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Digital Maintenance in the Digital Twin Era

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Identifying the Future Skills Requirements of the Digital Maintenance era

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Abstract

The ongoing surge in the digitization of industry and the increasingly stringent sustainability requirements are reshaping the discipline of maintenance and its management. To meet the demands of these digital and sustainable trends, it is crucial to have a workforce equipped with the necessary skills. Achieving compliance requires anticipating changes in the skill set required for maintenance management. With this context conditions, Sidenor, with the support of the University of Deusto, analyses the most suitable skills for effectively implementing maintenance strategies, to afterwards develop customized didactic materials based on, among others, digital twin approaches.

1. Introduction

The rapid and exponential increase of differentiation, along with a continuously growing demand for digitization and virtualization, is causing a significant transformation in Asset Management. On a global scale, the industrial and service sectors have experienced significant changes in recent years, and this trend is expected to continue. Companies must have a well-designed strategy to effectively tackle upcoming technologies and their simulation methods, such as digital twins or augmented reality. A digital twin is a virtual representation of a physical object or system.

Developing a workforce with a diverse range of skills should be the focus to successfully execute the strategy and achieve the digital and virtual transformation.

More specific, the industrial sector has undergone significant transformation in recent years due to the increased use of virtualization, digital twins, and augmented reality (AR). Virtualization has become a fundamental technology that allows businesses to simplify operations, improve scalability, and optimize resource usage by abstracting physical infrastructure. Simultaneously, digital twins have transformed industrial processes

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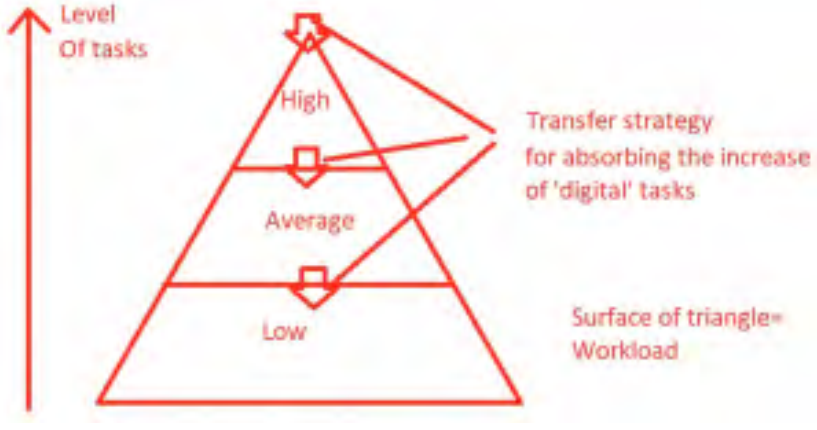
by creating virtual reproductions of actual assets in real-time, analysing new layouts or increasing productivity of existing ones. This enables predictive maintenance, optimization driven by simulation, and exceptional levels of efficiency. Augmented reality has moved beyond the world of entertainment and is now an emerging tool in multiple industries. It provides workers with immersive experiences that are filled with data, enhancing their talents and decision-making. These technologies are bringing about a new era of innovation, efficiency, and competitiveness [1]. Digital counterparts are seamlessly integrating with physical activities, resulting in unparalleled levels of production and value generation.

These two facts, technological advancements and increasing demands for environmental responsibility, are evolving the field of maintenance management to a new level. Thus, the industry necessitates a deep re-evaluation of the abilities necessary for adapting to this new scenario. To meet the requirements of a fast-evolving world, industries must prioritize the development of a skilled workforce that is proficient in the complexities of digitization and sustainability. To address this matter, it is necessary to take a proactive strategy to foresee changes in the skill sets that are necessary for effective maintenance management. This essay explores the core of this ever-changing environment, utilizing knowledge from specific sectors and interdisciplinary research efforts, and relevant literature.

In summary, anticipating changes and updating the skills of the current staff are essential for successfully achieving a transition. Previously, this transformation has occurred by transferring low-value work to roles with lower qualifications in the qualification chain. These duties constitute a substantial amount of the time that a mid-level Asset Management technician dedicates [2] (see figure 1).

Figure 1

Workload and difficulty level of tasks performed by Asset Management technicians



Source: https://eqvegan.eu/eqvegan-online-workshop-on-digital-skills-and-competencies-in-the-food-sector/ , visited Apr 30th, 2024, and adapted from Goti, 2024.

Put simply, it is not appropriate for highly skilled experts to engage in basic duties. Instead, these responsibilities should be delegated to operators with lesser levels of expertise. Only through this method will they have the opportunity to update and enhance their level of competence. According to Nakajima's Total Productive Maintenance [3], the transfer of lower-level duties like as cleaning, inspection, greasing, and basic adjustments has been a longstanding practice. To address the aforementioned requirements of digitalization and virtualization, it is necessary to make a visit for the purpose of transfer.

The major objective of this essay is to address a significant need in the field of maintenance management by recognizing new talents (specific skills required for these roles) that are emerging as a result of industrial evolution and sustainability requirements. As well, the aim is to select and develop the most appropriate materials to cover this skills gap using a train the trainers approach. To achieve this, the findings from prior research has been utilized.

Therefore, the article is structured in the following manner: In Section 2, the manuscript provides an overview of the research works and databases that were analyzed. Subsequently, Section 3 outlines the procedure and approach used to determine the most pertinent profiles. Section 4 proceeds by delineating the utmost crucial future capabilities that need to be cultivated for the selected profiles mentioned in Section 3, along with some samples of the pedagogic material developed within the framework of this research project, shown in Section 5. Section 6 serves to outline the primary closing remarks and future guidelines of this research.

2. **Related research**

2.1. *Projects*

The conducted research was supported by the ESSA project [4], which was established to build a comprehensive plan for a sustainable European Steel Skills Agenda led by the steel industry and coordinated efforts. In addition, we utilized data from the SPIRE-SAIS [5] -Skills Alliance for Industrial Symbiosis, a multi-sectoral EU project focused on energy efficiency (EE) and industrial symbiosis (IS), aimed at creating a sustainable process industry. Furthermore, we incorporated data from the EQVEGAN project [6], which pertains to the vegan food business. More lately, we employed another European Union initiative called SMeART —Making Europe's Small and Medium Enterprises (SMEs) smart— that aids in the digitalization of engineering SMEs [7]. In this moment, we are currently running a project called SUSTASKILLS [8], titled "Development of a roadmap for the implementation of skills related to industrial symbiosis and energy efficiency in order to achieve a sustainable process industry" that reinforces all experience and knowledge gained from previous project and continues to enhance the framework needed for industry to accomplish this change.

For these studies, we mostly relied on the ESCO [9] database (amongst other related databases), which was generated by the ESCO organization. ESCO stands for European

Multilingual Classification of Skills, Competences, Qualifications, and Occupations, and it was designed by the European Commission. This database is derived from the basic framework "International Standard Classification of Occupations" (ISCO-08) established by the International Labour Organization (ILO).

3. **Profile selection and future skill definition process**

As previously stated in Section 2.1, we relied on the ESCO database as our main source of data for choosing job profiles and their corresponding skill requirements [10]. To find job profiles directly associated with asset management, we initially established a list of keywords. Subsequently, we applied our historical expertise to filter and select the most pertinent and closely connected options. The roles that were chosen are as follows:

— (1) 3115.1.6 - industrial maintenance supervisor,
— (2) 2152.1.13 - predictive maintenance expert,
— (3) 2141.8 - maintenance and repair engineer, and
— (4) 1219.1.1 - facilities manager.

Furthermore, we have chosen three additional job profiles that are closely related to asset management. These profiles were picked based on our analysis of the projects and articles discussed in Chapter 2. The user's text has three occupation codes:

— (5) 2151.1 for electrical engineer,
— (6) 2144.1 for mechanical engineer, and
— (7) 1431.1.2 for performance production manager.

4. **Definition of the skills and competences to be developed by the future profiles**

After carefully choosing the most pertinent and illustrative job profiles associated with asset management, our subsequent task involved determining their shared requirements for future abilities. To achieve this objective, we thoroughly examined all the frameworks that were introduced in Chapter 2. The future skill requirements for asset management profiles have been established.

The abilities that have the largest gaps between the current and future levels of expertise are defined.

Active listening and adaptability are important skills that involve being receptive and responsive to others, as well as being able to adjust and thrive in changing circumstances.

Also following skills are considered important and we have been detected gaps that should be closed: Proficient in communication, Proficient in data analysis and modelling, Proficient in IT abilities and programming, Advanced literacy, Artificial Intelligence

(AI), Augmented Reality, Automation, Basic numeracy and communication and Circular economy. Elaborate cognitive processing and analysis, Computerized Maintenance Management and Continuous Learning. Creativity, critical thinking, and decision making.

Expertise in cross-functional process management, Cultural empathy, Cybersecurity Data management refers to the process of organizing and controlling data in a secure manner to ensure its safe storage.

Enhancing the effectiveness of energy utilization, Ecological consciousness, Ethical comprehension, Information and Communication Technology,

Integrative thinking and behaviour, Internet of Things, Mixed Reality, Evaluation of potential opportunities, Subjective encounter, Predictive and proactive maintenance strategies and Problem solving (process of finding solutions to complex issues or challenges).

Process analysis and product life cycle impact evaluation. Proficiency in quantitative and statistical abilities, Resource reuse/recycling Risk management Robotics and sensor technologies.

Resource management that is focused on long-term sustainability.

Educating and instructing people, Collaborative teamwork, Utilization of modern communication technologies, Minimization of waste and effective waste management and Operate independently.

5. **Samples of the pedagogic material developed to train the trainers**

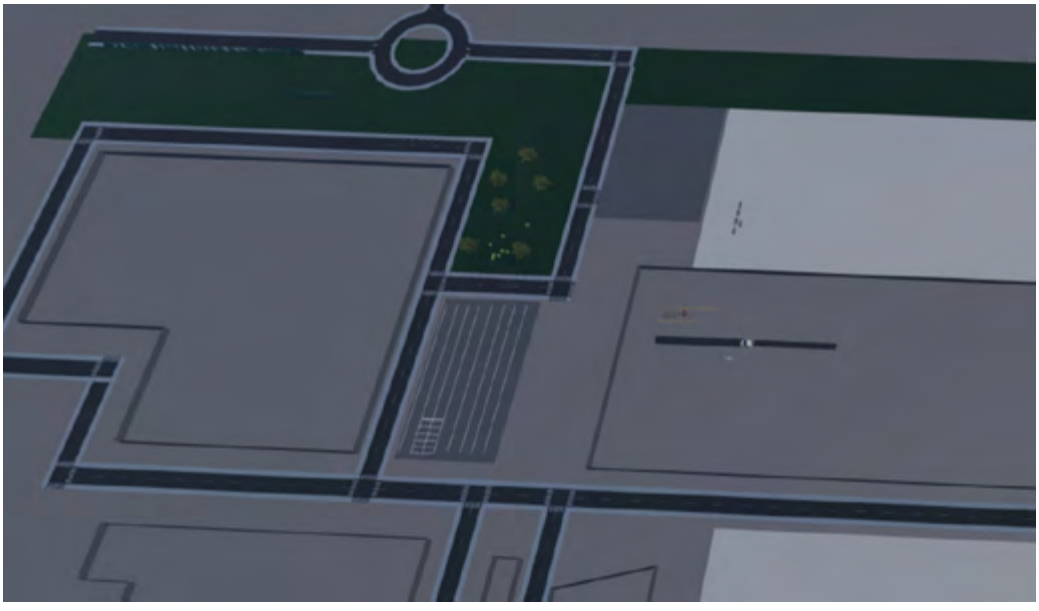
The university-industry collaboration established in this SUSTASKILL [8] project demands to generate material to train a bunch of technicians in very different areas of Sidenor. Part of the material generated can be concept based, but it is necessary to understand that a technician or operator should be able to make mistakes when producing or repairing, to notice the consequences of the failures they make. Thus, it is necessary as well to tackle virtual training. In this case, and as it can be seen in figure 2 and 3 several parts of the factory of Basauri have been modelled to develop training oriented to safety and manufacturing operations:

Figure 2

Sample Virtual Reality (VR) model of a loading dock of Sidenor Basauri

Figure 3

Sample Virtual Reality (VR) model of the transportation circuits of Sidenor Basauri



It is worth noting that the 3D models developed until now have been obtained using the 4Prot gamification for learning software.

6. Conclusions

The implementation of smart technologies and new environment and sustainability related policies is causing considerable changes in various sectors. Consequently, industries require a workforce with diverse skills that can effectively tackle the difficulties arising from digital and environmental changes, while also leveraging them to improve asset management. The "reshaping" of skills is crucial due to a significant disparity between future skill requirements and existing levels of expertise. To establish a trained workforce, it is important to anticipate skill changes in the manufacturing industry and provide the necessary upskilling and reskilling opportunities to the current workforce. Thus, this publication was designed to ascertain the skill requirements for the most prominent job profiles related to asset management, and to show that it is possible to provide training even at situations when failures can occur, thanks to the use of VR. We are confident that our work can make a valuable contribution to future efforts aimed at developing more targeted training for asset management.

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1

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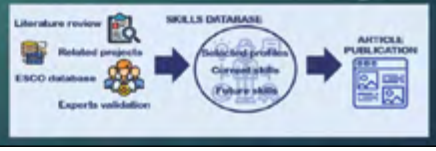

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Context

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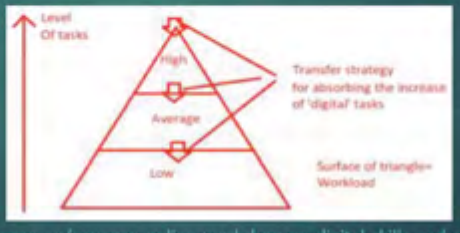
- Growth of digitalization
- Increasingly demanding sustainability needs
- Consequence? Need to adapt Asset Management profiles to these changes
- But noticing that:



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Reshaping industrial job profiles to better cover to needs of the Asset Management of the future - Goti et al.

Aims

4

- to address a significant need in the field of maintenance management by recognizing new talents (specific skills required for these roles) that are emerging as a result of industrial evolution and sustainability requirements.
- to select and develop the most appropriate materials to cover this skills gap using a train the trainers approach. To achieve this, the findings from prior research has been utilized.

Reshaping industrial job profiles to better cover to needs of the Asset Management of the future - Goti et al.