Interoperability for Maintenance workshop at the I-ESA conference, the 17th of November 2020

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Abstract
After the presentations of selected papers, a panel answered questions from a great audience of experts in the domain of maintenance terminology, ontologies and discussed the possible different approaches, their advantages and drawbacks. These topics have been further investigated in a collective intelligence session. Important issues have been addressed and partially answered. These issues deserve more work and can be input for future projects.

Keywords
Predictive maintenance, terminology, data model, ontologies

Summary on the workshop "Interoperability for maintenance " at the I-ESA conference, The 17th of November 2020

The questions from the audience after the presentations were mostly about the role of ontologies. Challenges for the use of ontologies were identified, such as how to reuse existing ontologies. More generally, the need to involve ontology modelers from the beginning of a predictive maintenance project together with maintenance and data science experts was seen as a barrier. Solutions discussed include applying standards such as ISO 13374 for CBM data processing for the data flow between system components, as proposed by the UPTIME project. The discussion also brought up that it is difficult to convince technical partners and industrial end-users to use ontologies without identifying clear benefits first. Nevertheless, some sectors such as Oil and Gas were identified as open to applying ontologies in their maintenance systems. Difficulties in agreeing on common terminology are still very much an open issue. The example of nuclear valves was discussed with the result that a workshop with maintenance experts would be required to simplify the terminology and to clarify the concepts, thus paving the way to a formal ontological approach.

The panel has been an opportunity to deepen these exchanges. The recordings deserve to be publicly available.

Antoine Despujols, editor of CEN 13306 and of CEN 17007, highlighted the difficulty for experts, e.g., from the maintenance and reliability domains, to agree on the definition of terms. He highlighted the need to be driven by the concepts and to work on the models to have a consensus on a set of complete and consistent terms. He thinks that predictive maintenance fits with the current concepts, but since it includes new maintenance techniques and strategies, more work needs to be done.

Farhad Ameri, from the University of Texas, and member of the IOF (Industry Ontologies Foundry), highlighted the complexity of the predictive maintenance ecosystem. He contrasted the difficulties with data migration and integration resulting from vendor lock-in strategies with the opportunities of Software as a Service for interoperability. He furthermore highlighted the disparities in the current maintenance standards and ontology landscape, which lacks a holistic view. In his opinion, there is a lack of a high-level understanding of the maintenance domain.

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Cosmas Vamvalis, Chairman of EFNMS, stressed that companies interested in predictive maintenance should also take into consideration the relevant costs. He compared the relatively low initial cost of implementing fully data-driven approaches with the higher costs of model-driven ones. Costs aside, in his opinion there is no clear winner between the two, with each having specific benefits. There is potential combining the two approaches in a cost-effective way – model-driven approaches can be used to train data-driven approaches, and one approach can be validated by the other.

Thomas Knothe from Fraunhofer IPK talked about the potential and barriers for using Digital Twins in predictive maintenance. He mentioned weaknesses in the current process of standardization on one hand and on the other, that ontologies have weaknesses in modeling behavioral concepts. He highlighted the need for prioritizing work on the synchronization of simulation systems, which is a must for realizing Digital Twins for predictive maintenance. He emphasized the practical need to ensure the flow of data and pointed out that Industry 4.0 concepts need more work to be operational in this context. He finally stressed that predictive maintenance is not an isolated concept and needs to be integrated into strategic operations management to be successful.

Following the panel discussion, a collective intelligence workshop was held, which offered the opportunity to work in smaller groups on different topics and generated the following insights:

- Predictive maintenance makes it possible to estimate an asset's RUL (Remaining Useful Life) allowing "active preventive maintenance actions" before expected failures occur. These actions can be carried out depending on specific events that may occur such as production shutdown, presence of expensive logistical support (e.g., cranes for wind turbines), favorable external conditions (e.g., marine weather for offshore wind turbines) and thus optimize costs and availability. We could therefore consider carrying out opportunistic maintenance as a new maintenance strategy that could complement and reduce scheduled maintenance and be more profitable.

Highlights of findings which proceeded from the workshop regarding interoperability challenges for predictive maintenance include:

- Data ownership and privacy concerns hinder predictive maintenance implementation- SMEs are still reluctant to share data.
- A common data model based on MIMOSA[1] is seen by many projects as a beneficial approach.
- We cannot expect customers/end-users to change the models or software they use for predictive maintenance or interoperability purposes, so predictive maintenance systems need to be designed to integrate with the wider enterprise system landscape.
- It remains challenging to bring heterogeneous technologies under a common umbrella.
- Work remains to be done to bridge the gap between industrial automation systems, network systems and "web" or "cloud" based predictive maintenance systems.
- Bridging the gap between engineering and computer science worlds remains an issue.

Finally, the discussion about ontologies for predictive maintenance shows the advantages of ontologies for establishing a common understanding of the maintenance domain, for their reasoning capabilities, to explain predictions from machine learning, and to support data traceability. However, defining ontologies takes time, especially when involving many stakeholders. Ontologies can be especially helpful when combined with other techniques.

[1] MIMOSA is already available in json format. MIMOSA approach has been expanded to the OIIE (Open Industrial Interoperability Ecosystem) principles in ISO TS 18101 which is about the ability to communicate across standards.