FASTEN - Flexible and Autonomous Manufacturing Systems for Custom-Designed Products

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UFSC / INESC P&D BR / FASTEN project

Panel Session: Strategic Value Networks for Industry 4.0 chaired by John Soldatos
Overview

“The adoption of the IoT by Manufacturing is first and foremost a cultural and a management issue, rather than a technology issue” (IoTWeek 2018).

There is a huge potential for the proposition of tools that integrate physical processes and their virtual representation based on IoT data aiming at real-time decision-making capabilities (FASTEN D4.1 report).

My aims:
- To introduce an advanced manufacturing project dealing with a pilot application of IoT technologies, which helps developing the cultural and managerial framework.
- To discuss challenges and implications.
What is FASTEN?

**Foster digital manufacturing** sustainability and be an enabler of technology development between Brazil and Europe

Provide a **multi-disciplinary decision support** tool to improve trade-off analysis

**Contribute to the competitiveness** of Brazil and Europe
What is FASTEN?

The FASTEN “mission” is to develop, demonstrate, validate, and disseminate an integrated and modular framework for efficiently producing highly customized products.

FASTEN project will develop an open and standardized framework to produce and deliver tailor-designed products, and that is capable to run autonomously, and deliver fast and low cost additive manufactured products.
Two pilot demonstrations

Smart Robot Additive Manufacturing Network

Manufacturing systema at Embraer Portugal
Partners from Europe and Brasil

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Grant Agreement No 777096.
Main expected results

1. Intelligent handling of custom objects
2. Full connectivity among hardware and software components
3. Improve accuracy and provide better insights regarding the near-future
4. Solid understanding of the system's behaviour and its sensitivity to different parameters
5. Consideration of involved legacy systems and affected people
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Predictive Real-Time Simulation and Optimization
Predictive Real-Time Simulation and Optimization

Goal:
The goal is to design and develop a **real-time application for monitoring of manufacturing system performance, using simulation, virtual commissioning, optimization and predictive analytical tools**. High interaction with the Robot and Manufacturing Systems Integration and with the Unified IoT Cloud Platform is performed.

Specific Objectives:

✓ Integrate optimization algorithms with a virtual representation of the production facility, providing a tool for understanding, experimenting on and optimizing the system without the downsides of doing so in the real version.

✓ Deliver interpretable insights from the manufacturing data and implement predictive models to aid the manufacturing processes.

✓ Develop an integrated system for real-time, online monitoring of performance of manufacturing systems, encompassing a decision-making data driven visualization dashboard.
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Smart Robot Additive Manufacturing Network

Manufacturing systems at Embraer Portugal
thyssenKrupp Elevators Services

• Services representes 80% of TSK Brazil Revenue

• Preventive Maintenance
  • Periodic visit of the Maintenance Team (MT)
  • Performs necessary cleaning, lubricating and adjusting
  • If necessary, calls Corrective maintenance

• Corrective Maintenance
  • Can be triggered either by the preventive Maintenance Team or by the Client
  • Repair and fix any eventual problem that might be causing elevator malfunction or lack of operation.
  • Based on a network of 61 Back-Offices in different cities of Brazil, and a 24-hour availability for emergency calls and breakdowns

Outdated Spare Parts + High Lead Time
Problems Faced by TSK

FASTEN Solutions

Lack of real-time information to the back-office and MT

70% of elevators demands one-of-a-kind spare parts

Additive Manufacturing

Delivery cost and time of spare parts to MTs along the different regions of Brazilian territory.

Optimization
thyssenKrupp Elevators Services
# Use Case Objectives

<table>
<thead>
<tr>
<th>Objective 01</th>
<th>To develop a Smart Robotic Additive Manufacturing (SRAM) Unit, composed of 3D printers and a MMR, aiming to provide <strong>flexibility, scalability and agility</strong> to cope with spare parts demand.</th>
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<tbody>
<tr>
<td>Scenario 01</td>
<td>Smart Robotic Additive Manufacturing Unit</td>
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<th>Objective 02</th>
<th>To develop and demonstrate a set of Optimization, Simulation and Predictive tools, not only capable of designing an optimal manufacturing network system configuration and spare parts production scheduling, but also perform these goals through <strong>real-time monitoring systems</strong>, improving responsiveness and supporting decision making.</th>
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<tr>
<td>Scenario 02</td>
<td>Smart Manufacturing Network</td>
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Embraer Physical Layout

Use Case Context

Scenario 1: Adaptive Pick and Place Robot for Logistics

Scenario 2: Wing Assembly Line Enhanced Decision and Management
Embraer Use Case

Scenario 1: Adaptive Pick and Place Robot for Logistics

Adaptable and Flexible Solution, IoT integration for Robotic Collaboration with Online Data & Skills Based Approach
Embora Use Case

Scenario 2: Wing Assembly Line Enhanced Decision and Management

IoT Enabled and Coordinated for:
Disruption Simulation & Optimization and Analytics for Prediction and Prescription
Demonstrator

Functional Platform & Pilot at Évora Facility (6.2 & 6.3)

Mobile Robot at the INESC TEC iilab

Scenario 1: Mobile Robot at the Évora Warehouse

Scenario 2: Monitoring, Simulation & Optimization at Évora Assembly Line
Embret: towards prescriptive maintenance

Dashboard
- Robot health monitoring;
- Relevant process parameters;
- Decision support information;
- Alarms

Robot

Loggs generated by robot stored in the robot interface

Associated robot processes

Data acquisition (streaming)

Run model using data generated from instant $t = k+1$

Database

Data analysis/Modeling

(Prediction)
Algorithms for robots health monitoring

Model generated by instant $t = k$
Predictive Real-Time Simulation and Optimization
Embraer Use Case - Requirements

- Scenario 2: Wing Assembly Line Enhanced Decision and Management Support
  - Main functionalities
    - Provide Scenario Analysis to Support WAL Balancing
    - Load Balance for New Product or Product Change
    - Calibrate Model Parameters with Real Data
    - Provide Best Date for Maintenance Event
    - Predictive Model Update

![Diagram of Predictive Real-Time Simulation and Optimization Tool]

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The impact of emerging IoT technologies and associated concepts will be huge in the manufacturing industry.

Research and application-oriented projects, as well as strategies and policies formulation and implementation underway.

Key takeaway points:
- A great moment for manufacturing, despite the challenges.
- Data
  - Manufacturing digitalization*
- Decision making models, procedures, capabilities
  - Increasing reliance on modelling, optimisation and simulation*
- **Emergence of data-driven decision making models**
- **People**
  - People, people, people everywhere. **Care about them!**
  - Social (distributed) manufacturing
  - Socio-cyber-physical systems (more interaction, not less!)

*https://www.researchgate.net/publication/318430955_Smart_manufacturing
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Thank you Questions?

www.fastenmanufacturing.eu