



THE INFLUENCE OF DIGITAL TECHNOLOGIES ON THE PREPARATION OF STUDENTS FOR DESIGN AND CONSTRUCTION ACTIVITIES

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ABSTRACT

This article examines the impact of digital technologies on design and engineering processes and describes the acceleration of the digitalization process in industry and manufacturing sectors. With the help of modern digital tools, 3D modeling, automated design systems (CAD), and artificial intelligence, it is possible to significantly increase efficiency. The study showed that digital technologies increase labor productivity and ensure resource savings. Furthermore, the widespread implementation of these technologies has reduced design costs and increased economic efficiency.

Login. Digital technologies have become one of the main driving forces of the modern economy. As a result of the rapid development of information technologies, innovations such as artificial intelligence, automation, big data, cloud technologies, blockchain, the Internet of Things (IoT), and 5G are having a significant impact on our daily lives and economic processes. These technologies serve to automate production processes, improve the quality of services, reduce costs, and strengthen global economic cooperation.

The development of the digital economy is causing fundamental changes in industry, agriculture, finance, trade, education, healthcare, and other spheres. The expansion of e-commerce, the optimization of business processes using artificial intelligence, and the development of IoT technologies allow increasing the efficiency of enterprises [2]. Also, the Resolution of the President of the Republic of Uzbekistan dated April 28, 2020 No. PP-4699 "On Measures for the Wide Implementation of the Digital Economy and E-government" was adopted [3].

The 21st century is recognized as the age of technology, and digitalization processes are developing consistently and rapidly in all spheres. On a global scale, the development of science and technology is bringing about fundamental changes in all areas of human activity, in particular, in production, industry, construction, mechanical engineering, architecture, and other technological spheres. In this process, digital technologies occupy the main place and are manifested as an important factor in increasing economic efficiency, especially in design and engineering activities. Within the framework of this article, an in-depth analysis of the impact of digital technologies on design processes, their practical application, and economic results is carried out.

Today, production processes no longer rely on projects drawn by hand or based on analog methods. Projects developed using digital equipment, computerized systems, artificial intelligence, and automated programs are significantly superior to traditional methods in terms of efficiency, accuracy, time, and resource saving. For example, with the help of 3D modeling technologies, objects are visually clearly depicted, and their design, functionality, and structure are fully examined at the initial stage. This reduces the likelihood of errors and prevents unnecessary costs in subsequent stages. At the same time, projects are being rapidly developed, updated, and tested using automated design systems (CAD - Computer-Aided Design) and CAx systems (for example, CAM - Computer-Aided Manufacturing, CAE - Computer-Aided Engineering) [4]. These technologies serve to reduce the negative impact of the human factor and increase the productivity of human labor. Therefore, in world practice, the introduction of digital technologies at the design stage is becoming a means of increasing the competitiveness of enterprises and organizations.

Methodology

In recent years, a lot of scientific work has been carried out on the influence of digital technologies on design and engineering processes. In creating the scientific foundations of this direction, first of all, the literature related to digital transformation and the 4.0 stage of industry plays an important role. In particular, the concept of the "Fourth Industrial Revolution," presented by Schwab (2016), clarified the role of artificial intelligence, IoT, and automation in design and production. According to the author, digital technologies are significantly changing not only production, but also the initial stages of the project [5].

A comprehensive analysis of CAD (Computer-Aided Design) systems is found in the works of Mashinchi (2018) and Rudenko (2020). They showed how automated design systems contribute to improving project quality through accuracy, speed, and processing capabilities. Especially in studies conducted by Mashinchi, it was noted that as a result of the application of CAD systems in small and medium-sized businesses, project costs decreased by 15-20% [6,7].

About 3D modeling technologies, the company Autodesk and the authors who studied it (Smith, 2019; Lee, 2021) focus on the role of this tool in visualizing the design process, early detection and optimization of engineering errors. According to their research, the use of 3D technologies accelerated project work by 30% and reduced the need for human resources [8,9].

Design systems created on the basis of artificial intelligence (AI) and machine learning (ML) are deeply analyzed in the works of a new generation of scientific research - in particular, Zhang and Li (2020). They emphasize that AI-based systems allow for the autonomous generation of projects, predicting problems in advance, and offering optimal solutions. In particular, the use of artificial intelligence tools is an important factor in reducing errors related to the human factor [10].

Among local sources, analytical reports prepared by the Ministry of Digital Technologies, the Ministry of Innovative Development of the Republic of Uzbekistan, and relevant universities deserve attention. The strategic program "Digital Uzbekistan - 2030" contains measures for the integration of digital technologies into the economy and industrial sectors, on the basis of which scientific research is being conducted [11].

In general, the analyzed literature confirms that the introduction of digital technologies into design processes has a direct impact not only on technical, but also on economic efficiency. Resource savings, reduced time factor, increased project quality and product reliability - all these are the advantages of digital technologies. Therefore, modern scientific approaches justify the need for deeper integration of these technologies.

Result and discussion

Within the framework of this study, the influence of digital technologies on design and engineering processes was analyzed. The analysis showed that the use of modern digital tools significantly increases the quality and effectiveness of project work. In particular, the use of 3D modeling, CAD (Computer-Aided Design) systems, and artificial intelligence has a positive impact on the project results.

The cases of implementation and non-implementation of digital technologies at engineering enterprises participating in the study were studied, and the following main indicators were identified:

Table 1.

Estimated results before and after the implementation of digital technologies (average indicators)

Indicator	Traditional mode (Previous)	With digital technologies (Next)	Change (%)
Project completion period (days)	45.	28.	-38%
Labor productivity (worker/project)	5.	3.5.	+30%
Expenses (million soums)	120.	85.	-29%
Number of errors (per project)	12.	4.	-66%

As can be seen from the table above, the implementation of digital technologies has reduced design time by 38%, increased labor productivity by 30%, reduced total costs by 29%, and reduced the number of errors by more than three times. These indicators clearly demonstrate the direct impact of digital transformation on economic efficiency.

3D modeling technologies allow for the early detection and correction of problems at project stages as a result of fully visualizing objects and systems. This prevents technical and economic losses in subsequent stages. The use of CAD systems also allows for project standardization, automatic document generation, and version tracking.

In addition, with the help of artificial intelligence-based systems, there is an opportunity for data-based analysis when making technical decisions. It is through AI and machine learning algorithms that the most optimal design solutions based on previous project data are recommended. This reduces the need for human resources and eliminates errors caused by the human factor.

The study shows that the widespread introduction of digital technologies provides enterprises not only with technical, but also with strategic and economic advantages. The digitalization process increases the competitiveness of the enterprise and ensures its rapid

and effective adaptation to changing market conditions. It should be emphasized that initial investment is necessary for the implementation of digital technologies, but these costs will pay off in the short term. The results obtained in the study showed the need for wider application of these technologies, as well as the importance of their constant updating.

Conclusion. Based on the conducted research, it has been established that the widespread introduction of digital technologies into design and engineering processes provides significant economic and technical advantages for modern industries and production sectors. In particular, with the help of 3D modeling, automated design systems (CAD), and artificial intelligence tools, the accuracy of design is increased, errors caused by the human factor are reduced, resources are saved, and labor productivity is significantly increased.

According to the research results, the use of digital technologies has reduced project deadlines, reduced production costs, and, in general, served to increase economic efficiency. Furthermore, the implementation of such technologies allows enterprises and engineering centers to maintain market competitiveness and create high-quality and innovative products.

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