

# Research on Fixture Design of NC Machine Tool Based on UG 3D Modeling

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**Abstract.** Research on the design of CNC machine tool fixture based on UG 3D modeling; Firstly, the processing procedure of the back cover parts is analyzed, and the overall scheme of the fixture is determined. Then the three dimensional model of each part of the jig is established including the standard part library of jig and the design of non-standard parts of jig. Then carry on the fixture 3D assembly drawing design; Finally, it is converted into fixture technical document including assembly drawing and specific part drawing. The design process is simple and clear, which improves the quality and efficiency of fixture design.

**Keywords.** UG software, fixture design, assembly drawing, 3D modelling

## 1. Introduction

2D CAD software is adopted for fixture design. The designer should first form the three-dimensional entity of the fixture in the mind of the structure, and then express it with 2D diagram to complete the fixture design. In the design process, thinking should be converted repeatedly in the three - and two-dimensional models, and finally two-dimensional assembly drawing is drawn, but three-dimensional assembly drawing is generally not drawn. There are unfavorable factors for fixture design quality and efficiency, as well as machining and assembly.

UG software is currently the most advanced in the world, for manufacturing industry, set of 3D CAD/CAM/CAE integration of high-end software, it not only has powerful entity modeling, but also associated with three-dimensional entity model completely two-dimensional engineering drawing function of UG two-dimensional engineering graphics can be directly generated from the product design of the three-dimensional entity, and two-dimensional engineering graphics when the 3D model changes in the related view, size and other information to update.

Based on UG 3D modeling of CNC machine tool fixture design, design fixture 3D assembly drawing under UG environment, and then convert it into 2D engineering drawing, which is described in detail below.

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## 2. Jig Information Processing

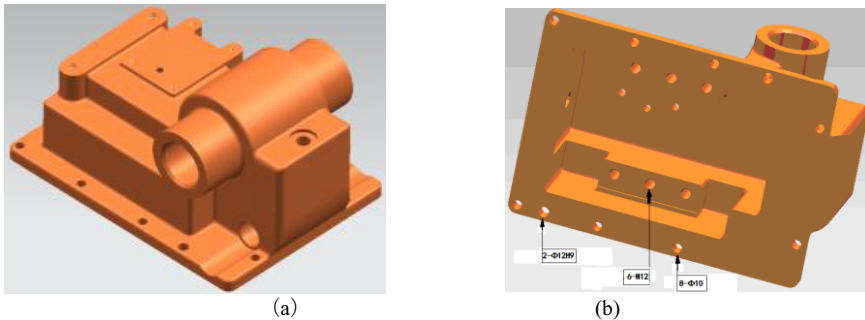
The information of fixture design includes parts geometry information, processing technology information, clamping process information and so on. Through the analysis of the structure of the parts, clamping features and technological requirements, make the fixture design scheme, that is, the positioning scheme, clamping scheme, the specific structure of the clamp layout scheme.

### 2.1 Analyze the Parts Process

As shown in Figure 1, (a) is the top surface of the rear cover, and (b) is the ground of the rear cover.

The underside and a side of the back cover parts have been processed. This procedure requires the processing of 8- $\Phi 10.5$  holes on the underside and 6-M12 threaded underside holes on the a side. The production scale is batch production.

According to the process requirements, the workpiece is processed on the machining center, with one side and two holes (bottom and two locating pin holes) as the positioning datum, and the  $\Phi 10.5$  drill bit is selected for processing the bottom 8- $\Phi 10.5$  holes, and the  $\Phi 10.25$  drill bit is selected for processing the 6-M12 threaded bottom holes, and all holes are processed by one-time clamping.



**Figure 1.** Back cover parts.

### 2.2 Determine the Overall Plan of Fixture

As the machining of the hole of the part to be machined feeds from the bottom to the top, it is necessary to place the bottom of the part upward for machining, but it is not convenient for positioning and clamping. It is comprehensively considered to place the part side vertically for positioning and clamping. After the clamping is installed, the whole clamp is turned 90° degrees, and the hole machining is carried out with the bottom upward.

According to the analysis, the overall plan of the fixture is that the workpiece is placed vertically on the side, one side and two pins are used for positioning (support plate and two positioning pins are selected), and the hinge pressing plate mechanism is used to press the workpiece from the top surface to the bottom surface for clamping; because the hole to be processed is on the positioning datum plane, the drilling template and the fixture body are combined to save space; because the fixture needs to be turned 90°, the turning mechanism needs to be designed.

### 3. Establish Three-dimensional Model of Each Part of Fixture

#### 3.1 Set Up Fixture Standard Parts Library

In the design of fixture, more than 50% parts are standard parts, designers have to carry out simple repetitive work;The establishment of fixture standard parts library plays an important role in improving fixture design efficiency.

(1) Set up parameter table

The parameter table mainly expresses the parameters of each part of the standard parts. The fixture design selects the appropriate standard components according to the parameters in the table.

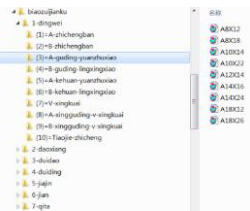
The first level heading includes positioning element, guiding element, aligning element, aligning element, clamping element, key and other elements.

There is a table for each standard part. The top of the table is the 2D graph and 3D graph of the standard part. The third line is the specification of the standard part and the bullet symbol corresponding to each part.

(2) Create a 3D gallery

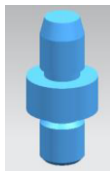
Firstly, the catalogue of the standard element 3D gallery should be established, which should be consistent with the catalogue of the parameter table. Then, according to the parameters in the parameter table, UG software was used to create the 3d modeling of the standard parts and put them in the folder of the corresponding directory of the 3D gallery to form the 3D gallery, as shown in Figure 2 (a).

In fixture design, if you need to use the parts in the standard parts gallery, you can directly copy the fixture assembly folder; If there are no parts of corresponding size in the standard parts library, but there are similar parts, you can simply copy the files in the gallery first and then make appropriate modifications, as shown in Figure 2 (b).

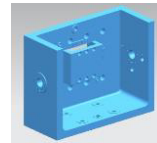


(a)

**Figure 2.** 3D drawing library of standard parts



(b)



**Figure 3.** Clamp the specific

#### 3.2 Design of Fixture Non-standard Parts

When jig is designed, the non-standard parts that need to be designed mainly include specific clamp, drilling template, etc., the design of non-standard parts needs to be carried out according to the specific situation, so it is more flexible.

The specific design of clamping, mainly considering the structure of the processed parts, the use of the machine tool, clamping device on the positioning element, clamping device, tool device, guide device and other dimensions and positions, clamping specific use of materials, the process of chip removal method, and so on. Therefore, it is difficult to unify the structure and size of non-standard parts, and the model library cannot be built as standard parts. Instead, the UG software can only be used to build three-dimensional models one by one, which will not be introduced here.

Figure 3 shows the details of the clamp for the processed rear cover parts.

#### 4. Design of 3D Assembly Drawing of Fixture

##### 4.1. Design of Fixture 3D Assembly Drawing based on UG

According to the overall fixture design scheme, copy and paste the required standard components and non-standard parts 3D graphics into the fixture assembly folder, and carry out 3D assembly design.

In 3D assembly design, the UG 3D shape of the processed part is first transferred and positioned according to the absolute origin. Then assemble positioning element, clamping element, guiding element and other devices; Then the fixture is designed and assembled according to the assembled standard components. Finally, an explosion diagram is created to facilitate the view of the relationship between the parts in the assembly diagram.

In the assembly process, if there is a position deviation between the matched parts, it can be seen directly that if there is a problem with the parts after selecting the matching conditions, it can be modified directly on the original drawing, and the size and shape of the original parts will be automatically updated on the assembly drawing.

##### 4.2. Design of 3D Assembly Drawing of the Parts and Fixtures of the Back Cover

The design process of 3d assembly drawing of machining rear cover parts and fixtures is as follows.

1) Back cover parts: The system enters the assembly module, and the back cover parts are shown in Figure 4 (a).

2) Design positioning element: One side and two pins are adopted for positioning, limiting six degrees of freedom. Supporting plate and locating pin of positioning element are selected, and the assembly is shown in Figure 4 (b).

3) Design of auxiliary support: Since the workpiece is installed on the side and the workpiece is heavy, to prevent damage to the positioning pin, the auxiliary support is added. The auxiliary supporting elements include support plate, supporting sleeve, adjusting sleeve, etc., as shown in Figure 4 (c) after assembly.

4) Design of clamping elements: adopt the hinge pressing plate mechanism to realize clamping from the top of the workpiece to the positioning surface, select and design B-type arc pressing block, B-type hinge pressing plate, union bolt and other clamping elements, as shown in Figure 4 (d) after assembly.

5) Design guide element: the replaceable drill sleeve shall be selected for 8- $\Phi$ 10.5 holes on the bottom surface of drilling, and the fixed drill sleeve shall be selected for 6-M12 threaded bottom holes on the surface a, as shown in Figure 4 (e) after assembly.

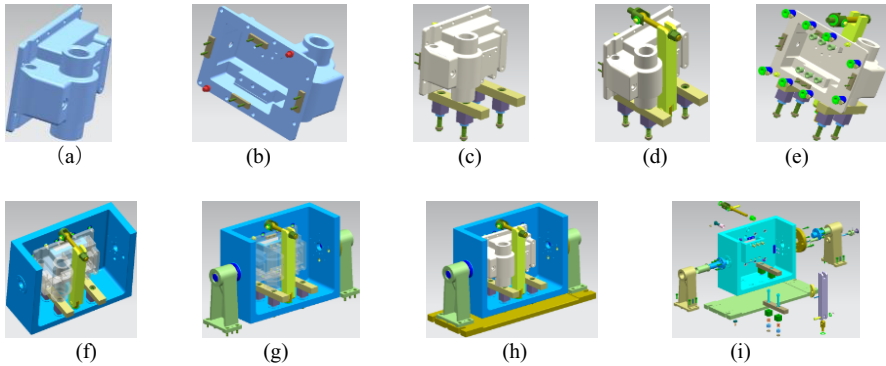
6) Specific design clamp: the clamp body is planned to adopt casting blank, and the clamp is integrated with the drilling template. The concave part of the bottom surface is used to install the fixed drill sleeve. On the basis of the L-shaped structure, a vertical plate is added to the left and right to install the turnover bracket, as shown in Figure 4 (f) after assembly.

7) Design of turning mechanism: the hole to be processed is currently placed side by side, and the whole fixture needs to be turned 90° during processing, so the turning

mechanism should be designed. The turnover mechanism includes the supporting part and the operation positioning part, and the main parts include the bracket, shaft, shaft sleeve, rotary disk, positioning pin, guide sleeve, handle, etc., as shown in Figure4 (g) after assembly.

8) Design connection mechanism: it is mainly used to connect the bracket and workbench, and the base and positioning key need to be designed, as shown in Figure 4 (h) after assembly.

9) Create exploded view: exploded view can easily view the parts in the assembly drawing, the assembly relationship between parts, and the number of parts included. The exploded view of the fixture is shown in Figure 4 (i).



**Figure 4.** Design of three dimensional assembly drawing of fixture

## 5. Design of Fixture Technical Documents

### 5.1. Design Method of Engineering Drawing Based on UG

In UG software, 2D engineering drawings can be directly generated from 3D entities of product design, and when the 3D model changes, the relevant views, dimensions and other information in 2D engineering drawings can be updated simultaneously, making the generation of engineering drawings very simple. The engineering drawing design method based on UG mainly includes setting drawing, parameter presetting, view creation, view annotation and drawing output setting.

### 5.2 The Design of the Fixture Technical Documents for Machining the Back Cover Parts

Click "Start" to enter the "Drawing" module. First, set basic parameters, including setting drawings, drawing preferences, annotation preferences, etc., and set all contents according to national standards. Then create basic view, section view, dimension label, part number label, drawing frame, title bar, drawing detail list, marking technical requirements, etc. Fixture assembly engineering drawing, as shown in Figure 5. The specific part drawing is shown in Figure 6.

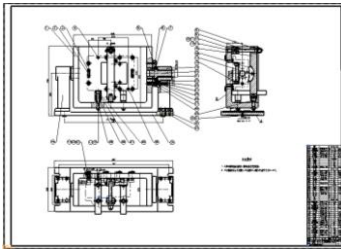


Figure 5. Fixture assembly drawing

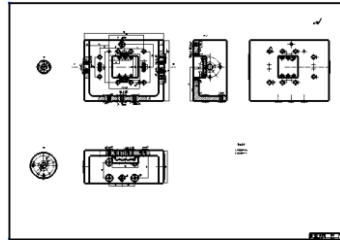


Figure 6. Clamp specific part drawing

## 6. Epilogue

Based on UG 3D modeling of CNC machine tool fixture design, the fixture standard library is established. During fixture design, the parts in the standard parts library can be directly called, which makes the assembly design process fast, convenient, simple and clear. The design of the fixture adopts the THREE-DIMENSIONAL model, which is not only intuitive and labor-saving, but also can check whether there is interference between the parts to improve the design quality; It is beneficial to improve the design efficiency by using the method of automatic transformation of 3D and 2D models and expert correction to generate 2D assembly drawings conforming to national standards. This method can not only free the fixture design technicians from the complicated and repetitive design labor, but also shorten the fixture development cycle, improve its design and manufacturing level and quality, so as to improve the overall productivity of the fixture industry.

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