #113 Winder Maintenance Strategy of Paper Mill

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The M1 Winder Maintenance Strategy came about to reduce the degrading performance on the winder which has occurred over the last 4 years. The winder is one of the last components of paper making which takes the paper made on the paper machine and cuts it down into customer required sizes. By analysing downtimes events and product waste trends, a gap analysis took place to eliminate and engineer out performance related issues on the winder. Through this study, a gap was found towards the understanding of the winder fundamentals (T.N.T, Tension, Nip and Torque) and identified as one of the root causes of the degraded life for the winder. The second root cause was marked as weak maintenance strategy for the winder assets. In particular, the Tension Roll and the Rider Roll assets alongside the functional location structure upon the winder were resolved within this scope. The overall review of the winder performance was successful in correcting the found issues and stabling the performance of the winder into the future.

Keywords - Winder, Rider Roll, Tension Roll, Functional Locations, asset management, gap analysis. Tension, Nip and Torque (TNT).

Track 3

Paper #4 Disaster impacts analysis using social media data

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Social media platforms become an important source of information in the event of disasters. In the event of any disaster, people try to post the information, raise their concerns such as help required, report property and assets damages, look for any rehabilitation facilities, and report about injuries or fatalities. In this paper, social media data was used to assess public sentiment and the impact of a disaster to extract valuable insights to support rescue operators, government agencies, and voluntary organizations. The two-stage methodology adopted in this paper uses the data collected from Twitter and applies a filtering layer to rule out non-disaster event messages. Further, state-of-the-art machine learning models combined with regular expressions are used to find information about persons, injuries, and entities. A threshold limit is imposed on social media posts to alert the Government of any rapid changes in public behaviour using tweets or posts. We evaluate our model on a recent industrial disaster, "Vizag Gas Leak Incident," and present the findings and evaluate the importance of this methodology.

Keywords—Machine learning, Safety Analytics, Social media data, Vizag gas leak.

Paper #23 Adaptive Neuro Fuzzy-Based Prediction of Safety Participation from the Personal Factors of the Workers

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Safety participation is a significant factor in occupational accidents. Enhanced safety participation of the workforce is crucial for ensuring safety at the worksite. Personal factors of the workers are influencing the level of safety participation. This research paper attempts to predict the level of safety participation based on three major personal factors- job stress, social support, and self-esteem. Safety research survey conducted in an government electrical organisation used for this study. The relevant statistical analysis including validity, reliability, and factor analysis was performed before attempting the development of the prediction model using adaptive neuro-fuzzy system (ANFIS). Training, checking, and testing of the data was performed using ANFIS were conducted and the estimated RSME values were found to be within the threshold. An app for predicting safety participation from the personal factor was also developed. Future researchers can use this research study to predict other safety factors from the individual factors.

Keywords— key words safety climate, safety participation, adaptive neuro fuzzy.

Paper #36 Prevention through Design (PtD) in major construction projects – Case study from Tata Steel

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The construction industry is a dynamic sector involving various kinds of activities, each having their own hazards. Most of these activities are of a constantly changing nature and their specific hazards are not very well known until much later into the construction process. Though the fundamental processes involved in construction remain the same, every construction project is unique & has its own specific jobs & hazards associated with them depending on the design specifications, materials, equipment & processes used & the safety culture followed by the working agency. Construction workers are especially vulnerable to injuries due to fall from height, electrocution, being caught in or between objects, being struck by moving machinery, falling objects, vehicles, etc. which can also lead to fatal incidents. Apart from these, they are also susceptible to irreversible health issues arising out of exposure to dust & other harmful substances.

Project execution & construction activities have been one of the most challenging activities in Tata Steel because of a large diversity in geographical locations, types of operations & various process requirements. The organization has undertaken many greenfield as well as brownfield projects which both have different kinds of risks involved. Since the last few years, Tata Steel has taken many initiatives to mitigate the hazards & reduce the incidents in construction activities. One of the major steps taken in this direction was the implementation of Prevention through Design (PtD) in projects. This included adoption of practices like virtual design & construction, use of bolted & prefabricated structures, laser scanning & 3D modeling, powered access system, e-work permit, site access control and AI-based CCTV surveillance for monitoring of site activities among many others. Prevention through design is a transdisciplinary process which aims at reducing the hazards in the design & planning phase itself, making the construction activities inherently safer and their safety management cheaper. Risk identification & prioritization is done for each job according to a risk heat map based on the potential consequences of each hazardous event & its likelihood of occurrence. The top risks are identified & design interventions are proposed to eliminate or substitute them.

Prevention through design, powered by automation & digitized safety management systems, is widely gaining use in several operations as well as construction projects due to its advantages and ease of implementation. The adoption of these safety technologies & automation has helped in proactively mitigating risks & significantly increased the effectiveness of health & safety management systems at construction sites. The construction companies should adopt these safety practices & policies, that combined with the implementation of digital health & safety tools & techniques could assist site managers ensure efficiency of their construction projects.

This paper discusses the methodologies adopted at Tata Steel to implement prevention through design in construction projects and their effect on the health & safety performance of the organization.

Keywords—prevention through design, construction safety, design for safety, PtD, construction projects, digitization, risk, risk mitigation.

Paper #40 Risk Assessment in the Calibration of Medical Equipment

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The calibration process of any health critical equipment is very important from the perspective of patient care. However, the calibration process is prone to human errors. A systematic and easy to implement methodology for detection and mitigation of the same is essential for any sustainable healthcare program. In this study, the entire calibration procedure is divided into sub-processes and the different modes of errors were identified. Expert opinions are collected for risk quantification. This assessment shows an overview of the calibration steps, along with the different modes of failures associated with the process. Then a failure mode and effect analysis (FMEA) based risk assessment is used to prioritize the failure modes followed by their identification and mitigation measures. The risk priority number (RPN) computed from the FMEA ranks the risks in the order of their priority. The methodology is demonstrated through calibration of a mechanical ventilator, and the results are presented. This framework can detect avoidable sources of errors, thereby increasing the reliability of critical patient care systems.

Keywords—Expert's opinion, FMEA, fuzzy, medical equipment, RPN, TOPSIS, Ventilator.

Paper #53 Human Factors Associated with Self-reported Aberrant Behavior- A Study of Different Indian Autorickshaw Driver Age Group

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Driving is a complicated task that demands a high level of concentration for processing information and reacting to the road environment. Therefore, Human factors play an important role during driving task performance. The objective of this study is to investigate the human factors that impact driving behavior in different age groups of autorickshaw drivers in India. These factors are mainly associated with cognitive or psychological factors and personal characteristics. This study was conducted in the Mumbai, Maharashtra region with a total of 96 male autorickshaw drivers of two different age groups. A conventional neuropsychological battery was utilized to assess the cognitive ability of the drivers including simple reaction time, concentration, short-term memory, visual acuity, and matrix reasoning. A driving behavior questionnaire (DBQ) was developed and applied to measure the violation and errors done by the autorickshaw drivers. To identify the traffic knowledge of the drivers 10 traffic sign-related photographs were shown to the drivers to know their awareness about traffic signs and rules. Finding from the result shows that the simpler reaction time, visual acuity, and short-term memory are significantly correlated with the DBQ score. Lack of education and traffic knowledge was found among both groups of drivers but in the young age group, the DBQ score was found higher in comparison with the old drivers due to increased violation and error scores.

Keywords— Autorickshaw drivers, Cognitive ability, Driving behavior questionnaire, Human factors.

Abstracts Day 2: Technical Session 2 (1:45pm – 3:30pm)

Track 1

Paper #92 Studies on the impact of carbon offsetting in the road transport industry: issues and challenges of meeting the objectives

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The overall performance of the transport industry is generally reported in terms of moving goods, or freight or people from any location to their final destination in a safe, reliable, cost-effective, and timely manner. However, greenhouse gas and exhaust fumes resulting from their operations has an adverse impact on climate and health of people living around transport corridors. Carbon dioxide (CO_2) in exhaust fumes, if not contained, can cause poisonous air pollution and contributes to global warming. Australia's Department of Agriculture, Water and the Environment statistics predict that in 2030, CO_2 emissions from the road transport industry through the usage of articulated and rigid trucks, are expected to grow by 37 percent from 2015 levels and is 80 percent higher compared to 2006 levels. In various parts of the world, there are annual mandatory road worthiness and exhaust testing requirements for responding to these problems. Some countries like Singapore (5.4 years) Luxembourg (6.5 years) and Austria (8.3 years), replace vehicles in five to 10 years on an average. Affordability, easy access, congestions, greenhouse gasses, impacts on health and safety are some of the important factors in asset management that can potentially impact climate change. Fleet asset management considers capital investments, operational and maintenance costs for informed decision making based on risks, life cycle costs and performances. This paper presents a review of studies on the impact of carbon offsetting on the transport infrastructure. Issues and challenges of alternative options for reducing risks and lifecycle costs along with approaches for enhancing performance covering reduction of greenhouse gasses and adverse impacts on human health have also been presented.

Keywords— Greenhouse gases, Carbon offset, Public Health, Transport Modes, Life Cycle Costs (LCC).

Paper #41 Management of fuel consumption and emissions of heavy goods trucks

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Heavy goods vehicles are an integral part of road cargo transportation and carried 85% of Europe's road freight in 2018. Many investigations have been carried out on different HGV aerodynamic devices to make them more fuel-efficient and reduce emissions. Cab Roof Deflectors (CRD) placed on tractor roofs are one of those devices used to guide the incoming flow on the roof of the trailer. Most HGVs have a mismatch in the heights of the tractor and trailer such that a largely exposed tractor face causes increased fuel consumption and turbulence in the gap area between tractor and trailer. The changing flow velocity and direction, however, require further research to find the optimum position at different flow conditions. This study has used computational fluid dynamics numerical modelling technique to investigate different relative velocities and yaw angles. It was found that the conventional way of adjusting the CRD in such a manner that it matches the height of the trailer, does not provide maximum fuel efficiency. Further investigations have revealed that there is not one fixed optimum position of the CRD, and it requires an active flow control system to adjust the position according to surrounding conditions. It was also found that the efficiency of the CRD was greatly reduced in strong crosswind conditions and requires adjustment to a different optimum position. This study has achieved an extra 7 to 13% fuel saving by adjusting the CRD to its different optimum positions according to the wind conditions.

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Paper #49 Asset Management System Framework Implementation in align with ISO55001 and AMAF- University Sector Case Study

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One of the leading Australian's University with multi-campuses manages about \$1 Billion of buildings and infrastructure, plant & equipment assets, which are fundamental to overall planning and to support the broad range of quality services (covering higher education, TAFE, VCAL and Research) to stakeholders. The University recognises that asset management needs a 'whole of organisation' approach. The regulatory framework also requires University to establish and implement asset management system (AMS) framework for sustainable management of assets and service delivery. In 2020 University decided to develop and implement a University-wide comprehensive asset management framework to achieve the compliance with the AMAF and ISO55001 which requires to undertake s structured, systematic review of the current AM practices and capabilities, and prepare a Roadmap to implement asset management framework to assist in achieving its strategic and AM objectives. This paper presents the challenges, roadmap and lessons learned for AMAF and ISO55001 asset management system framework implementation.

Paper #83 Cyber-physical System Management for Digital Twin Application of a Control Valve

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The monitoring and analysis of local flow conditions inside process units such as pipelines and control valves are key to diagnosis, control, and optimization. New technologies such as digital twins are increasingly being used for remote monitoring, control and diagnosis of many industrial systems. However, digital twin technology is in its infancy for process units such as control valves for oil and gas applications and effective asset management of these units requires thorough understanding and modelling of the system especially for digital applications. In this work, the design, implementation, and deployment of a cyber-physical system for a control valve digital twin application is reported. The system is linked to CFD software to collect real time pressure from the valve system to run simulations in real time. We hence demonstrate that Computational Fluid Dynamics can be used in this way to give local information within valves achieved with reliable and high-precision data and information in real-time bringing about the Digital Twin system of the real asset (system).

Paper #34 Analysis of Control Room Operators' Competence using Cognitive Engineering Approaches to Improve Process Safety

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Operator competence is critical to ensure safe and profitable operation in hazard intensive chemical process industries. Human errors account for the majority of the accidents in these industries. Therefore, it is imperative to develop methodologies to assess the competence of operators to minimize human errors. Traditional approaches to elicit operator competence are based on subjective measures and/or measures derived primarily from the process and operator actions. These approaches ignore the cognitive aspects of operators such as perception, decision-making strategy, and workload, which are crucial for improving performance. Recent development in sensor technology has enabled the researchers to measure human cognitive behavior objectively.

Sensors such as eye-tracking, electroencephalography (EEG) and galvanic skin resistance (GSR) are found to provide intrinsic human characteristics that cannot be measured otherwise. In this paper, we discuss how eye-tracking can be used to capture control room operators' cognition and help infer their competence. Eye-tracking provides information about the location of a person's gaze, which serves as a trace of their attention allocation. Eye gaze-based metrics show a strong correlation with operator cognitive behavior such as situation awareness and cognitive workload during process monitoring tasks.

Keywords— Cognitive Workload, Eye-tracking, Operator Competence, Process Safety.

Track 2

Paper #108 Data Driven Risk Based Decision Making Ability – Attainable or not?

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Capital and operational planning has historically been heavily reliant on past experiences and localised knowledge from long term, indoctrinated employees. But what if you could design a framework which was scalable and tailorable to suit small to large infrastructure domains that aligned to customer's expectations and corporate risk management requirements? It's a journey which is achievable it cannot be a sprint; it takes drive and ambition, but it is worth the journey.

This paper discusses the challenges of the framework's implementation and application across the various asset portfolio using enterprise asset management system. Designed and developed under a current enterprise Asset Lifecycle Management workbench as a one stop solution for asset maintenance, replacement, and capital planning. The key components that are required to support asset life cycle management and data driven risk-based decisions are: Assets, Asset data, Asset Maintenance data, Asset Condition, Criticality and Risk rating, Failure history, Asset Management Plans and Decision making criteria.

Venkat will discuss the journey and the lessons learnt through a proof of concepts into different segments to validate the framework, developing meaningful asset management KPI's which were real-time, getting granular and driving change to train and drive the workforce in the framework.

Keywords—Asset Maintenance, Risk Based Decision, Asset Lifecycle Management.

Paper # 109 Failure Analysis of a Large Motor Grader Engine

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A customer experienced a failure of a 6-cylinder engine within a motor grader application. The motor grader operates in a coal mining environment and the engine had achieved 4,180 hours of service prior to failure. Under this application, the preventative replacement interval for the engine is approximately 12,000 hours of service, which equates to the engine achieving 34% of its scheduled life. Initial diagnosis of the failure whilst in chassis indicated a cracked cylinder head was present at #4 cylinder and required premature removal of the engine. This research paper will investigate and analyse the failure of the engine and determine the root cause and failure mode that resulted in the premature removal of the engine. The failure analysis will predominately utilise visual Non-Destructive Testing (NDT) methods to assist in determining the root cause, with other techniques to be utilised as required. The evidence obtained was then analysed utilising Root Cause Analysis (RCA) tools with a root cause of failure established with recommendations made to improve the reliability and durability of the engine.

Keywords— Erosive Wear, Failure Analysis, Fretting Corrosion Wear, Motor Grader, Root Cause Analysis.

Paper #111 Reliability Centred Maintenance (RCM) in Liquified Natural Gas (LNG) loading

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Improvements to reliability, availability, and maintainability (RAM and reduction of life-cycle costs (LCC) are important goals of effective maintenance programmes. Preventative Maintenance (PM) reduces cost of failures in operation, compared with Corrective Maintenance (CM). Determining the PM frequency and level of PM requires cost/benefit analysis and is decided based on risk. For effective maintenance program, analysis of failure modes, their effects, and criticality needs be carried out. Recommendations for maintenance, inspection and testing programs needs to be made using Reliability Centred Maintenance (RCM) to align the maintenance strategies with how the equipment fails, how predictable the failure is and what overall impact the failure has to safety, the environment, and production impacting on bottom line. The application of RCM with new knowledge and experience with the actual built asset, provides insight. Application of RCM decision logic can bring about significant improvements to an existing maintenance strategy or can formulate one if it is not in place. This paper is on application of RCM in Liquefied Natural Gas (LNG) loading arms of an Australian operation.

Keywords— Failure Mode Effect and Criticality Analysis (FMECA), Reliability Centred Maintenance (RCM), Maintenance Strategy.

Paper #110 Development and implementation of Asset Management System Framework for Federation University Australia – University Perspective

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Federation University Australia is the largest Regional University in Victoria, with a history spanning over 150 years. The present-day University was formed when the former University of Ballarat and the Gippsland Campus of Monash University were amalgamated. This amalgamation gave rise to inconsistency in the Asset Management process, eventually impacting all asset performance, service delivery and reporting. These issues led to the university's Facilities Services directorate deciding in late 2019 to develop an Asset Management Framework that encompasses all assets owned or managed by Federation University Australia.

Paper #65 Sensitivity Analysis of Minimum Film Thickness on the Controllable Bearing Adjustments of a Multi-Pad Active Fluid Film Bearing Using DOE Technique

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Multi-pad actively controlled fluid film bearing is capable of undergoing quasi-static pad displacements for stabilizing the journal's equilibrium position. The bearing pads can be actively displaced using a mechatronic system from its reference configuration in the radial and tilt directions. Real time positioning of the active pad adjustments can directly modify the fluid film thickness and thereby influence the performance envelope of the bearing. Symmetrical and asymmetrical adjustments configurations of the multiple bearing elements will have varying influences over the minimum film thickness region developed over the bearing pads. In the present study,

the sensitivity analysis of the minimum film thickness to the bearing element adjustment is performed using the Design of experiment technique. The greatest influence of the radial adjustments of the bearing element 1 on the minimum film thickness is observed. The influence of the interaction effect of bearing element adjustments on the minimum film thickness is minimum in comparison with the main effect; their significance is eccentricity ratio specific.

Keywords— Active bearing, film thickness, mechatronics, sensitivity, Design of experiment.

Track 3

Paper #8 The Ohio State Model for ICS Cybersecurity

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We propose a simple framework for Industrial Control System (ICS) system cybersecurity. The proposed system is based on considerations which include known vulnerabilities, safety issues, and the centrality of assets in hypothetical attack vectors. We relate the proposed system to the Purdue Model and two optimization formulations from the literature. We also relate our point system to the results of a recent penetration testing exercise on a manufacturing robotic cell. Finally, we discuss multiple challenges including that posed by legacy equipment and threats to manufacturing uptime.

Keywords—Purdue Model, manufacturing, ICS410, vulnerabilities.

Paper #39 Network Intrusion Detection using Principal Component – Mahalanobis Taguchi System (PC-MTS) Approach

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The majority of conventional approaches for network intrusion detection have relied upon popular machine learning models, for instance, logistic regression, support vector machine (SVM), decision tree, and artificial neural network (ANN). These procedures deal with multidimensional datasets that often require different feature engineering and data preparation techniques. Robust design methods proposed by Taguchi have been extensively used in engineering design problems in relation to quality improvement. However, the potential for robust design techniques in the domain of cybersecurity has remained unexplored. In this article, a network intrusion detection system has been developed by implementing the Mahalanobis-Taguchi System (MTS), which is a derivative of the Taguchi methods. In the context of intrusion detection, MTS provides a supervised learning approach in which the attack instances are distinguished from the normal instances based on the Mahalanobis Distance (MD). Since network logs contain a number of variables, a principal component analysis (PCA) based framework has been developed for feature reduction, and subsequently, MTS is applied for classification. This new method is named PC-MTS, the effectiveness of which is demonstrated through implementation on two network intrusion datasets,

viz. NSL-KDD and IDS2017. The results show that the proposed method gives a high degree of accuracy at par with or even better than existing intrusion detection methods.

Paper #45 Data Security Management Framework for Digital Twins of Industrial Pipeline

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Digital Twin (DT) is an emerging technology that is a cornerstone of the 4th industrial revolution. Over the next decade, it is expected to revolutionise industrial processes via Internet of Things (IoT) and other enabling technologies such as 5G for better performance and safety. DT as a real time virtual representation of any physical system is envisaged to ensure better connectivity of industrial processes, increased speed of decision making and effective prediction that could lead to optimised performance enhancement at various levels in the business chain. However, unsecured, or poorly secured DTs can cause serious harm to an enterprise in key industrial sectors such as manufacturing and oil and gas which are of utmost importance to the world's economy. The focus of this paper, therefore, is to identify security vulnerabilities of DTs in applied to the oil and gas industry and analyse effective security frameworks for monitoring oil and gas pipeline data and its transmission over various networks including through the Cloud. This is to prevent man-in-the-middle-attacks and reduce economic losses that can result. Furthermore, important considerations on the data attributes will be explored. These include accuracy of the data transmitted under various security implementation regimes, its completeness, and transmission delay of the various frameworks.

Paper #9 Identifying Product Safety Concerns from Amazon Reviews Using Text Mining Approaches

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The product safety and user manuals often present detailed information about the safe and effective use of the product. However, people often use the product in different ways, not covered in the manual, which can lead to injuries of varying severity. Analysis of injuries related to a product is important from injury surveillance and product safety perspectives. Product related injury data is mainly collected from hospital emergency rooms, such as for the National Electronic Injury Surveillance System (NEISS) in the United States. While data for more serious injuries are collected at hospital emergency rooms, injuries with low severity or near-miss events are often underreported and can lead to more serious injuries for different product users in the future. Product users often mention their bad experiences or safety concerns about the product in their reviews on Amazon, which can potentially be identified using text mining and natural language processing approaches. The goal of this work-in-progress study is to analyse the amazon review dataset for the product category "art, craft and sewing" to identify potential safety concerns, accidents, or hazardous safety issues reported. To accomplish this, two approaches were used: (a) identifying the highly representative words and phrases for injuries of same product category from the NEISS dataset and text mining the Amazon reviews based on these keywords, and (b) applying document similarity approaches between NEISS dataset and Amazon reviews to identify reviews which are indicative of potential safety concerns. The preliminary results suggest that both the approaches were successful in identifying reviews with safety concerns but with relatively high false-positive rate. This workflow is being refined with expert knowledge based linguistic rules to improve the prediction accuracy. Based on the potential safety issues identified from Amazon reviews, the product's safety and user manuals can be analysed to check if these scenarios are already covered in or not and accordingly recommendations can be suggested.

Paper #95 Cybersecurity Risks in Meat Processing Plant and Impacts on Total Productive Maintenance

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Technological changes have been happening in industries including food industries in an ever-increasing rate. This includes sensors, hardware and software, automated process control and communication technologies including Internet of Things. This is more challenging where production systems are highly reliant on automation and robotics. Remote performance monitoring and controls are becoming more and more vulnerable due to risks associated with cyber security and corporate espionage. May 2021 cyber-attack forced JBS meats USA to pay $11m US dollar in ransom money to stop any further disruptions in services and this affected JBS global operations including the Australian branch. Food production has critical control points as part of their food safety management system supported by smart technologies. Cyber-attacks on production facilities could result in financial, operational, and health and safety consequences. In this paper, to present the potential cyber security threats and their associated risk level, a case study is presented based on the processing and manufacture of meat products in Australia. From this case study, to protect the meat industries from attacks, we identify cybersecurity attacks and their possible mitigation strategies. This research shows security attacks can severely affect Overall Equipment Effectiveness which motivate us to embed security as an additional pillar in existing 8 pillars Total Productive Maintenance. If security is added as additional pillar, it will improve the quality of end products and overall productivity of manufacturing industries.

Keywords— Cybersecurity, Internet of Things, Total Productive Maintenance, Critical Control Points, Overall Equipment Effectiveness.

Abstracts Day 3: Technical Session 3 (11:15am – 1:00pm) Track 1

Paper #12 Let's talk about Computer Audit Quality. A systematic literature review

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The quality of the computer audit contributes to the continuous improvement of public or private organizations due to the results obtained for decision-making. However, when addressing the quality of the results of computer audits in a general way, there is no comprehensive view of the factors that affect its execution and the metrics used for its evaluation. Therefore, this research is a Systematic Literature Review (SRL) on the quality, factors, and metrics to evaluate the quality of the results of the Computer Audit. For this purpose, 25 articles extracted from bibliographic databases were analyzed and collected, such as ScienceDirect, Scopus, Dialnet, IEEE.

Scientific documents answered three research questions proposed in this bibliographic study. From the results, various quality concepts, factors, and metrics used to obtain quality results in computer audits were identified.

Keywords— Computer audit, external factor, human factor, quality, quality metrics, technical factor.

Paper #50 Managing Sustainable Asset Networks using Advanced Information Systems

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In order to continue to deliver high quality service while meeting the goals expected of them, asset managers are increasingly required to utilize advances like advanced information management systems, automated data collection, and the integration of a range of data types. Through a review of asset management systems and research undertaken into its use in building design organizations in South-East Queensland, Australia, the use of Building Information Modelling (BIM) for life cycle sustainable asset management is discussed. The results of this research indicate that while there has been development of BIM and other advanced information systems in asset management, further work is required to fully achieve the potential for using these systems. Options for better facilitating this process include improved sharing of BIM models, interoperability between systems, improved training and having an Open BIM approach to facilitate its development.

Keywords— asset management, advanced information systems, building information modelling, sustainable.

Paper #51 Maintenance Management Conceptual Model: A System Dynamics Approach

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Literature depicts a great level of complexity that requires analysis of interdependencies between the technical and business aspects in the industry 4.0 context, this presents dynamic complexity between technical (maintenance) and business aspects (production measures). This complexity is commonly encountered by most industries in the context of systems optimization. This paper aims at addressing one part of complex phenomenon, namely, maintenance management presented by dynamic complexity using system dynamics. A system dynamic conceptual model for maintenance management controls, and their unintended effects is modelled from existing literature and using systems thinking.

Keywords—causal loop diagram, dynamic complexity, maintenance management, system dynamics.

Paper #98 Integration of ISM and System Dynamics to portray the antecedents and consequences of implementation of IoT in manufacturing firms

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Using the Interpretive Structural Modeling (ISM) and System Dynamics (SD) approaches, this study examines implementation of Internet of Things (IoT), its antecedents, and consequences in the context of the Indian manufacturing firms. While contemporary literature has studied implementation of IoT, its antecedents, and consequences in isolation, our endeavour to capture and highlight the interdependencies between the factors is

presented below. Based on expert opinions, twelve factors linking to IoT implementation are chosen for the study. ISM is adopted to clearly demarcate the driving and dependent factors. The key cause and effect relationships between the factors are visualized using a Causal Loop Diagram (CLD). The CLD suggests that management focus (MG), Competition (CM), and the Market requirements (MK) are the key drivers of IoT implementation (IoT), thereby leading to associated benefits like improvised partnership (PT), Technology standardization (TS), Compatibility and Reliability (CR), Product quality (PQ), and Customer Focus (CF), thereby leading to Purchase intention (PI) and Actual Purchase (AP). It's possibly the first study of its kind in the IoT implementation literature combining ISM with SD.

Keywords—Industry 4.0, Internet of Things, Interpretive structural modeling, System Dynamics, Causal loop diagram.

Paper #93 Experimental Investigation on Axial Groove Water Lubricated Journal Bearing

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An experimental arrangement has been developed to test the performance of water lubricated journal bearings. These are frequently used as stern tube bearing for fishing trawlers. The test bearing is manufactured with nitrile rubber material attached to a metal shell. The construction of the test bearing is unlike the normal plain bearings. This bearing has 8 plain regions around its circumference and amidst these staves are 8 axial grooves (flutes) evenly distributed. The present work discusses design and specifications of different components used in developing the test setup. The hydrodynamic pressure in the bearing clearance is measured using a flush pressure transducer for different operating speeds and loads. A set of inductive non-contact sensors were used to measure the journal location at each end of the bearing. The inductive transducer readings were used to locate the journal centre and measure the eccentricity and attitude angle for various loads and speeds in the hot rotating condition. The attitude angle and eccentricity is used to plot the static characteristics of the bearing.

Keywords—Experimental setup, Hydrodynamic pressure, Steady state characteristics, Water lubricated bearing.

Track 2

Paper #42 Air Quality Management in Railway Coaches

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With the outbreak of COVID-19 all over the world, it has become increasingly important to understand and effectively manage air quality in enclosed environments. The effect of HVAC (Heating, Ventilation, and Air Conditioning) systems in airborne disease transmission is crucial especially in confined public places such as hospitals, buses, and railway coaches. Computational Fluid Dynamics has become an important tool for studying and understanding the behaviors of fluid flow especially aerosol transport in such enclosed spaces. The current paper focuses on simulating the behavior of air in the indoor environment of a railway coach under four different conditions. These correspond to the conditions when the rail coach has no occupants and is with three occupants,

and for each of these conditions the effect of three and six different HVAC supply air inlet conditions were explored. The results show that without occupants, the air from the inlet spreads into the coach with relatively low velocity and maintains its speed throughout the coach until at the outlet where it speeds up. With occupants in the coach, the incoming air was observed to spread wide and exits the coach with much higher velocity. This is due to the reduced available flow area occasioned by the occupants, and this information will be useful in further studies with aerosol transport within the coach.

Keywords —Airflow distribution, Computational Fluid Dynamics (CFD), HVAC (Heating, Ventilation and Air Conditioning) System.

Paper #38 Reliability Block Diagram what-if scenarios helped to identify extra redundancy and resulted in over a few millions of dollars saving for a data centre design

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Holistic Asset Management (HolisticAM) has recently performed a Reliability, Availability and Maintainability (RAM) study by building a baseline Reliability Block Diagram (RBD) for a new data centre design. HolisticAM utilised the ReliaSoft BlockSim software, which provided a comprehensive platform for system reliability, maintainability, and related analyses that allows modelling the most complex systems and processes. It combined the system hierarchy, the process or system configuration, and relevant industrial standard or life data in a diagrammatic format. The performance of the model was then simulated over a nominated period using Monte Carlo simulation techniques. Value added what-if scenarios were performed to identify opportunities to reduce the resiliency level of the data centre without compromising the expected performance goals.

Keywords —Holistic Asset Management.

Paper #55 Centrifugal Blower Troubleshoot, Repair and Improved Reliability

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The effluent treatment plant known as *UpFlow Anaerobic Sludge Blanket* (UASB) at Gibson Island Brisbane Paper Machine treats and recycle wastewater. In this process biogas is vented out. This biogas is fed back to the boiler with the help of a centrifugal blower to utilize the energy content. In the past one year repeated failures have occurred on the blower with failure modes ranging from increased vibration, bearing failures and water ingress. It costs about $5000 a week to the business with biogas blower unavailability. This would amount to about $200,000 per year. Hence, it is very critical to the operations. This study is conducted to determine the failure causes and improve the Mean Time Between Failure (MTBF) of the biogas blower. To improve the reliability, a methodological step by step process was carried out to get to the root cause of the problem. Interestingly there were more than one root cause identified for the blower failure. It was a multi facet reliability improvement ranging from mechanical to process improvements. Failure Mode Effect Analysis (FMEA) was conducted, and each failure mode was addressed on its own merit, incorporating preventative and predictive maintenance actions.

Keywords— Biogas Blower (Centrifugal Blower), Failure Modes and Effect Analysis (FMEA), Mean Time Between Failure (MTBF), Root Cause Analysis (RCA).

Paper #61 Viscosity and Thermal conductivity studies on developed vegetable oil-in-water emulsions for metal working purposes

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The cutting fluid used in industries are predominantly petroleum based synthetic or semisynthetic fluids. The drawbacks associated with the petroleum-based metal working fluid are the disposal techniques along with operator health hazards. This work aims at preparing and testing metal working fluid from emulsions of vegetable oil which can be an alternative for the petroleum based cutting fluids. The prepared cutting fluid are evaluated for some of its thermophysical properties. The results from the testing gives an insight into the variation of the thermophysical properties with respect to various parameters.

Keywords—cutting fluids, vegetable oil-in-water emulsions, HLB system, viscosity, thermal conductivity.

Paper #105 Remaining useful life prediction using hybrid neural network and genetic algorithm approaches

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Recently, numerous approaches have been applied for predicting the RUL of machinery based on condition information. Artificial Intelligence (AI) methods such as Long Short-Term Memory (LSTM), Feed Forward Neural Network (FFNN), Convoluted Neural Network (CNN), Recurrent Neural Network (RNN), and many more have been applied successfully in detecting the faults and predicting the RUL of machines. But these methods involve uncertainties in RUL prediction due to the inability to select the best input and suboptimal Artificial Neural Network (ANN) structures. The manual method of optimizing the ANN structure is time taking preprocessing to formulate the prediction model. To sort out these issues, this paper proposes a hybrid ANN and Genetic Algorithm approach to select the best input and optimize the ANN structure for higher accuracy. The open-source simulated data sets of realistic large commercial turbofan engines have been used in the proposed network of ANN with GA. GA selects the case to trim down the data dimensionality. The application of GA intends to optimize the hyperparameters of ANN to make more accurate networks. This hybrid method has been implemented in a Jupyter Notebook Anaconda software environment and the language used is python. The outcomes of simple ANN and hybrid method of ANN and GA are compared and found that the latter approach provides better RUL than the former.

Keywords—Remaining Useful Life, Artificial Neural Network, Vibration Monitoring, Machine Vibration, Genetic Algorithm.

Track 3

Paper #52 Systemic improvements in safety management system through near miss capturing: A Case of a manufacturing unit of steel industry

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Background: Near misses are harrowing close calls that could have been a lot worse; they are incidences that could have happened but did not due to a gap in time or distance. While there should be a system to encourage people to record near misses, analysis of the same is also important to bring about the required improvements in the safety management system. Latent errors often exist for long periods before they combine with enabling conditions to produce a significant failure. Whether an enabling condition transforms a near miss into a crisis generally depends on chance; thus, it makes little sense to predict or control enabling conditions. Instead, companies should focus on identifying and fixing latent errors before circumstances allow them to create a crisis.

Problems: Recognizing and learning from near misses does not require only attention; it runs contrary to human nature. In this case study, we have examined near misses and reveal how companies can detect and learn from them. By seeing them for what they are—managers can apply their lessons to improve operations and, potentially, ward off catastrophe.

Contributions: This initiative has helped to develop systemic improvements in safety management systems, including a lockout tag-out system. 'Try out' has been deployed in the manufacturing unit, and various methods have been used for actually simulating the equipment.

Implications: 'My life is my life' tag has been justified in this initiative as after the group isolation lock has been done, the contract supervisor puts his lock on the box. Relevant documentation has been implemented in the control room. Other benefits like proper approaches and many commonly accepted unsafe practices have been identified and resolved through this approach.

Keywords: Safety management systems, Near miss, Lockout tag-out system, Manufacturing unit, Accidents.

Paper #59 Estimating the remaining useful life of process piping using Bayesian methods

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Remaining useful life (RUL) estimation is a crucial element of maintenance and risk assessment. In the oil and gas sector, RUL estimation is guided by well-established recommendations and increasing research. On the other hand, RUL estimation is more challenging in the mining and mineral processing sectors, partly due to the smaller amount of available data, which is also of poorer quality and less variety. This work aims to communicate a new approach for pipeline RUL estimation that uses historical and contextual data to reduce the uncertainty of RUL estimates. We adopt a Bayesian framework, which has been used in similar pipeline applications. In our application, degradation is assessed through ultrasonic inspections under a non-regular inspection schedule. Using this degradation data, we implemented a multilevel Bayesian model to produce RUL estimates for a small sample of pipes in a minerals processing operation. Our work highlights many of the advantages of the Bayesian framework compared to conventional approaches, and we suggest pathways for future research.

Keywords —Bayesian methods, remaining useful life.

Paper #96 Safety, Health and Environment culture transformation in 400 KV Transmission Assets

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Sekura Energy proposes to own and operate high quality assets across power transmission, solar energy, wind energy, and similar segments of the power sector. Sekura Energy focuses on operating assets in line with the best industry practices across every aspect of the business with emphasis on highest standards of governance, operational excellence and a key focus on health, safety & environment. The O&M (operation and maintenance) related safety, health and environment aspects are not up to the mark in acquired 400 KV transmission lines and substations. Sekura Energy believes that protecting people and environment is moral obligation as well as it is the key for sustainable business. 400 KV electrical power transmission lines O&M activities have significant electrocution, arc flash, fall from height, fire, oil spill and bites & stings risks/impacts. If these risks/impacts had not controlled well using preventive and recovery control barriers, they might have caused serious injuries to employees and contractors. To manage these risks/impacts, the organization has developed and implemented Safety, Health and Environment Management system in line with ISO 14001:2015, ISO 45001:2018 and other international standards e.g. NFPA 70E, OSHA Voluntary Protection Programs. Strong leadership commitment, static and dynamic risk assessment with controls, allocation of adequate resources, competence enhancement and periodic monitoring are key parts for this success story and supported the organization to achieve significant culture transformation in newly acquired assets.

Keywords —transmission lines, risks, 400KV.

Paper #103 An IoT-based Smart Grid Technology: Bidirectional Power Flow, Smart Energy Metering, and Home Automation

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The Internet of things (IoT)-based smart grid system is a burning tool for ensuring smart home automation monitoring systems, smart billing systems, and smart energy distribution. Smart grid has the advantage to integrate renewable energy resources (RESs) into the conventional grid that can reduce the effects of greenhouse gases (GHGs). This paper focuses on demonstrating the bidirectional power flow between generation units and the consumer's unit, smart energy metering, and home automation system. Solar photovoltaic (PV) system is supplies power to the home appliance with the grid and when the power solar PV is sufficient, it can contribute to the grid. The smart billing system provides the billing information to the users through message. Home automation system benefits the consumer to distribute energy efficiently s and to control home appliances from anywhere in the world. The proposed research work is implemented practically to verify the feasibility of the system. ESP32 with GSM module is incorporated into the system as the controller. The real-time data of voltage, current, and power are collected from the ThinkSpeak server. The error is calculated from the measured data and the actual data and is illustrated graphically. The average percentage of error for solar power is 7.542989% and for the grid is 3.443207%.

Keywords—IoT, smart grid, smart metering, home automation, solar PV, grid, ESP32.

Paper #73 Internal Leakage Detection in a Hydraulic Pump using Exhaustive Feature Selection and Ensemble Learning

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With an increasing demand for hydraulic pumps in the era of Industry 3.0 and 4.0 due to their higher performance, they are getting compact and thus more vulnerable to leakage due to tight tolerances. Thus, it is imperative to diagnose these faults at the early stage. In this study, an attempt has been made to diagnose the internal leakage of hydraulic pumps using an Exhaustive Feature Selection (EFS) with Random Forest (RF) classifier. The electrical power signal (unbalanced towards healthy condition) of the electric motor driving the pump has been used to diagnose the two different severities of internal leakage. Firstly, four statistical features namely skewness, kurtosis, shape indicator and impulse indicators are extracted. These four features are combined in all possible ways using EFS to get 15 different combinations. These 15 features are then used to train the random forest classifier and the accuracy and the standard deviation is evaluated for every combination. The methodology successfully determines the number of features best suited for the classification and accuracy corresponding to it. Secondly, the unbalanced dataset has been balanced using random under-sampling of healthy signals and the same methodology is used to ascertain the effect of balanced dataset classification using random forest. The study shows that a balanced dataset can be diagnosed more efficiently (89.21%) as compared to an unbalanced dataset (87.94%) using this methodology at the cost of loss of some information during under-sampling. In addition, another resampling method, Tomek Link has been employed. The test accuracy of trained random forest model is found to be highest among all (94.44%). It also decreases the false positive and false negative prediction for minority classes. Thus, this study provides an insight into the extensive combination of features and their effect on the pump leakage diagnosis and is highly useful when a limited amount of faulty data is available.

Keywords—Hydraulic pump, Internal leakage, Exhaustive feature selection, Random forest.

Abstracts Day 3: Technical Session 4 (1:45pm – 3:30pm)

Track 1

Paper #89 Minimizing uncertainties in roof rock reinforcement design for stable mine roadways

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This paper enumerates and includes the uncertainties in roof rock reinforcement designs for the mine roadways intersection under varying geomining conditions. The field data used in the analysis is collected from several coal mines. The rock loads, support resistance, and safety factors are determined, and their probabilistic distribution functions are best fitted to include their field uncertainties. The uncertainties quantified in terms of the failure probability of reinforcement systems are estimated and subsequently correlated with the safety factor. The acceptable values of the failure probability of the reinforcement design parameters are estimated. The design uncertainties of a stable reinforcement system can be minimized by selecting the optimum safety factor matching the acceptable values of failure probability. The method described in this paper would help to minimize the design

uncertainties in roof rock reinforcement at mine roadways intersections to improve safety and productivity in underground coal mines.

Keywords—Roof rock reinforcement; field uncertainties; Monte Carlo Simulation; failure probability; safety factor.

Paper #106 Years of EAM

Phil Williams

Paper #74 Viscosity Analysis of ZnO enriched Neem Oil Biolubricant at Sub Zero Temperatures

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Due to the environmental impact caused by the prolonged usage of petroleum-based lubricants has emphasised the need of more eco-friendly bio-lubricants in industrial machineries. For different tribological applications, the bio-lubricants in the original form are not effectives in comparison with synthetic lubricants. The efficiency of bio-lubricants can be improved with appropriate addition of nanoparticles. Based on this prospect, the present study focusses on the assessment of viscosity variation in Neem oil with the mixture of ZnO nanoparticles. The ZnO nanoparticles are dispersed into the Neem oil at 0.25% weight concentration. Magnetic Stirring process is carried out in this study for the appropriate dispersal of ZnO in Neem oil. The variation in lubricant viscosity for 0.25% weight concentration of ZnO blended Neem oil is experimentally analysed at higher temperatures and sub-zero temperatures using a Modular Compact Rheometer. Herschel Bulkley model was set in the Modular Compact Rheometer for the viscosity analysis of ZnO blended Neem oil. A notable variation in viscosity is observed in the nano-biofluid developed as engine lubricant by the blended mixture of ZnO nanoparticles in Neem oil.

Keywords — Biolubricant; Neem Oil; nanoparticles; nanofluids; Viscosity.

Track 2

Paper #43 Local flow analysis and management for digital twins of control valves

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Since about 2002, Industry 4.0, and Digital Twin (DT) research as we know it today, enjoyed increasing attention in academia and industry. The research on the DTs of control valves is currently not as mature as in other critical fields. It is however of utmost importance given the role control valves play in the process, nuclear, and petroleum industries. As a common and essential part of the pipeline system, valves are used to regulate fluid flow within pipelines to achieve a desired flow condition. However, the local flow characteristics within the valve domain are difficult to determine experimentally because of complex geometry and inaccessibility of the flow domain. The application of DT technology in pipelines allows real-time fluid flow data transmission both at global and local levels, and performance monitoring of the system as well as for predicting remaining useful life. Big data analytics and machine learning can be leveraged to improve valve system performance prediction as well as to improve safety. This paper describes initial work carried out on developing a control valve digital twin which incorporates tools for monitoring local flow conditions in the control valve. Computational Fluid Dynamics (CFD) is used to determine the internal characteristics of the fluid inside the valve, and the data are analysed and managed through the development of a DT of the valve system.

Keywords—Digital Twin, Control valves, flow coefficient, numerical simulation, valve design, pressure distribution, computational fluid dynamics, local flow analysis.

Paper #91 Using Data for Effective and Reliable Maintenance Optimisation

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Operational and proven data supporting maintenance strategies is essential in successfully managing asset performance over its asset life; it enables effective maintenance forecasting, resource planning and optimised lifecycle management. As a result of a recent review, Downer has further optimised a train maintenance plan by evaluating the passenger door subsystem overhaul interval using analytics and condition monitoring data to provide valuable real-time insights, in conjunction with "traditional" reliability engineering analysis, resulting in the optimisation of the overhaul intervals. Utilising the historic and real-time data has resulted in material and labour savings, as well as increasing operational efficiency and availability of the maintenance depot.

Keywords— Condition monitoring, data analytics, maintenance strategy, predictive maintenance.

Paper #112 Reliability Analysis of a Large Mining Dump Truck Engine

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The preventative replacement interval for engines is an extremely important decision that impacts the Total Cost of Ownership (TCO) of the assets, with about 34% of total maintenance costs being associated with the engine system over the asset's life. For a dump truck engine (4,000hp) in a coal mining application, this replacement interval is currently set at 20,000h. By extending the time between planned replacements (i.e. the serviceable life) of the engine, our customer will see a long-term reduction of the TCO of their large mining truck by elimination of a preventative replacement over its lifecycle. This paper analyses in-field time to failure data from a particular mine site is analysed for reliability of the engine at both the current preventative replacement interval, and at specified extended life interval targets. Individual failure mechanisms that are life-limiting factors are identified using Weibull Analysis and Failure Root Cause Analysis. Findings from analysis of life-limiting factors showed that only a few dominant failure mechanisms were affecting the reliability of the engine for the current application. Solutions to address these vital few failure mechanisms are used for further enhancing expected extended serviceable life and reduced the TCO.

Keywords—Component Life Extension, Engine Failure Mechanism, Life Limiting Factors, Preventative Replacement, Weibull Analysis.

Paper #104 A study on the use of machine learning methods to improve reciprocating compressor reliability via torque tailoring

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Reciprocating compressors have found popularity in applications where compressed air is required at high pressure levels with moderate flow rates. The mechanical drives used for these compressors are based on the traditional slider-crank linkage which, despite its simplicity, does not lend itself to optimization effort aimed at improving the compressor reliability and performance. The work presented in this paper adopts the notion that the mechanical reliability of the compressor drive is limited by the level and cyclical variability of the loads transmitted through its members and the effectiveness of its cooling system. In the paper, machine learning methods will be employed to craft an objective function suitable to use in a Bayesian optimization effort

undertaken to produce a more reliable compressor drive. A numerical example is presented to prove the validity of the presented method and its suitability for use in real life compressor designs.

Paper #31 Asset replacement forecasting based on asset criticality and life

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Many asset intensive industries have a challenge to estimate future expenditure based on asset expected lives. One challenge is to estimate the asset life, and to determine the appropriate life decay curves that can be expected. Another challenge is that the major expenditure cost over time needs to be determined - regular outages or major maintenance interventions needs to be modelled and their impact on equipment available life determined. It is also required to model various different scenarios in this process to understand the impact of various interventions. By utilizing equipment classes and equipment criticality, an efficient long term replacement and significant expenditure estimation process can be developed. When combined with equipment condition assessment this provides a powerful tool for long term planning. This paper defines the approach to develop this set of tools and defines the assumptions that are required to make this feasible.

<u>Keynote 1: Topic For Lecture</u>: Capability Building Of Industries And Professionals Through Asset Management, Maintenance And Reliability Engineering (MRE) Programmes

Work place based and Work Integrated Learning (WIL) in postgraduate engineering programs further enhances the capability of managers, engineers and professionals in industries while they are working to tackle the socio-technical-cultural challenges of their profession and provide solutions to real-life problems in their workplace. Postgraduate programs in Maintenance and Reliability Engineering (MRE) and Asset Management are uniquely placed to offer value form investment in capability building that immediately benefits student's existing industries, and this synergistic partnership is the key to the continued success of capability building programmes. Engineers, managers and technical professionals with existing industrial linkages and workplaces, are enrolled in postgraduate professional courses in one of the Australia's leading regional Universities. They negotiate industry-based practical projects within their workplaces, applying their knowledge and skills to address the existing challenges of their industries, supported by industry and academic advisors and supervisors. Project-based assessment does so much more than fulfilling academic requirements. It gives managers, engineers and professionals opportunities to contribute tangible solutions to their industries while studying and applying knowledge learned and forges mutually beneficial partnerships between their industry and the university.

Dr. Gopinath Chattopadhyay
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Churchill Australia
Dr. Gopi Chattopadhyay, Ph.D. (University of Qld), has 40 years of experience in industries and Universities in Maintenance, Reliability Engineering, Risk Engineering and Asset Management. He is Postgraduate Programme Coordinator for Maintenance and Reliability Engineering in Federation University, Australia, Chair of Gippsland, past Chairs of Brisbane and Gladstone of Asset Management Council, past President of Australian Society for Operations Research (Qld) and Vice President of Maintenance Engineering Society of Australia (MESA, Qld), industry reviewer of ISO55000 series of standards on Asset Management and Total Asset Management Plan of Queensland Government. Gopi supervised 18 PhD and Master students, secured over 2.5 Million Australian dollars of funding and published 170 international journal and conference papers.

<u>Keynote 2: Topic For Lecture</u>: Positive Influencing Factors Of Spiritual Paradigm That May Be Adopted To Human Aspects Of Asset Management.

Balancing cost, risk and performance is important in Asset Management in line with ISO55000 series of standards. The main focus is on physical assets including infrastructure. However, other assets including financial, human, information and intangible assets are extremely important. In a rapidly changing corporate world, organizations are increasingly realizing that people are the most critical contributors to success. Most organizations are now highly dependent on their intangible assets, such as human capital, organizational capabilities, knowledge and wisdom for their competitive advantage. Thus, Human Asset Management has become a significant factor for any organisation's success. In order to respond to various issues and challenges of the twenty-first century, organisations need to focus on inspiring knowledge workers to provide best value to their organisations and the society. This talk is on how to examine the needs and identify the positive influencing factors of spiritual paradigm that may be adopted to effectively meet the challenges in Human Asset Management.

Key Words: Human Asset Management, Spiritual paradigm, Critical contributors to success.

Swami Sunishthananda
E-mail: vedanta@vedantamelbourne.com

Swami Sunishthananda is the Resident monk in-charge of Vedanta Centre of Melbourne since October 2017. He is a monk of the Ramakrishna order. He comes from electronics engineering background before he joined the order in 1991. He served as Principal of various Higher Secondary Schools run by Ramakrishna Mission in India and was posted to Fiji as the Manager of Swami Vivekananda College, Nandi in 2012. He was posted to Vedanta Centre of Sydney as its Associate Minister of Religion in 2013 and continued there till he was posted to Vedanta Centre of Melbourne in October 2017 as its Resident Monk in-charge. Apart from conducting weekly spiritual discourses and online classes, he is an active participant in seminars, workshops on human values and interfaith events.

<u>Keynote 3: Topic For Lecture</u>: How Asset Management creates value for organisations especially during turbulent times.

John Hardwick
Asset Management Council Australia

John commenced as Executive Director Sydney in April 2017. Prior to joining Roads and Maritime, John was Head of Asset Management for Ausgrid, where he delivered ongoing savings of over $30 million per annum and the successful lease of the network business. Previously John held a number of senior management positions including Head of Network Strategy at Networks NSW, where he led key transformations and cost savings for three electricity distribution businesses (Ausgrid, Endeavour and Essential Energy). He did this by developing and implementing consistent frameworks and strategies for asset management and safety. John is a graduate of the Australian Institute of Company Directors and serves as a board member for numerous global and Australian asset management organisations and co-authored the book Living Asset Management. In 2018 John was awarded the MESA medal by the Asset Management Council.
John is accountable for the end-to-end management of the Sydney road network.

<u>Keynote 4: Topic For Lecture</u>: Challenges In The Energy Industry As We Transition To A Lower Carbon Future

Wendy McPate
Board Member
Asset Management Council Australia

Wendy is a progressive and trailblazer for women in Asset Management and STEM. She is passionate about putting people and customers at the heart of a business; of leading with courage and generosity of spirit; and of resilience. She is engaged, compassionate and believes in the importance of loving what you do; lifelong learning; backing yourself; and most importantly, integrity. Wendy has over 25 years' experience across multiple sectors in both Australia and the United Kingdom; commencing her career in mining, resource, sugar, petrochemical and transitioning to the utility and energy sectors. She is a highly motivated and experienced Asset Management professional with strong leadership, management, change and communications skills gained in a range of roles with Origin Energy, Stanwell Corporation, Scottish Water and consulting organisations. Currently the Engineering Manager - Asset Management at Origin Energy for the Power Generation Business Unit, Wendy is responsible for supporting the production and performance outcomes for Origin's ~7,000MW power generation assets.

<u>Keynote 5: Topic For Lecture</u>: Safety And Risk Analytics – Issues, Challenges And Future Directions

Prof. Jhareswar Maiti
Professor,
Department of Industrial and Systems Engineering,
IIT Kharagpur

J Maiti (PhD, FIE), the Founder Chairman of the Centre of Excellence in Safety Engineering & Analytics (CoE-SEA) and Professor of the Department of Industrial and Systems Engineering, IIT Kharagpur is pioneer in making safety analytics as core area of research in the broad domain of Safety Science. He has established "Safety Analytics and Virtual Reality Laboratory" at IIT Kharagpur. He has authored over 160 publications and is currently serving as Associate Editor of Safety Science and International Journal of Injury Control and Safety Promotion. Prof Maiti carries out inter- & multidisciplinary research on the interfaces of engineering, management science, and statistics including analytics. The recipient of several awards including the prestigious P C Mahalanobis Distinguished Educator Award in Management Science for the year 2020 by the Operational Research Society of India.

Keynote 6: Topic For Lecture: Global Certification in Asset Management

Asset management coordinates the financial, operational, maintenance, risk, and other asset-related activities of an organization to realize value from its assets. The ISO 55000 suite of standards was published in 2014 with the aim of providing a framework for a management system for asset management. As an asset management system relies on people, processes, and technology to function effectively, practitioners in the various disciplines of Asset Management are key to unlocking this value. It is essential that they are competent in carrying out their duties, and a coherent, transferable, system for developing and verifying these competencies is needed.

World Partners in Asset Management (WPiAM) is a worldwide partnership, established in late 2014, of national not-for-profit professional associations working together to enable individuals and organizations to develop, assess and recognize competence in Asset Management, for the benefit of their members and of the asset management community globally.

The four key objectives of the WPiAM are to:

- Be a global multi-lingual **certifier of personnel in the market place**

- Provide a recognised Certification suite to demonstrate minimum required knowledge and comprehension of asset management

- Create a **global certification scheme (GCS)** for asset management

- Demonstrate the values of integrity, collaboration and duty to the public

The AM Council, as a founding member of WPiAM has been at the forefront of developing the GCS in line with its own well recognised and mature Certification scheme. The AM Council's Certified Practitioner (CPAM) and Certified Senior Practitioner (CSAM) in Asset Management are now accredited to the GCS scheme and offer members internationally recognised Certifications in Asset Management.

Dave Daines
National Chair,
Asset Management Council, Australia

Dave Daines is the National Chair of the Asset Management Council of Australia and the representative on GFMAM (Global Forum in Maintenance and Asset Management) and WPiAM (World Partners in Asset Management). He is also the Chair of the Australian MB19 Mirror Committee for TC251/ISO55000 International Committee which is at the forefront of design and maintenance of the ISO55000 series of codes. Dave is a seasoned Asset Management professional with significant experience in all aspects of Asset Management within the Resource Industry and as a Lead Auditor in Asset Management.

<u>Keynote 7: Topic For Lecture</u>: New Technology Empowered Asset Management- Issue Challenges And Future Directions

The on-going efforts for digitalization of engineering assets and infrastructure provides enormous capabilities to collect vast amount of data and information (i.e., Industrial Big Data) which can facilitate correct decision making aligned to the planned asset performance. With advent of industrial internet, the effort has shifted towards finding transformative technologies and solutions suitable for the new and ageing assets to realise the economy of operation. These technologies such as big data analytics (predictive and prescriptive analytics), industrial Internet of Things(IIoT), Cloud computing, 5G communication technologies that offer near perfect solutions for the maintenance of the engineering assets and systems, are collectively termed as transformative technologies (TT) .

The presentation will be centered on the capability of enabling technologies – new and emerging that will facilitate development of transformative technologies and business solutions for the effective and efficient modern-day infrastructure or industrial systems using the power of predictive and prescriptive analytics. *The presentation will be an overview of matured, new and emerging technologies useful for effective life cycle management of engineering assets with focus on new transformative ce technologies and solutions incorporating big data analytics, industrial internet, artificial intelligence, etc. The presentation will cover both technological aspects and management issues based on experiences from R&D projects at Luleå University.*

Uday Kumar, PhD
Chair Professor
Division of Operation and Maintenance Engineering
Luleå University of Technology (LTU), Luleå, Sweden
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Prof Uday Kumar is the Chair Professor of Operation and Maintenance Engineering and Scientific Director of Luleå Railway Research Center at LTU (JVTC) and Scientific Director of Research and Innovation (Sustainable Transport) at Luleå University of Technology and Luleå , Sweden. He has more than 30 years of experiences in research, consulting and finding solutions to industrial problems directly or indirectly related to reliability and maintenance of engineering systems. He has been responsible for several EU projects on Maintenance Technologies, Chinese high speed Trains for CRRC, State Shipping Corporation projects on Intelligent maintenance. He has published more than 350 papers in International Journals and Conference Proceedings, and has co-authored 6 books. He was awarded the Nordea Science Foundation Award for significant contribution to science, society and region, recipient of distinguished alumnus award, of IIT BHU India (2017), Lifetime achievement award from Society of Reliability and Safety, Recognition award from APCOM council, USA.

<u>Keynote 8: Topic for Lecture</u>: AI On Maintenance Data – Challenges To Value Delivery.

The hype surrounding AI on maintenance data is souring as managers are burned by projects that promised much but fail to deliver value. This talk is about the limitations and risks associated with AI for maintenance and also a road map to where we could and should be focussing as well as what organisational processes need to be in place to support value capture.

Professor Melinda Hodkiewicz
BHP Fellow for Engineering for Remote Operations
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University of Western Australia, M050, UWA, Crawley, Perth, WA 6009
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Melinda Hodkiewicz FTSE graduated with a BA(Hons) in Metallurgy and Science of Materials from Oxford University in 1985 and a Ph.D. in Engineering from the University of Western Australia (UWA) in 2004. Her early career was spent in operations and maintenance roles in the mining industry in the USA, Australia and the UK. She has been the BHP Fellow for Engineering for Remote Operations at the UWA since 2015 and has an ongoing teaching and research position at UWA. She is a Chartered Engineer registered in the UK, a member of IEEE and the IOM. She sits on the Advisory Board for Australia's National Offshore Petroleum Safety Authority and METS Ignited. In 2012-2015 she led Australia's effort to develop the ISO 55000-55002 set of Asset Management standards. She has held visiting fellowships at NIST in the US and the Turing Institute in London. In 2016 she was awarded the MESA Medal, a lifetime achievement award for services to Asset Management in Australia and in 2019 she was made a Fellow of the Australian Academy of Technology and Engineering.

: Cybersecurity "Super-Critical" Vulnerabilities and Control Policies.

Prof. Theodore T. Allen,

Integrated Systems Engineering,

The Ohio State University

Theodore T. Allen, Ph.D. is an Associate Professor in Integrated Systems Engineering and Computer Science Engineering (Courtesy) at the Ohio State University (OSU). He is a simulation Area Editor for Computers & Industrial Engineering (IF: 5.3), fellow of ASQ, past president of the INFORMS Section for Social Media Analytics, and an inaugural member of the MIT Election Science Laboratory. He is also the President and founder of FactSpread which brings referenced facts to millions. Dr. Allen is also the Chief Content Officer for the Institute for Cybersecurity & Digital Trust and a member of OSU's Security Advisory Board. He is the winner six teaching awards and an OSU College of Engineering Lumely Research Award. He was also a semi-finalist in the 2020 INFORMS Edelman competition for helping DHL supply chain to save $160M with routing software. His applications have helped millions of save hours of waiting time in US elections.

Dr. O.B. Krishna
Visiting Professor IIT, Kharagpur

O B Krishna brings an experience of 37 years in engineering, manufacturing and commissioning of steel plant equipment, maintenance engineering of integrated steel plants including open cast and underground mining equipment, safety and health engineering (including process safety) and management systems, human factors engineering (macro and micro ergonomics) and business processes reengineering. During his career, he held the leadership position of heading the whole spares maintenance and manufacturing business for steel industry. He then moved to Tata Steel's steel plant equipment manufacturing business (design, manufacture, erection and commissioning of steel plant equipment) heading a 500cr business. He brought the concept of Tribology bench, Condition Based Maintenance (CBM), Reliability Centered Maintenance (RCM) and Zero-Based Maintenance (ZBM) to improve the reliability and cost in maintenance in Tata Steel. He is Visiting Professor at Indian Institute of Technology, Kharagpur (2017 onwards). Contributed for IoT based work design theory and lab; Safety Engineering, Management and Analytics to the student community.

Keynote 11: Topic For Lecture: Role Of Tribology In Maintenance And Asset Management.

Raghuvir Pai
Professor, Manipal Institute of Technology,
Manipal Academy of Higher Education (MAHE),
Manipal, India.
PhD in Tribology from the Indian Institute of Technology, Kharagpur. 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 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 and Malaysia. 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. Ten students have completed their Ph D dissertation with him and currently there are 06 other students pursuing their PhD. He is the founder President of Asset Management Society, India.

One of the major concerns globally is reliability and management of Energy and Flow Handling systems. This includes both the conventional and non-conventional energy systems. With the advent of powerful computers, it is now becoming possible to carry out numerical computations at much faster speed. Furthermore, extensive research in data mining and artificial intelligence is enabling enhancement in predictive ability. Presently fast, robust and accurate sensors are able to provide data about various process variables enabling monitoring of the energy and flow handling assets possible. Furthermore, accuracy of the numerical computations has increased significantly and in theory there is a possibility to simulate energy transfer and flow process from local level to the global level within an energy system. Thus a visualisation tool can be deployed that inputs data from both the sensor network and simulations and provides design, analysis, operation and maintenance information in an interactive manner. Image analysis and signal conditioning are integral part of a digital twinning process. This will enable a digital twin of an energy and flow handling asset to run on a powerful computer providing reliable information about state of the energy and flow handling system.

Professor Rakesh Mishra
Energy, Emissions and the Environment Research Group Leader
Division of Operation and Maintenance Engineering
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Professor Mishra has a strong background in the analysis, design and management of Energy and Flow systems. He has led many external research projects (worth more than £3M) with various industrial partners on Energy and flow systems' design, development and operational management. He has successfully supervised over 30 PhD students in cutting-edge research and development Energy and Flow systems research area. Prof. Mishra has had transformational effects on many industrial collaborators through knowledge transfer activities and has also run courses on the use of open-source CFD packages for industry. Prof. Mishra is a fellow of the Institution of Mechanical Engineers, UK and also a member of the Fluid Mechanics & Fluid Power Society of India, which promotes the effective use of fluid power in developing economies. He has published more than 300 papers in various journals and conference proceedings of repute and has been invited to give keynote lectures at various conferences. He has also organised and chaired several conference sessions addressing green issues.

Prof. Harekrishna Misra
Chair Professor,
Verghese Kurien Centre of Excellence
Institute of Rural Management, Anand (IRMA).

Prof. Harekrishna Misra, holds PhD in Information Systems. He is Chair Professor, Verghese Kurien Centre of Excellence at Institute of Rural Management, Anand (IRMA). He has around 38 years of experience in industry and academia in the fields of IT and Systems. His current research interests include software engineering, e-governance, ICT for Development, e-Business for rural enterprises. He has widely published refereed Journals and also is in the Editorial Boards of two international Journals. He is the Chairperson of the advisory committee of the Entrepreneurship Board of DST, GoI. He is currently the member in the Governing Council of National Council of Cooperative Training (NCCT), Ministry of Agriculture and Cooperation, GoI. He also works closely with United Nation University, Portugal on Measuring "Global Rural E-Governance Readiness". He chairs the Board of Governors, Sahaj Retail Limited, Kolkata, India, dealing with e-governance supported digital services in rural areas   in   India.

Keynote 14: Topic: Ergonomic Design of Human-Product Interface in Healthcare Systems

In the context of product and worksystem development in the present industrial context, development of human-product interface in the healthcare systems has been a critical issue, and depends primarily on assessment of existing interfaces from the ergonomic design perspectives as well as the technology used. While we consider design and development of an automated interface between humans and products in healthcare systems considering a number of ergonomic design aspects, such as postural analysis, anthropometric match, physical and mental work capacity, and impact of environmental factors on the performance of the persons, the main objective of designing such an interface is to create a risk-free environment for healthcare personnel under extreme conditions and constraints.

In this talk, details of a comprehensive evaluation system for human-product/process interface, and a methodology for developing an automated system for monitoring and control of the design interfaces will be presented. A number of applications of improved interfaces including automated systems ensuring risk-free environment in healthcare worksystems will be discussed.

Professor Pradip Kumar Ray

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Prof Pradip Kumar Ray is Emeritus Professor, Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur since August, 2004. He has significant experience and outstanding expertise in Ergonomics and product design Performance Management Operations & Supply Chain Management Quality and Safety Engineering TQM and with Analytics.