3D Product Display Based on Inventor Animation Design

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Abstract: With the rapid development of internet technology, some innovative fashion product are increasingly showed in the way of three-dimensional virtual display. Taking fashion jewelry as an example, the virtual 3D display method of product is studied by Inventor which is parametric 3D design software for efficient modeling and animation developed by the Autodesk Company. By discussing the methods of part feature creation and assembly design, the real simulation of the product is carried out. Three-dimensional animation techniques, such as fade animation, components animation and camera animation are used to depict product features and animation effects.

Key words: 3D Product Display, Inventor, Animation Design, 3D Modeling

1 Introduction

With the development of social economy, some innovative products and the latest products in line with the trend of fashion development are increasingly exhibited through product display. The most direct and intuitive way of product display is the physical display, which is to present the real product to customers, usually through press conferences, exhibitions and retail terminals for product display. However, with the explosion of information, this method can no longer meet the needs of customers for information collection. Virtual display in the form of media publicity has become the main form of product display[1-4].

With the development of network 3D technology, 3D virtual product display has been widely promoted. The product will be expressed in the form of virtual three-dimensional images, which truly simulate the product. Describing the product features with three-dimensional animation technology enables customers to intuitively understand the appearance and characteristics of the product and accurately grasp its details. Recently, many scholars have carried out considerable research on this aspect. Qian et al.[5] studied the key technology of 3D display using virtual reality (VR) and augmented reality (AR). Pfouga and Stjepandić[6] analyzed the methods and tools used in virtual product development to leverage 3D CAD data in the entire life cycle based on industrial standards. Tsygankov and Pokhilko[7] proposed an approach to represent the designed product functional structure in its 3D-model creation tree in a CAD-system. Zhang[8] examined the characteristics and application of 3D emulation animation, and studied the tips in 3D modeling, action setting and animation rendering. Yang and Zhang[9] presented a new 3D household products display system design concept – web 2.0 based user-generated 3D model displays. The virtual display method has been applied in many fields through Inventor, the product model can be easily created, and the 3D model can be made closer to reality by using the appropriate material or appearance. Inventor Studio is a rendering and animation environment in Autodesk Inventor which is able to produce realistic rendering pictures and animation effects. Taking fashion jewelry as an example, this paper introduces the process and technique of 3D product display with Inventor.

2 Characteristics of Inventor

Autodesk Inventor provides a set of comprehensive and integrated design tools that can be used to create complete product models, including part model, assembly model, design representation and analysis. The Inventor software system diagram is shown in Fig.1.

The parametric 3D feature modeling of Inventor integrates the variable technology, which can make the design and expression more effective. It starts with the creation of easy, simple, conceptual shapes, and adds details and constraints to the model design at any time throughout the design process. It uses geometric constraints and size constraints to determine the shape and size of the model, and integrates the design intention into the model. There is a breakthrough in adaptive technology to further improve the parametric design scheme. Extraordinary large-scale assembly processing function realizes assembly-based association design, effectively manages and uses data flow. Inventor quickly makes design changes by changing geometric structure and size or adding and deleting certain features. Through the rapid creation of a complete and accurate digital prototype, the design appearance, structure, function and engineering data are verified, and the process from conceptual design to product manufacturing is accelerated.

Inventor can exchange data reliably with other software through general or standard data format. The close integration of inventor and Autodesk data management software is beneficial to the efficient communication of design data, and is convenient for the collaboration between the design team and the manufacturing team. Inventor can quickly and accurately generate engineering drawings from three-dimensional models. With the world's leading dwg compatibility, user can read and write dwg files directly without converting the file format, and make greater use of the original design data.

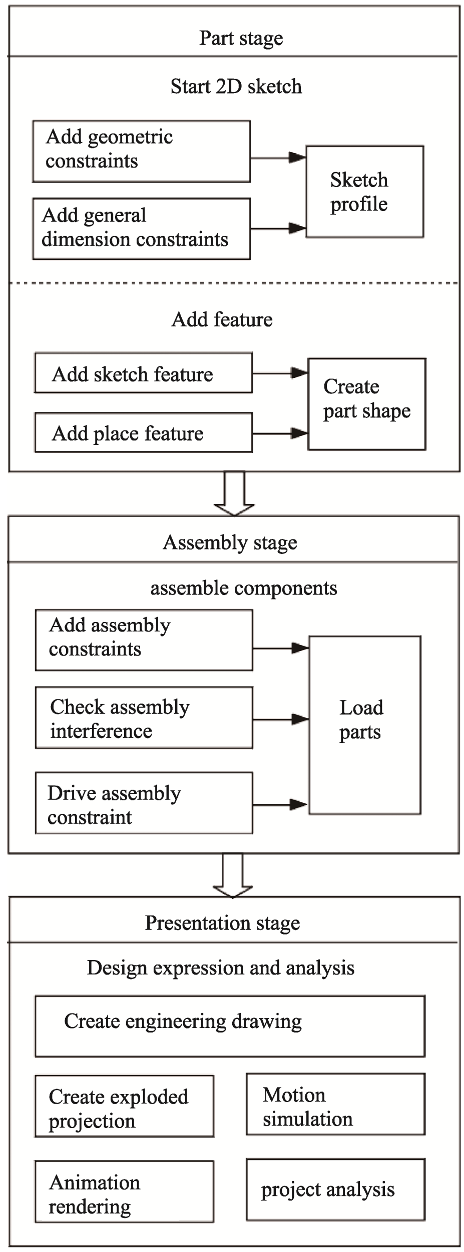


Fig.1 Inventor software system diagram

The product expression and analysis ability of Inventor is strong, the display coloring function is further strengthened, and the realistic feeling of material, light and color of the component model is enhanced. Inventor has embedded, easy to realize motion simulation and stress analysis functions, and uses these functions to predict the actual work of the product in the future. Inventor can create intelligent parts, such as steel structure, transmission mechanism, pipeline, cable and so on.

3 Design Process of Product Display

Autodesk Inventor provides an intuitive modeling environment to create parts and assembly models, and to design and display products with vivid animations. The design process is shown in Fig.2. Generate part models by creating sketch planes and adding features. Then the assembly constraints are applied to the part models to generate the assembly model. Finally, the 3D animation effect is created based on the assembly model.

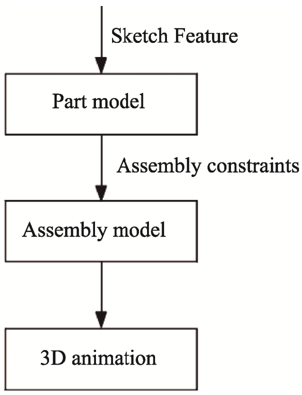


Fig.2 Design process of product display.

3.1 Part Model Building

The 3D model includes a part model and an assembly model. In Inventor, building a part model is divided into two parts: sketching and adding features. Sketch is the foundation of 3D modeling, feature is the basic unit of building model, and model is the set of features[10]. Features can be divided into sketch-based features and non-sketch-based features. However, the first feature of a part must be a sketch-based feature. Feature is a kind of simple geometric unit related to function, which is the basic element of part modeling. It is one of the data sources in the process of engineering design, analysis and manufacture. The modeling flow chart of the part model is shown in Fig.3.

Following is an example of a jewelry holder to illustrate the part modeling process of Inventor. Fig.4 is the features modeling process based on the sketch, mainly using the extrude method. Fig.5 shows a fillet on the model, which is a non-sketch-based feature.

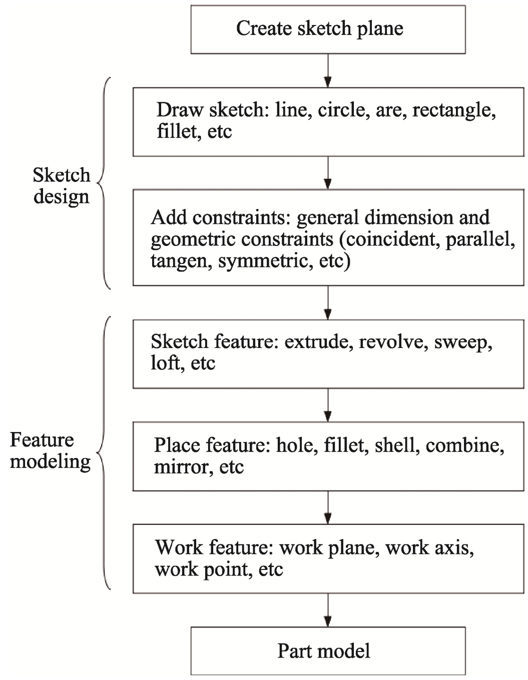


Fig.3 Modeling flow chart of the part model

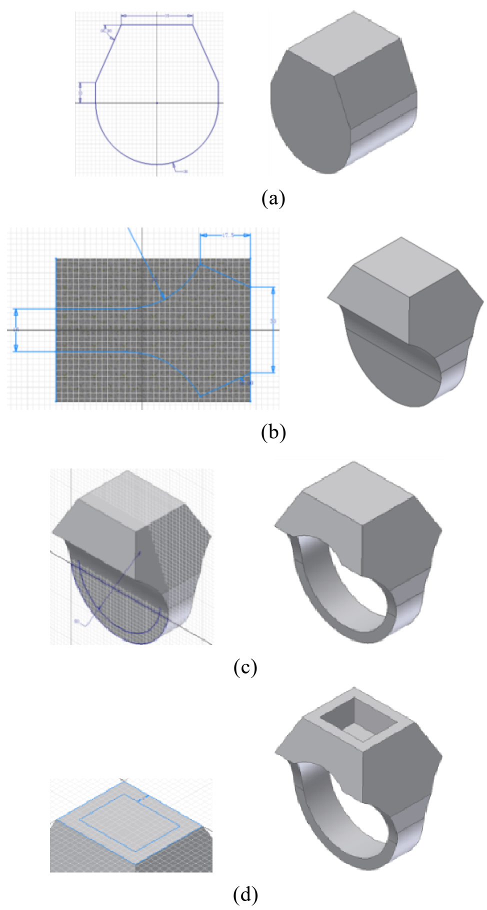


Fig.4 Features based on sketches. (a) Basic modelling; (b) Jewelry holder; (c) Ring hole; (d) Diamond braces

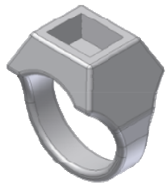
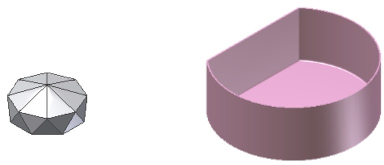


Fig.5 Non-sketch-based feature

Following, the modeling method of loft, extrude and circular pattern is used to build the diamond model as shown in Fig.6(a), and the modeling method of extrude, shell and fillet is used to build the model of jewelry box as shown in Fig.6(b).



(a) (b)

Fig.6 (a) Diamond model; (b) Jewelry box

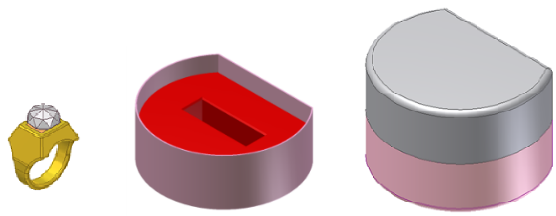
3.2 Assembly Model Building

Assembly model is the basis for creating animation. In the assembly environment, the parts or subassemblies that have been built can be loaded, and new parts can be created by combining the existing components and the relationship between them.

Putting existing parts or subassemblies into an assembly environment is a method of using existing components to create assembly, which embodies the "bottom-up" design step.

The assembly model is built by constraining and locating the parts and managing the assembly structure relationship of the parts. Assembly constraints determine how parts fit together in an assembly. The application of assembly constraints can remove the degrees of freedom of assembly, so that the components are correctly positioned and moved in the specified way. Inventor applies position constraints such as mate, angle, tangent, insert to position the components correctly. The relative motion relationships between parts can also be defined so that they move as specified. The finished jewelry holder and diamond parts are loaded in the assembly environment, and the jewelry model established by matching constraints is shown in Fig.7(a).

Creating parts in an assembly environment, that is, creating components in place can easily be associated with other components, thus improving design efficiency. This is a "middle" or "top-down" assembly design. Fig.7(b) is a model of jewelry box pad created in place, which contacts well with the size and location of the jewelry box. In this assembly environment, another jewelry box is placed as the cover, and the appearance of the jewelry box is changed to show the distinction, and the assembled jewelry is assembled into the box body. The jewelry box assembly model is shown in Fig.7(c).



(a) (b) (c)

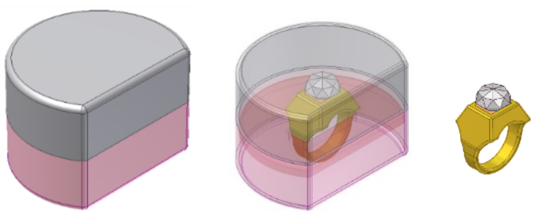
Fig.7 (a) Jewelry model; (b) Jewelry box pad; (c) Jewelry box assembly model

4 3D Animation Design

Inventor Studio can create multiple animations, such as components animation through components movement and rotation, fade animation by controlling the opacity of components within a given time frame, constraint animation by modifying constraint values, parameter animation by modifying the parameter values in the document, and camera animation. Choosing the appropriate animation form according to the product characteristics is the important content of the product 3D display design. Jewelry products can be expressed in the forms of fade animation, components animation and camera animation.

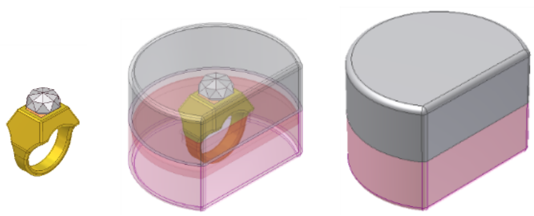
4.1 Fade Animation

Fade animation is the animation effect that changes the transparency of an object over a period of time. Fade can be run in conjunction with other operations. A fade animation can be created by setting the start and end times of the animation and the percentage of the visibility of the components during this period. The starting value for visibility is specified by the last operation of the selected object. If there is no previous action, it is the original value in the part or assembly environment. In order to display the jewelry in the jewelry box, this example gradually fades out of the jewelry box within 9 seconds, and the animation effect is shown in Fig.8. It can be seen that the jewelry box and the jewelry box pad gradually fade, until they disappear. In contrast, we can also set the fade-in animation in the period of 9s to 12s, as shown in Fig.9.



(a) (b) (c)

Fig.8 Fade-out animation. (a) 0s; (b) 4.5s; (c) 9s



(a) (b) (c)

Fig.9 Fade-in animation. (a) 9s; (b) 10.5s; (c) 12s

In order to achieve better animation effect, the fade-out order for each part can be modified. The jewelry box cover first fades out gradually to reveal the upper part of the jewelry, then the jewelry box pad fades out to reveal the lower part of the jewelry, and finally the jewelry box fades out to reveal the jewelry completely. Editing, copying, and deleting any animation actions can be done in the action editor of the animation timeline dialog box. In order to make the jewelry showing its dazzling diamond, the jewelry box cover is not shown again by deleting the fade-in animation of jewelry box cover. The animation process is shown in Fig.10.

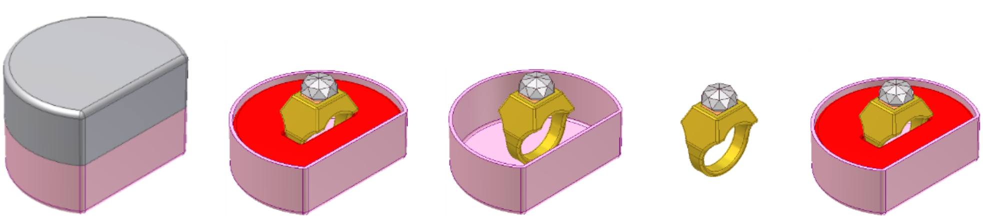
4.2 Components Animation

Components animation is the movement and rotation animation of components. Before components animation is carried out, some assembly constraints of the parts to be animated must be suppressed to prevent these constraints from blocking animation commands. The animation is completed by setting the position of the components to be animated at the end of the animation and by the starting and ending time of the animation.

In order to highlight the jewelry, it flies out of the jewelry box in this example. For this reason, the constraint animation of the jewelry box cover opening needs to be made first. By changing the constraint value of jewelry box cover, the animation effect of box cover opening in 3s is shown in Fig.11.

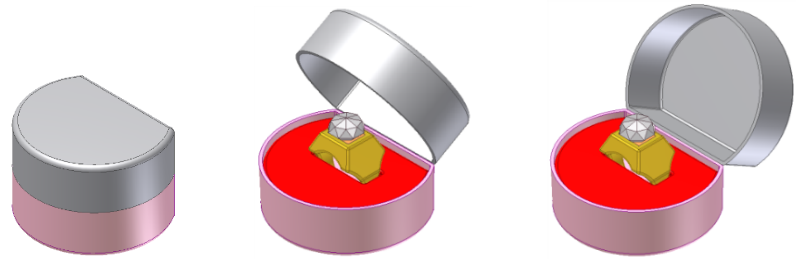
In components animation, specifying the position at the end of the animation is a key step. Fig.12 shows the coordinate system on jewelry which is defined by a 3D move/rotate dialog box.

The next step is to let the jewelry fly out of the box. The animation of the jewelry slowly flying up from the jewelry box is shown in Fig.13. The animation of the jewelry rotating in the air is shown in Fig.14.



(a) (b) (c) (d) (e)

Fig.10 Fade animation. (a) 0s; (b) 3s; (c) 6s; (d) 9s; (e) 12s



(a) (b) (c)

Fig.11 Box cover opening animation. (a) 0s; (b) 1.5s; (c) 3s

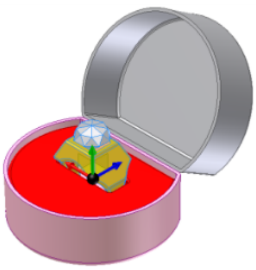
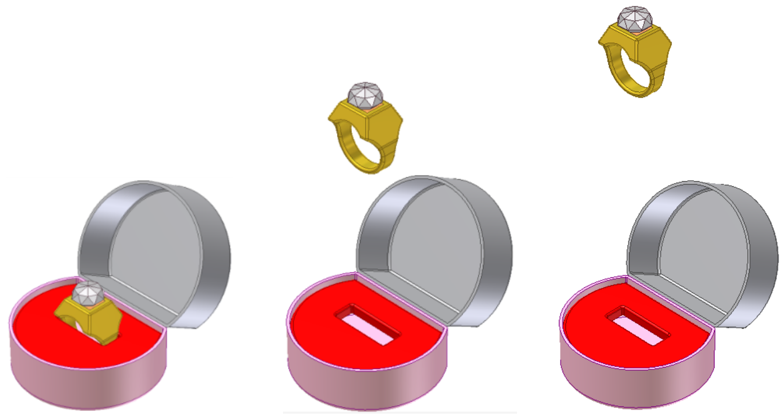
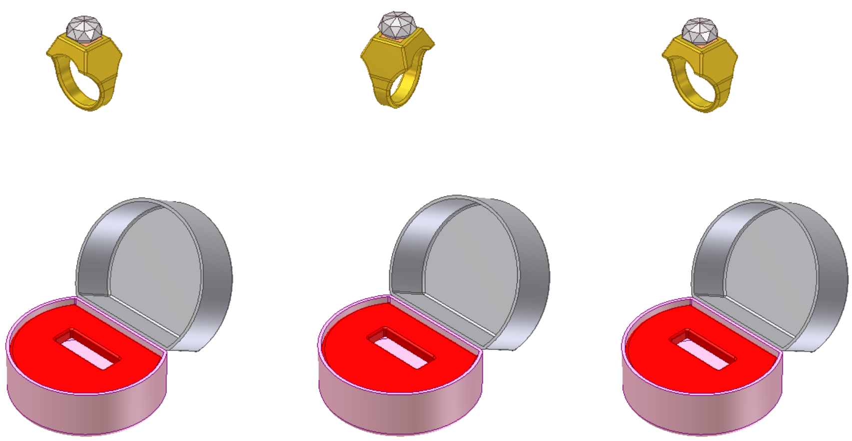


Fig.12 Coordinate system on jewelry



(a) (b) (c)

Fig.13 Jewelry flying up. (a) 3s; (b) 4.5s; (c) 6s



(a) (b) (c)

Fig.14 Jewelry rotating. (a) 6s; (b) 7s; (c) 8s

4.3 Camera Animation

In order to highlight the details and present the features of the product, camera animation can be added to the existing animation. For example, camera position animation can be added to the components animation mentioned above to transform the position of the camera to express the product. Camera rotation animation can also be added to the fade animation mentioned above to view the product from different angles. Fig.15 shows the camera rotation animation of 12s to 15s added to above fade animation. Fig.16 is the camera position animation added to above components animation of the jewelry moving up and rotating. At 6s,

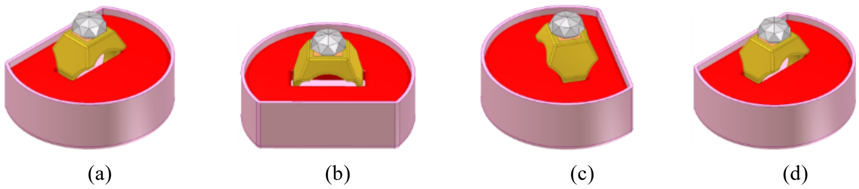


Fig.15 Camera rotation animation. (a) 12s; (b) 13s; (c) 14s; (d) 15s

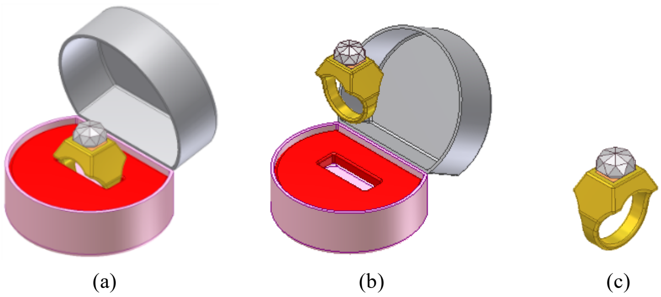


Fig.16 Camera position animation. (a) 3s; (b) 6s; (c) 8s

the view is pulled away, so that the jewelry is still displayed in the interior of the view after it flies out of the box. At 8s, the view is not rotated, but the view is drawn closer so that the view only displays jewelry, not the jewelry box.

5 Results and Discussion

5.1 Results

Inventor 3D modeling technology generates 3D entities by feature modeling based on sketches. Inventor sketch environment has the powerful function of dimension driving geometry element, and it also has geometric constraints such as coincident and parallel, making drawing more convenient and fast. Inventor feature modeling design generates 3D entities on the basis of sketches through extrude, revolve and other sketch features, and further creates 3D part models through hole, fillet and other place features.

Inventor assembly model has two design methods: bottom-up and top-down. The bottom-up design method assembles the loaded parts into a whole by adding assembly constraints. The top-down design method, namely the in-place design parts, can be easily associated with other parts and improve the design efficiency.

Inventor is able to display the product in three-dimensional form, and directly generate the most advanced color pages and animations in the design environment, so that customers have an intuitive experience, and obtain a satisfactory display effect. Through fade animation, the important parts of the product can be shown, which highlights the local features of the product. Through components animation, the motion effect of the product can be created, which makes the product more vivid. Through camera animation, the product is viewed from different angles to highlight the details of the product.

5.2 Discussion

Inventor Studio not only correctly represents the optical effects of materials, but also simulates all complex and continuous movements under all possible structural conditions. In addition to the fade animation, components animation, and camera animation applied in this paper, other animation forms such as constraint animation, parameter animation, lighting animation provided by Inventor studio can also be explored in the product display. For example, the light source can be animated for the product display environment; animating the lighting style produces the effect of background shading. Alternatively, adjusting the location, color and other parameters of a single or local light source can highlight the prominent features of products.

Autodesk Inventor parts and components can be enhanced in the Inventor Studio environment, such as adding surface styles, lighting styles, scene styles, and camera views. Surface style can define the material of the model and set the refraction, reflection and relief of the material. Lighting style can define the illumination of the light when the object is rendered, resulting in a shaded interlaced effect. Scene styles can provide the background for an image or animation. The camera can set up viewing angles for any given scene. In this way, the rendered picture will have a stronger visual impact.

6 Conclusion

Inventor can be used to complete the whole process of product modeling to animation display. Product display animation can demonstrate the features, principles and internal structure of the product and can make the product more visual. The product demonstration with Inventor simulation animation technology can better enable customers to have an intuitive and comprehensive understanding of the appearance and features of the product, and to quickly and accurately understand and grasp the details of the product. It greatly improves the display effect of the product and promotes the promotion and application of the product. With the three-dimensional modeling and animation function of Inventor software, parametric modeling and animation production were carried out for the display of jewelry products, which had certain reference value for the promotion and display of similar products.

Acknowledgment

This work is supported by the Education and Teaching Reform and Research Project of University of Science and Technology Beijing (JG2018M15).

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