Advanced manufacturing technology and modeling optimization based on moldflow analysis —— Take the design process of "Snowflake Bracket" as an example

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Abstract. In the past product creative design process, the design mainly relied on the designer’s intuition and experience. After the plan is completed, it needs several revisions and adjustments before it can be officially put into production. After discovering the problem, it is necessary not only to re-adjust the process parameters, but also to modify the plastic products and molds. This design method reduces the development speed of new products. This research proposes an innovative design method that applies moldflow advanced manufacturing technology to the initial shape optimization of product design, which can help us to accurately grasp the initial product design link and ensure that the product meets the plan expectations and aesthetic needs. Shorten the overall product development process and have good application prospects.

1. Introduction
Product innovation design under the background of advanced manufacturing technology should consider the pre-modeling design and processing as a whole. On the premise that the modelling design is basically completed, how to implement the plan and output should also be a problem that designers need to think about. At this stage, the commonly used advanced manufacturing technologies mainly include 3D printing and injection molding. In the face of the demand for mass production of plastic products, considering the cost of 3D printing, injection molding is the best way. The injection molding process is affected by many factors such as mold design, pouring port and runner design. In the past, the design plan will continue to conduct mold opening experiments on the mold design before production and processing, until the processed products meet the accuracy requirements. [1].

Nowadays, we can effectively avoid the waste of time and cost caused by mold opening by using computer simulation software. At present, the commonly used advanced manufacturing simulation analysis software includes moldflow and moldex3d. Through software analysis, the key processing elements of the injection molding process can be simulated and analyzed many times, and the parameters and design schemes can be adjusted to achieve the best state for actual processing.

At present, the advanced manufacturing technology is developing rapidly, and the technological level is rising steadily. Based on this, this study, combined with the current flow analysis software of computer-aided technology applications at home and abroad-moldflow, proposes to apply moldflow software to appearance design in the process of optimizing plastics processing. Initial stage. Through the simulation analysis of the injection molding process of the scheme, the defects that may appear in the post-production are found, so as to achieve the effect of auxiliary appearance design. To ensure the
smooth realization of the designed product appearance, improve the success rate of a trial mold, in order to achieve the purpose of reducing production costs and shortening the production cycle. Only by ensuring that the cost of product innovation and design matches the value of the product itself in the market can the economic benefits of the product be maximized[3].

2. Research process

2.1. The goal and purpose of research
In the past when advanced manufacturing technology was not popular, product creative design mainly relied on the designer's intuition and experience to design. After the plan is completed, it needs several revisions and adjustments before it can be officially put into production. If the production cost far exceeds expectations, not only the process parameters and production molds will need to be re-adjusted, but the design plan may also be subject to modification. This repeatedly modified production method will reduce the development progress of new products.

Nowadays, advanced manufacturing technologies, led by 3D printing and injection molding technologies, enable more design solutions to be quickly mass-produced. Innovative design is not just a matter of fact, it should ensure the feasibility of the scheme and product quality on the premise of beautiful appearance, and have good economic benefits. With the rapid improvement of the national economy and the continuous progress of the manufacturing level, the product update iterations are also rising rapidly, leading to the gradual exposure of some modern product design problems. Therefore, we realize that in the design and production process of product innovation design, in addition to product appearance design from the perspective of user needs, it is also necessary to conduct a comprehensive analysis of material texture and production technology to effectively enhance product creativity. Only then can the existing technology and methods be used to successfully complete the manufacturing. Therefore, as a product designer, on the basis of understanding the appearance design method, have enough knowledge of the production and processing technology, and at the same time adopt the correct and appropriate technical methods, it is very important to simulate the processing of the scheme and the optimization and upgrade of the innovative design in the early stage of the design. Necessary.

Advanced manufacturing technology and modeling optimization assisted by moldflow analysis can help us to accurately grasp the initial product design process, and then in the processing conditions and quality control links, to ensure that the production of products that meet the program expectations and aesthetic needs. Therefore, the application of mold flow analysis software to the initial stage of product creative design can shorten the overall product development process, reduce the repair rate of the program, and have a good application prospect[4].

2.2. Research content
With the rapid development of economy and technology, coupled with the promotion of the epidemic at the end of 19, wearing masks has become our normal way of life. Many problems have also been exposed indirectly, which has accelerated the process of my country's formulation of more comprehensive mask production standards and the study of mask morphology by various corporate scholars.

- Combining the existing advanced manufacturing technology to analyze and research the shape of the new mask, a new mask bracket shape is designed. And adopt the control variable method to design the diversified structure of the set model, and select the best structure that is conducive to injection molding through comparative analysis. The purpose is to explore the optimal shape of the innovative design plan.
- The mask holder requires a beautiful appearance and a smooth surface transition. Therefore, there are certain requirements for the accuracy of the processing mold and the performance of all aspects of the material. In order to avoid quality defects such as product breaks and bubble marks, it is necessary to optimize the shape design many times and improve the production
quality. Check more. With moldflow analysis software, under the premise of fixed processing parameter settings, the relevant factors of different models are analyzed, and the best is selected as far as possible to reduce the volume of the parts to save raw materials.

2.3. Sample design
In order to obtain more accurate stent accuracy, this study uses a single variable research method to explore the influence of the above model factors on the stent forming accuracy. The creative design of the scheme is based on the snowflake shape. The 1-a element diagram in the sample design shown in Figure 1 is the inspiration diagram. The lines are simplified, and the sharp parts of the mask should be reduced when worn on the face to avoid accidental injury. Therefore, the element diagram is rounded, and the final version is changed to the basic simplified design diagram of Figure 1-b.

![Element diagram](image)

Figure 1. Scheme design drawing

The three-dimensional model is drawn using Rhino5.0 version. After the modeling of the mask body is completed, use the "projection" command to project the basic simplified design of Figure 1-b onto the mask body, then divide it, and finally add rounded corners. Save the model file in stp format to complete the drawing of the 3D model.

The model scheme information is shown in Table 1:

| Sample | Body shape | Remark |
|--------|------------|--------|
| 1      | ![Element diagram](image) | On the basis of the basic simplified design drawing, the rib position is thickened, and the original line is thickened twice. |
| 2      | ![Element diagram](image) | On the basis of the simplified design of the basic model, the overall model is thinned to 4mm. |
3. Simulation analysis

This research mainly focuses on the injection molding method, and takes the mask design as the research object. In the process of optimizing the plastic processing, the moldflow software is applied to the initial stage of the appearance design. Through the simulation analysis of the injection molding process of the scheme, the influence of the support structure design on the injection molding is found, so as to achieve the effect of auxiliary appearance design. The feasibility of the plan design is very important, and it will directly affect the mold structure design, the molding effect and product performance of the injection molded part, and the final production cost. Use moldflow software to simulate and analyze the molding process of its appearance plan. Under the premise of fixed injection molding process, control a single variable of the model to generate five model samples, and compare and analyze them, and obtain the best results from the dual perspectives of appearance design and processing feasibility. Optimize innovative design schemes. This simulation program is close to the objective facts of product molding and manufacturing and quality evaluation, and an innovative design method based on moldflow analysis method to assist modeling design is proposed.
3.1. Analysis pre-processing
The sample of the research model is shown in Table 1. After being saved as igs format, it is imported into Moldflow mold flow analysis software to obtain the injection mask bracket model. Use the mesh tool to mesh the model. Moldflow software has three types of mesh. The plastic model in this study is very thin. In order to obtain a better division effect and more accurate simulation results, a surface mesh is used to divide the model into a finite element mesh. Make the software optimize and modify the original grid after it is automatically divided to ensure the connectivity of the model and make the result of grid division meet the simulation requirements[5].

Mold flow analysis selects Alkathene VRM-19: INEOS Acrylice molding material (brand: Alkathene VRM-19, INEOS Acrylics), mold material is tool steel P-20, mold surface temperature is 40 degrees, melt temperature is 220, cooling time is set for 20s. The system default parameters are selected for the process controller and injection molding machine.

3.1.1. Design. The location of the gate has a great influence on the performance of the design scheme. Therefore, it is very important to choose a reasonable gate location[6]. The flow channel simulation in this study only provides reference for the feasibility of the scheme design and modeling optimization, so the flow channel and cooling water path are not set and only the design effect of the model itself is investigated. Using the gate position command in Moldflow to predict the optimal gate position area of the model, the analysis result has reference value for the real mold design. Through gate analysis, it is preliminarily determined that the best gate location is located at the middle beam node of the support beam, as shown in Figure 2.

![Figure 2. Schematic diagram of gate location](image)

The results of the gate position analysis can be used as important reference information for gate design, but not necessarily the actual gate position used in mold design. In the actual mold design process, the location, quantity and size of the gate will be optimized according to the product appearance quality, material, process and other requirements. At the same time, it is necessary to avoid the occurrence of spraying, stagnation, dents, etc. in the actual production process.

3.2. Single factor simulation analysis of appearance design optimization

3.2.1. Filling time analysis. Filling time refers to the time that the plastic melt enters the cavity from the gate until it fills the entire cavity. In theory, in order to ensure uniform temperature and flow, an excellent filling process can make the polymer melt reach the end of the mold cavity in the same time. At the same time, the filling time determines the production efficiency during product processing. The shorter the filling time, the higher the injection efficiency. Figure 3 is a simulation diagram of the filling time of the five schemes. It can be seen from the figure that the two edge parts of the injection-molded mask holder of the scheme are the final filling parts.
Table 2. Filling time simulation chart

The filling time of sample one to sample five is 0.4559s, 0.7420s, 0.4658s, 0.4504s, 0.4595s, respectively. Among them, the filling efficiency of sample four is higher, and the filling time of sample two is the longest. The main reason is: sample one and the four ribs of the sample are thicker, the pressure loss is small, and the filling rate is faster. The second and third samples have finer ribs and are not easy to fill. The pressure loss is large, and the flow rate is reduced, which leads to a longer filling time.

3.2.2. Frontier temperature analysis. The temperature distribution of the flow front reflects the rationality of the temperature distribution during the injection molding process of the product. In general, the smaller the temperature difference of the flow front, the better the quality of the product and the higher the accuracy. Figure 4 shows the simulation analysis results of the flow front temperature of the five schemes. It can be found that the difference in the front temperature of the five schemes is small. Among them, the temperature of the flow front of sample five is slightly different, and the difference between the highest and lowest front temperature is about 2°C. The overall temperature difference is small, and it is maintained at 220 °C, indicating that the gate position is reasonable.
3.2.3. Warpage deformation analysis. Bending deformation is an important factor that affects the accuracy of the product. It refers to defects caused by surface deformation, uneven internal stress, or uneven cooling of the product that is not formed according to the design shape[7]. For most plastic parts, warping deformation is the main reason that affects quality and performance. Large or small deformation of plastic parts will cause matching problems. Therefore, warpage deformation is the most important evaluation index for plastic molding[8]. In the design of the forming scheme, the warpage deformation of the part should be reduced.
largest deformation. The analysis shows that, compared with sample 2, under the premise that the conditions are basically the same, sample 3 has no perforation design at the connection, so the warpage deformation of solution 4 is significantly less than that of solution 2.

From the above simulation and result analysis, we can draw the following conclusions:

- For innovative design products with complex shapes, moldflow software can be used to assist the appearance design, and the appearance design can be used as a reference through the simulation analysis of the processing process.
- On the basis of the processing technology and the fixed materials, we can know through simulation that in the process of program design, we should not blindly pursue "light and thin". If the connection structure is too thin, the plastic parts will be prone to warpage and deformation and difficult to process. If the overall structure is too thin, the injection time will be prolonged and the production efficiency will be reduced.

After a comprehensive comparison of experiments, the results show that the snowflake-shaped bracket design. The third plan is the optimal design plan, which finds a reasonable balance between lightness and beauty, which is conducive to injection molding.

4. Conclusion

Advanced manufacturing technology and product innovative design integrate design expression, analysis and simulation capabilities, intelligent manufacturing and other discipline knowledge, which is a very complex process. The output of the plan should be integrated into the whole process of manufacturing, publicity, and sales, and the implementation of manufacturing technology should be considered in the overall design and creativity of the product[9]. Under the premise of comprehensively considering the manufacturing process and assembly parameters, the realized innovative design helps to avoid problems that may occur in the future processing in the early stage[10].

This research is mainly based on the new trend of mask design research under the background of the epidemic at the end of 19, using advanced manufacturing technology computer-aided design software-moldflow to carry out innovative research related to plastic stent design, molding and modeling optimization. At the same time, for the molding of plastic stents, mold flow analysis was used to simulate, and the influence of different structural thickness and scale on the injection molding process was analyzed. Furthermore, evaluation, screening and feasibility analysis of the formation of different design schemes are carried out to obtain the most feasible and innovative appearance design scheme. The creative design method combined with advanced manufacturing technology is feasible and has application significance.

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