Research Article

THE ROLE OF COMPUTER ANIMATION IN TEACHING TECHNICAL SUBJECTS

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ABSTRACT

Computer animation has a positive effect on memorizing knowledge by students. Used in the process of teaching of technical subjects, it is conductive to the development of mind. Animation allows to familiarize the students with the schemes of solving technical problems and shows the mode of operation of machinery and equipment. In the technique, animations are used, inter alia, in the processes of designing, engineering calculations, visualisation and monitoring technological processes and visualisation of assembly processes. The article discusses the role of computer animation in the teaching process and the examples of applications using computer animation and supporting the teaching process of technical subjects. Selected examples of technical processes in both computer-aided design and manufacturing programs as well as in graphics and animation programs are presented.

Keywords: computer animation, teaching, computer-aided design.

INTRODUCTION

Nowadays it is possible to use a lot of teaching materials in the teaching process to support the work of a teacher and facilitate memorizing the material by students. It is worth noting that along with the development of technologies in education the innovative solutions for the transfer of knowledge are being introduced. Many teachers use computer programs which familiarize students with solutions for solving some problems that are encountered in the classroom and help them deal with problems in both everyday life and future career. Memorization process is influenced by many factors. Human mind develops during the performance of brain-training exercises. Skilful brain-training exercises affect the rapid process of remembering. The human brain consists of two hemispheres. The right hemisphere is responsible for creative thinking or spatial imagina-

tion, while the left hemisphere is responsible for logical thinking. In the teaching process, it is essential to introduce visual elements that will help develop the right hemisphere, but also mathematical elements, logic puzzles, geometric shapes, etc., which support the development of the other hemisphere. Such solutions affect the so-called brain synchronization and thus its development, faster mastery of knowledge and the process of understanding the problem [1–3]. Therefore, solutions supporting the development process are introduced into the teaching process. An example of such a solution is computer animation. Using it in the process of teaching, facilitates students' remembering the material and gives them a general idea of a given issue.

The use of computer animation in the industry is very broad. In practice, all automated industrial processes does the animation support both monitoring and control processes. It is used

at every stage of "life" of a product, starting from conceptual and design phases, through manufacturing, operation and withdrawal of a product from the market or its disposal. Currently, the so-called "virtual manufacturing" is developed very intensively. The use of computer-aided techniques CAx in designing and manufacturing supports visualisation processes, including both technology and production process control. CAx programs (CAD/CAM/CAE) are part of systems that control the life-cycle of a product (product life-cycle management – PLM). CAx programs are widely used in the process of teaching technical subjects [4–6].

COMPUTER ANIMATION IN TEACHING TECHNICAL SUBJECTS

Computer animation is a process of creating a series of images appearing one after another synchronised into a single whole and causing the so-called image animation effect. Animation shows the mode of functioning of many elements. It has wide application in the processes of teaching of various technical, medical and natural science subjects. A still image is more and more frequently substituted by an image that changes over time – animation – while presenting different types of content. In technical disciplines, computer animation is used, inter alia, to teach subjects related to material science, both engineering and utility graphics, fundamentals of machine design, automation of processes and production engineering. It shows the way of operation of many machines which makes it easier for students to design such a machinery, join its parts into a single unit, assemble, etc. Animation can be also used to present different types of processes, such as the process of wear and tear of elements, processing and monitoring processes. In this way, a student has a general idea of how many devices work. It is worth noting that the introduction of tasks aimed at obtaining animated elements by the students into the process of education fosters the development of their both technical and spatial imagination [7-8]. Also in education of students of medical courses relating to biotechnology and biomedical engineering, computer animation is applied in the presentation of the processes of the body's internal organs, the way of moving and functioning of the human body, affected by the use of medical devices and mechanisms replacing hu-

man organs or parts of the body (artificial inserts, bones, screws). It should be also mentioned that students of such courses use simulation process related to animation as well, e.g. during virtual operations.

The teaching process must take into account the current state of knowledge, methods and the means used in the industry. Both virtualization and animation facilitate the presentation of current issues. In the teaching of technical subjects, it is important to combine theory and practice. Hence, animation allows to present a proper application of knowledge. It facilitates the understanding of the issues being presented and the interpretation thereof. It should be remembered, however, that animation does not always include the laws of physics and, therefore, it is often an element of simulation and visualisation of technological processes [9–10].

EXAMPLES OF USING COMPUTER ANIMATIONS OF TECHNICAL ISSUES

Students who study technical majors find it difficult to imagine 2D-drawings in a 3D-system and to analyze complex issues. Therefore, it is right to solve such problems by creating animations. It is necessary to familiarize students with programs that make it possible to execute computer animations. Teaching CAx programs, in particular computer-aided design programs plays a leading role in the process of teaching technical subjects. In the field of technological-computer education at the Faculty of Fundamentals of Technology of the Lublin University of Technology it is implemented, inter alia, in teaching of such subjects as utility CAD programs in machinery design, engineering graphics, 3D modelling, production engineering. Creation of digital geometric models which determine the structural form of a product (one or more objects) is characteristic for CAD. Computer-aided design programs are intended to support the work of an engineer primarily in the first phases of product development. Modern CAD programs make it possible to perform computer animation. It is used for the presentation of 3D models, creation of technical documentation, unit movement simulation, assembly processes, presentation of the results of computational processes, etc. [11].

Animation of 3D models is possible by using one of the basic CAD programs, i.e. Auto-

CAD. It is possible to perform animations of 3D models using such techniques as animation along a trajectory, flight or walk through or next to a 3D model. An example of setting trajectory, camera and a shot action of a shield-like element is shown in Figure 1.

Another important application of computer animation in technical issues is creation of assemblies of modelled parts. This type of activities is possible by using most CAD programs, including Autodesk Inventor. Using Autodesk Inventor, a student has the opportunity to perform the assembly of elements into units and then to transform these elements into animation, e.g. of an assembly process. In this way he/she learns a method of combining parts into a whole. This will help him/her understand the operation of the units being designed. An example of performing an animation of a tap handle is shown in Figure 2. The

creation of an assembly animation makes it easier for a student to prepare technical documentation and to make the handle.

Using assemblies of virtual models, it is possible to simulate circular or linear motion of individual elements (motion animation). This gives the opportunity not only to present a visualization of his/her work, but also helps eliminate mistakes during operation. Motion simulation is possible by using such CAD programs as Solid Edge, Solid Works, Inventor, Catia, NX [12].

CAD programs allows you to create an animation in order to graphically present the results of calculations, e.g. strength calculations using a FEM method. Using FEM, one may examine structural strength in the framework of computer mechanics, simulate deformations, strains, displacements, heat transfer and liquid flow. Dynamics, kinematics and statics of machines as well as
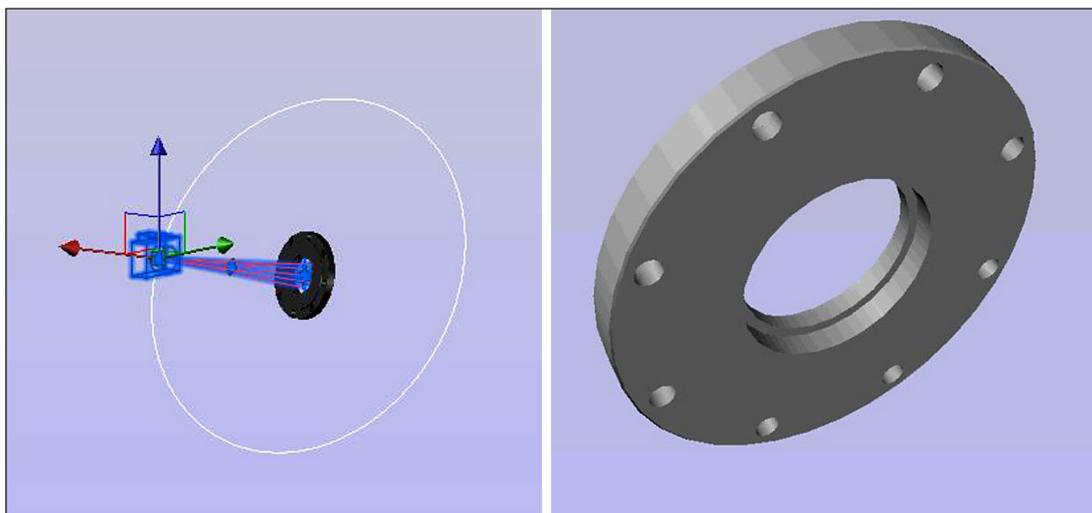

Fig. 1. Computer animation using AutoCAD: a) trajectory and camera setting, b) 3D model animation shot action
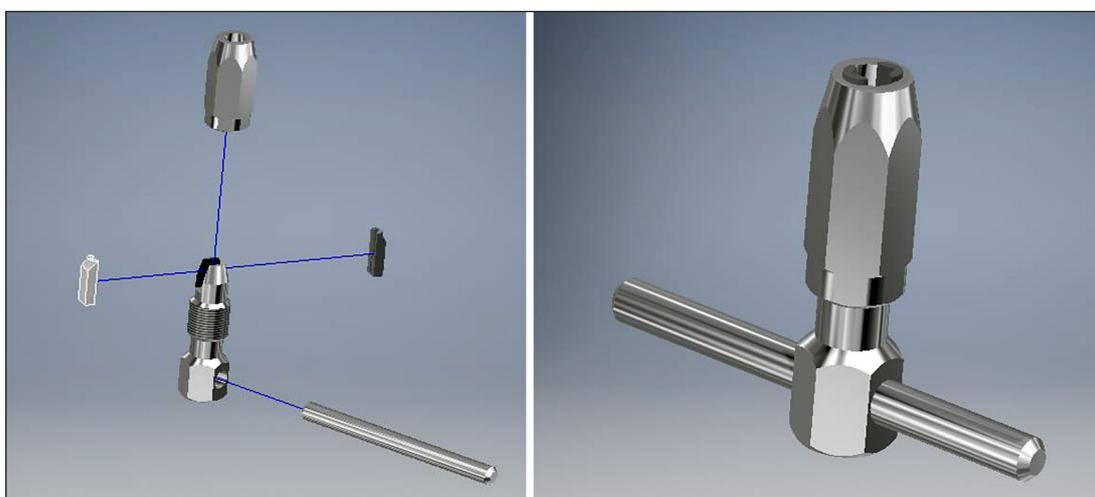

Fig. 2. An assembly animation using Inventor program: a) 3D models with visible installation tracks, b) assembly

electrostatic, magnetostatic and electromagnetic interactions are examined as well.

Another important group that uses animation are computer-aided manufacturing programs CAM. Computer-aided manufacturing consists in the integration of the design and manufacturing phases. CAM programs facilitate designing technological processes. In the field of technological-computer education it is implemented in such subjects as: manufacturing engineering, simulation and visualisation of both technological and research programs. Animation is often used as a graphical element of presentations of simulated technological processes of milling and rolling (Fig. 3). Computer animation of the machining process is applicable finds its application in e.g. verification of the correctness of the machining process, whether it is free from the collisions between the tool and the workpiece or between the machine components. This will help avoid the risk of damaging expensive tools during machining, tool breakage, damages to frames or handles.

This also guarantees the machine to avoid a collision as a result of CNC software errors. Edge-CAM or Sinutrain software by Siemens are the examples of CAD programs supporting the learning of machining processes [13–15]. Figure 3 presents a virtual machining process by rolling using EdgeCAM and Sinustrain software.

Virtualization with elements of animation and simulation of machining processes makes it easier for the students to learn CNC machines programming through checking the correctness of the accuracy of the process and elimination of possible errors. Utility graphics software, such as 3 ds. Max or Blender are also used in the teaching process of technical subjects. In the field of technological-computer education, it is used in the framework of 3D Graphics-Animation. They make it possible to create advance animations, including technical, architectural or production process animations [15]. Figure 4 presents an animation of a residential building along with its interiors created using 3ds Max program.
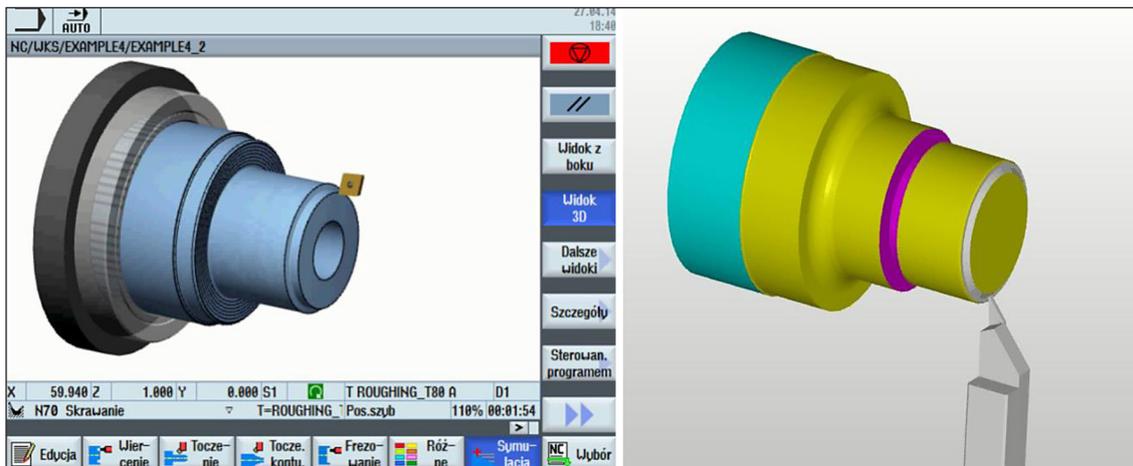

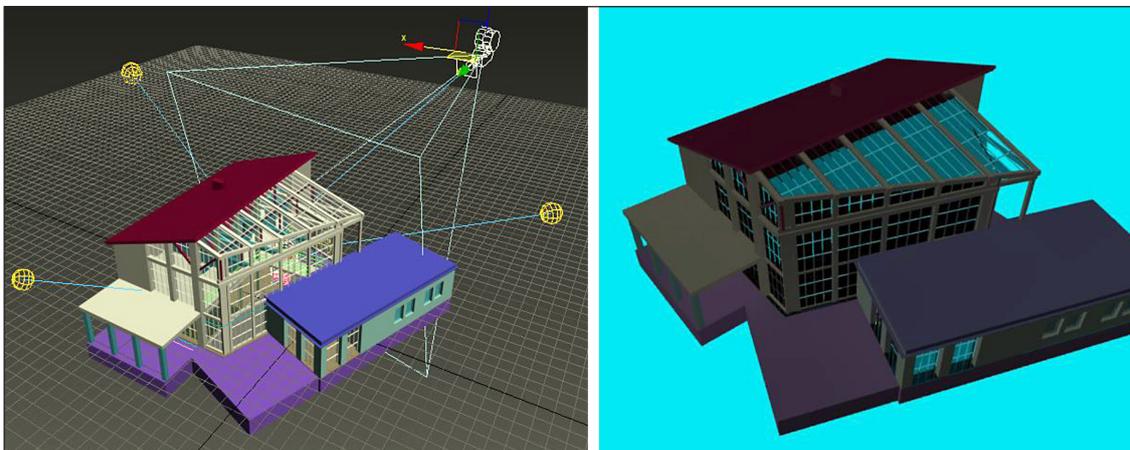**Fig. 3.** Virtual machining by rolling using CAM programs: a) Sinutrain, b) EdgeCAM

Fig. 4. Animation created using 3ds Max program: a) setting of lights and cameras, b) rendering

CONCLUSIONS

Computer animation is currently a rapidly developing field of IT that has found wide application in many fields of science. In the framework of engineering applications, the animations are created using different types of CAx programs (CAD, CAM, CAE), which are the basic tool for a modern engineer. In the field of technology, they are used, inter alia, in the process of designing products, engineering calculations, visualisations of both technological and assembly processes, both monitoring and control industrial processes, etc.

In the teaching process, computer animation has a positive effect on memorization of knowledge by students. Its use in teaching technical subjects is conductive to the development of the mind. Animation allows to familiarize the students with the schemes of solving technical problems. It makes it possible to show the principles of operation of machinery and equipment. The use of computer animation in teaching technical subjects ensures more effective way of preparing students to carry out the task assigned to modern engineers. In conclusion, one can say that computer animation is an important element supporting the process of teaching students in technical fields.

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