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The Use of Graphic Programs in the Educational Process of Technical Subjects at Secondary Schools and Universities

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Abstract

In the era of digital transformation in education, graphic programs are becoming an indispensable tool in the educational process of technical subjects at secondary schools and universities. Their use extends beyond innovative methods of knowledge transfer and positively influences the development of students' cognitive abilities, such as spatial imagination, analytical thinking, and problem-solving. Moreover, mastering graphic programs prepares students for the demands of the current labour market in fields such as engineering, architecture, and design. This study analyses the use of graphic programs in the education process of technical subjects at secondary and higher education institutions, focusing on their specifics in the context of each educational level.

Keywords: graphic programs, technical subjects, cognitive skills, digital transformation of education

Introduction – pedagogical benefits of graphic programmes

Graphic programs offer numerous benefits in teaching technical subjects. They increase student engagement, enable visualization of abstract concepts, and develop spatial reasoning. They improve work efficiency and accuracy, foster creativity and innovation, and prepare students for professional practice. However, implementation also presents challenges, such as financial and time constraints, the need for technical support, and the risk of over-reliance on technology.

The future of graphic programs in education lies in integration with cloud services, utilization of virtual and augmented reality, development of collaborative tools, and implementation of artificial intelligence.

Aim and methodology of the research

The aim of the study is to present selected graphical computer programmes which are useful in technical education as well as the presented method to analyse their functionality.

Research results - taxonomy of graphic programmes in technical education

Several dominant categories can be identified in the broad spectrum of graphics programs applied in engineering disciplines:

1. **CAD software (Computer-Aided Design):** this software is a fundamental pillar in the study of disciplines such as engineering, construction, architecture and design. It allows students to create accurate 2D and 3D models, technical drawings, simulations and analyses. The most widely used CAD programs include:

- **AutoCAD:** A highly sophisticated program with extensive functionality, used primarily in universities and professional practice. AutoCAD it's a very simple software for creating 2D and 3D drafting, yet it is very powerful. With the new released instalments, the only limitation it's user's creativity. In the figure below its presented AutoCAD's user interface (*Autodesk Auto CAD 2025*).

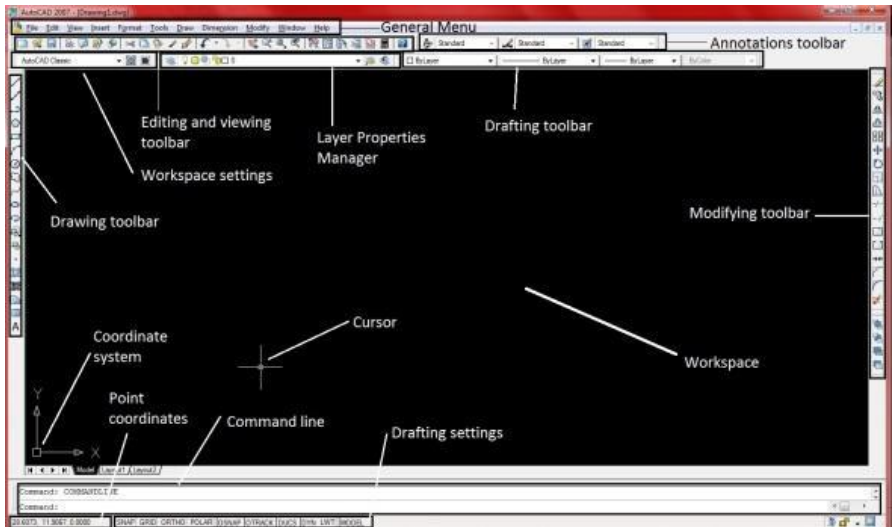

Figure 1. AutoCAD user interface

- **SolidWorks:** an intuitive and user-friendly program with advanced 3D modelling tools, often implemented in teaching in high schools and colleges. Getting started with SOLIDWORKS can be a challenge, especially for new users coming from 2D CAD programs.

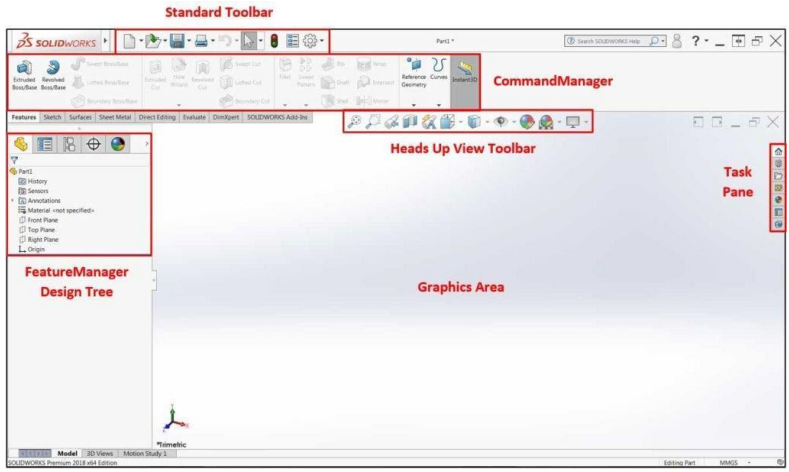

Figure 2. SolidWorks user interface

- **CATIA:** (Computer Aided Three-dimensional Interactive Application) is a comprehensive software system developed by Dassault Systèmes. It is a leading CAD/CAM/CAE software used for 3D modelling, simulation, and analysis. Its wide range of applications makes it an indispensable tool in various industrial sectors, particularly in the automotive, aerospace, and manufacturing industries.

It enables designers and engineers to design complex products, simulate their behaviour in a real-world environment, and optimize their performance. Due to its complexity and advanced features, CATIA is a typical tool for higher education studies in technical fields and scientific research. Students and researchers use it to solve complex engineering problems, simulate various processes, and develop innovative products (*CATIA*, 2023).

- **Inventor:** Autodesk Inventor is a popular CAD software developed by Autodesk. It focuses on 3D mechanical modelling, product design, and simulation. Due to its intuitive interface and wide range of features, it is suitable for secondary and higher education in fields such as engineering, industrial design, and manufacturing.

Inventor allows students and engineers to create accurate 3D models of parts and assemblies, generate technical documentation, and simulate the functionality and performance of designs. The software offers tools for parametric modelling, finite element analysis, motion simulation, and visualization. Its flexibility and compatibility with other software make it a sought-after tool in industrial practice.

2. **Mathematical software:** Mathematical software is an integral part of the study of engineering subjects, enabling students to solve complex mathematical problems, create graphs, analyse data and visualise mathematical models. The most prominent programs in this category include:

- **MATLAB:** (short for “MATrixLABoratory”) is an interactive environment and programming language developed by MathWorks. It is a powerful tool for numerical computation, simulation, data visualization, and programming, used in a wide range of scientific and technical fields.

MATLAB offers a comprehensive system of functions and tools for mathematical operations, signal processing, image analysis, system control, and much more. It allows users to create models, prototypes, and simulations of complex systems, analyse and visualize data, and develop algorithms. Due to its flexibility and extensive function library, MATLAB is a popular tool in higher education in fields such as mathematics, physics, engineering, and economics (*MATLAB*).

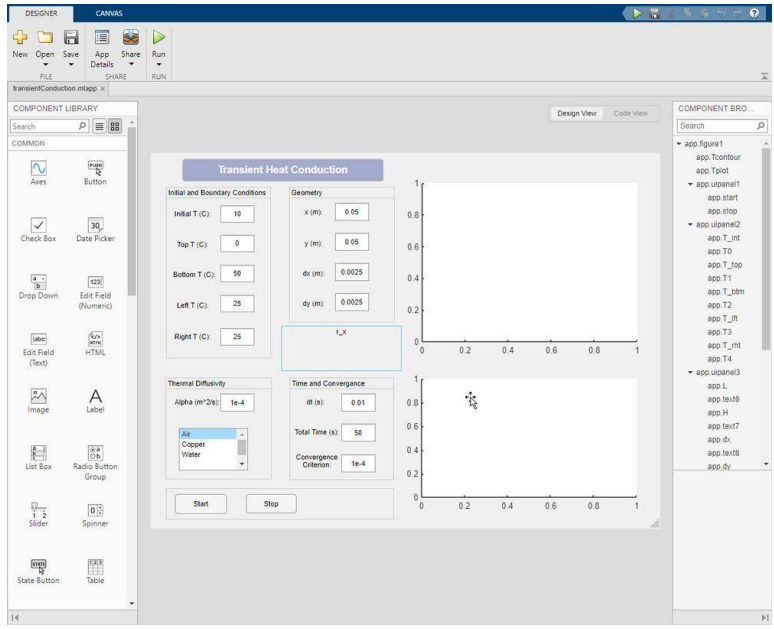

Figure 3. MATLAB user interface

- **Wolfram Mathematica:** is a modern computational system developed by Wolfram Research. It is a powerful software with extensive capabilities for symbolic and numeric computation, graphical data processing, and programming. Mathematica is used in scientific research, education, and various industrial sectors.

Mathematica offers a unique environment for solving mathematical problems, simulating physical phenomena, analysing data, visualizing, and creating interactive models. Its strength lies in its ability to work with symbolic expressions, which allows for precise mathematical calculations and manipulations. It

also offers extensive function libraries for various fields of mathematics, physics, computer science, and engineering. Due to its complexity and wide range of possibilities, Mathematica is a suitable tool for higher education studies and scientific research (*Wolfram Mathematica*).

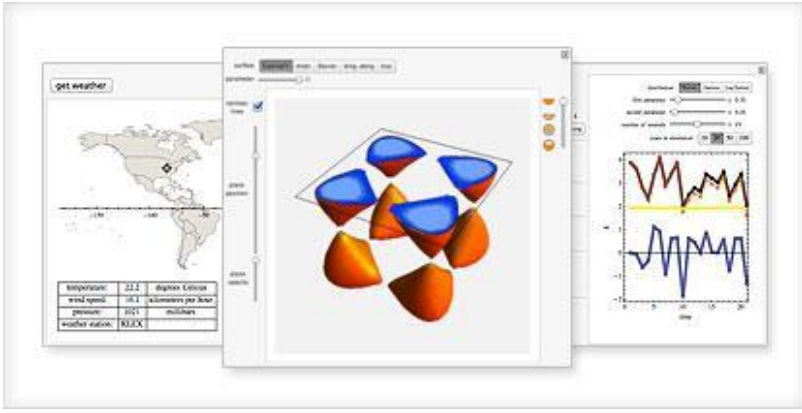

Figure 4. Mathematica user interface

- **Maple:** is a powerful mathematical software developed by Maplesoft. It focuses on symbolic computation, mathematical analysis, data visualization, and programming. With its intuitive interface and wide range of features, it is suitable for secondary and higher education in subjects such as mathematics, physics, and engineering.

Maple enables students and teachers to solve complex mathematical problems, perform symbolic manipulations, numerical approximations, graphical representations, and create interactive applications. The software offers tools for algebra, calculus, differential equations, linear algebra, statistics, and many other areas of mathematics. Its ability to work with symbolic expressions allows for precise solutions and a deeper understanding of mathematical concepts.

In addition to education, Maple is also used in scientific research and various industrial sectors where complex mathematical problems need to be solved.

3. **Simulation software:** represents a broad category of programs that allow for virtual modelling and analysis of various systems and processes. It is used in various fields, from technical sciences and engineering to economics and social sciences. In the context of technical education, simulation software allows students to experiment with different parameters, test proposed solutions, and optimize technical systems without the need for physical prototypes.

Simulation programs offer the possibility to visualize complex physical phenomena and processes, analyse their behaviour over time, and predict their

evolution. Students can thus gain a deeper understanding of theoretical concepts and apply them in practice. Among the most used simulation programs in technical education are:

- **Ansys:** Ansys is a comprehensive Multiphysics simulation software developed by Ansys, Inc. It is one of the leading tools for engineering simulations, allowing for modelling and analysis of complex physical phenomena and processes. Its wide range of applications includes areas such as solid mechanics and structural analysis, thermal analysis, electromagnetism, fluid dynamics, and many others.

This program uses the finite element method (FEM) to solve complex engineering problems. It allows for simulating the behaviour of materials and structures under the influence of various loads, temperature changes, electromagnetic fields, and fluid and gas flows. Ansys offers a wide range of modules and tools for different types of simulations, including structural analysis, thermal analysis, fluid flow analysis, electromagnetic analysis, and acoustic analysis.

Due to its complexity and advanced features, Ansys is mainly used in higher education institutions within engineering disciplines and in scientific research. Students and researchers use it to solve complex engineering problems, optimize designs, and develop innovative products. Ansys is also widely used in industrial practice in various sectors, such as the automotive industry, aerospace industry, energy sector, and manufacturing (*Ansys – Engineering Simulation Software*).

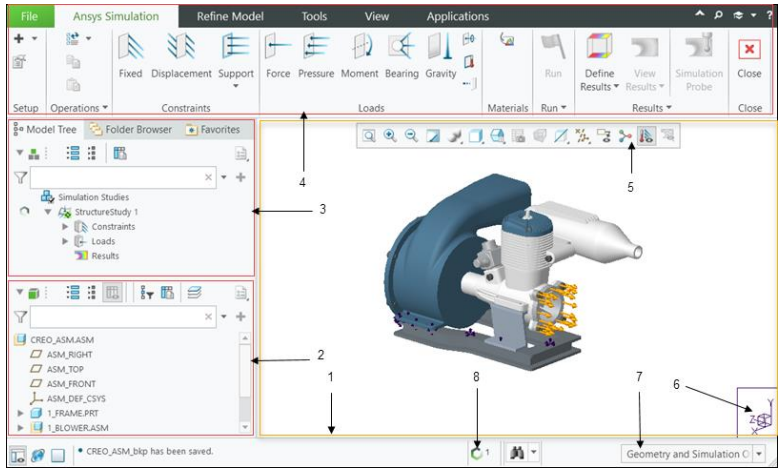

Figure 5. Ansys user interface

- **COMSOL Multiphysics**: is a powerful software for Multiphysics simulations developed by COMSOL, Inc. It allows for modelling and analysing a wide range of physical phenomena and processes, including mechanics, acou-

stics, electromagnetism, thermal processes, chemistry, and fluid flow. Its strength lies in the ability to combine different physical models and simulate their interaction, which is crucial for understanding complex systems.

It features a user-friendly interface and a flexible modelling environment. It offers extensive libraries of physical models and material properties, as well as tools for geometric modelling, meshing, and visualization of results. Thanks to its modularity, it is possible to adapt the software to the specific needs of the user and extend its functionality with additional modules for specialized simulations.

It is suitable for higher education studies and research in various technical fields, such as mechanical engineering, electrical engineering, physics, and chemistry. It allows students and scientists to gain a deeper understanding of physical principles and apply them in solving real-world problems. In addition, COMSOL is also used in industrial practice in the development and optimization of products and processes (*COMSOL*).

- **Simulink:** Graphical environment for modelling and simulation of dynamic systems, integrated with MATLAB. Used in high school and university courses such as automation, robotics and cybernetics.

4. **Graphic editors:** are software applications designed to create and edit digital graphics. They are divided into two basic types:

- **Raster graphic editor** – works with images composed of pixels, i.e. coloured dots arranged in a grid. Suitable for photo editing and creating realistic images. Examples: Adobe Photoshop, GIMP.
- **Vector graphic editor** – works with images defined by mathematical curves and shapes. Suitable for creating logos, illustrations, technical drawings, and diagrams. Examples: CorelDRAW.

Among the most famous graphic editors are:

- **Adobe Photoshop:** is a leading raster graphics editor developed by Adobe Inc. It is a professional tool for editing and creating digital images, used in a wide range of areas, from graphic design and photography to web design and multimedia creation.

Photoshop offers a comprehensive system of tools and functions for photo retouching, colour manipulation, creating effects, drawing and painting, working with layers, and much more. It allows users to create complex graphic compositions, edit images in detail, and add various effects. Due to its flexibility and extensive function library, Photoshop is a standard tool in the graphic design industry.

In the context of education, Photoshop is suitable for secondary and higher education in fields such as graphic design, multimedia creation, photography, and data visualization. It allows students to gain practical experience in editing and creating digital images and develop their creativity and technical skills (*Adobe Photoshop*).

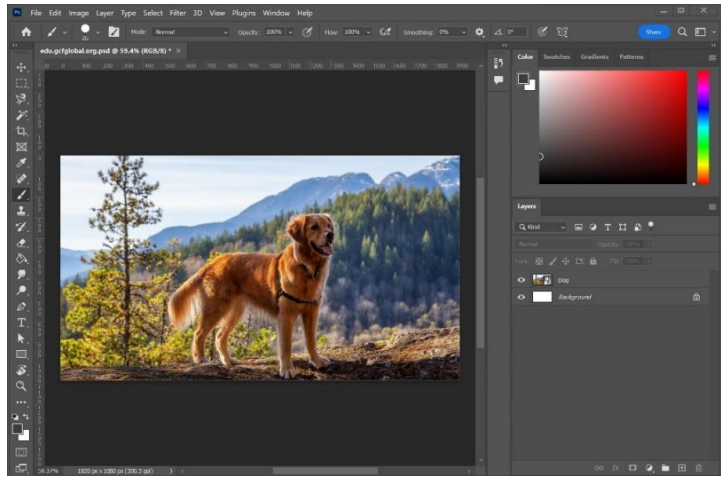

Figure 6. Adobe Photoshop user interface

- **GIMP:** (GNU Image Manipulation Program) is a free and open-source raster graphics editor that represents a powerful alternative to Adobe Photoshop. It offers a wide range of features for editing and creating digital images, including tools for photo retouching, colour manipulation, drawing, painting, and creating graphic effects.

Due to its free availability and extensive functionality, GIMP is an ideal choice for secondary and higher education in fields such as graphic design, photography, and multimedia creation. It allows students to learn the basic principles of working with raster graphics and develop their creative and technical skills without having to invest in expensive software.

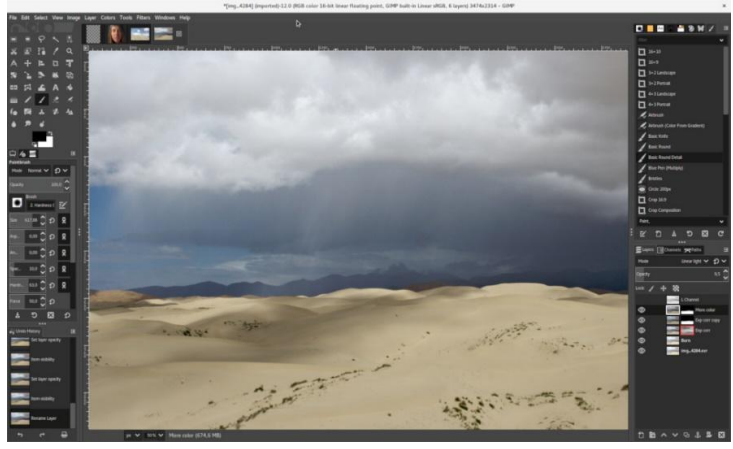

Figure 7. GIMP user interface

In addition to education, GIMP is also used in professional practice by graphic designers, artists, and photographers who are looking for a free and powerful alternative to commercial graphic editors (*GIMP*).

- **CorelDRAW Graphics Suite**: is a comprehensive software package developed by Corel Corporation, with CorelDRAW as its core vector graphics editor. It is a professional tool for graphic design, illustration, publishing, and web design. CorelDRAW offers a wide range of features for creating and editing vector graphics, including tools for drawing, shaping, typography, colour management, and effects.

It is characterized by an intuitive interface and advanced tools that allow for creating accurate and detailed illustrations, logos, technical drawings, brochures, flyers, and many other graphic materials. The software offers extensive libraries of shapes, fonts, and clipart, as well as the ability to import and export various file formats.

In the context of education, CorelDRAW is suitable for secondary and higher education in fields such as graphic design, illustration, technical drawing, and multimedia creation. It allows students to gain practical experience with vector graphics and develop their creativity and technical skills.

Conclusion

In the current context of digital transformation in education, graphic programs play a crucial role in preparing students in technical fields for the demands of today's job market. Their implementation in the educational process allows students to gain practical experience with tools and technologies that are standard in industrial practice. Furthermore, graphic programs foster the development of students' cognitive skills, such as spatial reasoning, analytical thinking, and problem-solving. However, the effective use of graphic programs in education requires not only adequate technical provision but also thoughtful integration into curricula and professional development for educators. It is important to find the right balance between acquiring digital skills and developing fundamental technical knowledge and manual skills. The future of graphic program utilization in technical education is promising. Further software advancements, integration with cloud services, utilization of virtual and augmented reality, and implementation of artificial intelligence are expected. These trends will further expand the possibilities of graphic programs and contribute to more effective and engaging instruction in technical subjects.

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