Application of Artificial Intelligence Technology in Decision-Making of Mechanical Manufacturing Process

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Abstract. The traditional mechanical manufacturing process is to transform all raw materials into the final materials and products and directly into the international market all the production process, in this process we involved a lot of problems about decision-making methods, decision-making process is a most basic production technology activity, it is widely exists in the whole social life and each link of enterprise production. This paper studies the decision-making method of mechanical manufacturing process based on artificial intelligence, optimizes the process parameters of plastic integrated mechanical manufacturing process, and compares it with the traditional decision-making method. Finally, the experimental results are obtained that the traditional decision-based method is reduced by more than 10% in size error. But several experiments, the AI decision-making method appeared deviation, the error results are higher than the traditional decision-making method, which may be objective factors, but also reflects the possibility of instability, in the result of deformation. AI-based decision method performance is higher than the traditional decision-making method, reduce the deformation amount by 3.5%

Key words: Artificial Intelligence, Machinery Manufacturing, Decision-Making Methods, Parameter Optimization

1. Introductions

With the rapid development of the industry, environmental and resource issues have become increasingly prominent. Changing the traditional construction mode and applying green technology is an important direction for the transformation of the machinery manufacturing process [1-2]. Green manufacturing, also known as environmentally conscious manufacturing or environmentally-oriented manufacturing, is a modern manufacturing model that examines the impact and benefits of resources on the environment in detail. Its purpose is to coordinate and optimize the social benefits of the company during the entire life cycle of the product from design, manufacturing, packaging, transportation, use to disposal [3-4]. Green construction is the embodiment of human sustainable
development strategy in the process of machinery manufacturing. In the material selection process, in addition to considering the usability, cost and construction, the environmental coordination of materials must also be considered as an important aspect of achieving green construction [5-6]. Therefore, studying the optimization of decision-making methods in the process of mechanical engineering helps to transform the traditional manufacturing model into a green manufacturing model [7-8].

Aiming at the research of decision-making methods in the machinery manufacturing process, some researchers have used data mining technology, machine learning and interpretable artificial intelligence methods to predict the company’s manufacturing information in a deep learning model, and proposed a new interpretable predictive quality analysis solution method [9]. There are also researchers who study the supply chain issues of suppliers. By discussing the supplier selection decision-making process of manufacturing enterprises, they find that the use of information technology, intelligent manufacturing products, and the use of artificial intelligence tools can be due to the selection decisions of the supply bank [10]. Some researchers also carried out a reengineering process plan for the shaft of a used machine tool in a certain factory, and then used MATLAB software for performance analysis, and proposed the introduction of an improved Takagi-Sugeno fuzzy neural network in the mechanical manufacturing process, which is the best plan for the reengineering process. The decision model is optimized and compared with the traditional neural network method to verify the effectiveness of the method [11]. The researchers also proposed a sustainability evaluation method of CNC process planning with energy saving control strategy. First, the fourth school energy saving control strategy was constructed based on artificial intelligence to reduce the energy consumption of the process, and then establish a two-sided energy saving decision-making mechanism of random forest to adapt to the energy consumption control on different occasions [12].

This paper studies the decision-making method in the mechanical manufacturing process based on artificial intelligence, understands the decision-making method based on the relevant literature, then analyzes the impact of the introduction of artificial intelligence on the mechanical manufacturing process, and lays the theoretical foundation for the later experiment. The effectiveness of mechanical process decision method is verified by AI and compared with traditional decision making methods.

2. Research on Decision-Making Methods in the Machine Manufacturing Process

2.1. Decision-Making Methods in the Machinery Manufacturing Process

During engineering, especially in the engineering transformation, there are many problems requiring decision optimization, such as how to select the best green material from the large number of materials, determine the best process parameters to enable the process to meet the performance requirements, how to select the best maintenance strategy to minimize maintenance resource consumption for optimal maintenance results, construction process scheme selection and evaluation, partners in flexible supply chain selection and optimal allocation of tasks, and error diagnosis of equipment. Due to the uncertainty, complexity and relevance of decision-making parameters in the machinery manufacturing process and the limited knowledge of decision makers, most machinery manufacturing decision-making processes are in a fuzzy and uncertain environment, and there are relevance. The traditional method only selects a specific design based on the experience of the decision maker or selects the process parameters only based on the instruction manual, which lacks
scientific basis. How to make scientific and reasonable decisions, improve product accuracy and processing efficiency in the production process, reduce production costs, and maximize customer demand is the key research content of the manufacturing process.

2.2. The Introduction of Artificial Intelligence

(1) The introduction of artificial intelligence into the decision-making method of the mechanical manufacturing process can improve the uncertainty of decision-making parameters in the mechanical manufacturing process and the complexity of the calculation process, and it can also improve the accuracy of decision-making. For example, in the process of fault diagnosis, in the face of high-speed, massive and real-time equipment status data, it is difficult to provide timely feedback and processing of these data. However, through the processing of BP neural network, these data can be quickly reacted and diagnosed as feedback.

(2) Most of the current decisions are made under the assumption that the properties are independent of each other. In fact, there are different degrees of correlation between different attributes. For example, in the green material decision attributes, in general speaking, the greater the hardness, the lower the elastic modulus, the lower the tensile rate; the maintenance decision attributes, the fault damage is higher, the maintenance scheme with high technical reliability is easy to accept, using artificial intelligence can be well solved to these problems.

3. Experiments of Decision-Making Methods in the Machine Manufacturing Process Based on Artificial Intelligence

3.1. The Purpose of the Experiment

This paper conducts plastic integral molding experiments in mechanical manufacturing to verify the decision-making method based on artificial intelligence to find the best process parameters in plastic integral molding.

3.2. Experimental Equipment

This article uses the MEM-300 rapid prototyping machine developed by Beijing Yinhua Laser Rapid Prototyping Mold Technology Co, Ltd. The processing wire is ABS plastic (composed of acrylonitrile (A), butadiene (B) terpolymer and styrene (S)). Since the three indicators of horizontal size, angular distortion and deformation and machining time accuracy are mainly investigated, the shape and position characteristics such as roughness, parallelism and cylindricity are not included. The rectangular cast pipe part does not need to be supported, does not need post-processing, and is easy to process and casting time moderate. According to the experimental design, this chapter processes parts under different experimental conditions, understands the influence of process parameters on the process and its accuracy, and further defines the best process parameters through optimized decision-making methods.

3.3. Experimental Evaluation Criteria

(1) The evaluation criteria of the plastic integral molding process are mainly from the accuracy error after plastic molding, and the time used for molding, so this article selects three factors such as the
dimensional error of the part, the amount of deformation and the molding time as evaluation Standards.

(2) The process parameters to be used in the process of plastic integral molding include linear width, extrusion speed and filling speed, layer thickness, and plastic molding temperature.

3.4. Experimental steps

(1) First, use the modeling software to model the plastic parts to be tested with a ratio of 1:1. In order to simplify the difficulty of the experiment and control other related factors, the part design directly selects a cuboid, the parameter: 30x20x10mm. Then it is sliced and converted into STI files.

(2) Slicing is to use software to slice the 3D model of the plastic part, and cut into multiple thick plane contour slices along the X-axis or Y-axis.

(3) Finally, a control file with a certain scanning path is generated and transmitted to the molding system to form a numerical control code.

(4) Under the control of the computer and the computer, according to the profile information of the cross section of the nozzle, the numerical control system drives the nozzle to move along the coordinate x-y plane; the wire sent to the nozzle is heated and melted at high temperature, and then due to special conditions the wire is selectively melted and stacked on the workbench, and a layer of cross section will be formed after cooling; after processing to the one-layer section, the formed bottom plate will drop one layer thick, and then continue to the next layer the accumulation of such a cycle, until the entire processing process is completed.

3.5. Decision-Making Method Based on Artificial Intelligence

Through a comprehensive review of various indicators, a number of selected experts listed the pros and cons of alternatives and the decision-making plans made by many participants. Suppose set 2 is the selected expert set, and the element a (i = 1 ... 1) represents each selected expert, 1 in total.

Suppose that two experts use the same decision evaluation index system to evaluate the same decision draft and get two different results: fuzzy number x and fuzzy number y, both of which can be expressed in words, then fuzzy number x and fuzzy number y the ambiguity between is:

\[ S(x, y) = \frac{D(x \cap y, 0)}{D(x \cap y, 0) + \alpha[D'(x, y) + D''(x, y)] + \beta[D'(x, y) + D''(x, y)]} \]  (1)

In the formula: D(\(a\text{\(b\text{, 0}\)) is the repeated region between fuzzy number x and fuzzy number y, that is, the indistinguishable part between fuzzy number x and fuzzy number y, a and \(\beta\) are weight coefficients for decision makers and satisfy 0 \(\leq a, \beta\leq 1\), decision makers often give their own values based on their own degree of membership.

Let Sr, j (a, b) be the expert Zr in attribute M. The degree of participation obtained by evaluating the draft decisions x and y made by two different agents can be calculated using the formula given in
the previous membership definition. If the weight vector of the feature set \( M = \{M_1, M_2, ..., M_g\} \) is \( o \in \{o_1, o_2, ..., o_g\} \) and \( = 1 \), then the total participation \( Z_r \) evaluated by the experts is the decision creation procedure a and b Used for:

\[
S_r(x, y) = \sum_{j=1}^{g} w_j S_r, j(x, y)
\]  

(2)

Use OWA operator to collect fuzzy participation of decision-making team experts in the same decision-making plan.

4. Analysis of Experimental Results

4.1. Dimensional Error Analysis

The experiment compares the decision-making method based on artificial intelligence with the ordinary decision-making method. This experiment is repeated 10 times to statistically analyze the dimensional error of the plastic part on the Y axis, and calculate its error rate. Related data results are shown in Table 1:

Table 1. Dimensional error analysis

|    | Improve decision-making methods | Standard decision method |
|----|---------------------------------|--------------------------|
| 1  | 0.00                            | 0.32                     |
| 2  | 2.64                            | 0.67                     |
| 3  | 0.95                            | 10.78                    |
| 4  | 7.71                            | 0.98                     |
| 5  | 0.26                            | 1.56                     |
| 6  | 10.50                           | 15.89                    |
| 7  | 2.75                            | 1.69                     |
| 8  | 10.10                           | 0.89                     |
| 9  | 4.43                            | 10.34                    |
| 10 | 0.00                            | 0.45                     |
Improve decision-making methods

Standard decision method

It can be seen from Figure 1 that the overall error rate of the decision-making method based on artificial intelligence is lower than that of the standard decision-making method, and the error rate is reduced by more than 10%. However, it can be seen from the summary that there are several decision-making methods based on artificial intelligence. The error rate is higher than that of the standard decision-making method. It can be seen from this that the decision-making method based on artificial intelligence is still unstable and needs to be improved.

4.2. Deformation Analysis

The experiment compares the decision-making method based on artificial intelligence with the ordinary decision-making method, and repeats this experiment 10 times to statistically analyze the deformation of plastic parts. Related data results are shown in Table 2:

**Table 2.** Deformation analysis

|    | Improve decision-making methods | Standard decision method |
|----|---------------------------------|--------------------------|
| 1  | 5.00                            | 5.32                     |
| 2  | 5.64                            | 5.78                     |
Improve decision-making methods

|   |   |   |
|---|---|---|
| 3 | 5.95 | 6.23 |
| 4 | 5.71 | 6.34 |
| 5 | 5.26 | 5.56 |
| 6 | 5.50 | 5.89 |
| 7 | 5.75 | 5.98 |
| 8 | 5.10 | 5.89 |
| 9 | 5.43 | 5.76 |
| 10| 5.00 | 5.45 |

Figure 2. Deformation analysis

It can be seen from Figure 2 that the artificial intelligence-based decision-making method reduces the deformation of plastic parts from 5.24 to 5.08, which is a reduction of 3.5%. It can be seen from this that the performance of the artificial intelligence-based decision-making method is higher than that of the standard decision-making method.
5. Conclusions

This paper studies the decision-making methods in the process of mechanical manufacturing based on artificial intelligence. Through the plastic integral molding experiment of mechanical manufacturing, the decision-making method based on artificial intelligence is used to optimize the decision-making method of plastic integral molding. The experimental results show that the dimensional error is based on artificial the intelligent decision-making method is generally smaller than the standard decision-making method, but it can be seen from the experimental data that the decision-making method based on artificial intelligence is unstable and sometimes biased. It can be seen from the deformation experiment of the plastic part. The performance of artificial intelligence-based decision-making methods is higher than that of standard decision-making methods. This shortcoming still exists in the research process of this article. Due to technical problems, the research depth of this article is insufficient.

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Development of a tower type automatic filter press.

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