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Development Of Application Program Libraries For The Design Of The Sectional Drilling Augers By Means Of Solid Works

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Abstract

Research relevance: The urgency of the problem under investigation is due to significant changes in the PDM systems, general informatization of society and the growing need for higher level of business processes automation, which as a result should cause corresponding changes in the educational process. Under these circumstances, in order to improve their competitiveness the educational institutions should intensively create educational computer programs and educational libraries for CAD / CAE / CAM systems of the world's leading software developers, improving the quality and efficiency of educational process.

Research objective: The aim of the article is to present the experience in the development of software libraries aimed to create 3D reference models of "Drilling auger" parts for subsequent verification of 3D models made by students.

Research methods: The leading research method applied in this work is the simulation modeling of designing 3D models of "Drilling auger" parts using predetermined geometric parameters (made on the basis of algorithmization, programming and visualization), which improves the efficiency and quality of the students' works and their level of self-study as well as expands their professional horizons.

Research results: The article presents a fully completed software library consisting of interlocking procedures simulating the process of designing 3D models of "Drilling auger" parts and an algorithm for the use of the library in the educational process.

Practical value: The model is aimed at adapting the educational process to the new conditions, in which it is located, and oriented to the development of advanced training and methodological support of graphic disciplines.

Keywords*:* CAD / CAE / CAM, API technology, 3D models verification, CAD systems adaptation, drilling auger.

INTRODUCTION

Global informatization of society and the widespread introduction of automation in manufacturing necessitates a substantial change in the educational process consisting in increasing the share of special software libraries for the most famous and popular CAD / CAM / CAE systems (Folomkin & Simenko, 2015; Folomkin & Simenko, 2016; Simenko & Folomkin, 2015; Voronina et al., 2016; Tretyakova et al., 2016; Merkulova, 2012; Merkulova, 2015; Merkulova & Tretiyakova, 2015; Merkulova, 2014; Merkulova, 2016; Merkulova, 2016), revealing and demonstrating the functionality of these systems and giving an understanding of the organization and the degree of work automation in modern factories.

Such libraries are to meet the following requirements:

1. They should be easy to use and have a user-friendly interface.
2. They should clearly demonstrate the design object, its component parts and basic engineering calculations.
3. Their code should be available to perception and self-study as part of the educational process.
4. They should be adapted to the specific curriculum and careers.

These requirements are met by the design of "Drilling auger" performed by students of the St. Petersburg Mining University within the subject of "Computer Graphics".

As is well known auger drills with the help of a variety of technical equipment are used in construction, agriculture, industry and domestic environment (Voronina, Isaev, Semashkin, 2007; Isaev, Voronina, Shurekov, 2008; Isaev, Voronina, Semashkin, 2010). Representative examples of auger drilling usage is drilling of wells of various depths for installation of transmission lines' supports and fence posts, building piles and poles for road signs. In construction drilling replaces expensive pile driving equipment and allows increasing the productivity of work. Holes for planting trees are prepared by means of shallow drilling.

Advantages of auger drilling are the following:

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- Effective operation of the drilling bit without flushing or purging;
- Good cleaning of the backwall;
- High drilling speed.

The only drawback of auger drilling is hole depth limitation. This limitation is due to the small length of the auger and the capabilities of vertical movement of working bodies of the underlying mechanism. But this obstacle can be combated by increasing the drill length during its deepening into the ground. So there telescopic and sectional auger drills appeared.

The largest suppliers of drilling equipment including drilling augers are such countries as the USA, China, Italy and the Netherlands (Falcon industries, the USA; Hunan Unimate Heavy Industry Co., Ltd. China; Via Flaminia, Italy; A. Hak, the Netherlands, ARMADOR; Consultancy Machinery Ltd – Turkey, ROSCHEN INC. Germany). The design of drilling augers of listed manufacturers is quite similar.

The main feature of auger drills is the presence of helix along their entire length. By means of this helix the earth loosened by cutting edges is output on the surface of the ground. This makes it possible to drill continuously until the desired depth of the well without the need for periodic lifting tool to the surface. This drilling technology is more economical in terms of time.

In addition, a number of Russian scientists are engaged in application of the electromechanical surface hardening outside and inside of the drill pipe castle thread which was substantiated by them (Fedorov, Fedorova et al., 2010; Fedorova, Bagmutov et al., 2012; Fedorova, Morozov et al., 2012). In the researches of scientists Fedorov S.K., Fedorova L.V. and others the results of the experimental researches comparative wear resistance of the threaded connections of nipple and coupling, made of steel after only improvement and improvement and electromechanical surface hardening has been given. These scientists have proven that the most typical defects of nipple and coupling drilling pipes is the threads wear, a coupling end wear, the nipple thrust collar wear and the wear of the outer diameter of the locks. The effectiveness of hardening thread by the electromechanical surface hardened has been proved.

Augers are composed of pipes and helical blades, made of steel sheet 5.6 mm thick, which are welded to the outer surface of pipes. The augers are manufactured with a diameter of 100-400 mm. The lead of helix of auger blades is equal to 0.5-0.7 of auger diameter (for soft and viscous rock) and 0.8-1.0 (for loose and hard rock).

Two- and three-bladed bits are used for auger drilling. Two-bladed bit, whose faces are reinforced with hard alloy powder, is used for drilling soft rock.

Three-bladed bit with a cast steel body has serrated blades with an inclination along a helical path. The blades are reinforced with hard metal cutters. One of the blades goes over into auger helix. The pin serves to connect the bit with the auger. These bits are used to drill medium hard rock.

The connection of bits with auger and the connection of augers with each other are carried out by means of thread less locks. Tool joint box is put on the shank, and then the pin is inserted into the hole. The pin is locked by a spring retainer supported by a sleeve. To disconnect auger links the pin is rotated, the retainer comes out of the pin slot and releases it. The pin is knocked out and the auger links are disconnected.

Mechanical speed of auger drilling depends on the physical and mechanical properties of the rocks, the borehole diameter, its depth, and number of auger column revolutions, as well as slaughter load and design of rock cutting tool.

With the increasing number of revolutions and the axial load the penetration rate increases. However, these drilling mode parameters must be adjusted depending on the properties of the rock, the diameter of the borehole and the engine power. The harder the rock and the more the borehole diameter, the greater the axial load on the slaughter.

MATERIALS AND METHODS

Research methods

During the study the following methods were used: theoretical (analysis, synthesis, concretization, generalization, analogy method, and modeling); diagnostic (questionnaires, interviews, testing, method of tasks and assignments); empirical (the study of educational institutions' experience, regulatory and instructional documents, pedagogical supervision); experimental (ascertaining experiment, formative experiment and control experiment); methods of mathematical statistics and graphical representation of results.

Experimental research base

Experimental research base was Federal State-Funded Educational Institution of Higher Professional Education St. Petersburg Mining University.

RESULTS

The structure and content of a model

The library was developed in *Visual Basic for application* programming language using SolidWorks API which is a unique platform to develop your own software libraries providing a high level of automation and allowing effectively addressing the specific needs of the specific customer.

Since the developed library is aimed at the generation of the basic samples of digital models for the subsequent verification of 3D models of parts made by students, its development was carried out in accordance with the existing curriculum and educational developments.

The library consists of procedures intended to create 3D models of parts belonging to the "Drilling auger": a pipe; an auger helix, left-hand tool joint thread and right-hand tool joint thread.

For data input in accordance with the tasks, ***Userform*** control element is used (Fig. 1) with ***textbox*** controls located on the dimensional lines of the auger drawing which is used as background for ***Userform***. ***CheckBox*** controls were used to specify three possible types of tool joint. ***CheckBox*** controls provide an opportunity to select square, hexagonal prism and a trapezoidal thread as tool joint thread. Below there is a ***CommandButton*** control which allows you to calculate and design the details included in the product.

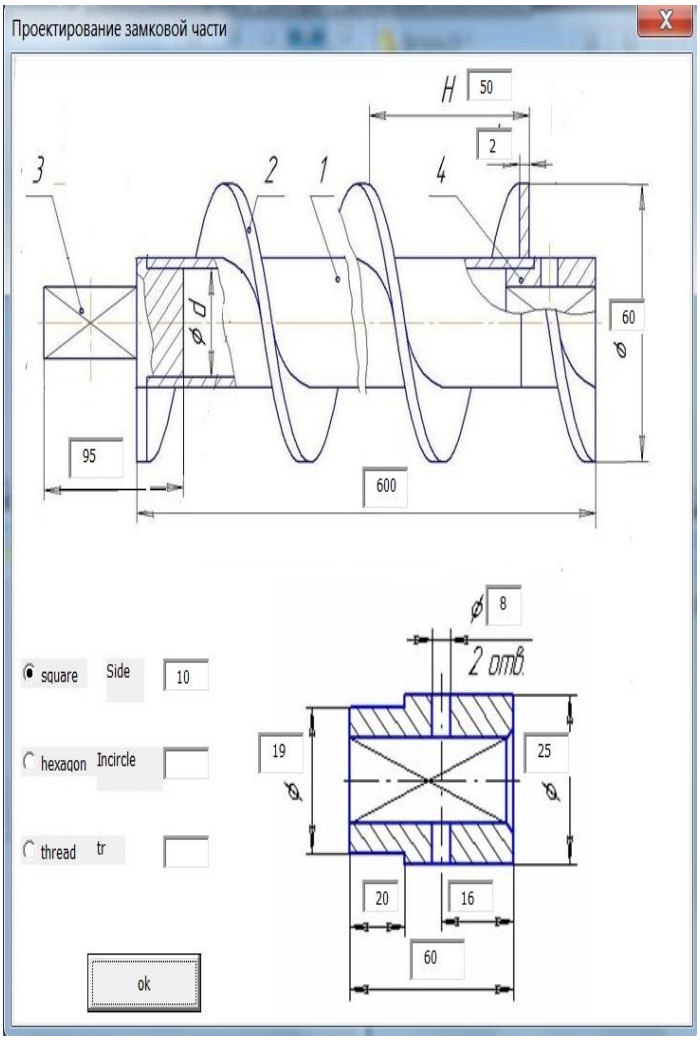

Figure 1. Screen form for data input

After clicking ***Ok*** the developed library by means of SolidWorks API generates a 3D model of the left tool joint and creates three additional files of 3D models containing 3D model of the right tool joint, pipe and auger helix (Fig. 2).

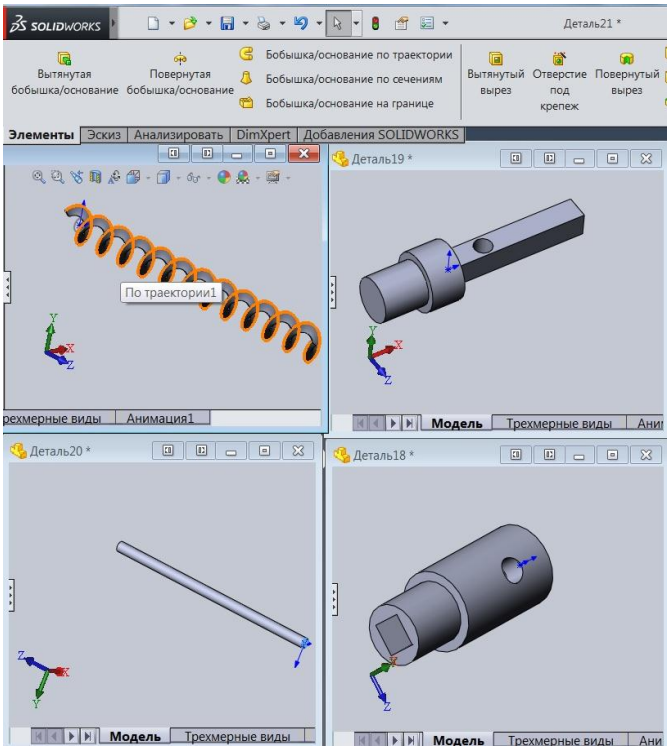

Figure 2. The results of the library application

Once the library has finished its work, it is necessary to save all the files generated by application and perform assembling (Fig. 3).

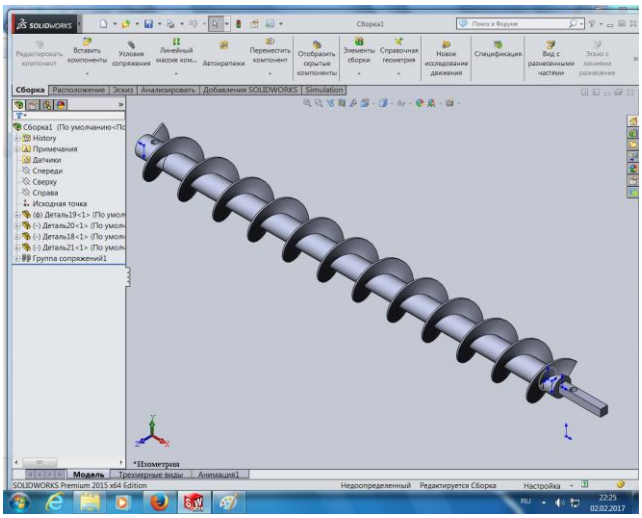

Figure 3. 3D model of the drilling auger

The model usage

The proposed library is used in the educational process for the verification of 3D models designed by students as part of the educational process. For this purpose the command ***Compare Geometry*** of Solid Works comparison tool is used (Fig. 4). This command enables the comparison of surfaces and volumes. Volume comparison results are shown in the new

window **Volume Comparison of <Reference Document> and <Modified Document>**.

Changed and unique surfaces are marked by different colors in the graphics area. Identical surfaces retain their original color.

The total volume, removed or added material are displayed in different colors. In the two assemblies only volumes can be compared.

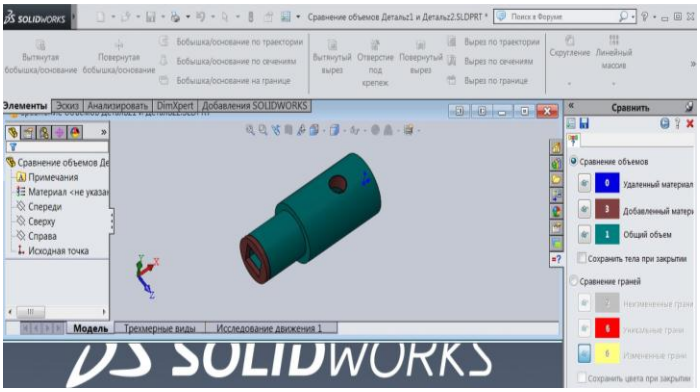

Figure 4. The results of Solid Works comparison tools application

DISCUSSIONS

The study of educational literature allows ascertaining the absence of specially developed software libraries of modern CAD systems for the study of such subjects as “Engineering and Computer Graphics” aimed at creating holistic and complete perception of computer technologies and trends that have emerged in recent years. The main essence of CAD systems development is full integration and interaction of all components of the software and its application techniques to create at an enterprise the unified information space for product lifecycle management (SolidWorks Russia 16.02.2017). It is obvious that the proposed standard solutions of known CAD / CAM / CAE manufacturers do not fully cover the whole life-cycle stages of the product because of its complexity, specific features of production organization, etc. Creation of automated control systems for each of the stages is expensive and long time event (Kovtunov, Leachman, 2013). Any student dealing with engineering should have general information and obtain initial training in this area, in order to meet the current demands of the labor market.

Items concerning creating libraries for Solid Works as well as Solid Works application in the learning process were considered in many works of such scholars as Khanov G.V., Todorov A.N., Dolgov K.O., Dyatlov M.N., Nebaykina Yu. A., Chugunov M.V., Su H., Ren H., Liu X., Prince S.P., Ryan R.G., Mincer T. Stavridis O.M., Kajfez R.L., Riter E.A., Mollica M.Y. and others (Khanov et al., 2014; Khanov et al., 2015; Nebaykina, Chugunov, 2011; Stavridis et al., 2016; Prince et al., 2005; Su et al., 2011).

CONCLUSION

A fully completed educational application program library has been created for development of basic digital models of parts included in the “Drilling auger” for the subsequent verification of 3D models parts made by students of the St. Petersburg Mining University. This development can be used as a visual aid for studying the principles of modern CAD libraries creation using API technologies.

The contents of this article can be useful for professionals working with integrated CAD / CAM / CAE systems and in particular for computer graphics educators and professionals in the field of education focused on the development of educational software.

In the process of creation and introduction of the library into the educational process we have encountered the issues related to carrying out engineering calculations of “Drilling auger” and the automation of this process. This problem is quite significant in terms of the library development and its practical application and it needs future solution.

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