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«DESIGN AND DEVELOPMENT OF PRODUCT-SERVICE SYSTEM BASED ON AUGMENTED REALITY FOR MACHINE MAINTENANCE»

Abstract:

Maintenance is a demanding set of tasks performed on industrial equipment. Technicians, are obliged to carry printed manuals, in order to perform all the necessary corrective actions. Moreover, there are cases where the technician needs to communicate with an engineer or even call specialized personnel in order to accomplish complex maintenance tasks. Technological advances in mobile technologies and mixed reality, have enabled engineers over the world to produce useful applications for providing all the needed instructions and communication with the use of any smart device, just by registering 3D content on the real environment. Augmented reality is a powerful technology with which technicians' cognitive load is reduced, no special skills/training are required and in conjunction with communications technology expert engineers are able to guide on-site technicians without having to travel many miles away from their base. In this document, an AR based remote and smart maintenance application is proposed and tested on an industrial use case of mold maintenance.

Keywords: Augmented reality, Product-Service System (PSS), Maintenance, Engineered-to-Order (ETO)

Problem Statement:

Modern companies towards **Industry 4.0** aims to re-shape their business models providing combined products and services mostly provided through maintenance and equipment customization.

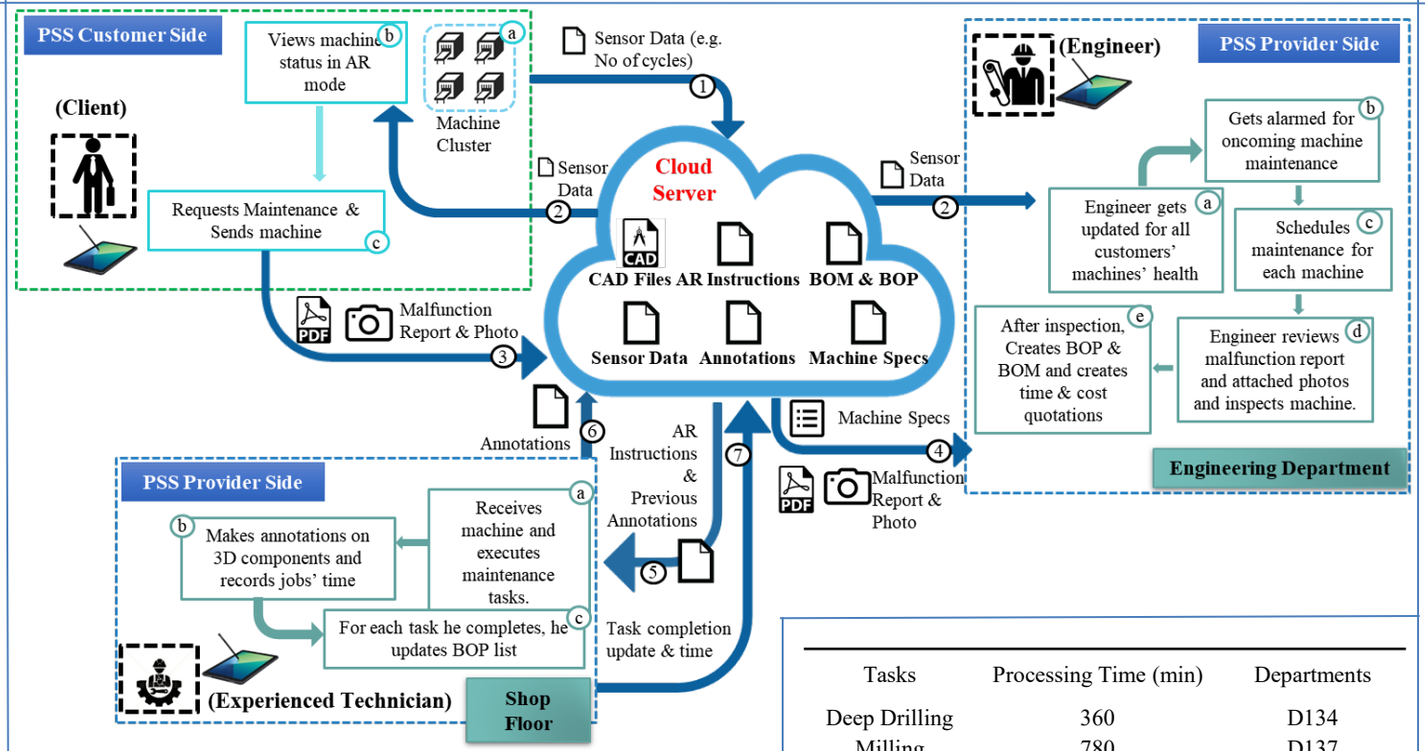
What is needed?

Advanced maintenance approaches that will enable **accurate** and **effective** maintenance and provision of added value solutions (**product-services**)

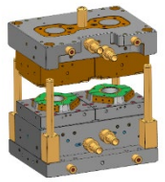
How is this achieved?

The development of **AR mobile application for effective maintenance supported by Cloud technology and smart assembly/disassembly algorithms.**

System Architecture:



Case Study: Mold Industry



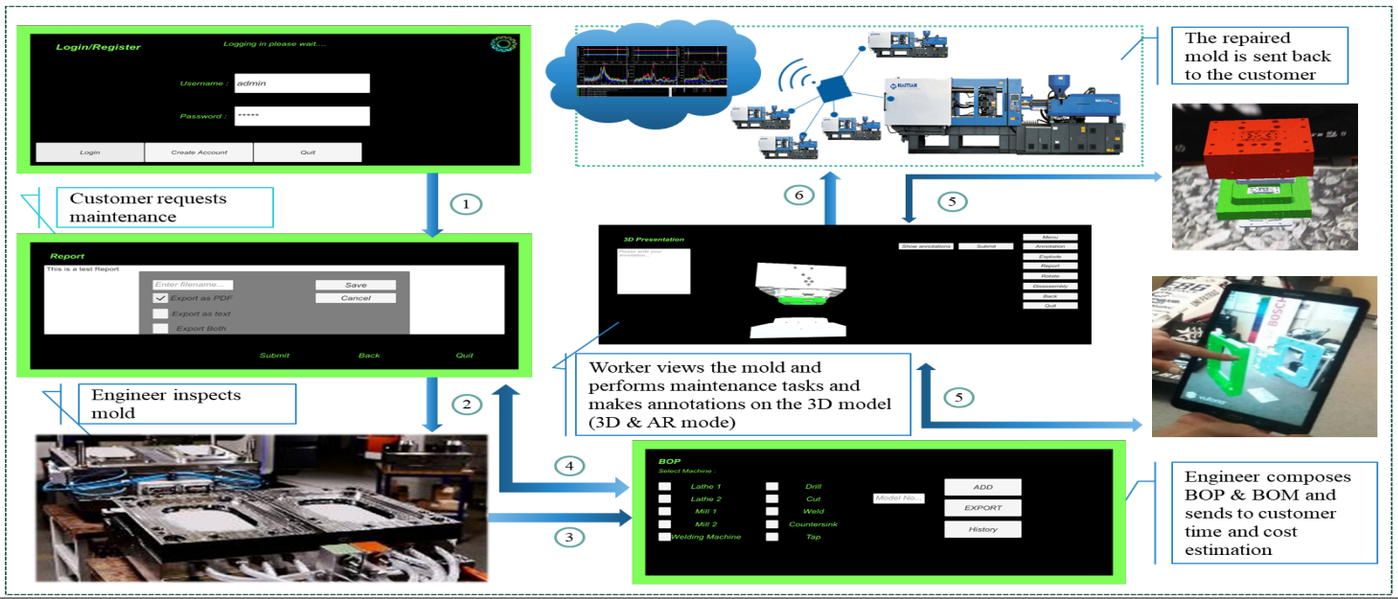
Mold inspection

Malfunction report

- Flash at Bottom Plate
- Flash at Rim
- Logo modification
- Uneven wall thickness

BOP Creation

Tasks	Processing Time (min)	Departments
Deep Drilling	360	D134
Milling	780	D137
5 x Milling	180	D137
Grinding	60	D136
Milling	180	D137
Milling	480	D137
Milling	240	D137
Finishing	360	D138
Polishing	1440	D132
Quality Control		D133

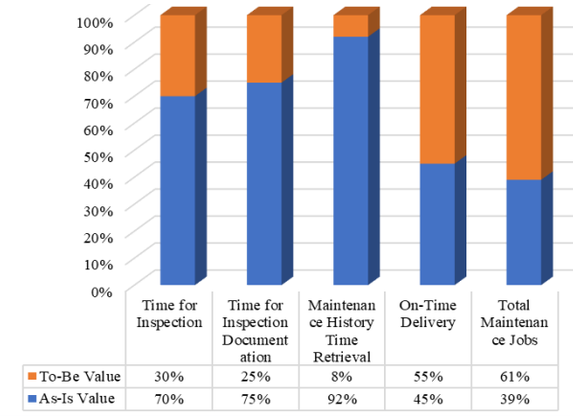


Results:

In order to justify the aforementioned estimations a list of common industrial **Key Performance Indicators (KPIs)** were used. Also, **semi-structured questionnaires** were handed to the participants, in order to depict their opinion on the developed framework.

- Inspection time, reduction up to 50%.
- Time for inspection documentation, reduction up to approximately 70%.
- Maintenance history time retrieval up to 95%.
- On time delivery, increase more than 20%.

Although the proposed approach has not yet reached its final form (the main components are completed) the results appear to be really promising.



Conclusions-Further Investigation:

- Development and testing of an Augmented Reality maintenance application used for providing PSS maintenance service. A cloud platform was also implemented as a communication enabler and to assist existing knowledge reuse.
- Algorithms which increase the efficiency of the procedure and the automation level by reducing the actions and expertise required by the engineer to create the service sequence instructions which can be effortlessly perceived by less experienced technicians
- Through the proposed approach the required maintenance time and cost is highly reduced.
- Manufacturing companies can provide AR based maintenance as a service, increasing their customer's satisfaction and delivering added value solutions.
- Manufacturing companies can use the tool internally, reducing cost and time and increasing efficiency of existing maintenance model.
- The implementation of such high-end services allows SMEs to increase customers' satisfaction, withstand competition pressure and expand their sales networks.

Publication:

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