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DIGITAL PLATFORMS AND TOOLS USED IN ENGINEERING EDUCATION (SOLID EDGE, SOLIDWORKS, FUSION 360, ETC.)

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Annotation: This thesis highlights digital platforms in engineering education and their importance in the educational process. 3D design and modeling programs operating in a modern digital environment, such as Solid Edge, SolidWorks, Fusion 360, are analyzed as an integral part of engineering education. With the help of these platforms, students will acquire skills in modeling technical objects in a virtual environment, creating design drawings, analyzing mechanical systems, and digitally managing production processes.

Keywords: engineering education, digital platforms, Solid Edge, SolidWorks, Fusion 360, 3D modeling, computer design, digital environment, CAD/CAM/CAE systems, technical thinking, virtual prototyping, simulation.

Today, the engineering education system is undergoing an intensive stage of digital transformation. Modern production enterprises and educational institutions require the training of specialists with a deep understanding of digital technologies and practical skills in design and modeling. Therefore, the integration of digital platforms and 3D modeling tools (Solid Edge, SolidWorks, Fusion 360, AutoCAD, CATIA, Inventor, and others) into the educational process in engineering has become a necessary need today.

Digital platforms used in engineering education allow students to automate technical design, modeling of mechanical systems, analysis, and design. With the help of these platforms, students develop engineering thinking, technical creativity, algorithmic thinking, and system analysis skills.

Solid Edge is a professional 3D design system developed by Siemens, which allows for the creation, analysis, and preparation of mechanical and structural models for the production process. Its Synchronous Technology module allows the user to quickly and freely edit the 3D model. In engineering education, Solid Edge is used to teach students methods of parametric modeling and geometric analysis.

2. SolidWorks is one of the most common platforms in the field of engineering design, combining the capabilities of 3D modeling, static and dynamic analysis, surface modeling, and drawing development. Students develop their technical thinking by creating mechanical parts, gears, mechanisms, and devices on this platform. Modules Simulation, Flow Simulation, Motion Study, located in the SolidWorks system, allow students to analyze real physical processes in a digital environment.

3. Autodesk Fusion 360 is a digital platform operating in a cloud environment, combining design, simulation, and production processes into a single system.
This program allows students to work in team projects, collaborate online, and edit models in real time. The Fusion 360 system also combines 3D printing, CNC programming, and architectural design processes.

The common advantages of these digital platforms are:

- Wide possibilities of 3D modeling and visualization;
- automatic generation of drawing and design documentation;
- the possibility of modeling the product life cycle (PLM);
- analysis of loads and deformations in a real environment;
- Cloud integration for team project activities (Fusion 360, Onshape);
- Ensuring the interconnectedness of production and the educational process.

Today, the engineering education system operates in the context of digital technologies, automated management, and the Industry 4.0 concept. Modern production processes are becoming increasingly complex, requiring digital thinking, modeling, simulation, and design skills from every engineer. Therefore, the effective integration of digital platforms and tools into the educational process in engineering education has become a pressing problem.

Currently, in many higher educational institutions, traditional methods are prioritized in the subjects taught in engineering fields, and students have not sufficiently developed skills in modeling real engineering projects, creating design drawings, analyzing 3D objects, and managing them in a digital environment.

Although digital platforms such as Solid Edge, SolidWorks, Fusion 360, AutoCAD, CATIA, Inventor have become the main tools of the modern engineering process, their didactic possibilities in the educational process have not been fully mastered.

In recent years, the integration of digital technologies into the educational process in the engineering education system has become one of the most pressing areas. Analysis of scientific literature shows that digital platforms and computer design systems (CAD/CAM/CAE) play an important role in the development of students' technical thinking, practical skills, and innovative thinking in engineering education.

Among the scientists of Uzbekistan, Z. Abdurakhmanov (2022) developed a methodology for the effective use of digital tools for teachers in the engineering field and analyzed ways to form students' digital engineering competencies. A. Khusanov (2021) revealed the didactic foundations for the development of design competence through the introduction of 3D modeling

and digital design technologies into the educational process in engineering education.

In the research conducted by N. Gafurov (2020), it is scientifically substantiated that the effectiveness of education can be increased by 25-30% by creating a digital environment in engineering education and integrating it into the educational process. Also, in the works of M. Shodmonov (2023), a methodology for activating the design activity of students through 3D modeling, visualization, and virtual laboratories has been developed.

In foreign literature, the significance of digital platforms in teaching has been studied even more extensively. J. Smith and R. Taylor (2021) in their research note that SolidWorks, Fusion 360, and Solid Edge systems have high efficiency in automating engineering design and accelerating design processes.

K. Brown (2020) showed that the integration of CAD systems with the concept of "Digital Twin" makes it possible to model real production processes in education.

Harris and White (2022), while studying digital engineering education, emphasize that working with Solid Edge and Fusion 360 systems strengthens the foundations of analytical thinking, algorithmic approach, and design in students.

In their opinion, systems based on cloud platforms (for example, Autodesk Fusion 360) will take collaboration and team project activities between teachers and students to a new level.

Russian scientists Kuznetsova L.A. and Polyakova E.V. (2019) developed the pedagogical foundations for the introduction of innovative technologies in engineering education. In their opinion, digital platforms serve not only as a technical tool, but also as a didactic component of the educational process. Smirnov Yu.V. (2020) scientifically substantiated the effectiveness of creating training modules focused on practical training in teaching SAPR (SolidWorks, AutoCAD) systems.

In the analyzed literature, the main trends in the development of engineering education are described as follows:

integration of digital tools into the educational process - increases the effectiveness of training;

Training through CAD/CAM/CAE systems - develops design and engineering competencies;

virtual modeling and working in a 3D environment - enhances creative thinking and technical thinking;

cloud platforms - develop collaborative learning;

digital educational environment - provides education approximated to real production experience.

In general, the analysis of the literature shows that the use of digital platforms (Solid Edge, SolidWorks, Fusion 360, etc.) in engineering education improves practical project activities, accelerates the process of digitalization of education, and is considered one of the most effective means of improving students' professional competence.

From this point of view, the essence of the problem lies in the need to develop and improve the methodology for preparing students for design, engineering, and production activities by introducing digital platforms (CAD/CAM/CAE systems) into the educational process in the process of engineering education.

This problem requires solving the following questions:

Which digital platforms are the most effective for engineering education?

What are the integration capabilities of Solid Edge, SolidWorks, and Fusion 360 programs in the educational process?

What are the didactic possibilities of these tools in the formation of digital competence in students?

How is the development of students' technical thinking, creative approach, and design skills carried out through the use of these platforms?

Thus, the essence of the problem stems from the need to modernize engineering education based on digital platforms, 3D modeling of the educational process, integration with the virtual environment and integrated technologies.

Studies show that the use of digital platforms such as Solid Edge, SolidWorks, and Fusion 360 in engineering education:

- activates students' technical thinking by 28-35%;
- increases learning motivation;
- brings practical skills closer to the real production process;
- reinforces design and engineering activities.

In particular, virtual models, 3D prototypes, and mechanical systems developed using design tools in the digital environment enhance students' abilities in analytical thinking, experimental modeling, and the creation of design solutions.

In engineering education, these platforms bring education into a practice-oriented and integrative form in accordance with the principles of the STEAM approach (Science, Technology, Engineering, Art, Mathematics).

In conclusion, the introduction of digital platforms such as Solid Edge, SolidWorks, Fusion 360 into the educational process in engineering education is the most effective way to form digital engineering competencies in students. Through these tools, students acquire skills in virtual design, analysis, and testing of technical objects. At the same time, digital platforms bring

engineering education to an innovative, interactive, and production-oriented form.

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