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Application of CAD/CAM Tools in the Production of Investment Casting Part

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***Abstract** : Application of CAD/CAM in product development cycle has transformed every sector of manufacturing process from black-art into a knowledge based intelligent technology. Proper Application of the CAD/CAM tools in manufacturing stages minimizes to a greater extent the production cost, lead time and deliver good quality products. In this paper, the CAD/CAM technology was briefly introduced and the CAD/CAM tools were applied in modelling an investment casting part, design and modelling of wax pattern injecting mold, and finally NC machining simulation for the wax pattern injection mold cavity.*
***Keywords**: CAD/CAM, Investment Casting, Mold, NC Machining, Pro/E, UG-NX 8, Blank*

I. Introduction

Application of CAD/CAM technology has been a breakthrough regarding the technical application of computer technologies for manufacturing products in the most efficient manner, high quality and minimum cost. With the constant development of modern manufacturing, advanced manufacturing technologies increasingly impose great impacts upon these techniques thereby, proposing higher requirements for the research on and development of CAD/CAM and its application in product design and manufacture more significantly in the tooling designs for processes such as investment casting which requires large number of human-controlled parameters, and therefore involves many changes in tooling and process parameters before producing satisfactory parts[1,2]. Computer Aided Design (CAD) refers to the use of computer technology for the design of objects, real or virtual. The design of geometric object shapes, in particular, is often called computer-aided geometric design (CAGD). However, CAD often involves more than just shapes, as in the manual drafting of technical and engineering drawings, the output of CAD often must convey also symbolic information such as materials, processes, dimensions, and tolerances, according to application-specific conventions . On the other hand, Computer-Aided Manufacturing (CAM) involves the use of computer-based software tools that assist engineers and machinists in manufacturing or prototyping product components. CAM may also be referred to the use of a computer to assist in all operations of a manufacturing plant, including planning, management, transportation and storage, its primary purpose is to create a faster production process and components with more precise dimensions [3-5]. Integration plays an increasingly important role in CAD/CAM systems and as such the technology has rapidly developed and widely spread in manufacturing industries. The Current major commercial CAD/CAM systems, such as Unigraphics, Pro/E, IDEAS, CATIA, etc. have many specialized modules packed together and running on their own proprietary databases. These systems have both CAD and CAM capabilities and the geometric data from CAD can be used in the CAM module without any conversion [6]

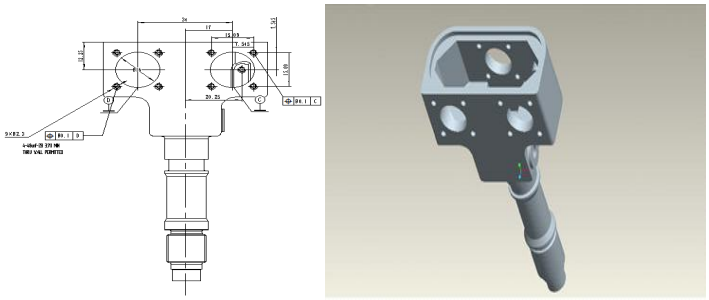
II. Methodology

Although the investment casting part production involves many steps, in this approach the CAD/CAM tools were applied in the following 3 major steps, these are:

I. 3D modelling of the part
II. Mold design and Modelling
III. Mold Cavity NC machining simulation.

3D Modelling Of the Investment Casting Part

Pro/E Wildfire 4.0 features were repetitively exploited in modelling the investment casting part. The Pro/E software base features were used in creating the major geometrical structure of the part, these features were made up of primitive shapes namely: Rectangular and cylindrical shapes that gives the part its main geometry, then followed by modifiers that aids the creations of engineering features such as chamfers, corners, rounds and other cavities and contour radii of the part as specified in the 2D drawing. Fig.1.1 shows (a) 2D drawing and (b) 3-D model of the part.



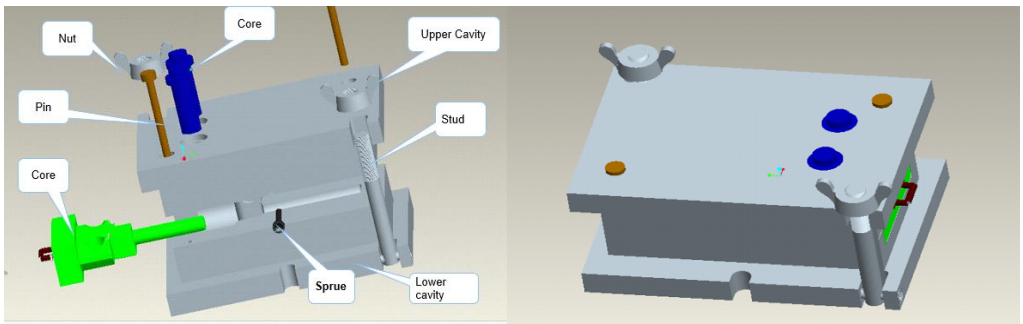
(a) 2D drawing **(b) 3D model**

Fig.1.1 An Investment Casting Part.

2.2 Mold Design and Modelling

The wax pattern injection mold was designed based on the casting drawing specifications. The 3D model of the as-cast blank was created as shown Fig. 1.2 and the mold cavities were created as follows: The as-cast model (i.e. the blank) was imported into the Pro/E assembly module and a 2-workpieces of specified dimensions were created thereby making the bottom and top part of the mold (i.e. lower and upper cavities) using cut-out method. After considering all the tolerances, the draft angles, shrinkage allowance as well as machining processes, the other components such as the sprue, pins, clamping nuts and studs, screws, etc. were separately modelled based on standard sizes and shapes as required for mold assembly and the whole components were assembled. The Fig.1.3 (a) and (b) shows the exploded and assembly views of the mold respectively.

Fig. 1.2 As-cast blank

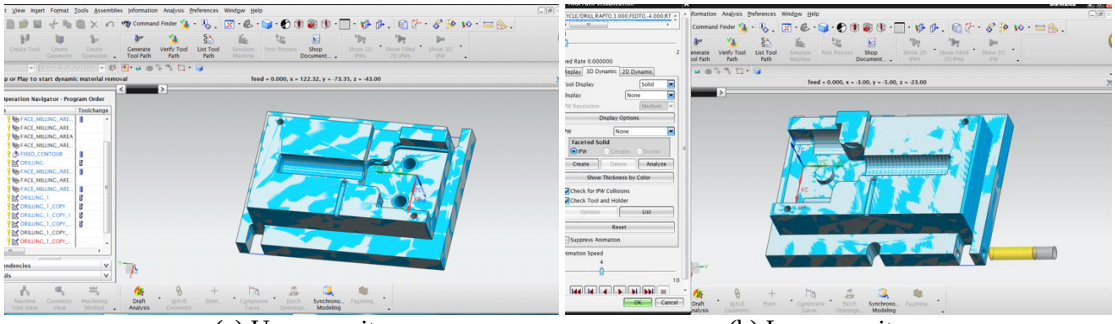


(a) Mold exploded view (b) Mold assembled view

Fig1.3 Wax Pattern Injection Mold Views

Mold Cavity NC Machining Simulation

The machining of mold cavity requires very high accuracy and excellent surface quality. Therefore, it is essential to make use of simulation techniques so as to reach a very high surface quality and an upper surface layer with low stresses and distortions. The machining simulation of the mold cavities from the 3D models (i.e. upper and lower cavities) all the way to the NC codes generation can be summarized as follows: The 3-D models of the mold upper and lower cavities were saved in STEP file format and imported into the UG-NX8 manufacturing module; Geometry, tool path style and the tools to use were properly defined and selected; the type of material, feed and depth of cut were also specified; tool paths were verified and some adjustments on the cutting parameters were made; the NC code was produced by post processing the model and NC code were created and then customized to accommodate the CNC machine. The Fig.1.4 (a) and (b) shows the finished upper and lower cavity of the mold respectively.



(a) Upper cavity (b) Lower cavity

Fig.1.4 Finished cavities of the mold

III. Conclusion

The paper has successfully discussed a simple approach of using CAD/CAM tools in the tooling design stages for investment casting parts production. Proper application of the CAD/CAM tools in this manner can bring a tremendous reduction for the diminishing expertise in using computer aided tools in the tooling design methods and therefore can reduce product development cycles, faster time to market and greatly enhance the competitiveness of any enterprises that fully adapt the techniques.

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