

## Utilization evolving prototype technologies in industrial design in the light of industry 4.0

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### **Abstract:**

The Fourth Industrial Revolution (Industry 4.0) creates a set of new opportunities due to the emergence of evolving technologies that have enormous potential for industrial design and prototypes. Industrial design in the age of constant transformation and technological experiments represents new opportunities to realize current technological innovations and translate them into tangible products, as well as to create a direct connection between technology and society. Design plays an essential role in the new manufacturing environment to ensure innovation in product design and management of its operations, by introducing evolving prototype technologies such as rapid prototyping, digital modeling, augmented and virtual reality for prototyping and product development into the design process, allowing the creation of highly flexible products at a reasonable cost. Thus, the concept of research aims to utilization evolving prototype technologies, classifying, and applying them in the field of industrial design, where the combination of physical and virtual or augmented prototypes allows the creation of smart products that are flexible and provide a realistic presentation of the appearance and behavior of the product. The fourth industrial revolution has been discussed by defining its concept and the technologies on which it is based, then moving on to exploring the types of evolving prototype technologies considering the fourth industrial revolution technologies in achieving a classification of these technologies in preparation for utilizing and applying them in the stages of the product design and development process in the field of industrial design. Adaptation and utilizing evolving prototype technologies in the field of industrial design leads to the creation of more collaborative design environments among the design team, in addition to supporting the acceleration of product design and development processes, and companies in their competitive market. Research Problem: Earlier industrial attempts included modeling, simulation, and design exploration activities with the aim of improving knowledge early on and making internal decisions in the conceptual stages of the product design and development process (Tatipala et al., 2021). The Fourth Industrial Revolution (Industry 4.0) offers a variety of new opportunities, particularly with the emergence of evolving prototype technologies, including advanced computing platforms like Virtual Reality (VR) and Augmented Reality (AR) technology, which help to completely rewrite the rules of product development processes and hold enormous potential for industrial design and prototyping. The Fourth Industrial Revolution (Industry 4.0) aims to speed up the design and manufacturing process by introducing new technological trends and tools, leading to innovative processes and new ways to integrate information for instance: using rapid, virtual, and augmented prototyping to integrate product design and visualization. The research focuses on the exploration, and classification of those evolving prototype technology that assist in integrating the physical, digital, and virtual worlds, utilizing, and integrating them into the industrial design process. Research Objectives: The research aims to utilization evolving prototype technologies - which help to integrate the physical, digital, and virtual worlds in the light of industry 4.0 - by classifying, integrating and applying them within the stages of the product development process in the field of industrial design. Significance of Research: Developing the cognitive and professional skills of industrial designers with the evolving prototype technologies and including them in the management of product development processes. Introducing new technological trends and tools that lead to innovative processes and new ways of integrating information, such as using rapid, virtual, and augmented prototyping to bring product design and visualization together. Adopting the technological developments of the industry 4.0 and integrating them within the industrial design education program. Encouraging businesses to adopt the technologies of the industry 4.0 will lead to accelerating the process of developing the product and achieving its competitive advantage in the markets. Research Methodology : The research follows the analytical experiment method. Results: Emphasis on the significance of industry 4.0 technologies and its impact on the future of design and education of industrial design. Utilization evolving prototype technologies in the product design stages and classify them into 3 categories: physical prototype (included additive manufacture as:3D and 4D printing). And virtual prototype (3D modeling, simulation, and digital twins). virtual environments (included: virtual reality (VR), augmented reality (AR), and mixed reality (MR) ). utilization evolving prototype technologies integrating and applying them in the stages of product design in the field of industrial design. The emergence of evolving prototype technologies such as 4D printing and digital twins, through which the virtual world can be linked to the physical and digital world. A digital twin is a computer application that receives input from a real object continuously. These inputs are processed by this programme, and its outputs produce knowledge about performance and prospective issues. Classification of digital twins into four types: digital twins physical (DTP) , digital twins Instance (DTI) , Digital Twin Aggregate (DTA) and Intelligent Digital Twin(IDT) Classifying the levels of digital twin models according to their ability to exchange data into three: digital model, digital shadow, and digital twin. Utilization the digital twin in accurately simulating the use of the product in actual conditions, which helps designers to understand and formulate the functional requirements of the product more accurately. Three basic components must be provided for the work of the digital twin, namely the physical entity, digital planning and communication that allows communication between the physical and virtual worlds. Distinguish between the concept of a digital twin and simulation. Whereas in simulation there is the creation of a scenario of what

might happen to a product in each circumstance, a digital twin represents what is happening in real time in an asset.

### **Keywords :**

Industry 4.0 - Additive Manufacture - Physical prototype - Virtual Prototype – Virtual Environment - Virtual reality (VR) - Augmented reality (AR) - Extend reality (XR) - Digital Twin (DT) - Simulation - 3D printing - 4D printing – 3D Modeling.

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