

Development of student's skills of 3D modeling of assembly units

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Abstract. The paper presents data on the influence of additives of the pre-treated aluminium oxide powder on the structure of cast lead-tin-based bronzes. The article demonstrates that modern, advanced from the point of view of automation, methods in designing products are the basis for the successful implementation of any production task. The advantages of product presentation in the form of an assembly consisting of 3D models of its details are described. The extreme importance of high-quality preparation of students of engineering specialties for work in computer-aided design programs such as AutoCAD, Compass 3D, Inventor, Solid Edge, Solid Works, Revit, ANSYS is considered. It is established that one of the most effective forms of increasing the level of computer graphic preparation of students are academic competitions and contests on modeling and prototyping products. The stages of creation of assembly unit models in the AutoCad and Compass 3D software suits generally accepted both in design in a business environment and during training of specialists are considered. The developed 3D models of assembly units are presented in the course of preparation for academic competitions (called Academic Olympics in Russia) of students of the 2nd-5th years of study and the first year students of the master's program in engineering. The conclusions and recommendations on the development of the direction of three-dimensional design in the environment of higher education are given.

1. Introduction

Rapid automation of production processes in instrumentation, mechanical engineering, construction requires improvement of existing approaches to design and construction. High-tech industries can no longer exist without the widespread use of CNC machines, robotics and other equipment interconnected by software algorithms. Obviously, any production begins with a project. Using modern, advanced from the point of view of automation, methods in product design is the basis for the successful implementation of any task.

When designing a new product, the primary stage is creating a general arrangement drawing, according to which design and engineering documentation is developed: for assembly parts - working drawings; for assembly units - assembly drawings and specifications. Due to the development of new technologies, namely 3D drawing technology, it is advisable to use three-dimensional models: to manufacture parts; to develop working drawings of parts, and also to assemble the product. The assembly unit consists of models and gives the most complete and visual information about the parts of the product, the way they are connected and the assembly sequence.

Representation of the product in the form of a 3D assembly consisting of parts models allows:
- designing and changing the shape of parts at various stages of development;



- establishing ways of connecting parts;
- changing elements of parts because of connection methods;
- simulating the movement and interaction of parts;
- observing the sequence of assembly and disassembly of the product;
- performing strength and heat-engineering calculations of the product as a whole and the processes affecting it.

Sometimes during designing, one needs to change the shape or some element of the part in the assembly unit. To do this, modeling directly "in place" is used, where one can use the geometry of existing objects as reference ones. In addition, an associative relationship is formed between the parts, which means that when the geometry of one part changes, the others associated with it change their shape and size. All these tasks are solved using software suits of computer-aided design, such as: AutoCAD, Compass, Solid Edge, Solid Works, Revit, ANSYS, etc.

Turning to the issue of training personnel for work in design organizations using the above-mentioned software packages, it should be noted that any highly-skilled specialist receives basic technical knowledge in a higher education institution, therefore, training students at a decent level is currently unthinkable without the introduction of new technologies into the training process [1-6]. Industrial University of Tyumen actively introduces modern computer technologies; the curriculum includes such disciplines as Computer Graphics, Engineering and Computer Graphics, Automation of Graphic Works. The main goal of the course is to form aesthetic and functional qualities of the subject graphic environment among students with the use of computer graphics hardware and software [7].

One of the ways to increase the efficiency of computer graphic training of students is academic competitions [8]. Since 1998, students from Industrial University of Tyumen have successfully participated in the All-Russian and International academic competitions in Graphic Information Technologies. In Industrial University of Tyumen, an internal round of the student's academic competition in Engineering Computer Graphics is held annually. In April each year, a regional tour of the "Intellect" academic competition is held.

Licensed versions of AutoCAD and Compass 3D are used as a software product. Participants of the academic competition must perform the following tasks: according to the general arrangement drawing, they perform solid models of the specified parts (necessarily the body), included in the product, and working drawings of the same parts. Sometimes apart from the working drawing, it is proposed to assemble a product using a block bank (three-dimensional models). Thus, the task is based on the knowledge of the course of Computer Graphics (three-dimensional geometric modeling) and Engineering Graphics (projection and technical drawing). Preparation of competition tasks is carried out by a third-party institution on behalf of the organizing committee of the academic competition. Preparation of the task on Computer Graphics involves the development of detailed criteria for assessing the work of students in points for each section, since unlike competitions in other nominations, one should take into account not only theoretical knowledge of modeling visual objects, but also the skills of fast work with computer graphics software, as well as a creative approach to the fulfillment of tasks.

2. Methods

Let us consider the generally accepted (both in production and training) stages of product modeling in the software environment of AutoCAD or Compass 3D.

At the first stage, a 3D model of the body part is formed; it includes the unity of bases: design, technological and measuring. The body part is given very great attention in connection with its functional purpose, complex shape, number of attachable parts, etc.

At the second stage, a bank of 3D models of parts included in the product is developed. A model bank is a set of ready-made blocks, both standard parts and original ones, from which further assembly of the product is performed, depending on the way the parts are connected. In such design systems as Compass 3D, there is no need to create models of standard parts because there are libraries.

At the third stage, the assembling process is carried out. The assembly unit is created by connecting

three-dimensional models of parts from the body in such order that each successive detail has common mating surfaces with already inserted parts models, which are superimposed with constraints that limit the degree of freedom. Thus, every detail takes its place in the product. Sometimes it is necessary to pre-combine several parts in the assembly unit with subsequent mating with the product.

Visualization of the interior of the assembly unit is carried out with the help of a section where one can see: the location of parts, the accuracy of connection, the presence of gaps, etc., which allows tracing the correctness of the assembly and identifying collisions, i.e. impossible overlapping of elements, inaccuracy in their connection.

When creating 3D assemblies in the kinematic connections module, it is possible to simulate the movement of parts, ways of mutual displacement. Thus, three-dimensional modeling of the assembly allows us to analyze the process of the work of the product in terms of the adequacy of movements of moving parts of the product. Modeling of assembly units allows eliminating a number of errors at the early stages of designing, for example:

- incorrect part connection sequence;
- misalignment of connecting dimensions;
- absence of gaps;
- inaccuracy in determining the insertion point of a part, etc.

The expertise of the authors of the article showed that a logical development of 3D modeling skills is training in specialized programs for strength and heat calculations and optimization of the shape and functions of the product. A striking example of this approach is the works [9, 10], in which the authors solved the problems of ensuring the strength and stability of vertical steel tanks for oil storage. So, in these works, a 3D geometric model of the structure was first modeled, and then using the finite element method (FEM), calculation was carried out to ensure the strength conditions taking into account the operating loads, boundary and contact conditions.

3. Results and Discussion

Figures 1-3 present the 3D models of body parts developed during training for student academic competitions by students of the 2nd-5th years of study majoring in engineering specialties.

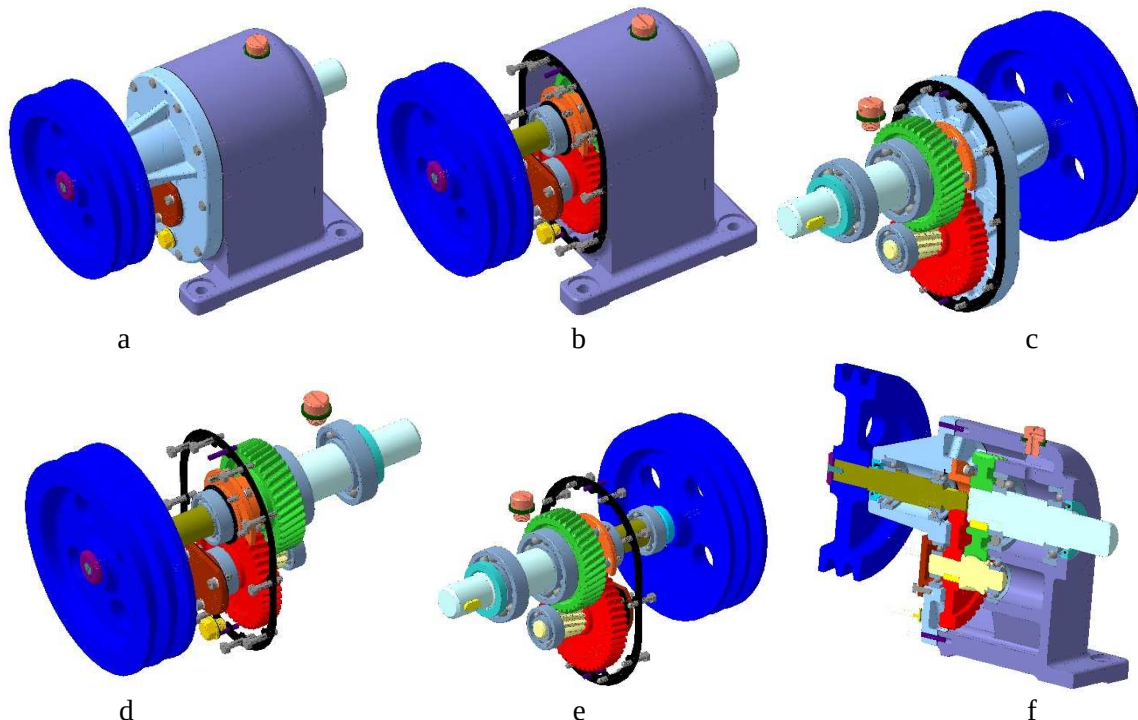


Figure 1. 3D gear assembly.

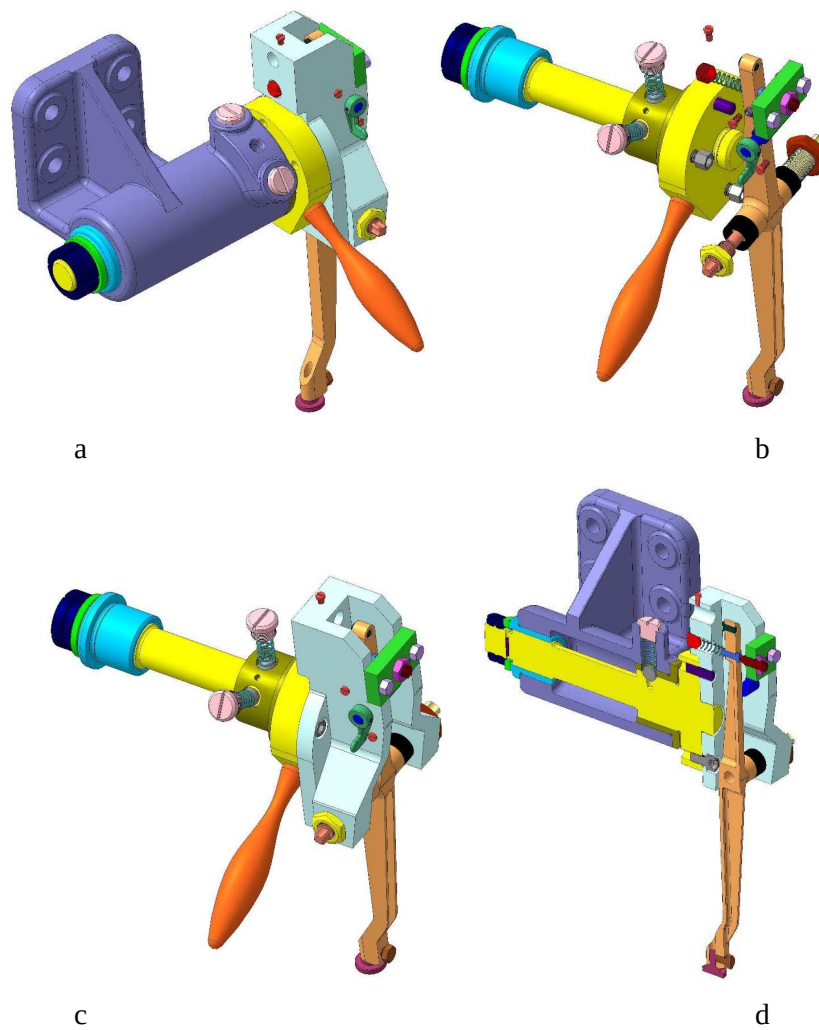


Figure 2. 3D assembly of the device for checking the beating of the end of the gear unit.

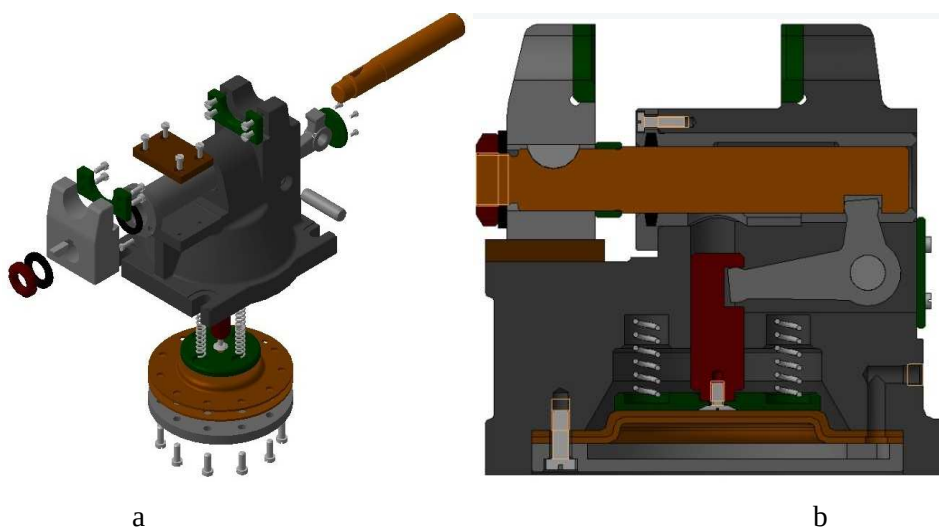


Figure 3. 3D air clamping assembly.

One of the important results of academic competitions is recommendations of the expert panel, consisting of representatives of different universities and administration of Tyumen and Tyumen region, to increase the number of directions in computer programs on Computer Graphics in order to attract students of not only engineering specialties, but also design students.

4. Conclusion

Modern, advanced from the point of view of automation, methods in designing products are the basis for the successful implementation of any production task. The advantages of product presentation in the form of an assembly consisting of 3D models of its details are described.

One of the most effective forms of increasing the level of computer graphic preparation of students are academic competitions and contests on modeling and prototyping of products.

Also, an urgent task of the development of the academic competition movement is expansion of directions and attraction of more students due to the club activities.

1) Modeling assembly units, prototyping products, creating a prototype product and executing the model in compliance with the requirements of 3D printing.

2) Graphic computer design using CorelDraw, Adobe Photoshop or 3D Studio Max.

References

- [1] Fokina N I 2015 *Mechanics and Control Processes* 132-134
- [2] Kochina T B, Melnikova T N and Fokina N I 2005 (Nizhnevartovsk: Nizhnevartovsk Humanitarian University)
- [3] Feoktistova L A and Rzaeva T V 2016 *Theoretical and Practical Problems of Modern Science Development* 60-63
- [4] Romanova V A and Thoma A 2017 *Structural Mechanics of Engineering Constructions and Buildings* **5** 5-11
- [5] Study N E 2011 *Engineering Design Graphics Journal* **75(2)** 2-8
- [6] Ruiters R 2008 *Computer Graphics and Geometry* **10(3)** 54-69
- [7] Corneliu L, Renata A and Sheryl A 2001 *J. for Geom. and Graph.* **5(1)** 81-91
- [8] Tsutsumi E, Ichikawa A and Kadowaki N 2001 *J. for Geom. and Graph.* **5(1)** 101-109
- [9] Tarasenko A, Gruchenkova A and Chepur P 2016 *Procedia Engineering* **165** 1125-1131
- [10] Tarasenko A, Chepur P and Gruchenkova A 2016 *MATEC Web of Conferences* **73** 01018