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REVIEW OF LITERATURE ON THE DESIGN OF INTEGRATED PRODUCT-xml-ph-0000@deepl.internalING NEW INDUSTRY 4.0 TECHNOLOGIES IN PROCESSES WITH OR WITHOUT HUMAN INTERACTION.

REVIEW OF LITERATURE ON THE DESIGN OF INTEGRATED PRODUCT- INCORPORATING NEW INDUSTRY 4.0- . TECHNOLOGIES IN PROCESSES WITH HUMAN INTERACTION OR WITHOUT HUMAN INTERACTION.

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Abstract: The design of an automotive product is complex, due to the many components involved and the interference of many teams from different organizations. These products must comply with regulations, specifications, and the quality expected by the consumer. A very important challenge is the market for which the product is intended, as this defines the engineering specifications and budget available for the project. The automotive sector is very diverse. Commercially, it defines luxury through common qualities such as performance; iconic design features (mainly visual); outstanding quality, precision, and detailed craftsmanship; and the use of unique and expensive materials. Luxury brands offer fast, powerful, and agile driving experiences associated with dream scenarios. There are several phases in product development, starting with the product concept, followed by market segmentation, where the product's needs and scope are selected. Finally, in the last stages, where the product is communicated to the supplier responsible for design, the manufacturability of the product is validated, where in many cases the original design needs to be changed, generating a change in the concept and consequently delaying the introduction of projects to the market. The current product design and development methodology used by OEMs focuses solely on aesthetics, which causes problems in the manufacturing validation phases due to a lack of consideration of potential manufacturing issues and market regulations. The objective is to design a methodology that integrates Scrum and Industry 4.0 technologies to reduce prototype development and validation time, from the concept phase to design development with the supplier selected by the OEM.

Keywords: Product design, Industry 4.0, Manufacturing.

Abstract: The design of an automotive product is complex, as it involves many components and interference from various teams within different organizations. These products must comply with regulations, specifications, and the quality expected by consumers. A significant challenge is the target market, which defines the engineering specifications and budget available for the project. The automotive sector is diverse, commercially defining luxury through common qualities such as performance; iconic design features (primarily visual); outstanding quality, precision, and detailed craftsmanship; and the use of unique and expensive materials. Luxury brands offer fast, powerful, and agile driving experiences associated with dream scenarios. There are various phases in product development, starting with the product concept, followed by market segmentation to select the product's needs and scope.

Finally, in the later stages where the product is communicated to the responsible design supplier, the feasibility of manufacturing the product is validated. Often, the original design needs to change, leading to a change in concept and consequently delaying project introductions to the market. The current methodology for designing and developing products by OEMs focuses solely on aesthetics, causing issues in manufacturing validation stages due to a lack of consideration for potential manufacturing problems and market regulations. The objective is to design a methodology that integrates Scrum and Industry 4.0 technologies to reduce development and prototype validation time, from the concept phase to the design development with the supplier selected by the OEM.

Keywords: Product Design, Industry 4.0, Manufacturing.

INTRODUCTION

The continuous evolution of automotive design is at a critical moment of transformation, driven by the intersection between human-centered design (HCD) and the disruptive technologies of Industry 4.0. This essay explores the implications and opportunities arising from this convergence, highlighting the need for a holistic approach to better leverage the capabilities of Industry 4.0 in the design process. It examines how the integration of human and non-human actors within the design process can improve human diversity, ergonomics, economics, manufacturing, and sustainability.

The study highlights the importance of a comprehensive evaluation methodology to quantify the results of design activities during the stages of the product life cycle. It also highlights the need to unify the various variants of HCD in order to effectively integrate them into the Industry 4.0 infrastructure. This involves not only considering the aesthetics of the design, but also the end customer experience and the functionality of interactive electronic systems, such as the human-machine interface (HMI).

The role of luxury car brands in the evolution of automotive design cannot be underestimated. These brands have led the way in utilizing superior materials and precise craftsmanship to create exclusive driving experiences. However, the advent of interactive technologies is changing the landscape of luxury, elevating the value of the end-user experience in automotive interior design.

The evolution of automotive HMI, from analog instruments to integrated digital components, reflects the complexity of user-centered design in a technologically advanced environment. Collaboration between professionals from various disciplines, such as engineers, designers, psychologists, and marketing specialists, is crucial to building a successful and unified driving experience.

On the other hand, Industry 4.0 signifies a revolution in production and operations, integrating smart technologies into all elements of the automotive industry. This transformation not only affects efficiency and productivity, but also redefines business models and supply and value chains, promoting data-driven value creation and the integration of business and production processes.

The convergence between human-centered design and Industry 4.0 offers an exciting outlook for the future of automotive design. However, to fully leverage these opportunities, a deep understanding of the technical and human complexities involved is required, as well as interdisciplinary collaboration between academics and industry professionals. Only through a comprehensive and collaborative approach can we successfully navigate the era of the digital revolution and Industry 4.0.

PROBLEM STATEMENT

Currently, OEMs' product design and development methodology focuses solely on the aesthetic appearance of the product. This has an impact on the manufacturing validation phases in the initial stages of product development by the supplier responsible for the design selected by the OEM, as potential problems in manufacturing and regulations for the type of market for which the product was designed are not identified, leading to changes in the original design and delays in the process of defining and producing new products.

Objectives

Design a product design methodology integrating the scrum methodology and new Industry 4.0 tools to reduce prototype development and validation time, from the OEM concept phase to the design development phase with the supplier selected by the OEM to design the product.

Specific objectives

• Design key stages in product development integrating the Scrum methodology.

• Integrate Industry 4.0 technologies into the product development phase.

THEORETICAL FRAMEWORK

One hundred articles related to Industry 4.0, automotive design, and Scrum methodology were reviewed, using a filter to identify the articles that could contribute most to the research. Only the term "automotive design" was searched. After reviewing the 100 articles, where only the introduction and conclusion were collected, only 50 articles that contributed theoretical knowledge to the research were selected.

Industry 4.0

Product manufacturing is a complex process that can be impacted by a number of factors, ranging from human error to changes in customer requirements. These elements, such as inaccurate information or communication problems, can have a significant impact on the quality and efficiency of the process. It is crucial to recognize these interferences and address them effectively to ensure optimal production results.

Latin American thought and popular culture in the construction of a unique regional identity. Regarding the challenges and opportunities of engineering in the knowledge society, it is clear that knowledge has become a fundamental part of the modern world. Rapid technological evolution demands sophisticated skills to use knowledge effectively, highlighting the importance of continuous education and training in engineering. In this context, engineering plays a fundamental role in generating new resources, knowledge, and technological advancement, facing challenges such as adapting to new technologies and efficient resource management.

Interference in the manufacturing process, the influence of popular culture in Latin America, and the new goals and objectives of engineering in the knowledge society are key elements that influence the development and identity of the region. Recognizing and addressing these elements effectively is essential to promoting sustainable growth and cultural diversity in Latin America.

IoTa

The Internet of Things is transforming the way companies operate, as well as the benefits they can obtain by incorporating IoT into their business strategies. It is noted that IoT implementation is on the rise and is expected to continue growing in the coming years. The issues and challenges companies face when trying to implement IoT, such as security, privacy, and technological complexity, are also addressed. It is noted that the IoT is a technology with significant economic and innovative implications, capable of generating new business models and radically transforming the way companies manufacture. In addition, some challenges and concerns associated with the IoT are mentioned, such as cybersecurity and information privacy, system interoperability, and the need for adequate regulation.

Within the IoT, it should be noted that this technology is a very novel topic with limited information that has not yet been developed or discussed in the most basic publications and research. The importance of digital technologies in the field of communications and operations leadership lies in the fact that they provide numerous benefits in terms of costs, productivity, and operations, thanks to the discoveries they enable in the design and selection of new products, as well as in the simulation and representation of processes.

Machine Learning

Industry 4.0 was born as a paradigm that revolutionizes the way companies operate, especially with regard to the employment and training of young people. This technological transformation not only involves the adoption of automated tools and processes, but also entails a change in the dynamics of work, which poses significant challenges, such as youth unemployment.

In this sense, proposals that explore the intersection between Machine Learning and Industry 4.0 highlight the need to address this challenge on multiple fronts. One of the fundamental pillars is improving knowledge generation and training for young people. In an environment where digital and analytical skills are increasingly in demand, it is crucial to raise awareness of educational programs to equip young people with the knowledge necessary to improve their prospects in the labor market of the future.

In this context, machine learning emerges as a powerful tool for addressing the challenges of youth unemployment. Through techniques such as linear regression, classification, and clustering,

companies can create predictive models that allow them to anticipate labor market needs and make informed decisions about hiring and training staff.

The integration of machine learning into Industry 4.0 offers significant opportunities to tackle youth unemployment and boost economic and social development. By focusing on increasing education and training for young people, fostering entrepreneurship and innovation, and promoting public-private partnerships, we can build a more inclusive and prosperous future for the next generations.

Augmented Vision

Teaching programming in the context of augmented reality poses unique challenges, especially when problem solving is used as the main pedagogical approach. While this method can be highly effective in promoting active learning in higher education in industrial computing, the authors point out the need to carefully address the difficulties that may arise, especially among less motivated students or those with less previous programming experience.

Problem-solving strategies offer a valuable opportunity for students to develop practical and critical thinking skills necessary in the field of computer science. However, their successful implementation requires the creation of a supportive learning environment that encourages ongoing participation and communication among students. Educators should design activities that challenge students to apply their programming knowledge in real-world situations, allowing them to develop a deeper and more meaningful understanding of the concepts and techniques involved.

Blockchain

Blockchain technology has emerged as a powerful tool for transforming the healthcare industry, offering significant improvements in the management and protection of medical data, as well as in the efficient management of medications and medical devices.

A recent project on the use of blockchain in the specific area of healthcare has shown that this technology can have a considerable impact on reducing medical errors and optimizing resources. By considering an unknown and decentralized registry of medical data, blockchain

It guarantees the completeness and cybersecurity of information, which helps prevent fraud and ensures patient privacy.

In addition, the use of blockchain in the management of medicines and medical devices allows for greater traceability and visibility throughout the supply chain, reducing the risk of counterfeiting and ensuring the quality and authenticity of products. This not only increases patient safety, but also increases operational efficiency and reduces the costs associated with inventory management and logistics.

Blockchain technology is evolving the healthcare industry by improving the management and protection of medical data, as well as the efficiency of medication and medical device management. By offering an innovative and secure approach to information exchange, blockchain has the potential to radically change the way healthcare services are provided and managed, increasing the quality of care and optimizing the use of resources for the benefit of patients and healthcare workers alike.

AI

Artificial Intelligence (AI) has emerged as a disruptive change in the business world, offering companies advanced tools and techniques to make decision-making more efficient, optimize processes, and increase measurable results.

AI, which focuses on generating algorithms and systems that can simulate human intelligence, can be an invaluable tool for companies in decision-making, data analysis, customer service, and process automation. The techniques used, such as autonomous learning, natural language interpretation, computer vision, and robotics, have enabled companies to increase the efficiency and accuracy of their operations, allowing them to remain competitive in a globalized and constantly changing market.

However, the use of AI also raises ethical and legal challenges, such as data security and responsibility for the results of AI systems. It is crucial that companies proactively address these challenges by implementing measures to maintain data privacy and ensure transparency and fairness in the use of AI.

In the context of industrial mechanics, AI has proven to have a significant impact on improving the efficiency, precision, and reliability of mechanical systems. Through the

implementing autonomous learning algorithms and data interpretation techniques, AI is helping companies optimize their manufacturing processes and increase the quality of their products.

In addition, digital manufacturing is emerging as a crucial catalyst for industrial development in Latin America. The adoption of technologies such as CAD/CAM/CAE in the region is increasing the efficiency and accuracy of product development processes, enabling companies to compete in the global market.

DEVELOPMENT

The research to be carried out has a mixed approach, and its objective is to validate a new method for product design using the SCRUM methodology and emerging Industry 4.0 tools. The aim is to reduce product development times, covering everything from the customer's conceptualization process to the material selection phase based on the market, the project budget, customer needs, and current technology. Subsequently, the phases of product feasibility and production process manufacturability will be applied, complying with process ergonomics standards. Finally, the functionality and appearance of the product will be evaluated.

To obtain results, an assembly object will be developed using the traditional design method with NX software. At the same time, the same object will be developed using the new method developed during this research. The number of design iterations necessary to achieve the expected result, the development time, and the quality of the assembly will be measured, including dimensional aspects and the tolerances of the subassemblies and the final assembly.

Finally, in the process of verifying the results, those obtained during product development using both the traditional method and the new method developed in the research will be reviewed and compared in order to determine which of the two methods is the most efficient. The most accurate comparison to validate the design method will be dimensional analysis, which will determine which of the two designs is closer to the nominal values. Additionally, the number of iterations necessary to arrive at the final design will be evaluated.

Proposed Method

• Literature analysis to optimize and integrate the Scrum method into the design phases.

• Pugh analysis to determine which Industry 4.0 tools to integrate

• Cause and effect analysis to determine the sustainability phases in the design phases.

DISCUSSION AND ANALYSIS OF EXPECTED RESULTS

Upon completion of the literature review and research, the methodology to be implemented will be determined. This new design method will include Industry 4.0 tools, generating greater efficiency in the development of an automotive product. This new method will incorporate the Scrum methodology and must be validated through a stack-up tolerance analysis. This analysis must determine and consider all geometric tolerances, material properties, and assembly properties, with the aim of reducing the time required for conceptualization, development, and implementation with different suppliers.

Table 1. *Summary of the literature review*.

Articles/Books Reviewed	Articles/Books Accepted	Rejected Articles/Books
103	65	38

After conducting this literature review, we gained new insights into which tools should be key in the new design method being developed in the research. It helped us understand the limitations of these tools and learn about their strengths, which will be useful in future phases of the research.

At this stage of development, machine learning will be integrated as an essential tool, as it can be used to explore human perception and improve the user experience in various contexts, such as voice modification. Recent research has shown that listeners are sensitive to changes in voice and can distinguish between different types of transformations, suggesting the dynamism of this technology to increase communication and human interaction in the workplace and beyond, as mentioned by Maisueche Cuadrado, A. (2019) in his publication "Use of machine learning in Industry 4.0," generating more information that can be used when making decisions in the product development phase.

In the component integration, material selection, product development, and historical data analysis phases, we will integrate artificial intelligence (AI). Since AI focuses on generating algorithms and systems that can simulate human intelligence, it can be an invaluable tool for companies in decision-making, data analysis, customer service, and robotization.

processes. The techniques used, such as autonomous learning, natural language interpretation, computer vision, and robotics, have enabled companies to increase efficiency and accuracy in their operations, allowing them to remain competitive in a globalized and constantly changing market, as mentioned by Ding, W., & Lin, X. (2010). In their publication AI research, design, and evaluation, AI will be used to generate a living database that will inform the best option during the development stages, taking historical data and technical information from previous launches.

During the integration of raw materials and the conceptualization of the design, augmented reality will be integrated. According to Rodríguez, F. (n.d.) in his publication "Technologies for education: Augmented reality for self-directed learning in manufacturing laboratories (AR-ManufacturingLab)," teaching programming in the context of augmented reality poses unique challenges, especially when problem solving is used as the main pedagogical approach. Although this method can be highly effective in promoting active learning in higher education in industrial computing, the authors point out the need to carefully address the difficulties that may arise, especially among less motivated students or those with less previous programming experience. This technology will help us visualize the design concept, taking into account the information previously collected and understanding the market needs of the target product.

CONCLUSIONS

Based on this literature review, further research will continue on the Industry 4.0 tools that should be integrated into the new design method being developed in the research. More than 100 articles were read on Industry 4.0, machine learning, IoT, AI, among others. As a result, only 50 articles that contributed to the research were selected; this process was based on automotive design criteria and provided more knowledge about which Industry 4.0 tools should be integrated into the new method.

The research will continue with the aim of obtaining results and meeting the specific objectives of the study:

- Design key stages in product development by integrating the Scrum methodology.
- Integrate Industry 4.0 technologies into the product development phase.

FUTURE WORK

Based on this research, we will determine which additional tools or technologies can be included in the newly developed method. The goal will be to reduce the time required to conceptualize and implement a new automotive project or product.

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