

# Analysis of Systems for Development of 3D Models

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**Abstract:** The article initially discusses Maya and 3Ds Max because to some extent they are systems for developing three-dimensional models. Further, most popular systems for development of three-dimensional models and analysis, engineering calculations were analyzed: SolidWorks, Ansys, Compass 3D, Autodesk Inventor and as result of analysis identified their advantages and disadvantages; application features. As result, 5 main indicators have been formed according to which it is necessary to choose system.

**Keywords—**preferences; systems; environment; development; 3D model.

## 1. INTRODUCTION

Computer graphics is one of the most well-known fields of technical knowledge.

Modern Computer Aided Design (CAD) and solid-state parametric object modeling systems, which reflect latest advances in computer graphics engineering, are most important developments in field of new technologies for automation of engineers and designers [1]-[4].

In recent years, work of modern CAD in solving intensification problems of opening processes and production of new products will increase more. Medium-level systems are especially intensively developed, which are reflected in their own capabilities to high levels of CAD [5], [6]. That is, issue of creating three-dimensional image of object / production and choice corresponding systems for disclosure is topical issue.

Low-level CAD (two-dimensional CAD design): AutoCAD, CADdy, CADMECH Desktop, MasterCAM, T-FlexCAD, OmniCAD, Compass-Graph.

Intermediate CAD (3D modeling CAD): SolidWorks SolidEdge, Cimatron, Form-Z, Autodesk Inventor, CAD SolidMaster, Mechanical Desktop, DesignSpace.

Top-level CAD (3D modeling CAD): ADAMS, Ansys, Catia, Euclid3, Pro / Engineer, UniGraphics.

That is, modern modeling systems are divided into several categories, each of which is convenient in its field.

For example, in architect's arsenal you can rarely find programs such as ZBrush, in which engineer will not be able to show characteristics of details. Unlike two-dimensional graphics, modeling allows you to see result of work realistically, on scale of its practical implementation, which is especially relevant today.

If you want to display volume in most detail, you need system that works in 3 dimensions at once.

If part is depicted from regulated types: side, back – it is difficult to get complete picture of configuration of part.

Systems for creating 3D-models – multi-vector space in which it is possible to rotate part in any direction, edit it in three coordinates.

## 2. RELATED WORK

At the moment, when paper design documentation is gradually giving up its position and "entered into communication" with electronic.

Thanks to modern CAD (CAD-systems) it is possible to create electronic models of products and significant number of works are devoted to this topic [7]-[10].

In [8] describes process of creating an electronic three-dimensional model of rectangular plates in Ansys system.

In [9] is devoted to process of creating an electronic three-dimensional model in SolidWorks system.

In [10] process of creating an electronic three-dimensional model of conveyor drive in the KOMPAS-3D system is considered.

The work [11] fully describes stages of 3D modeling, lists systems for three-dimensional modeling, and compares capabilities of 2D and 3D models.

Systems for developing three-dimensional models are needed in many areas of human life.

The work [12] is devoted to review of dental CAD / CAM systems.

An overview of open and free CAD for use with 3D printing [13].

An overview of CAD / CAM interfaces is given in [14].

Review of CAD / CAM literature in [15].

In [16] comparison of programs for 3D modeling.

The work [17] is devoted to review of software libraries characteristics for three-dimensional solid-state modeling for small-scale modeling.

### 3. ANALYSIS OF SYSTEMS FOR DEVELOPMENT OF THREE-DIMENSIONAL MODELS

Choosing right system for developing three-dimensional models is important and strictly related to project.

The interface of any simulation system has 4 main view windows:

- from above;
- in front;
- on left and in perspective.

As an example SolidWorks design tree (fig. 1).

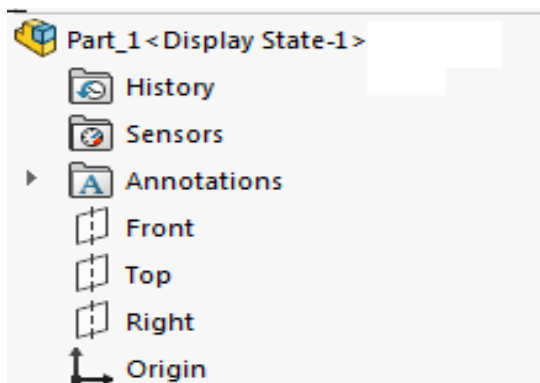


Figure 1. SolidWorks design tree

The first three correspond to standard coordinate system X, Y, Z. All changes are reflected in three-dimensional model in "Perspectives" window.

Experienced designers prefer systems whose file format is imported into other programs [7].

For example, it is more convenient to make drawings in system AutoCAD or in package for creation of vector graphics CorelDraw.

You can transfer created model to desired projection, while maintaining exact dimensions, in system SolidWorks, or another system for engineering modeling, and make three-dimensional model.

Professional CAD systems are not cheap, but they give user complete control over process of creating objects of any level of complexity. Such systems provide image rendering, with any orientation in space, process animation is possible.

There are free CAD systems, most of which have limited simulation tools, but most of inconvenience is due to file format, which cannot be imported into other environments.

First, model of elements is created, and then drawing is created from them. Errors in drawings may remain invisible until installation of finished structural elements. But this is not possible in CAD-systems.

When creating assembly of CAD-system show relative position of parts. But here advantage is that when creating an assembly in CAD system, check is made on anchor points, and this will reflect whether there are errors or inaccuracies.

Solid modeling in CAD system deserves special attention. After entering data on size, density of materials, program calculates physical properties of part, namely center of gravity, strength, temperature and other parameters.

Many companies try to win over users, but there are not many leaders in production of professional programs for designing important projects.

Autodesk is one of leaders. At once two systems of developer are most widely used at professionals – Maya and 3Ds Max. It is difficult to compare them, as computing engine and interface are significantly different, and after rendering only high-level professionals will be able to distinguish results.

It is believed that Maya is more convenient when creating animations, characters, but harder to learn.

Advantages of Maya include:

- increased speed;
- high functionality of animation;
- capture movement of character;
- procedural platform for creating special effects.

Disadvantages of Maya include:

- not suitable for detailed sculpting;
- no built-in vray.

But we will still pay more attention to CAD, for development of technical facilities.

3Ds Max is more used for design of heavy technical objects, due to its lightweight system of surface materials and wide design possibilities (fig. 2).

3Ds Max requires Reactor engine developed by Havok to calculate physical properties, which allows you to modulate behavior of solids, soft bodies, tissues by calculating gravity and other influences.

3Ds Max is also widely used in gaming industry, namely to create models of characters or environment.

For development of three-dimensional models, key place is occupied by engineering and design systems, which are aimed precisely at engineering requirements.

For example, SolidWorks is first program on Windows platform to support all CAD standards.

Advantages of 3Ds Max include:

- ease of use;
- built-in vray (but you need to buy and install additionally; it is chosen depending on version of 3Ds Max) allows you to create realistic images;
- transfer of scenes and models to Unity, UE4 engines.

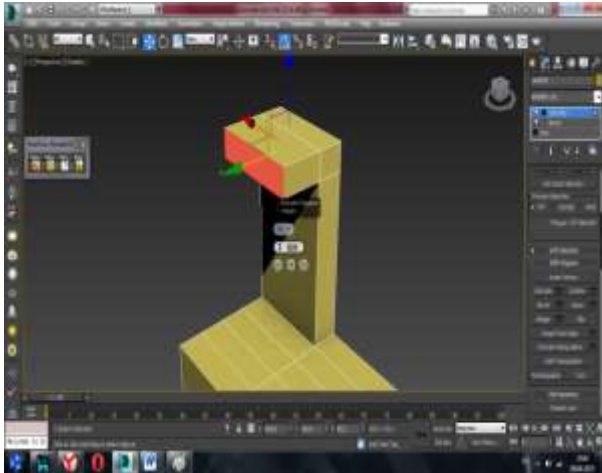


Figure 2. Interface 3Ds Max

Disadvantages of 3Ds Max include:

- high price for professional package;
- not suitable for sculpting people and animals.

Among CAD systems, most popular today are middle-class systems, namely: SolidWorks, Autodesk Inventor and Compass 3D, so let's look at them in more detail.

SolidWorks is multifunctional system for creating high-quality three-dimensional models. The system is also able to calculate physical properties of elements, taking into account their size, weight, material, you can also calculate behavior of gas or liquids in different environments.

Advantages of SolidWorks include:

- clear Interface;
- ability to use one sketch for different processes (assembly, etc.);
- ability to use an incomplete sketch to create elements;
- automatic display of relationships between model elements.

In fig. 3 below you can see result of creating three-dimensional model.

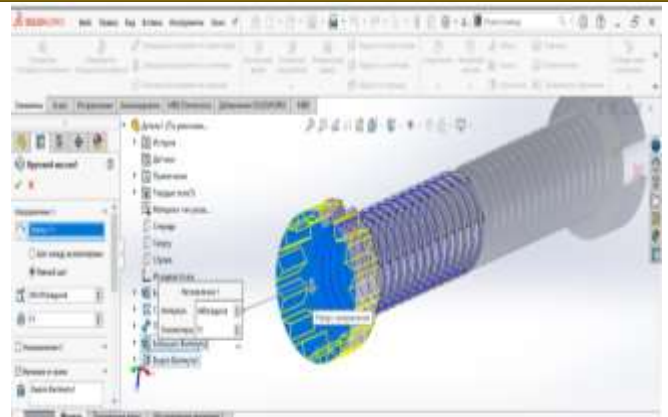


Figure 3. Interface SolidWorks

Disadvantages of SolidWorks include:

- sometimes there is an incorrect automatic sizing, which is easily corrected by user himself;
- to work in this system requires "powerful" hardware, otherwise system is slow or unstable;
- not fully adapted for construction of drawings in accordance with only system of design documentation (OSDD) – it is necessary to make additional settings.

Compass-3D – CAD, which is used to design products in mechanical engineering and construction (fig. 4).

The system allows to implement classical process of three-dimensional parametric design – from the idea to associative three-dimensional model, from model to design documentation [18].

Compass-3D contains standardized structural elements. The system fully supports OSDD standards, with all associative types of spatial models automatically generated by Compass-Graph, and all changes in model are automatically changed in drawing.

Based on once designed prototype, you can quickly create models of various standard products.

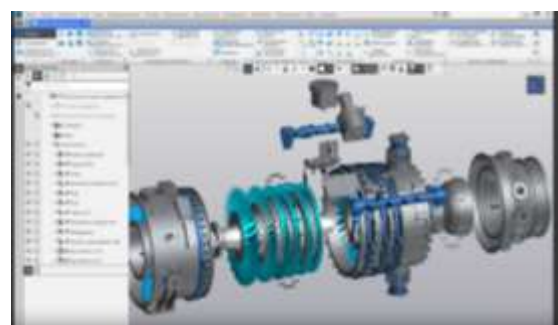


Figure 4. Interface Compass 3D

Advantages of Compass-3D include:

- system is very easy to learn, even for designers who do not have skills to use 3D editors;
- low cost;
- system has large number of elements libraries standardized by OSDD;
- presence of well-thought-out 2D module for drawing;
- allows to check documents for compliance with design standards for OSDD;
- check of models for manufacturability;
- calculation of elastic parts.

Compass-3D include following characteristics:

- not very good ability to visualize objects;
- there may be problems with importing models from other CAD;
- there is no connection of dimensional lines in drawing with geometry of model. After changing model, you need to adjust drawings and spend time to change size, which "took off" and are in air;
- unstable operation of system when creating complex part with large number of elements;
- lack of strength, kinematics calculation, temperature and frequency analysis;
- lack of ability to perform ergonomic calculations.

Ansys is universal system for simulation, analysis and calculations of both objects and physical processes. This system has been developing for 30 years (fig. 5).

Ansys is advanced set of computer engineering modeling tools that uses finite element method.

Ansys is used to solve linear and nonlinear, stationary and non-stationary problems of solid deformation mechanics, problems with gas and liquids, heat transfer and heat exchange, acoustics and electrodynamics.

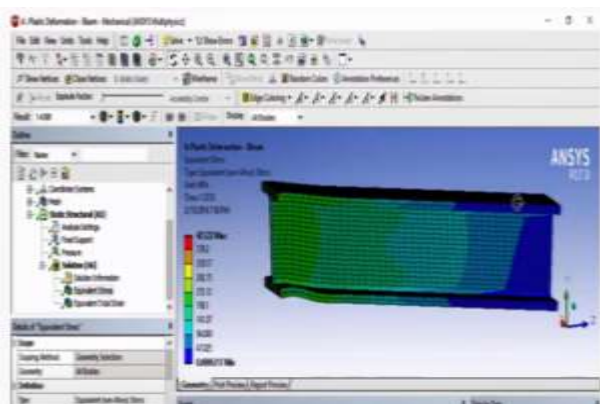


Figure 5. Interface Ansys

Ansys ranks high in 3D printing. With Ansys solutions, you can print parts from variety of materials, including SLM laser printing.

This program covers all engineering fields.

The method of display in systems of this type is similar, but here it is presented in more detail.

Advantages of Ansys include:

- ability to automatically create grid – it is easy to create grid of blocks (hexahedra) or combination of blocks and prisms;
- ability to use for volumes that cannot be "extracted";
- better integration with CAD systems (parametric two-way connections with all major CAD systems);
- automatic detection of contact (assembly mode, mixed connections of shell, beam and integral end elements, hinged connections);
- speed of database creation because there are various templates;
- automatic generation of reports. Integrated reporting, PowerPoint, Word, HTML.

Disadvantages of Ansys include:

- system is not very easy to learn;
- element selection in Ansys means selection of equations that formalize process, and in other systems selection of element does not oblige;
- difficulty in creating structured grid for complex volume because it may be necessary to cut it several times and combine.

Autodesk Inventor is three-dimensional solid-state design system, most powerful Autodesk solution for mechanical engineers [19], [20].

Autodesk Inventor supports various methods of modeling three-dimensional models of any complexity (fig. 6).

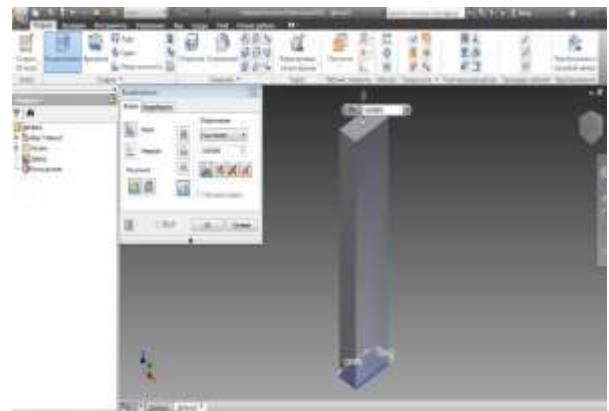


Figure 6. Interface Autodesk Inventor

3D CAD to create and study behavior of digital prototypes of products and parts from Autodesk. Used mainly in mechanical engineering. As in systems described above in Autodesk Inventor, it is possible to give created object such basic characteristics as material, texture, and then system automatically calculates weight of this object.

Autodesk Inventor allows you to give electronic layouts an intelligent component, giving engineers means to flexibly configure their internal parametric structures and providing them with single control point for entire model.

It is possible to easily combine solid and surface modeling, as well as models in form of triangular grid.

Relationships are used automatically when building primitives, but they can also be added or removed later.

The core of Autodesk Inventor is adaptive technology [19, 20].

In this case, user has in his arsenal following methods of creating model:

- traditional parametric method based on tree of construction from separate elements, including constructions on section;
- free "sculptural" modeling based on T-splines;
- free manipulation of elements, faces, edges and vertices of models which very much helps if necessary to continue development of model received from third-party CAD.

Advantages of Autodesk Inventor include:

- work in system is intuitively simple, Interface is convenient;
- productivity when working with complex objects that have "large format";
- full compatibility with DWG format;
- ability to use two-dimensional parametric elements from Autocad to create new three-dimensional models.

Disadvantages of Autodesk Inventor include:

- narrow specialization of system;
- large size of source file;
- when AutoCAD is installed, drawings can open in it, not in Autodesk Inventor.

Note that three-dimensional sketch is more convenient in SolidWorks, but more complete library of standard elements in Autodesk Inventor.

As for SolidWorks and Compass 3D systems: when performing sketch, it is necessary that contour is displayed in style of "Main" line (in Compass 3D). Sketch lines should not intersect or overlap (in Compass 3D and SolidWorks). It is

impossible to track correct construction of primitives (Compass 3D), and in case of SolidWorks, system will not do anything and will display "Error".

Thus, when choosing system for developing three-dimensional model, it is necessary to take into account following indicators:

- scope of particular system, because each system is most convenient in its own field;
- convenience and clarity of Interface for user;
- theoretical foundations laid for numerical modeling;
- high speed of system without lags;
- operating system requirements.

#### 4. CONCLUSION

The article first considers Maya and 3Ds Max systems because, to one degree or another, they are systems for developing three-dimensional models.

Further, most popular systems for development of three-dimensional models and analysis, engineering calculations were analyzed: SolidWorks, Ansys, Compass 3D, Autodesk Inventor and as result of analysis identified their advantages and disadvantages; application features.

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