Research on Furniture Design Based on Computer Software Technology

Yanyun Chen\textsuperscript{1,*}

\textsuperscript{1}Nanchang Institute of Technology, Nanchang, Jiangxi, 330038, China

*Corresponding author e-mail: xjc00f10@nut.edu.cn

Abstract. With the development of computer technology, there are more and more related software for various fields. This paper mainly studies the specific application of Solidworks parametric 3D design software and ANSYS software in home design.

Keywords: Solidworks, ANSYS, Three-dimensional Design, Furniture Design

1. Introduction

With the development of information and digital technology, three-dimensional design software has gradually become popular in the field of furniture design. Solidworks parametric 3D design software is widely used in the industry. It can achieve interactivity in two-dimensional drawing and three-dimensional modeling. In the later stage, it also can be further developed in the later stage. At present, there are few researches in the development of furniture. However, the advantages and functional characteristics of this software can provide a reference for the development and design of furniture products [1].

2. The application status and existing problems of parametric 3D design software in our country's furniture R&D and design

Most domestic furniture companies currently use AutoCAD and 3DsMAX in furniture product R&D and design. AutoCAD is mainly used in the production of two-dimensional drawings such as furniture three views, structural drawings, and process flow charts. 3Ds MAX is mainly used. In the drawing of three-dimensional furniture renderings and overall home improvement renderings. Among them, AutoCAD has a powerful two-dimensional plane drawing function, and the parameterized design is accurate, but its three-dimensional renderings are not as good as 3Ds MAX. Although 3Ds MAX is a three-dimensional design software, it does not have parametric functions, so it is only in effect. The drawing is made with 3Ds MAX software with good rendering effect, which leads to the low degree of intelligence of the drawing of the two software, poor interaction, and can not be effectively modified according to the needs of consumers, and the design efficiency is relatively low. Its workflow is to
separate 3Ds MAX 3D and AutoCAD 2D. In the early stage of product design, 3Ds MAX 3D modeling is used to demonstrate the product to customers, and it is convenient for customers to make requirements and implement further modifications to the product [2,3]. It is still in actual production. It is necessary to manually use AutoCAD drawing software to draw two-dimensional drawings according to the design plan, which greatly wastes the time of product development and is easy to cause errors.

In addition, some large domestic companies are also trying to adopt new back-end 3D design software for furniture, such as KD, 3D-Golden, 72Xuan, Yuanfang Furniture Design Software, 2020, Wood CAD/CAM, etc., such as KD, Yuan Fang, 2020, etc. are widely used in cabinet design. Most of these softwares only quickly build and render three-dimensional furniture models. They lack effective connection with product disassembly, structural optimization, and furniture manufacturing, and cannot guarantee the accuracy of parametric design. Therefore, it is often necessary to use AutoCAD's two-dimensional auxiliary drawing function; although some of the software is highly intelligent and easy to dock, the software is expensive to purchase, and companies often need to establish their own furniture model library, including different specifications and sizes. Furniture models and furniture panels, panel codes, hole diagrams, cutting board diagrams, and machining center programs, etc., which enable companies to invest a lot of money and energy on designer training, model library establishment, and software maintenance and operation. higher cost [4].

3. The role of Solidworks parametric 3D design software in domestic furniture R&D and design

Solidworks software is a three-dimensional parametric design software. It is characterized by size-driven, so that the computer-aided system has the function of interactive drawing. By changing the size of a certain part or several parts of the graph, or modifying the defined part parameters, Automatically complete the changes of the relevant parts of the diagram, and even drive the system to automatically draw based on the information provided by the user, which greatly improves the means of modifying graphics and improves the flexibility of the design. The software can provide modeling, drawing, assembly and secondary development functions. It shows great advantages in the problems of two-dimensional drawing and three-dimensional modeling. It can simultaneously update and update between three-dimensional parts, assembly and two-dimensional engineering drawings. Conversion greatly saves product development time [5].

The application and research of Solidworks software in product research and development at home and abroad are mainly focused on the generation of two-dimensional engineering views and engineering drawing optimization by model-driven, secondary development and establishment of model libraries to shorten the research and development cycle, and the use of finite elements for structural rationality Carry out analysis and optimization design, design and processing integration and other aspects. In our country, Solidworks software has been widely used in the research and development of domestic machinery field, but it is less used in furniture research and development. Most domestic furniture companies still use AutoCAD and other two-dimensional software to draw drawings. Compared with foreign countries, the penetration rate of three-dimensional parametric design software in my country is low. In addition, most of the furniture companies in my country separate the sales, design and manufacturing of furniture products. Use three-dimensional software to organically unify the three. Therefore, the effective use of Solidworks 3D parametric design software is a key link to improve product development.
Compared with other design software, Solidworks software is more suitable for the furniture industry. Compared with AutoCAD, its parametric design, modular design, visual design, and automatic update design have more advantages; the furniture industry has fewer complex models and does not particularly emphasize animation, so Solidworks software can fully meet the needs of furniture design. In addition, the design process emphasizes the application of design parameters in the bomb and emphasizes serial design [6]. E-drawing strengthens the interaction between enterprises and customers.

Although the secondary development of Solidworks software has been widely researched and applied in product development in other fields, it has not been researched and applied in the field of furniture. Therefore, in the process of furniture product development, using the secondary development function of Solidworks software to optimize two-dimensional engineering drawings, establish a plate library and five-piece library, strength analysis, and CNC processing, it is for achieving modular furniture design, accelerating product development, and reducing design. The workload of personnel and shortening the time to market of products play an important role. At the same time, the quality and accuracy of the drawings can be guaranteed, which also brings a good reputation for the company, thereby maximizing the economic benefits of the furniture company.

4. Application analysis of Solidworks software in furniture research and development

4.1. Application of the secondary development of Solidworks engineering drawing in improving the efficiency of furniture drawing

It is the future development trend that three-dimensional aided design software replaces two-dimensional aided design software. However, most furniture companies still use two-dimensional three-view as the main auxiliary guidance production method. Solidworks software can realize the rapid conversion of three-dimensional models into two-dimensional drawings. This method can improve efficiency and reduce the error rate, but Solidworks’s own templates and marking styles do not meet national standards. With the help of the relationship between the 3D model and the 2D engineering drawing, the intelligent generation of the 2D engineering view can be realized; using Solidworks The secondary function of the software standardizes two-dimensional engineering drawings, so that Solidworks software can intelligently generate engineering drawings that meet national and corporate standards, add standard fonts, and customize standard drawing formats and materials [7].

Detailed, engineering drawing templates, custom attribute links in the three-dimensional template, make two-dimensional engineering drawings, three-dimensional model graphics, text information all relevant, and thereby improve the efficiency and quality of the two-dimensional engineering drawings.

4.2. Application of Solidworks model library in furniture modeling and structural modular design

In the design of a furniture product, a lot of standard panels, hardware, common parts of enterprises and purchased parts are inevitably used. The Solidworks software is used to establish the corresponding standardized plate and hardware libraries, so that the models in these libraries can be called by the Solidworks software in an organic and orderly manner, and a three-dimensional model library management system is developed based on this to realize the modular design of furniture products.

5. Simulation mechanics analysis of ANSYS software in furniture research and development
5.1. Model processing

After the model is imported into the ANSYS software, you first need to set an element type for the material, and define the model as a wood characteristic and orthotropic model body with the material used in the table case. In this case, the Structural Solid 3DSOLID 45 element type is selected. Wood characteristics such as shape, creep and expansion. Secondly, according to the real material properties of wood, various performance indicators of wood, such as elastic modulus, Poisson’s ratio, etc., need to be given to each part of the furniture. The unit of elastic modulus is MPa; due to the different force directions of furniture parts, The test needs to define three material properties: longitudinal, radial, and chord. Thirdly, for the assembly model, it is necessary to establish a force transfer association between the components through Boolean operation, so that the assembly model becomes a whole that can be calculated and analyzed. The Boolean operation method can choose Glue or Over-lap [8]. Finally, according to the force direction of the furniture components, the set material properties are given respectively, and the finite element mesh of the assembly model is divided to prepare for the next analysis and calculation. The specific steps of the above operations are shown in Table 1.

| Operation instruction | First level instruction | Second level instruction | Third level instruction | Fourth level instructions | Fifth level instruction | Sixth level instruction | Seventh level instruction | Eighth level instruction |
|-----------------------|-------------------------|-------------------------|------------------------|--------------------------|------------------------|------------------------|--------------------------|-------------------------|
| Select unit type       | Main Menu               | > Preprocessor          | > Element Type         | > Add/Edit/Delete        | > Add                  |                        |                          |                         |
| Give material properties| Main Menu              | > Preprocessor          | > Material Props       | > Material Models        | > Structural           | > Linear               | > Elastic                | > Isotropic             |
| Boolean operation      | Main Menu               | > Preprocessor          | > Modeling            | > Operate                | > Booleans            | > Glue/Overlap          |                          |                         |
| Grid selection         | Main Menu               | > Preprocessor          | > Mesh Attributes      | > Picked Volumes         |                        |                        |                          |                         |
| Meshing                | Main Menu               | > Preprocessor          | > MeshTool             |                          |                        |                        |                          |                         |

Table 1. ANSYS operation steps (1)

Model processing is prone to errors in Boolean operations and meshing operations. The main reason is that the contact surfaces of parts in the assembly model overlap or incompletely fit, which can be avoided by changing surface contact to planar contact.
5.2. Applying loads and restraints

Table 2. ANSYS operation steps (2)

| Operation instruction                  | First level instruction | Second level instruction | Third level instruction | Fourth level instruction | Fifth level instruction |
|----------------------------------------|-------------------------|--------------------------|-------------------------|--------------------------|-------------------------|
| Force analysis and calculation         | Main Menu               | > Solution               | > Solve                 | > Current LS             |                         |
| View deformation                       | Main Menu               | > General                | > Plot Results          | > Deformed Shape         |                         |

constraint and load can be applied to the furniture in accordance with the corresponding national standard testing standards according to the content that needs to be tested. The national standard GB10357.1-89 specifies the method of table strength and durability test. The test items include vertical static load, horizontal static load, desktop vertical impact, table leg drop, durability and other tests. The location and size of the load and the constraint conditions at each point have been specified in detail. In this case, only the vertical static load test is carried out. The concentrated load is applied to the center of the tabletop vertically downwards. The load level considers ergonomics, and the large load is 1528N. The table legs are fixed in contact with the ground and are fully restrained. The specific steps of the above operations are shown in Table 2 [9].

| Operation instruction                  | First level instruction | Second level instruction | Third level instruction | Fourth level instruction | Fifth level instruction | Sixth level instruction |
|----------------------------------------|-------------------------|--------------------------|-------------------------|--------------------------|-------------------------|-------------------------|
| Define constraints                     | Main Menu               | > Preprocessor           | > Loads                 | > Define Loads           | > Apply                 | > Structural            |
| Apply load                             | Main Menu               | > Preprocessor           | > Loads                 | > Define Loads           | > Apply                 | > Structural            |

5.3. Model mechanics calculation

After the above operations are completed, the ANSYS software can start the solution, the calculation lasts for a few minutes, and then a variety of result analysis graphs are generated. The deformation, stress, and strain distribution and magnitude of the furniture can be visually displayed in the graph. By comparing the maximum stress and strain obtained in the simulation analysis with the relevant standards of material strength and furniture mechanics, it can be judged whether the mechanical properties of the furniture meet the requirements, so as to adjust and optimize the shape and size of the furniture components at any time during the design process to ensure The mechanical strength can beautify the shape of the product and reduce the material consumption, achieve the synchronization and unification of the mechanical design and the overall furniture design, and provide a scientific basis for the furniture structure design. In addition, the deformation stress and strain distribution of each node on the furniture can also be viewed by way of list generation, as shown in Table 3 [10].

Table 3. ANSYS operation steps (3)
6. Conclusion

In summary, with the development and popularization of software technology, this has brought unprecedented opportunities and challenges to the furniture design. Of course, the application of software technology in furniture design has gradually matured, but there are still some problems. This requires us to improve software technology and use software technology more proficiently.

Acknowledgments

Project Name: Jiangxi University Humanities and Social Sciences Research. Project approval number: YS19238.

References

[1] Zhang Guoliang, Cai Xiaona. Application of SolidWorks Software in Furniture Design [J]. China Wood, 2011:29-30.

[2] Chen Feng, Xia Xinghua, Yin Manxin. Application of SolidWorks Software in Furniture Design Course Teaching [J]. Journal of Liaoning Higher Vocational Education, 2016:60-62+92.

[3] Xia Xinghua, Chen Feng. Application of SolidWorks Parametric Design Software in Furniture Research and Development in China [J]. Liaoning Forestry Science and Technology, 2017

[4] Chen Shao-yu, Ke Qing, Guo Hong-wu, Zhang Fan, Li Li. Application of finite element software ANSYS in structural design of solid wood furniture [J]. Forest Products Industry, 2014:43-45.

[5] Zhang Guoliang, Cai Xiaona, Liu Zhijun, Zhu Yanzhong. Application of ANSYS Software in Structure Optimization Design of Panel Furniture [J]. China Wood-Based Panel, 2011:14-17.

[6] Hu Yanping, Li Run. Application of CAXA Entities Design Software in Plastic Mold Design [J]. Journal of Lanzhou Petrochemical Vocational and Technical College, 2017

[7] Li Zhuo. Application of Bionic Design in Furniture Design [J]. Art Education Research, 2018

[8] CHEN Qiao. Application of Computer Design Software in Graphic Design [J]. Electronic Technology and Software Engineering, 2016:85.

[9] Dong Jiangjiang. Application of 3D Design Software in Packaging Design [J]. Tomorrow Fashion, 2016

[10] WANG Xiuli, WEI Yonghui. Application of UG Software in Mold Design [J]. Mechanical and Electrical Engineering Technology, 2016:127.