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APPLICATION OF COMPUTER TECHNOLOGIES (CAD/CAM SYSTEMS) FOR QUALITY IMPROVEMENT OF EDUCATION

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ABSTACT: Using computer technology gives the possibility of testing the created models, ie, replaces the need for creating more prototypes in order to test the practical construction. In production systems, there is a need to connect the computer with the executive elements of production (CNC machines). This provides a more efficient production (reduced production time, reduces the cost of production, increases accuracy and quality of the product). This paper presents one of modern CAD tool for modeling (Autodesk Inventor) and one of CAM tool for defining parameters of machining and programming CNC machines (InventorCAM). These tools are used to determine whether usage of these tools improves the quality of education in production preparation for students.
Keywords: education, production, modeling, machining

1. INTRODUCTION

Manufacturing is a primary area of human activities necessary to meet the needs of participants in work processes, work systems and stable development of the society in accordance with established objectives. Without producing society could not survive even the shortest period of time regardless of the natural resources of the country and forms in which it is located. [01]

In production processes designers play an important role. In modern production design cannot be imagined without computer supported technologies. Computer design requires a higher level of knowledge in relation to the classic design, because it means, in addition to design methods, knowledge of hardware and software to work. [02] Modern computational programs are solving more complicated and more extensive problems, so the use of such programs is complex and must be approached systematically and methodically. [02] Particularly important area of computing for technical needs is a field of computer graphics. [02]

Using computer technology gives the possibility of testing the created models, ie, replaces the need for creating more prototypes in order to test the practical construction. In production systems, there is a need to connect the computer with the executive elements of production (CNC machines). This provides a more efficient production (reduced production time, reduces the cost of production, increases accuracy and quality of the product).

Bearing all this in mind, it can be said that important part of must have in education of future designers is supported by computer technology (in this case, the CAD/CAM technology). Similarly, the constant upgrading of existing knowledge engineers in the field of application of new technologies is the imperative of quality production and ensure competitiveness in the market.

2. CAD/CAM TECHNOLOGY DEVELOPMENT

Computer-aided design is one of many disciplines used by engineers and designers in many ways, depending on the specific profession and the type of software. The basic function of CAD activities is certainly a part of integrated management of development activities in the product lifecycle

(Product Lifecicle Management - PLM), and as such is used in conjunction with other tools, which are either integrated modules or stand-alone products, such as: Computer Aided Engineering (CAE), computer-aided manufacturing (CAM), engineering finite element analysis (FEA), including Computer Numerical Control (CNC). [10]

Autodesk Inventor and InventorCAM represent CAD/CAM software tools used in:

1. parametric modeling, animation assemblies created from individual parts, creating technical documentation (Inventor)

Parametric modeling helps designers to present their idea as a 3D model. The model is created based on the geometrical design features that can change at any time for necessary corrections in the design process.

2. Implementation of 3D models into production (software prepares 3D models for physical processing, generating G code used for programming CNC machines) (InventorCAM).

InventorCAM is a certified integrated CAM engine for Inventor that has full connectivity with the model in Inventor. InventorCAM is used in the mechanical manufacturing, electronic, medical and consumer products, machine design, automotive and aerospace industries, as well as workshops for the manufacture of molds, tools and rapid prototyping.

Today, successful companies are using integrated CAD/CAM systems to quickly place the product in market and reduce costs. With InventorCAM software there is advantage of the integration of Inventor + InventorCAM software that can be used.

3. INVENTOR AND INVENTORCAM APPLICATION IN QUALITY IMPROVEMENT OF EDUCATION

By using Inventor and Inventor-CAM software attempt was made to explain to the students the possibility of modeling of products and milling operation. In this way, instead of classical lectures (PowerPoint presentation or slideshow) students view video material of modeling and milling operations represented in manufacturing. On the figures 1, 2 and 3 are presented segments of a given presentation.

Here it will shown the usage of Inventor and InventorCAM in modeling and milling. The purpose of these models is their display in the classroom. For this reason, existing examples of machining is used from course of InventorCAM manufacturer's, (Figure 1 and Figure 2 that the students will be shown the proposed methodology of analysis, while the third example is the model of the pump cover (Figure 3). The model used in the third example is modeled in Autodesk Inventor following the model provided for learning the software.

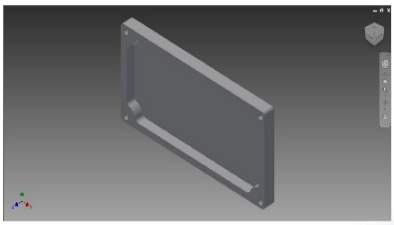

Figure 1. Model view prepared for milling process

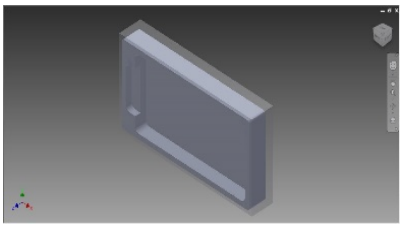

Figure 2. Model view prepared for iMachining milling process

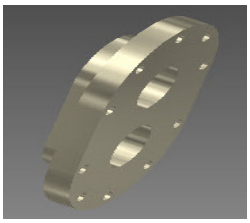

Figure 3. Model view of pump cover

Modeling in Autodesk Inventor

One of the ways of creating 3D models in Inventor relies on the creation of 2D drawings which can get a surface or solid (in this case the solid). Further procedure relies on the use of the same algorithms, but on another level, as well as the processing of the obtained models (drilling holes, chamfering ...) The following illustration (Figure 4 to Figure 7) shows some of the steps of modeling the cover.

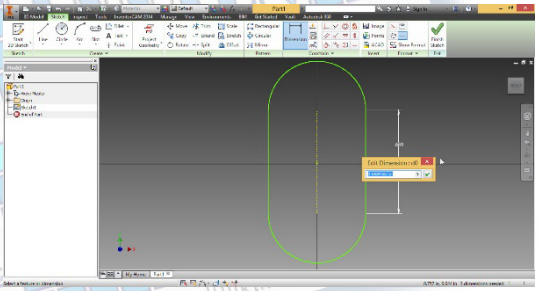

Figure 4. Creation of 2D sketch

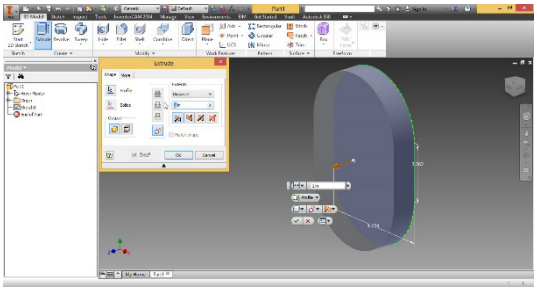

Figure 5. Creation od 3D solid model with command extrude

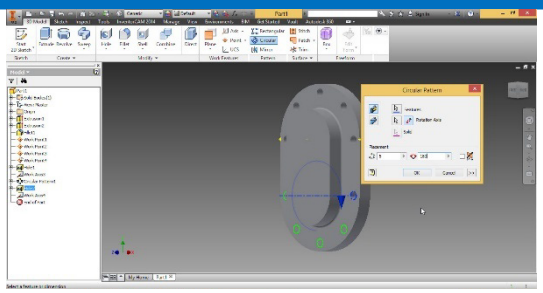

Figure 6. Usage of Create pattern command

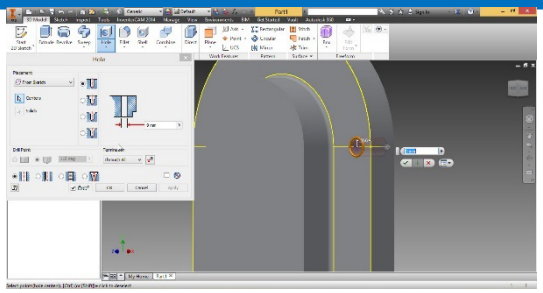

Figure 7. Command Drill

Milling machining

After creating a model in Inventor, machining is defined in InventorCAM-in. After the selection of InventorCAM in Inventor menu bar the type of machining is defined. In this case, the milling (Milling). Then the storage location of the model and procedure is defined, and continue to initial settings.

The initial settings are as follows (Figure 8):

» Definition of CNC machines on which to perform machining
» Defining the coordinate system
» Define the size of the workpiece (in this case the workpiece is rectangular)
» Defining the final layout (select models)

When these settings are made, then it is proceed to the determination of machining operations. Machining of this part includes following operations:

- Machining of the upper surface (Face) (Figure 9);
- Machining of the side of part (Profile) (Figure 10);
- Machining of pocket (Pocket) (Figure 11);
- Drilling holes (Drilling) (Figure 12).

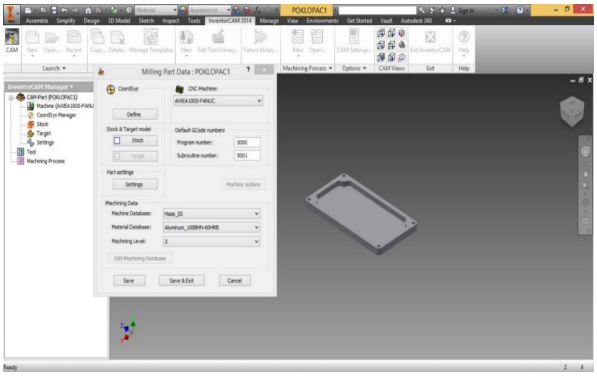

Figure 8. Initial settings dialog

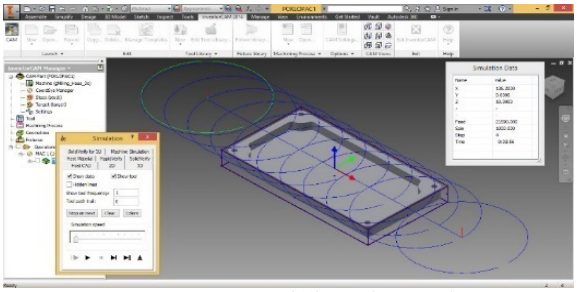

Figure 9. Face milling simulation

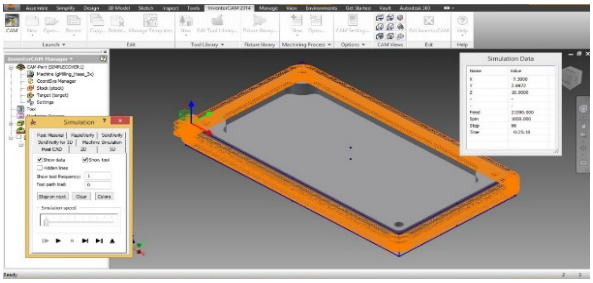

Figure 10. Profile milling simulation

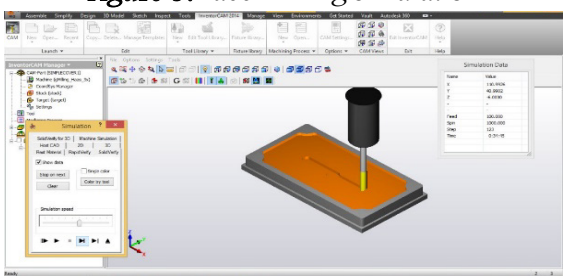

Figure 11. Profile milling simulation

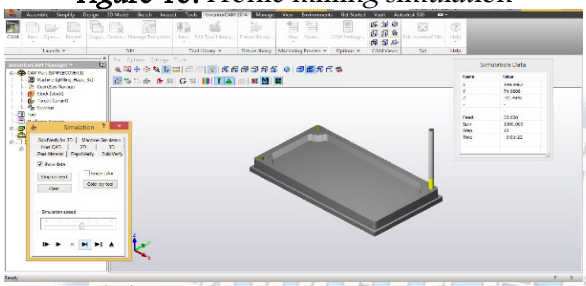

Figure 12. Drilling simulation

Within each operation the following segments are defined:

» Geometry Processing (Geometry) - can be selected in various ways depending on the needs. The most common ways are selecting a machining surface or surface edges, which represents the boder of the machining;
» The tool to be used for machining, the type and characteristics of the cutter (Tool) - perform the settings for dimensions of the blade, the cutting conditions, the material of the blade, determining the type of the holder, blade shape, type of cooling medium, ... In addition there is the view of the blade that is selected in the area with all the segments that have been set;
» The depth of machining (Level) - set the depth and the number of passes of the tool in the operation;

- Strategy process that is applied - the path of the blade (Technology) - can be set the way to enter the blade (spiral, zig - zag ...), the way in which the blade moves (of course depending on the type of milling) (Hatch, Contour, One Pass, Spiral);
- Determination of the inputs and outputs of the tool in machining (Link) - determined by the way the tool will go into operation and how to get out of it.

There more setup options, but for this example are not necessary.

Machining with iMachining technology

Technology iMachining represents revolution in machining. Using its algorithms only saves machining time up to 70%, increasing the life of the tool, provides more efficient machining, and so on. This machining technology is performed in a similar manner as the regular machining technology. Beginning is with the selection of the model and saving the file on computer, and then followed by the selection of equipment, the origin, the size of the workpiece and defining the model. Then the machining operation is chosen. With this type of machining, closed contour, open contour and half-closed contours are defined. In places where we define an open contour or half-closed contour the tool is allowed to enter in machining.

Defining the operation is performed in the same way as in regular machining. The only difference is that for each contour is defined the iRough and iFinish machining (there is no difference between the outer or inner edge). Details of the machining can be set, or can be set to automatic algorithms.

Machining of pump cover

Making the pump cover has been done on the milling machine, using regular milling machining. The machining is like and processing the first model except that the pump cover machining is performed on the two sides to be fully processed. To achieve this, one must define another coordinate system in the plane of the model to the other. Figures below (Figure 13 and Figure 14), represent part of the procedure of machining the cover.

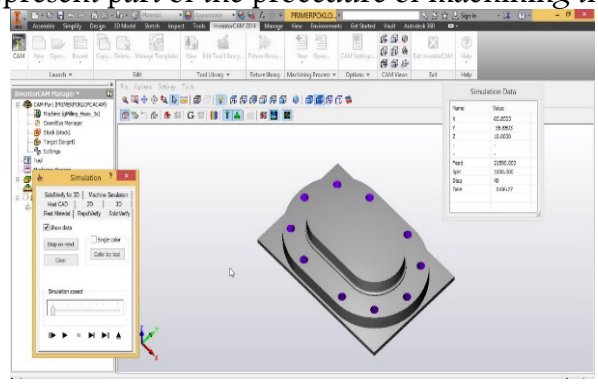

Figure 13. Simulation of drilling through workpiece

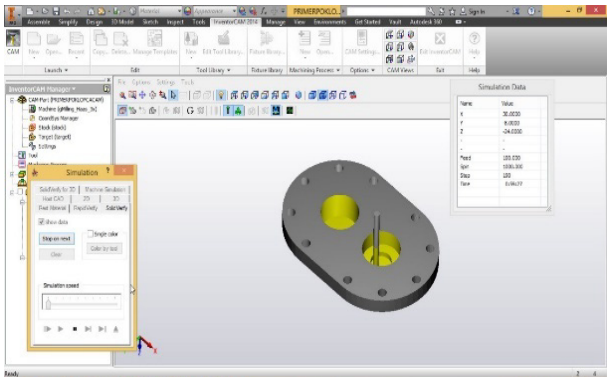

Figure 14. Pocket milling

4. ANALYSIS OF USAGE OF CAD/CAM TECHNOLOGIES IN ORDER TO IMPROVE THE QUALITY OF EDUCATION

The main goal of research is to determine whether, and to what extent, the quality of lectures is improving in the field of modeling and machining, using CAD/CAM software (learning the software or displaying its use in the visual presentation). The expected result is a presentation of the impact of CAD/CAM technology to the education of students.

The sample of this research were students of the Technical Faculty "Mihajlo Pupin" on study programme Industrial Engineering and Mechanical Engineering. It covers an undergraduate and master studies. The total number of participants is 32. Research is conducted in year 2015.

Students are tested by means of a survey.

The research was conducted in the following manner: a lecture was held for students in area of production preparation and related to the machining technology. Briefly was explained to students what is the preparation of production, what are machining technologies and then presented the possibilities of modeling software (Inventor) as well as the capabilities of the software for machining (InventorCAM). Emphasis is placed on the machining operations and animations using the same InventorCAM to determine if using this method of explanation of machining students better accept and understand.

5. DISCUSSION AND RESEARCH RESULTS

Using the survey on students (Table 1) it can be determined if application of CAD/CAM technology in classroom increases the quality of lectures. Results are as follows:

Table 1. Students' opinions on the application of CAD / CAM technology in the lectures

Statement	I absolutely disagree	I do not agree	Neither of the two	I agree	I absolutely agree
1. Shown presentation greatly increases understanding of machining process	0 (0%)	0 (0%)	4 (13%)	12 (37%)	16 (50%)
2. It would be very helpful to introduce the usage of these softwares in education	0 (0%)	0 (0%)	2 (6%)	9 (28%)	21 (66%)
3. This kind of presentation can replace the lack of practice	17 (53%)	8 (25%)	1 (3%)	2 (6%)	4 (13%)
4. This type of presentation (visual presentation) can help in quality improvement of education	0 (0%)	0 (0%)	0 (0%)	6 (19%)	26 (81%)
5. I am interested to learn this software	0 (0%)	0 (0%)	9 (28%)	10 (31%)	13 (41%)

After analysis of acquired data conclusions are next:

1. Using CAD/CAM technologies in order to explain machining process leads to greater understanding of the matter in a large number of students (Figure 15). There is not a single student who claims that this method of presentation has not helped.

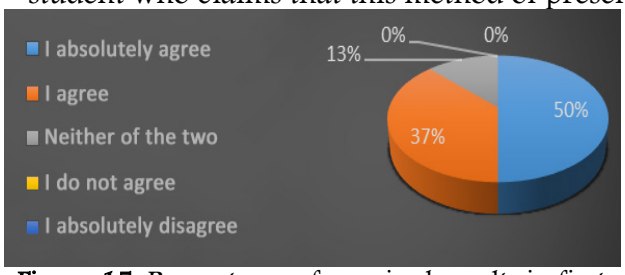

Figure 15. Percentages of acquired results in first statement of survay

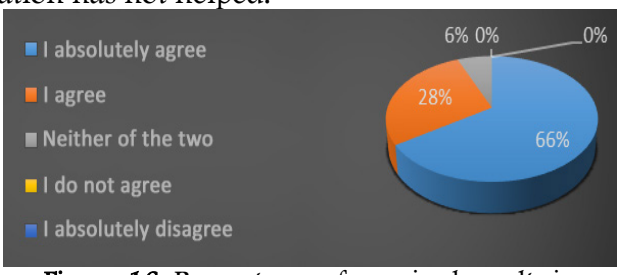

Figure 16. Percentages of acquired results in second statement of survay

2. Application of CAD/CAM technology contributes to quality improvement of education and provide students knowledge of technological development in the world of machining (Figure 16).
3. Practice represent one of important and integral way of transferring knowledge in education system and it is nessesary in learning of Mechanical engineers. It can't be replace, and most of subjects agrees with that (Figure 17).

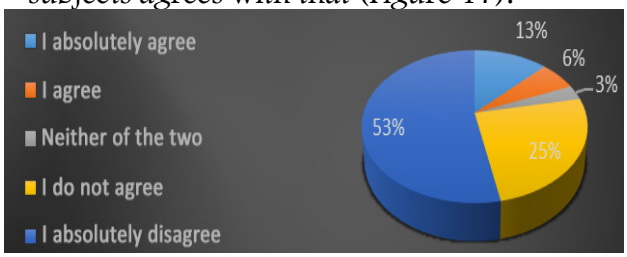

Figure 17. Percentages of acquired results in third statement of survay

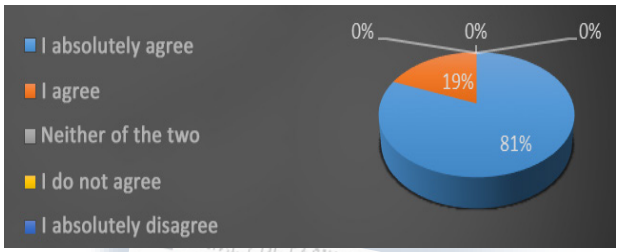

Figure 18. Percentages of acquired results in fourth statement of survay

4. The development of computer technology led to the possibility of creating diverse visual presentations that contribute to improved teaching. Today, the purpose of teaching, from different software can make a visual presentation (on this example it is done from InventorCAM and visual presentation is the animation of milling). From the results, we can see that all the students believe that the presentation will help to improve the quality of education (Figure 18)

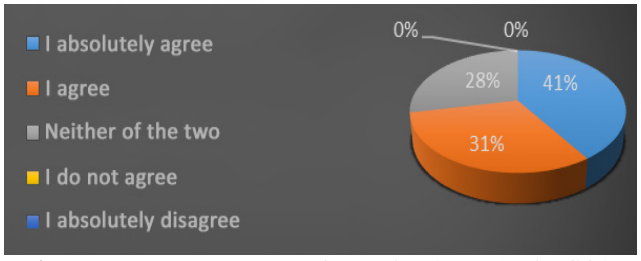

Figure 19. Percentages of acquired results in fifth statement of survay

5. There is interest of students to learn new technology (learning and application of new CAD/CAM technology) (Figure 19). Of all students, no one is opposed to learning software in the field of production).

The conclusion to be drawn from the whole of research, is that the use of CAD/CAM software for display segments of production improves the quality of education.

6. CONCLUSIONS

Improvement of production must be reflected in the improvement of production technology solutions, improvement of tools and improvement of the expertise of employees.

One of the starting factor must be the education of young people for work in production. One can no longer imagine a production without the use of information technologies. In production are especially interesting CAD/CAM technology. As should actively train engineers who are already in production, so should give young employees the necessary tools to work.

The benefits we receive by using CAD/CAM technology (in this case, Inventor and InventorCAM) are the following: savings up to 70% of processing time on the CNC machine; increasing the working life; using patented algorithms and receive an automatic setting of optimal speed, optimal trajectory, the optimal size of the workpiece before machining, as well as tools and materials specification of the machine; saving and increased efficiency which can be seen as a profit and success in the market.

This paper presents a modern CAD modeling tools (SolidWorks), and one of the CAM tools used to create parameters for programming CNC machines (InventorCAM). These tools are used to determine whether their use improves the quality of education in the preparation of production. According to the results of tests it is determined that in this way raises the quality of education and the students are introduced in new software necessary for their further teachings. Software themselves cannot replace the practical education, but does provide an insight into modern production methods. It remains only to think about the future implementations of these technologies. One of perspective might be in the field of lifelong learning, and to create courses that will attended engineers who want to improve themselves in their profession.

Note: This paper is based on the paper presented at the Vth International Conference Industrial Engineering and Environmental Protection 2015 – IIZS 2015, University of Novi Sad, Technical Faculty „Mihajlo Pupin", Zrenjanin, SERBIA, October 15-16th, 2015, referred here as[13].

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