Method of NC processing for the cover of auto gearbox

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Abstract

In this paper, the common car gearbox cover is studied as a processing object, the reasonable technology and equipment is selected based on the figure process firstly. The standard processes and process card are developed through reasonable process, the PRO/E software is used for the processing set, solid modelling, then the processor and the machine code generating, The MATLAB Genetic Algorithm Toolbox is applied for the optimization of cutting parameters.

Keywords: CNC processing; Parameters optimization; the cover of auto gearbox; PRO/E

1 Introduction

Product engineering drawings is shown in Figure 1, this part is gear cover of thin wall with complicated surface. Have much screw holes and technology area, the appropriate location and orientation fixture should be selecting in the process to ensure the quality of finished part.

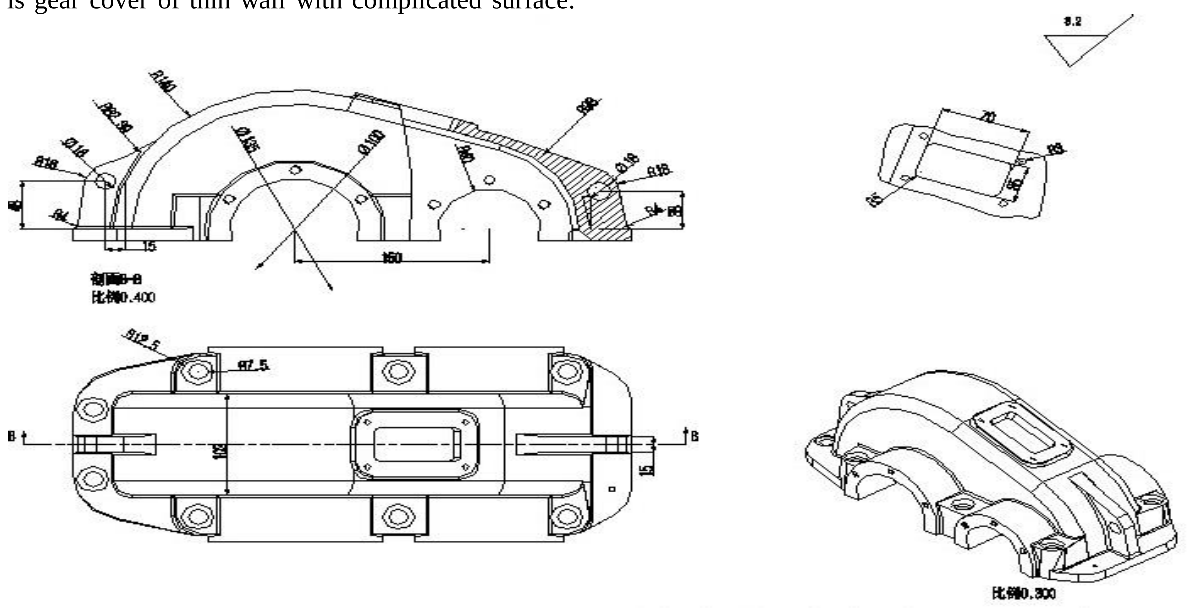

FIGURE 1 Product engineering drawings

2 Application Examples

2.1 PROCESSING AND TECHICAL REQUIREMENT

The blank of the gear box cover is rough casting with some allowances, the main processing including: the material of part is HT200, the rough castings parts of blank left some allowance for machining. The aging processing of the top slope, the bottom division surface of the processing, bears hole of the process, the bottom of the groove surface machining, hole head machining, the side bearing screw whole machining, screw top with the surface processing of peep cover. The tapping screw machining processing is not as machining content this time. Treatment is required before processing, to eliminate the stress of castings for parts dimensional stability, part of the process technology requirements are: surface segmentation accuracy Ra1.6, flatness is 0.03 mm; the top of slope roughness is Ra25; two precision bearing hole are Ra3.2, the bottom of the groove roughness is R25; bearing bore surface roughness on both sides are Ra25; screw holes are R3.2. After the analysis of the part drawing shows that the five fixture is needed to complete all processing content of the gear cover, so the workpiece coordinate system is determined to five [1].

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2.2 DETERMINE THE PROCESSING FLOW AND CLAMPING SCHEME

The main line of the cutting process for the gear cover is as follows: processing at the top of inclined plane - the bottom division side processing - processing of bearing whole circle arc - the end of the groove surface milling - Milling the sides of bearing whole - drilling holes - drilling, milling head holes - holes drilled at the top. The process of clamping are identified as the following programs: 1) surface for clamping the base surface divided by line alignment, with special tooling (B665) clamping the work piece, milling the top surface; 2) the machined top slope surface is used as the locating datum, crossed alignment, with special tooling (B665) clamping the work piece, the division side, bearing bore and the bottom of the groove are processed. 3) The split surface as the base and special tooling fixture is used, milling the sides of bearing hole drilling respectively. 4) divided by bit alignment surface orientation, with special tooling (Z3050) clamping the work piece, milling and drilling head hole; 5) the partition surface as the orientation, with special tooling (Z3050) clamping, drilling the top of slope on the thread [2].

2.3 MACHINE TOOLS, CUTTING TOOLS AND CUTTING PARAMETERS SELECTING

Based on the determined processing, precision requirements, size requirements and linkage of existing machining tools, the three-axis CNC machining centres is used (HNC-21M) for processing. According to the performance parts drawing and performance of the tools we have prepared the cards.

The reasonable amount of milling is directly related to the milling effects, including the ability to achieve high efficiency, low consumption and high quality processing. Starting from the cutter wear regularity, the principle of choice milling parameters is: take a larger ap and ae when using end mill to milling firstly, and then get larger Fz, an to take a larger Vc finally . Many factors are involved when choice of milling parameters, in general, rough milling with a larger margin and the lower processing requirements, the durability and the milling force of cutter are the main considerate factors; while fine milling with small margin, and high precision and roughness of small are required.

3 The application of milling parameter optimization

The concept of agile manufacturing and green manufacturing industry, represented by the requirements of the 21st century manufacturing to achieve high-quality, high efficiency, low cost, and to give full play to the expensive automated machine processing performance. Optimization of processing parameters is a key part to achieve this goal. Genetic algorithm as a random search and optimization methods, can handle arbitrarily complex objective function and constraints, to achieve global optimization to avoid falling into local optimum [3].

3.1 OPTIMIZATION MODELING

In NC machining, in order to achieve optimal processing quality, working hours and the cost will increase significantly. It is not appropriate to just pursuit of the optimal processing quality from the Economics considered, so in the multi-objective optimization with work time, cost, quality as objectives, the cost of the work is the main goal generally, while the quality objectives as the constraints. The lowest cost is the processing of each product (or process) with the minimum cost required, the goal is the least cost to process products, if the single profit is constant, then the standards are consistent with the maximum profit. If the single cost is C, then the calculation expression is:

$$C = t_m M + t_c \frac{t_m}{T} M + \frac{t_m}{T} C_t + t_0 M \,, \qquad (1)$$

where, M for the process unit of time the plant's share of the expenditure (Yuan / min), including wages, equipment, management, and other work expenses; Ct for is the cost of each tool (Yuan). After finishing the above formula can be drawn from the objective function as follows: (Yuan / min)

$$\min C = q\{t0 + \frac{0.001lD\pi}{v_c f_z Z}[1 + (t_c + ylq)(\frac{v_c f_z^{\,b} (a_e/D)^c a_p^{\,e} HB^g}{C_v D^d})^{1/m}]\} \quad (2)$$

where: C-single process cost (Yuan); q-labour and administrative expenses in unit time (Yuan); y-tool cost (Yuan)

$$\min C = q\{t0 + \frac{0.001lD\pi}{v_c f_z Z}[1 + (t_c + ylq)(\frac{v_c f_z^{\,b} (a_e/D)^c a_p^{\,e} HB^g}{C_v D^d})^{1/m}]\} \,.(3)$$

Sometimes our optimization objective of course is not only processing costs, but also a variety of goals to achieve certain requirements, and then they would use the purity of the weighting. Linear weighting method, the basic idea is to construct an evaluation function, multi-objective function into a single objective function solution. Evaluation functions of the form:

$$\text{Min } f = \lambda 1T + \lambda 2C, \qquad (4)$$

where, 0 <= λ <= 1, 0 <= λ2 <= 1, λ1 + λ2 = 1, λ1 and λ2- are the relative importance of the weighting factors for T and C respectively.

It seems that the bigger f value the better from above formula, but in actual production, due to production conditions and parts processing quality and other factors limit the choice of cutting, for example, the selecting of machine tool spindle speed, feed rate, cutting power, cutting torque, surface quality and other restrictions. The general optimal design of cutting constraints should satisfy the following conditions, only the various constraints are considered that the optimal cutting parameters is of practical significance. For example, spindle speed must be greater than 0, the spindle speed is less than the maximum speed of machine tools can provide.

3.2 OPTIMIZATION STRATEGY

The above mathematical model can be attributed to the following optimization problem:

$$\left\{\begin{aligned} &\min f(vc, fz) \\ &s.t.gi(vc, fz) \\ &where, i, h: 1, 2, 3.....8 \end{aligned}\right\}. \tag{5}$$

The objective function and constraint equations are nonlinear equations, the traditional optimization algorithm not only make calculating complex but also difficult to search the global optimal solution. Genetic algorithm is a natural evolutionary process by simulating the optimal solution search methods; the first professor of Holland from the University of Michigan used it [4]. The advantages of genetic algorithm are good at global search.

3.3 GENETIC ALGORITHM BASED ON MATLAB TOOLBOX

The corresponding optimization program can write by the genetic algorithm toolbox to solve practical optimization problems. The following is MATLAB7.0 genetic algorithm toolbox graphical user interface, shown in Figure 2, through the corresponding operation we can optimize the corresponding parameters [5-14].

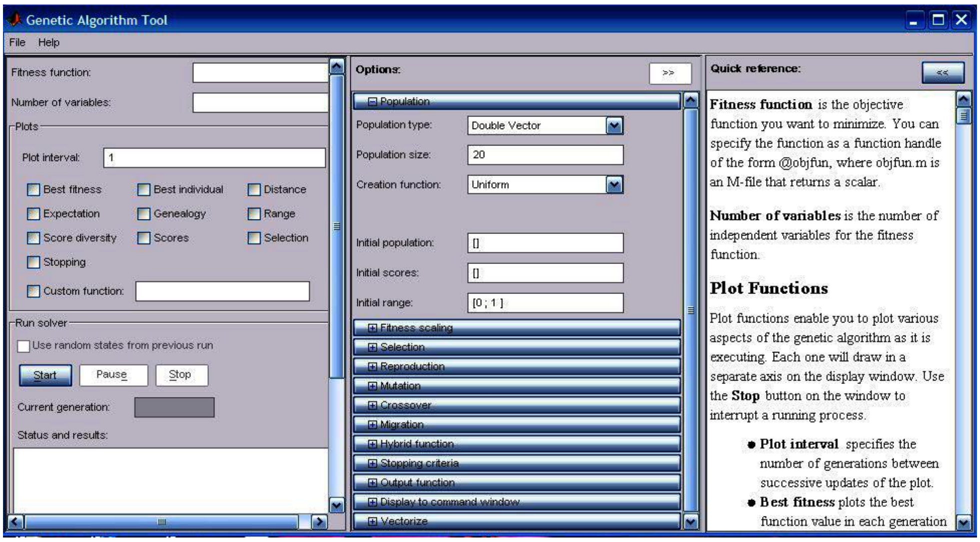

FIGURE 2 MATLAB genetic algorithm toolbox

4 The method of CNC Machining for the cover of auto gearbox based PRO/E

4.1 MODEL NC FILES IN PRO/E

Before the operation in the CNC machining, CNC manufacturing a model file, enter the PRO / E NC user interface, its operation prompt as follows: (1) set the working directory (2) In the toolbar click the "New" button, pop-up "New dialog box. (3) In the"New"dialog box, select the type Make of option group, option group subgroup in the sub-type selected The output defined name, uncheck the button Default template and confirm. (4) the system pop up "New File Options" dialog box, select the template and make sure that the establishment of mmns.mfg.nc and enter a numerical model of the new file.

4.2 MANUFACTURING SETTING AND NC POST-PROCESSING

The set above is complete, to demonstrate the tool path, generating CL data, to view and modify the generated tool path. (1) Tool path demo: Select "NC sequence " - "Demo Track"- "screen shows". Generating tool path; (2) Process Simulation: In the "demo track" menu, select "NC detection" process simulation shown in Figure 3. Throughout the end of the process, Tool ASCII format (CL) data file documents that has been generated of the tool trajectory parts processing. The cutter location data file translated into the specific NC code program (the MCD files) that the CNC machine tool system can identify, this process is know as post-processing. We choose to create or select an existing post processor to generate the NC code, and its suffix to (. TAP) to save the file in the working directory for machining.

FIGURE 3 Cutting process simulation

5 Conclusions

Through the use of common car completed process analysis of the cover of auto gearbox, process flow design, tooling selection, parameter optimization applications, PRO/E-based part modelling, based on PRO/E for machining, post-processing until the generation CNC the whole process of NC code. Reduced the machining time and cost.

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