Manufacturing Process Modelling (MPM)
Ramentor R&D for TAU-CERN-BF co-innovation project

Videoconference 2019-09-17
Ramentor MPM – Background

- Ramentor is a private software/expertise company
  - Founded in 2006, based in Tampere, Finland
  - Solutions for reliability engineering and risk management

- In 2014 Ramentor joined FCC Study consortium
  - ELMAS software was used for CERN LHC availability modelling
  - 2016–2018 Ramentor developed in co-operation with CERN and TAU a new approach (OpenMARS) for complex analyses
  - Currently the new approach is tested for FCC-ee operation modelling and identification of critical systems (arto.niemi@cern.ch)
ELMAS 4.9

Model failures of the selected system (FTA)

http://www.ramentor.com/elmas/

Water filtration

Primary cooling circulation - Water

Secondary cooling circulation

Primary cooling circulation - Chiller

Model process functions (RBD)

All items of the model listed

Input data for the selected component
Ramentor MPM – Three phases for R&D

1) **Define a new approach for MPM**
   - The approach should enable including capacities, resources, failures, delays, quality aspects and other essential features
   - Assess/analyse manufacturing process' key performance indicators (KPI)

2) **Specify interfaces between MPM and MES/ERP**
   - Enables system providers to integrate MPM into their MES/ERP

3) **Evaluate the benefits of applying the new MPM**
   - Case: CERN's superconducting magnet manufacturing process
Ramentor MPM – Extends OpenMARS

Original OpenMARS specification

- FTA simulation
- Markov simulation
- Petri net simulation

OpenMARS methodology

- FTA modelling
- Markov modelling
- Petri net modelling

Tabular model definition format

Future work:
Implementation of graphical user interfaces (GUI), application programming interfaces (API) and a computing environment for efficient and user-friendly simulation based analysis of OpenMARS models.

New approach for manufacturing process modelling (MPM)

Manufacturing process simulation
- Improvements to tabular format
- Improvements to OpenMARS methodology
- Manufacturing process modelling

Future work:
Implementation of graphical user interfaces (GUI) and application programming interfaces (API) for efficient and user-friendly OpenMARS model definition.
Ramentor MPM – OpenMARS documents

- Modelling Future Hadron Colliders’ Availability for Physics
  - PARB journal: [https://doi.org/10.1103/PhysRevAccelBeams.19.121003](https://doi.org/10.1103/PhysRevAccelBeams.19.121003)

- An open modelling approach for availability and reliability of systems - OpenMARS
  - RESS journal: [https://doi.org/10.1016/j.ress.2018.11.026](https://doi.org/10.1016/j.ress.2018.11.026)
  - Preprint: [https://cds.cern.ch/record/2649261](https://cds.cern.ch/record/2649261)
  - Specification: [https://cds.cern.ch/record/2302387](https://cds.cern.ch/record/2302387)
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