Programming and machining of complex parts based on CATIA solid modeling

Xiurong Zhu
Jilin Teacher’s Institute of Engineering and Technology, Changchun, Jilin, China 130052

Abstract. The complex parts of the use of CATIA solid modeling programming and simulation processing design, elaborated in the field of CNC machining, programming and the importance of processing technology. In parts of the design process, first make a deep analysis on the principle, and then the size of the design, the size of each chain, connected to each other. After the use of backstepping and a variety of methods to calculate the final size of the parts. In the selection of parts materials, careful study, repeated testing, the final choice of 6061 aluminum alloy. According to the actual situation of the processing site, it is necessary to make a comprehensive consideration of various factors in the machining process. The simulation process should be based on the actual processing, not only pay attention to shape. It can be used as reference for machining.

1. Introduction
In the traditional NC machining technology of computer, RF sensor detection technology, electrical and mechanical modern manufacturing technology, CNC machining parts with high precision, high production efficiency and low production cost, NC machining is a very important part of the manufacturing and aerospace industry in all production technology, especially the geometric shape automotive parts and aerospace industry in the complex, high precision parts, showing the absolute advantage in the processing and manufacturing of CNC machine tools.[1]

The CATIA version of V5, which is based on the concept of digital products and the integration of e-commerce, can be used to build a working environment for the whole development process of digital enterprise. In this environment, the various aspects of the product development process can be simulated, and the electronic communication between engineers and non engineers can be realized. The whole development process of the product includes concept design, detailed design, engineering analysis, finished product definition and the use and maintenance of manufacturing and finished products in the whole life cycle.[2]

As the world's leading CAD/CAM software, CATIA can help users to complete the small aircraft to design and manufacture a screwdriver, it provides a complete design capability. At the same time from 2D to 3D to the technical specifications, software system modeling, as a fully integrated, CATIA will combine mechanical design, engineering analysis and simulation processing functions such as organic, to provide users with strict paperless work environment so as to shorten design time, improve quality and reduce production cost effect.[3]
2. Processing technology analysis of complex parts

2.1 Analyze the parts drawing and determine the installation standard

Parts as shown in the drawings, according to the technical requirements shown in the drawings on the part of the need to process the ladder hole and the central hole precision is relatively high. Considering the structure and shape of parts, and with the actual processing of machining features, select datum parts for clamping and positioning, CNC milling machine fixture standard machine with a flat jaw.[4]

![Figure 1 part drawing](image)

2.2 Selection of processing methods

Part of the internal contour of the roughness requirements for Ra=6.4, so in the milling process, you can call the first rough milling, and then fine milling program. Taking into account the selected parts of the blank is 6061 aluminum alloy, its cutting No deformation, excellent corrosion resistance and good processability and high toughness after processing, so in the milling machining with a diameter of 8 mm hard alloy three edge milling cutter for machining and fine machining, which can improve the surface roughness of the machined parts and can reduce tool wear. In the processing of inner hole, considering the precision and the orientation precision of the machining of the machine tool, can be used with a diameter of 10 mm drill, it can meet the requirements of machining precision. The corner cutting using drama department adhesion, to ensure machining after the completion of the cube can rotate freely.[5]

2.3 Select the processing route

In determining the processing route, should follow the principle of "first base, the first hole behind, coarse to fine".

According to the characteristics of the blank, in the process, select the bottom as the datum plane, first in chronological order, drilled the first center hole with a diameter of 10 mm, to ensure concentricity center hole and ladder hole. Then the processing of the parts of the ladder hole were rough and finishing. Take the processing route in turn, until all six surfaces are finished. Finally, the semi finished parts are processed and modified.[6]

2.4 Selection of cutting parameters

The parts of the blank selection is 6061 Aluminum Alloy, so the cutting processing performance is good, the use of machine tools are CNC milling machine, the machined surface roughness is required, so the need for rough and finish machining in machining. When rough machining, cutting depth selection for 8mm, depth selection precision machining for 1mm. In order to improve the efficiency of the process, in roughing, the choice of feed is 100m/min. In order to ensure the good surface quality of the parts, the feed quantity is 50m/min. When the center hole drill a molding, it is cutting depth is 1mm, the amount of feed is 200mm/min. Taking into account the actual use of CNC milling machine performance and processing characteristics of all machining processes spindle speed are 1200r/min cutting parameters of the three elements of the table as shown in table 1.
Table 1 cutting three elements

| Procedure name         | Spindle speed (r/min) | Feed rate (mm/min) | The cutting depth (each time the maximum cutting depth) (mm) |
|------------------------|-----------------------|--------------------|-------------------------------------------------------------|
| Step hole roughing     | 1200                  | 100                | 8                                                           |
| Step hole finishing    | 1200                  | 50                 | 1                                                           |
| Drilling center hole   | 1200                  | 200                | 1                                                           |

2.5 select tool

1). In the center of the part of drilling hole, the diameter of 10 drill hole drilling tool, and the material is made of hard alloy, good stiffness, stiffness can meet the requirements of processing. [7]

![Diagram of twist drill](image2.png)

Figure 2 Diagram of twist drill

2). In the stepped hole milling parts, adopting 8 three vertical milling cutter, hard alloy tool material selection, to meet the demands of processing.

![Milling cutter](image3.png)

Figure 3 milling cutter

2.6 determine the workpiece machining coordinate system

Select the center of the upper surface of the workpiece as the origin of the workpiece coordinate system. [8]

![Setting of workpiece coordinate system](image4.png)

Figure 4 setting of workpiece coordinate system

2.7 milling process card and tool

According to the structural characteristics of the parts, according to the parts of the clamping and positioning method to divide the process, due to the different structural shapes of each part, the technical requirements of the processing surface are different, and the positioning method is different.
To locate the bottom surface and the side surface of the workpiece, stepped up through the bench. In the process of a step, according to the rough machining of the first rough machining to the division of the work.[9]

### Table 2 NC machining process card

| Procedure number | Program number | Fixture name | Fixture number | Working content | Tool number | Tool specification | Spindle speed (r/min) | Feed (mm/min) | The cutting depth (mm) | Remarks |
|------------------|----------------|--------------|----------------|-----------------|-------------|-------------------|-----------------------|---------------|------------------------|---------|
| 1                |                |              |                | On the surface of drilling hole diameter of 10 | T1          | Phi 10 twist drill | 1200                  | 200           | 1                      | automatic |
| 2                |                |              |                | Rough milling surface | T2          | Phi 8 mills       | 1200                  | 100           | 8                      | automatic |
| 3                |                |              |                | Fine milling surface | T2          | Phi 8 mills       | 1200                  | 50            | 1                      | automatic |
| 4                |                |              |                | Rough milling surface | T2          | Phi 8 mills       | 1200                  | 100           | 8                      | automatic |
| 5                |                |              |                | Fine milling surface | T2          | Phi 8 mills       | 1200                  | 50            | 1                      | automatic |
| 6                |                |              |                | The left surface of phi 10 hole drill | T1          | Phi 10 twist drill | 1200                  | 200           | 1                      | automatic |
| 7                |                |              |                | Rough milling left surface stepped hole | T2          | Phi 8 mills       | 1200                  | 100           | 8                      | automatic |
| 8                |                |              |                | Fine milling left surface step | T2          | Phi 8 mills       | 1200                  | 50            | 1                      | automatic |
| 9                |                |              |                | Rough milling surface | T2          | Phi 8 mills       | 1200                  | 100           | 8                      | automatic |
| 10               |                |              |                | Rough milling surface | T2          | Phi 8 mills       | 1200                  | 50            | 1                      | automatic |
| 11               |                |              |                | The 10 hole surface before drilling | T1          | Phi 10 twist drill | 1200                  | 200           | 1                      | automatic |
| 12               |                |              |                | Rough milling surface | T2          | Phi 8 mills       | 1200                  | 100           | 8                      | automatic |
| 13               |                |              |                | Fine milling surface | T2          | Phi 8 mills       | 1200                  | 50            | 1                      | automatic |
| 14               |                |              |                | Rough milling surface | T2          | Phi 8 mills       | 1200                  | 100           | 8                      | automatic |
| 15               |                |              |                | Fine milling surface | T2          | Phi 8 mills       | 1200                  | 50            | 1                      | automatic |
3. Programming and processing
The method of NC milling machine with 10 center hole processing procedures are as follows:

O0001
G00G90G54X0Y0Z30M03S1200M08;
G99G83X0Y0Z-55R5Q1F200;
G00Z100;
G80M09;
M30;

CNC milling machine ladder hole processing procedures are as follows:
O0002
G90G54G00X0Y0Z30M03S1200M08;
G01Z-14F100;
X-8;
G02X-8I8;
G01X-16;
G02X-16I16;
G01X-17.5;
G02X-17.5I17.5;
G01X-18.5F50;
G02X-18.5I18.5;
G00Z30;
X0Y0;
G01Z-8F100;
X-8;
G02X-8I8;
G01X-16;
G02X-16I16;
G01X-17.5;
G02X-17.5I17.5;
G01X-18.5F50;
G02X-18.5I18.5;
G00Z30;
X0Y0;
G01Z-14F100;
X-8;
G02X-8I8;
G01X-9.5;
G02X-9.5I9.5;
G1X-10.5F50;
G02X-10.5I10.5;
G00Z100;
X0Y0M09;
M30;
4. Analysis of CATIA solid modeling results
After CATIA solid modeling, analysis and calculation of the results of the previous chapter is fully consistent, parts design is completed, you can enter the next program [10]

5. Concluding remarks
Through the use of the complex parts of the CATIA solid modeling programming and simulation processing design, summed up in the field of CNC machining, programming and processing technology on the importance of a mechanical industry technicians. In parts of the design process, encountered a lot of difficulties, the first is the depth of analysis in principle, and then the size of the
design, the dimension chain, Interconnected. After the use of backstepping and a variety of methods to calculate the final size of the parts. In the selection of parts materials, careful study of various materials, the final choice of 6061 aluminum alloy. The processing plan is not empty talk, the processing of each location varies according to the actual situation, to do a good job of positioning processing site, then combining various factors in machining, considering the full range. The simulation process should be based on the actual processing, not only pay attention to shape. It can be used as reference for machining.

Reference
[1] Guangzhen, Lu Jianxiang, NC technology and programming [M]. Beijing: Peking University press, 2015.08
[2] Meng Lingxia, Zhang Zhi, numerical control technology training course [M]. Beijing: National Defence Industry Press, 2014
[3] Tang Wenxian, introduction and improvement of CNC machining process [M]. Beijing: China Machine Press, 2013
[4] Wu Zhiguo, Huang Yunlin, and so on, CNC lathe programming 80 cases: the essence of the [M]. Beijing: Chemical Industry Press, 2014 (in Chinese)
[5] Lv Binjie, Gao Changyin, Zhao Wen (FANUC.SIEMENS), CNC lathe programming example of the essence of [M]. Beijing: Chemical Industry Press, 2011
[6] Ni Xiangming, CNC machine tools and CNC machining technology [M]. people's Posts and Telecommunications Press, 2011
[7] Sun Xingwei, Xue Xiaolan, FANUC programming and processing of CNC machine tools [M]. Beijing: China Water Conservancy and Hydropower Press, 2015 (in Chinese)
[8] Yunjie Zhang, Lijian Hao, CATIA V5-6 R2014 foundation design case. Tsinghua University Press,2015.06
[9] Yunjie Zhang, Yunjing Zhang, CATIA V5 from to master. Tsinghua University Press, 2013, R21, entry, the entry
[10] Zhan Yi, CATIA V5R20 CNC machining tutorial [M]. Beijing: China Machine Press, 2013