

Research Article

CAD Education Resource Platform for Mechanical Design and Manufacture

¹Yan Cao, ¹Yun Lu, ¹Hui Yao and ²Hengguo Cheng

¹Department of Mechatronic Engineering, Xi'an Technological University, Xi'an, 710032, Shaanxi, China

²Xianyang Institute of Science and Technology Information, Xian yang, 712000, Shaanxi, China

Abstract: There are no corresponding CAD education resources for CAD courses for students at colleges and universities. A CAD education resource platform for mechanical design, manufacturing and automation speciality is developed. Feature-based modeling, Pro/TOOLKIT and Family Table provided by Pro/ENGINEER and Visual C++6.0 are utilized to develop three-dimensional standard part resources according to the newest Machinery Design Handbook. Its man-machine interface is developed that accords with engineering personnel's habit. The interface between Pro/ENGINEER and Access databases is developed to call the data in Access databases from Pro/ENGINEER. The platform is mainly used to provide standard part models for the students studying CAD related courses. It is intuitionistic and easy to use. The approach can also be applied to develop other education resource platforms.

Keywords: CAD, education resource, platform development, pro/ENGINEER, Pro/TOOLKIT, standard part, visual C++

INTRODUCTION

According to the survey of machinery enterprises, the statistics show that the use of standard parts accounts for about 50% of the total parts and components and the use of typical variable parts accounts for about 40%. Practice has proved that standard parts have excellent performance (Du and Cao, 2012). Engineering personnel can guarantee product quality and reduce production cost by adopting the standard parts. However, there are no corresponding CAD education resources for CAD courses for the students at colleges and universities (Hui-Ying, 2011).

In the study, we try to establish a CAD education resource platform for mechanical design, manufacturing and automation speciality. The platform is mainly used to provide standard part models for the students studying CAD related courses. The standard parts can accumulate design results, maximize the reuse of design resources in design process and improve design quality and efficiency. In the study, the platform is constructed to establish a three-dimensional standard part library to meet educational demand. The platform is integrated with Pro/ENGINEER to facilitate its use and provide standard part models for the students studying CAD courses and technologies.

OBJECTIVE OF THE PLATFORM

In CAD (Computer Aided Design) of mechanical design and manufacture, there is a lot of graphics workload which involves standard parts, such as rivet, rivet nut, bolt, nut, etc. Because of their large number of types, structures and parameters, their drawing is very cumbersome and engineering personnel have to repeatedly check manuals or handbooks to find the corresponding data. Accordingly, it requires a very intuitive, convenient, speedy and accurate system to generate the required standard part models. In the study, a CAD education resource platform for mechanical design and manufacture is established to provide the standard part models for the students in their studying CAD related courses.

The objectives of the platform are as follows.

- The platform is to store the information of a variety of the standard parts. With a management system and corresponding CAD man-machine interface, the student can easily query and retrieve the necessary information of the standard parts in their studying process or CAD applications (Zhang and Luo, 2011).
- The students need not to construct every standard part. The platform can generate the models

Corresponding Author: Yan Cao, Department of Mechatronic Engineering, Xi'an Technological University, Xi'an, 710032, Shaanxi, China

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automatically according to the students' requirements. Thus, they can be familiar with a variety of standard parts easily. It can also improve the efficiency and standardization degree of students' CAD application (Li and Qiu, 2006).

- The platform should provide a wide range of standard parts in accordance with the latest version of Machinery Design Handbook that includes the detailed specifications of different structural parameters of the standard parts. It will facilitate the students' studying other related knowledge of mechanical design and manufacture (Yu and Liu, 2007).
- The platform should provide a convenient interface for the students to use the platform in Pro/ENGINEER. This demands the platform to be integrated with Pro/ENGINEER.
- The platform should be expanded easily and accord with national and industrial standards. The generated standard part models should be modified easily and can be used to establish assemblies in Pro/ENGINEER.

PLATFORM ARCHITECTURE

The platform architecture in Pro/ENGINEER environment is shown in Fig. 1. There are four elements that is, user interface, Pro/TOOLKIT interface procedures and parametric models of standard parts and relational database of standard parts. The core elements are parametric models of standard parts and relational database of standard parts (Cao *et al.*, 2009).

Three-dimensional standard part models are created by using feature-based modeling technique, so the standard part models are not only solid models, but also parametric models driven by sizes. The relational database stores the various parameters of standard parts. Because the parameter types and values of a kind of standard parts are different, different table is used to store the data of different kind of standard parts. In the study, the relational database is established with Microsoft Access.

The user interface of the platform is composed of a number of menus and dialog boxes. It is the bridge to link the parametric models and relational database of standard parts. The platform can achieve real-time interaction with the students and guide them to choose the specific structure and type of standard parts. When the platform is called, the user interface prompts the students to choose key parameters of standard parts. In the study, the user interface is developed with VC + +6.0.

Then, in the light of the students' choice, the platform accesses the relational database according to the key parameters. The platform retrieves the structural parameters and performance parameters of the selected standard part from the relational database, assigns these parameters to the corresponding design variables and forms an external parameter document associated with

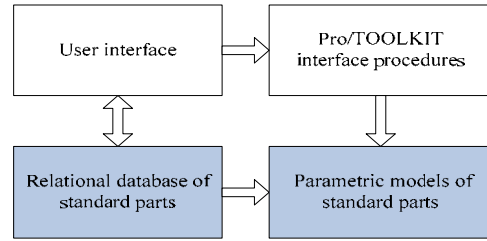


Fig. 1: Platform architecture

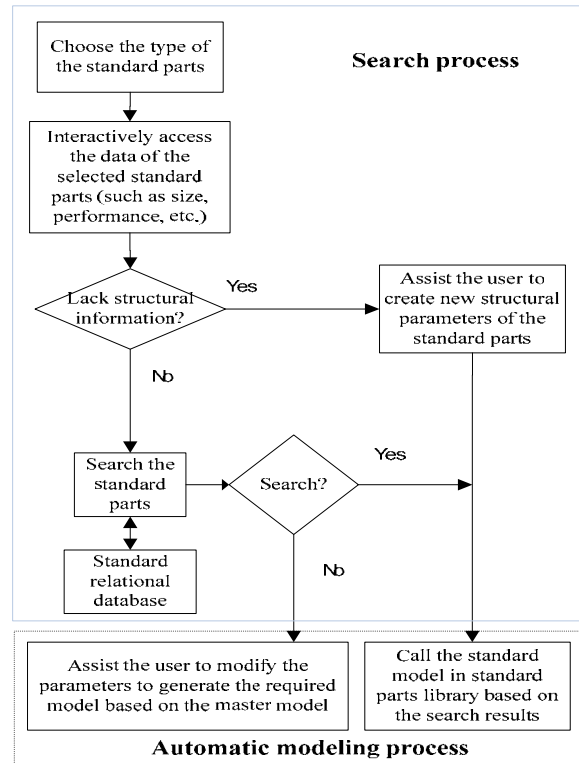


Fig. 2: Search process and automatic modeling of the standard part

the standard part model. This function is developed using VC++ 6.0 and Pro/TOOLKIT and runs in Pro/ENGINEER environment as a dynamic link library (.DLL).

And then, based on the pre-defined parametric standard part model, automatically generate the required three-dimensional standard part model through size-driven Pro/TOOLKIT interface procedure in accordance with the parameter values in the external parameter document.

Search process and automatic modeling process of the platform are shown in Fig. 2.

ESTABLISHMENT OF THE MASTER MODEL OF STANDARD PARTS

Using Pro/ENGINEER powerful feature-based modeling and Family Table, the master model of standard parts is constructed.

Before set up the master model, we classify the types of all standard parts in accordance with their structures. For each type, a master model is constructed. On the basis of the type and the similarity principle of standard parts, we are able to determine how to

completely express all characteristics of a standard part type using a composite part (the master model). After analyzing its features and their creation order, the master model can be created using feature-based modeling in Pro/ENGINEER environment. Based on

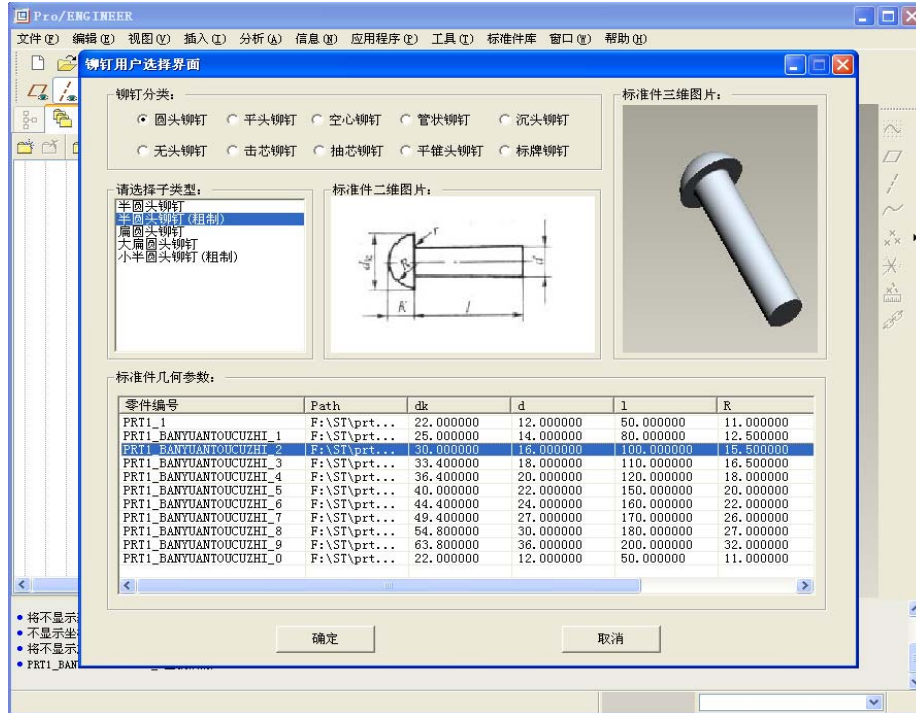


Fig. 3: Parameters of a half-round head rivet

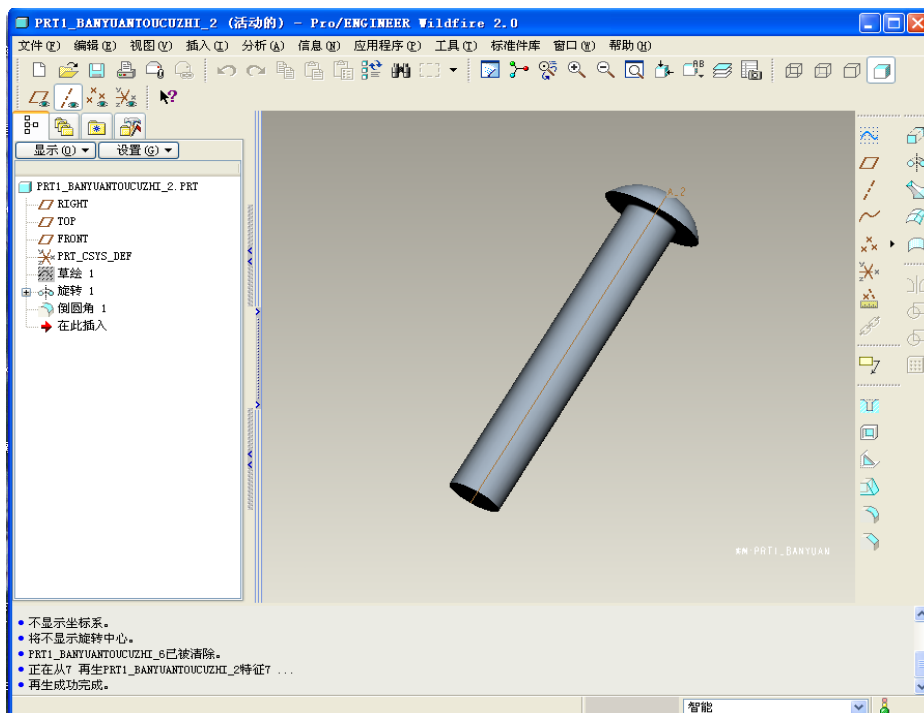


Fig. 4: The generated half-round head rivet

the master model, any standard part of the type can be derived. In order to realize the three-dimensional parameter-driven master model, a set of design parameters are determined to control the shape and topological relations of the master model. All the parameters in accordance with national and industrial standards are stored in Pro/ENGINEER Family Table that is used to automatically generate the three-dimensional models of standard parts.

The procedure to create the master model is as follows.

- In order to ensure that feature regeneration will not fail when using the parameters in Family Table to drive the master model, the structure and "father and son" feature relationship and feature order of the master model should be fully analyzed. The fixed features should be modeled before the features that are more likely to change are modeled.
- Complete the creation of the three-dimensional master model of standard parts in Pro/ENGINEER and define the relationships between parameters in the master model.
- Using Family Table in Pro/ENGINEER, add features, sizes and other parameters for the standard part type that are used to create a series of standard parts of similar structure and slightly different shape and size based on the master model.
- To verify the data correctness of Family Table, each standard part of the type has to be created.

APPLICATION

Start Pro/ENGINEER, the platform is integrated with Pro/ENGINEER as a new added menu. Taking half-round head rivet for example, the application of riveting joint standard parts is as follows. Choose a rivet type needed, as shown in Fig. 3 and 4. Then, choose the corresponding parameters. Click "OK" button to generate the half-round head rivet model.

The process to select a rivet nut is similar to selecting a rivet. The interface to generate a flat head rivet nut model is shown in Fig. 5 and 6.

The process to select a coupling joint is shown in Fig. 7.

CONCLUSION

For modern CAD education, infrastructure construction is gaining more and more attention. How to construct education resources and corresponding platforms is an important issue. In the study, a CAD education resource platform is developed that is integrated with Pro/ENGINEER. It provides a wide range of standard parts in accordance with the latest version of Machinery Design Handbook for the students studying CAD related courses at colleges and universities. In the development of the platform, feature-based modeling, Pro/TOOLKIT, Family Table and Visual C++6.0 are used to achieve user-friendly man-machine interface, search functions and automatic

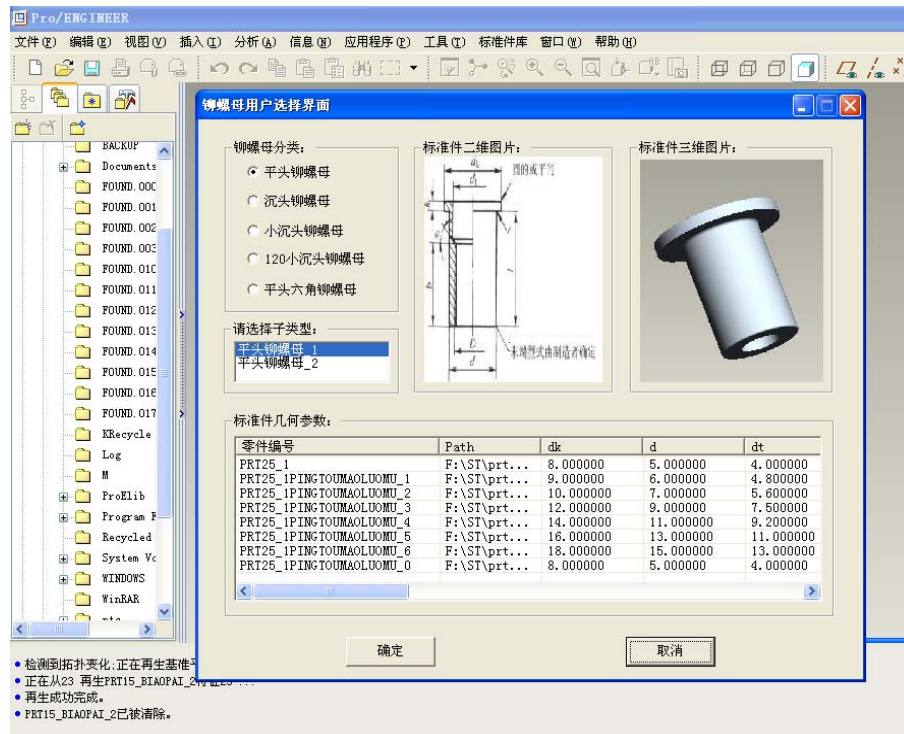


Fig. 5: Parameters of a flat head rivet nut

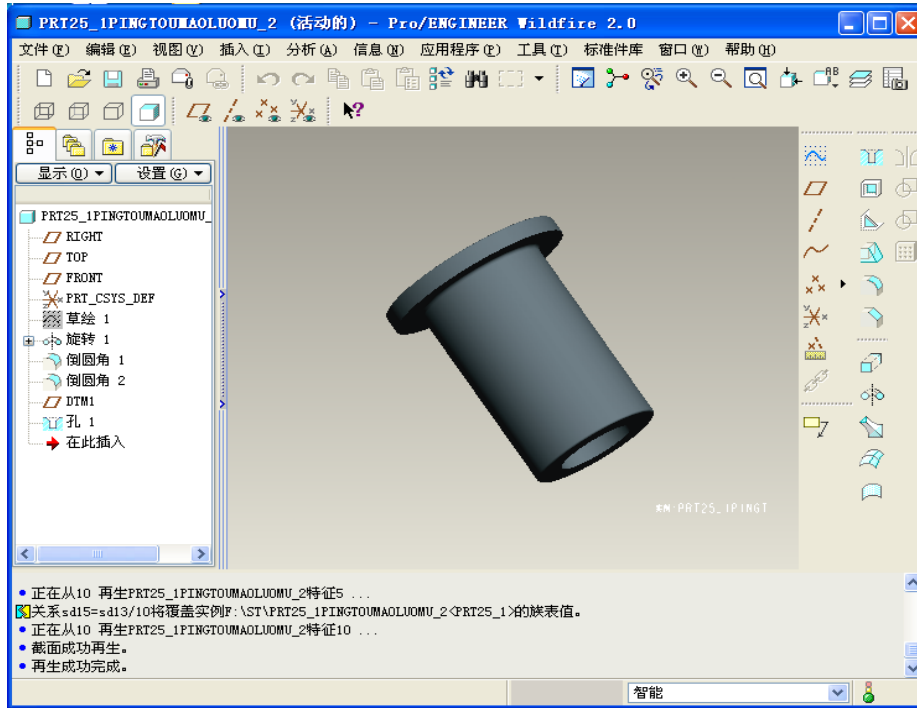


Fig. 6: The generated flat head rivet nut

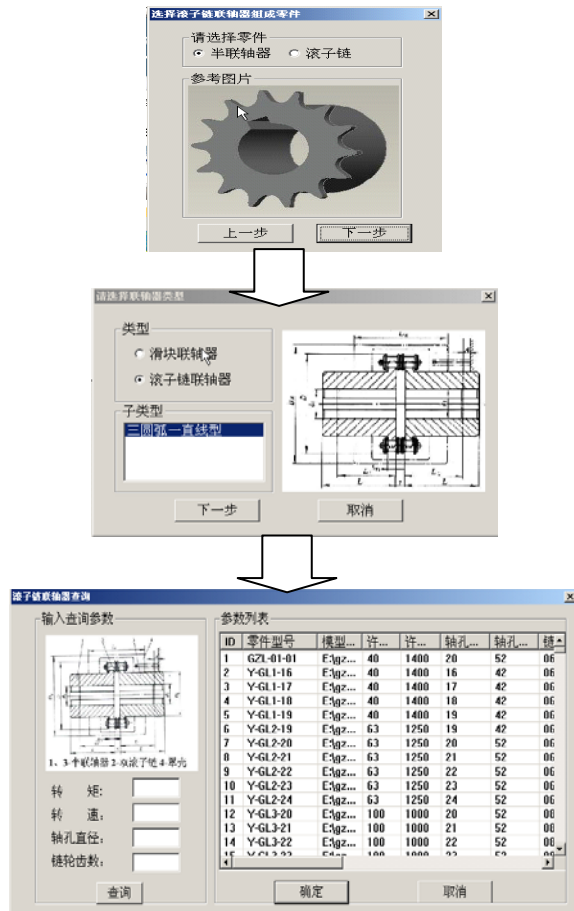


Figure 5. Parameters of coupling joint

generation of three-dimensional standard part models. The students who have Windows operation experience can easily use the system. The platform can improve CAD education resource infrastructure and students' studying efficiency.

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REFERENCES

- Cao, Y., Y. Bai, Y. Wang and L. Yang, 2009. Three-dimensional standard part library development based on Pro/TOOLKIT and database. Proceedings of International Conference on Networking and Digital Society, Guiyang, Guizhou, 1: 158-161.
- Du, J. and Y. Cao, 2012. Development of the performance-driven part library of cylindrical spiral spring based on Pro/ENGINEER. Adv. Mat. Res., 411: 365-369.
- Hui-Ying, C., 2011. The meaning of constructing teaching resource platform by ourselves. Mod. Comput., 47(22): 40-41.

- Li, C. and W. Qiu, 2006. Educational resources construction of platform of colleges in Western Area. *Higher Edu. Forum*, 5: 31-33.
- Yu, L. and J. Liu, 2007. Construction on college's network teaching resources platform. *China Edu. Tech. Equip.*, 5: 58-59.
- Zhang, J. and L. Luo, 2011. Construction of cloud-based computing platform for digital teaching resources. *Mod. Edu. Technol.*, 21(3): 100-102.