IFAC
INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL

AMEST 2024 Advanced Maintenance Engineering, Services and Technology CAGLIARI

**12-14 June 2024**
**Cagliari, Italy**

# 6th IFAC International Workshop on Advanced Maintenance Engineering, Services and Technology

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## Maintenance and Asset Lifecycle Management for Sustainable and Resilient Systems

***TECHNICAL PROGRAM - FINAL release***
***(updated on 6th june 2024)***

### Wednesday (June 12th)

**08:30 – 09:00**
**Registration**

**09:00 – 10:00**
**OPENING CEREMONY**

**Keynote Prof. Adolfo Crespo Marquez**
*Lessons from the GFMAM 25DX project: unlocking digital transformation in maintenance and asset management through a global initiative*

**10:00 - 10:30**
**Coffee break**

**10:30 - 12:30**

| Digital Twins for maintenance applications | | Chair: Marco Macchi<br>Co-chair: Mauricio Rodriguez | Maintenance strategies, simulation and optimisation of complex systems | | Chair: Giacomo Barbieri<br>Co-chair: Roberto Sala |
|---|---|---|---|---|---|
| 38 | Application of Digital Twin Technology for the Digitization of Railway Maintenance Services in Compliance with European Regulation EU 779/2019 | Antonio Guillen*, Antonio Sánchez, Mauricio Rodríguez Hernández | 22 | Towards a Business Intelligence Application for Evidence-Based Maintenance | Giacomo Barbieri*, Juliana Laserna, Luis Mario Mateus |
| 40 | Integrating maintenance and energy problems through a Digital Twin-based decision support framework under the guidance of Asset Management | Edoardo Palmitessa*, Angelo Premoli, Irene Roda, Marco Macchi | 29 | Maintenance Lifecycle Cost Analysis through Agent-Based Simulation | Roberto Sala*, Fabiana Pirola, Veronica Arioli, Emanuele Dovere |
| 41 | Ontology-Based Digital Twin for Maintenance Decisions in Manufacturing Systems: An Application at Laboratory Scale | Sofia Zappa*, Chiara Franciosi, Adalberto Polenghi, Alexandre Voisin | 58 | A Methodology to Support the Strategic Implementation of Smart Maintenance Solutions | David Sanchez-Londono*, Irene Roda, Giacomo Barbieri |
| 43 | Digital Twins Based on Integrated Models: Supporting Joint Decisions on Maintenance and Production Planning | Chiara Cimino, Laila El Warraqi*, Elisa Negri | 64 | Supply Chain Demands and Cooperation Maintenance for Resilience in Manufacturing in Post-COVID Era - a Literature Review | Justyna Patalas-Maliszewska*, Marcin Topczak, Małgorzata Szmolda |
| 46 | Digital Model of a Wind Turbine Oriented to Broken Tooth Analysis | Deiver Jiménez-Santín, Mariela Cerrada*, Josué Enríquez-Zárate, Diego Cabrera, René-Vinicio Sánchez | 73 | An optimal maintenance strategy for machining system considering production rates | El Mehdi Guendouli*, Lahcen Mifdal, Sofiene Dellagi, El Mehdi Kibbou, Abdelhadi Moufki |
| 93 | Physics-Enhanced Digital Twin Based Solution to Control Process State in a Steel Manufacturing Plant | Kisan Sarda, Carmen Del Vecchio, Fabio Fruggiero*, Francesco Mancusi, Fernando Menchetti, Oreste Riccardo Natale | 94 | Maintenance Optimisation of Heating, Ventilation and Air Conditioning Systems to Improve Indoor Air Quality | Alena Puchkova*, Jorge Merino, Ajith Kumar Parlikad |

**12:30 - 13:45**
**Lunch**

**13:45 - 15:45**

| Artificial Intelligence for maintenance, asset, and product lifecycle management (1) | | Chair: Alexandre Voisin<br>Co-chair: Katarzyna Antosz | Reliability, dependability, and risk-based approaches | | Chair: Manuel Herrera<br>Co-chair: Alessandra Cantini |
|---|---|---|---|---|---|
| 13 | Extending Asset Lifespan through Data Augmentation-Assisted Quality Control | Ruben Alonso, Guido Noce, Vincenzo Cutrona, Diego Reforgiato Recupero* | 17 | A Model for Dependability Analysis of a Complex System | Virag Wasnik*, Ayeley, Philippe Tchangani, Carmen Martin, Francois Pérès |
| 18 | Perspectives for the Application of Reinforcement Learning for the Integrated Order-Dispatching and Maintenance Scheduling | Djonathan Quadras, Marina Meireles Pereira, Lúcio Galvão Mendes, Lynceo Falavigna Braghirolli, Enzo Morosini Frazzon* | 26 | Alarm Webs: A Framework for Decoding RAN Alarm Dynamics | Anandarup Mukherjee*, Manuel Herrera, Hanu Priya Indiran, Luning Li, Henry Brice, Arjun Parekh, Ajith Kumar Parlikad |
| 25 | A Novel Semi-Supervised Contrastive Learning Approach for Rotating Machinery Fault Diagnosis with Limited Labeled and Class-Imbalanced Data | Qin Zhao*, Zhixing Wei, Tianhao Li | 37 | Hydrogen in Glass Sector: A Comparison between Risk-Based Maintenance and Time-Based Maintenance Approaches | Giulia Collina*, Alessandra Cantini, Leonardo Leoni, Saverio Ferraro, Filippo De Carlo, Marta Bucelli, Nicola Paltrinieri |
| 36 | Digital Twin Enhanced Multitask Learning Framework for Fault Diagnosis of Electromechanical Coupling System | Laifa Tao*, Xuanyuan Su, Jin Kaixin, Li Shangyu, Zhengduo Zhao, Qixuan Huang | 78 | Application of Degradation and Optimization Models for Digitization of Maintenance Management in Railway Infrastructures | Mauricio Rodríguez Hernández,Vicente Gonzalez-Prida Diaz,Antonio J. Sanchez Herguedas*,Adolfo Crespo Marquez |
| 57 | Evaluation and Comparison of Selected Machine Learning Methods for Improving Maintenance Processes | Katarzyna Antosz*, Monika Kulisz, Jozef Husár | 104 | Contribution of Maintenance to Reconfigurable Manufacturing Systems: State of the Art and Challenges | Huu-Truong Le, Chiara Franciosi*, Phuc DO, Alexandre Voisin |
| 100 | Predicting Defect Rates of Printed Circuit Board Assemblies: Towards Zero Defect Manufacturing and Zero-Maintenance Strategies | Emiel Miedema, Hendri Kortman, Christos Emmanouilidis* | 87 | A Reliability-Based Methodology for Resilient Spare Parts Planning and Control | Gabriele Sirri*, Riccardo Accorsi, Giorgia Bartolotti, Riccardo Manzini, Michele Ronzoni |

**15:45 - 16:15**
**Coffee break**

**16:15 - 18:35**

| Artificial Intelligence for maintenance, asset, and product lifecycle management (2) | | Chair: Vibhor Pandhare<br>Co-chair: Mariela Cerrada | Industry 5.0, human factors, education, and skills in maintenance | | Chair: Christos Emmanouilidis<br>Co-chair: Luca Fumagalli |
|---|---|---|---|---|---|
| 66 | The Use of Decision Trees to Identify the Causes of Failures in a Medical Enterprise - a Case Study | Malgorzata Jasiulewicz-Kaczmarek, Mariusz Piechowski*, Izabela Rojek, Dariusz Mikołajewski | 85 | Building and Sustaining Competence in Maintenance: A Prescriptive Training Model | Valentina Di Pasquale*, Salvatore Digiesi, Ivan Ferretti, Antonio Padovano |
| 75 | Anomaly Detection Using Electrical Signature Analysis and Machine Learning: Application to a CNC Mill | Paola Cocca*, Gökan May, Valerio Pesenti Campagnoni, Elena Stefana, Ruggero Bortolani, Davide Romagnoli | 92 | Empowering Operator 5.0: human-centric design of an augmented reality tool for a learning factory | Antonio Padovano*, Martina Cardamone, John Klaess |
| 79 | Deriving Inferences through Natural Language from Structured Datasets for Asset Lifecycle Management | Sanchit Singla, Soumyabrata Bhattacharjee*, Vibhor Pandhare | 97 | A Decision Support System Tailored to the Maintenance Activities of Industry 5.0 Operators | Ludovica Maria Oliveri, Ferdinando Chiacchio*, Francesco Facchini, Giorgio Mossa |
| 89 | Diagnostic Method for Hydropower Plant Condition-Based Maintenance Combining Autoencoder with Clustering Algorithms | Samy Jad*, Xavier Desforges, Kamal Medjaher | 103 | Asset Criticality and Risk Prediction Via Machine Learning in Wind Farms: Problem-Based Educational Activities in a Smart Industry Operations Course | Christos Emmanouilidis*, Ype Wijnia |
| 60 | Fault Classification in Reciprocating Compressors: A Comparison of Machine Learning and Deep Learning Approaches | René-Vinicio Sánchez*, Jean Carlo Macancela, Diego Cabrera, Mariela Cerrada | 99 | Transformation of the Product Lifecycle Value Chain towards Industry 5.0 | Hanbing Xia, Jiahong Li, Milisavljevic Syed Jelena, Konstantinos Salonitis* |
| 33 | AI in Assessing Industry 4.0 Adoption in Colombia: A Case Study Approach | Luis Alberto Cruz Salazar*, Santiago Gil, Germán Darío Rueda Carvajal, Gabriel Jaime Sánchez- Zuluaga, German Darío Zapata-Madrigal | 44 | From OEE to OSEE: How to Reinforce Production and Maintenance Management Indicator Systems for Sustainability? | Theresa Madreiter*, Fazel Ansari |
| 7 | Optimizing 'Explorer' Rose Production Data with SVM in Smart Agriculture | Vicente D. Herrera, Estefani Lucero, David I. Ilvis, Jessica Carmelina Mora, Cristian Paul Chuchico Arcos, Kevin A. Espinel, Michelle Herrera, Juan Escobar, Marcelo Vladimir Garcia* | 39 | Experience on Centralizing the Asset Management and Maintenance Engineering Function in an Italian Multi-Utility Company | Irene Roda, Adalberto Polenghi*, Marco Macchi, Ilaria Marini, Bartolomeo Greco, Lorenzo Benevento, Paolo Parenti, Andrea Pegoiani |

**19:30**
**WELCOME RECEPTION**

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## Maintenance and Asset Lifecycle Management for Sustainable and Resilient Systems

### Thursday (June 13th)

**08:30 – 10:15**

**Panel**
*Interoperability in maintenance*

**Keynote Prof. Birgit Vogel-Heuser**
*Modular and adaptive field level automation architectures to support predictive maintenance*

**Keynote Prof. Dimitris Kyritsis**
*Ontology based asset information modeling for predictive maintenance*

**10:15 - 10:30**

**Coffee break**

**10:30 - 12:30**

| Digitalisation for asset and product lifecycle management | | Chair: Adolfo Crespo<br>Co-chair: Mario Caterino | Prognostics and health management, condition-based maintenance and condition monitoring | | Chair: Alessandro Guzzini<br>Co-chair: Janusz Szpytko |
|---|---|---|---|---|---|
| 27 | Asset Digitalization Strategy Using IoT Platforms and Asset Health Model | Eduardo Candon*, Adolfo Crespo Marquez, Antonio Guillen | 15 | Adaptive Ensemble Learning for Machine Tool Prognostics from Meta-Feature-Based Context Information | Simon Leohold*, Michael Freitag |
| 31 | Application of Digitalisation in Regulated Environments for Predictive Failure Modelling | Frank Doyle*, Samuel Carvalho, Zsolt Kovacs, John Cosgrove | 42 | A Transfer Learning Approach for Anomaly Detection within a Collaborative Prognostic Framework for Advanced Maintenance Services | Melissa Negri, Luca Pavan, Adalberto Polenghi*, Marco Macchi, Alessandro Ruberti |
| 52 | Improving the Efficiency of Greasing Operations with the Lubrication Management Support System - a Case Study | Mariusz Piechowski*, Ryszard Wyczółkowski, Waldemar Paszkowski, Artur Meller | 49 | Data-Driven Fault Detection in Reciprocating Compressors: A Method Based on PCA and GLRT | Mauricio Cabrera*,Diego Cabrera,Mariela Cerrada,René-Vinicio Sánchez |
| 53 | An investigation into connection between BIM and Digital Twins technologies | Sergey Sychev*, Andre Batako, Thanh Trung Nguyen, Anthony Xavior, Katarzyna Antosz, José Machado | 74 | Experimental Measurements of the New Gas Smart Meters' Current Discharges to Suggest Improvement Solutions for Power Supply Battery Life Extension | Alessandro Guzzini*, Cesare Saccani, Marco Pellegrini, Marcello Bondesan |
| 63 | OPC-UA in Interoperability – a Performance Comparative Testing | Luís Freitas, Filipe Pereira, Helena Lopes, Ana Lima, Pedro Marujo, Erika Ottaviano, José Machado* | 82 | State-Of-Art of Heavy Machinery Monitoring System, Perú Case Study | Cecilia Cuadros,Renzo Vidaurre Moreno,Janusz Szpytko* |
| 72 | Cyber Physical Systems: A Brief Survey and an Application of a MIR (Mobile Industrial Robot) for Inspection | Pieluigi Rea, Maurizio Ruggiu, Piero Ponchietti, Erika Ottaviano*, Angel G. Gonzalez Rodriguez | 96 | Enhancing Feature Extraction in Sensor Fault Detection through Canonical Correlation Analysis | Natalia Trapani*, Leonardo Longo |

**12:30 - 13:45**

**Lunch**

**13:45 - 15:30**

| End of life management of complex systems | | Chair: Maria Holgado<br>Co-chair: Foivos Psarommatis | Product-service systems for maintenance and asset management | | Chair: Fabiana Pirola<br>Co-chair: Marko Simic |
|---|---|---|---|---|---|
| 45 | End-of-life Management of Consumer Products and Industrial Assets: A State of the Art Analysis of Decision-Making Approaches and Methodologies | Irene Roda*, Maria Holgado | 54 | Designing Smart Product-Service Systems: The SEEM-Smart Methodology and Its Application in the Electrical Industrial Sector | Vanessa Zani, Vicente Gonzalez-Prida Diaz,Veronica Arioli*, Roberto Sala, Fabiana Pirola, Adolfo Crespo |
| 28 | Do Obsolescence and Shortages have an impact on Reliability, Maintainability and Availability? | Sahar Karaani*, Mariem Besbes, Marc Zolghadri, Claude Baron, Maher Barkallah, Mohamed Haddar | 81 | Smartphone As a Tool in Remote Maintenance of Healthcare and Laboratory Equipment | Janusz Szpytko*, Pawel de Sternberg Stojalowski |
| 19 | Understanding Obsolescence and Shortage in French Industry: An Empirical Analysis | Mariem Besbes*, Marc Zolghadri | 98 | Predictive Maintenance Servitisation Pathways | Jiahong Li, Milisavljevic Syed Jelena, Konstantinos Salonitis* |
| 48 | Circular Product Design for Allowing Re-Using and Re-Purposing of Products and Components: A Conceptual Framework for Circularity | Foivos Psarommatis*, Victor Azamfirei, John David Lindström | 76 | A preliminary investigation on DDPSS requirements to provide process quality as a service: example on laboratory scale | Lorenzo Ghedini*, Adalberto Polenghi, Irene Roda, Marko Simic, Denis Janković, Niko Herakovic (Italy) |
| 51 | Resilience Strategies and Techniques to Extend the Lifespan of Complex Systems Dealing with Obsolescence | Imen Ben Brahim*, Marc Zolghadri, Christophe Theillet, François Dechamp | 90 | Preliminary investigation of the state of the art on digital servitization for Industrial Asset lifecycle Management | Lorenzo Ghedini*, Irene Roda, Marco Macchi, Alessandro Pozzetti |

**15:30 - 15:45**

**Coffee break**

**15:45 - 17:45**

| Resilience and sustainability | | Chair: Chiara Franciosi<br>Co-chair: Robert Meissner | Maintenance, product and asset lifecycle management | | Chair: Ajith Parlikad<br>Co-chair: Adalberto Polenghi |
|---|---|---|---|---|---|
| 59 | A Discrete Event Simulator to Support Maintenance Decision-Making Considering Economic and Environmental Sustainability | Carlos Torres, Giacomo Barbieri*, Mariela Muñoz | 23 | Evaluating Investment in Condition Monitoring for Fleet Maintenance | Adolfo Crespo del Castillo*, Ajith Kumar Parlikad |
| 11 | Hydrogen-based aircraft auxiliary power generation: Economic and ecological comparative assessment of preventive maintenance implications | Robert Meissner*, Antonia Rahn, Anne Oestreicher, Kai Wicke, Gerko Wende | 86 | Asset Performance Management: current status and future development | Marco Macchi, David Sanchez-Londono*, Alejandro Martinez, Adalberto Polenghi, Irene Roda, Alessandro Pozzetti, Cristóbal Barriga |
| 35 | System Resilience of a Liquid Hydrogen Terminal During Loading and Unloading Operations | Lucas Claussner*, Federico Ustolin | 61 | Management of Spare Parts for Efficient Maintenance: A Case Study in the Dairy Sector | Beatrice Marchi*, Caterina Galati, Simone Zanoni |
| 55 | Resilience and Sustainability Plants Improvement through Maintenance 4.0: IoT, Digital Twin and CPS Framework and Implementation Roadmap | Federico Briatore*, Mattia Braggio | 67 | Organizational Value Framework for Asset Management Decision-Making | Giacomo Barbieri*, Ana Maria Benavides, Esteves Luis Alfredo, Camilo Olaya, Freddy Zapata |
| 77 | Decentralised Persistent Identification - an Emerging Technology for Sustainability Maintenance and Knowledge-Driven Processes | Andrey Vukolov*, Erik van Winkle, Vyacheslav Tikhonov | 30 | Exploring MBSE for Asset Digitalisation in the Energy Sector. a Battery Energy Storage System Design Study | Celia Martinez Sillero*, Antonio Guillen, José López Domínguez, Vicente Gonzalez-Prida Diaz, Juan F. Gomez Fernandez |
| | | | 95 | Predicting Road Condition Using Linear Hierarchical Modelling | Maharshi Harshadbhai Dhada*, Georgios M. Hadjidemetriou |

**18:00 - 19:00**

**AMEST Working Group meeting**

**20:00**

**CLOSING CEREMONY & GALA DINNER**

### Friday (June 14th)

**09:00 - 13:00**

**Technical and Social activities**