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OBTAINING MOLD INSERTS CAVITIES USING RAPID PROTOTYPING TECHNIQUES

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Abstract: *This paper aims to present an application of the technique of rapid prototyping (RP). RP process has its own advantages and disadvantages. These techniques allow designers to produce tangible prototypes of their designs quickly, rather than just two-dimensional picture. For small series and complex parts, these techniques are often the best manufacturing processes available. This paper presents the manufacturing of mold cavities using a particularly case off RP techniques, the subtractive process and the steps that must be followed in order to obtain the products. Subtractive Rapid Prototyping (SRP) is a process who transforms 3-D digital models content into physical objects.*
Key words: *subtractive rapid prototyping, FEM, CAE, mold*

1. INTRODUCTION

Rapid prototyping (RP) by definition means the ability to generate models directly from computer-aided design (CAD) data in a very short time.

There are two distinct RP processes:

- subtractive processes
- additive processes.

The RP processes include, amongst others, Subtractive Rapid Prototyping (SRP), Stereo Lithography (SL), Laser Sintering (LS), Fused Depositions Modelling (FDM), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS) and 3- Dimensional Printing (3DP) (Chua et al., 2005). RP technologies have gained diversity, complexity, sophistication and popularity since their introduction in the late 1980's (Hague et al., 2004).

These techniques allow designers to produce tangible prototypes of their designs quickly, rather than just two-dimensional picture. For small series and complex parts, these techniques are often the best manufacturing processes available. After all, CNC technology and injection moulding are economical, widely understood, and available for wide material selection (Chua et al., 2005).

In RP, the term "rapid" is relative, it aims at the automated step from CAD data to machine, rather than at the speed of the techniques. Depending on the dimensions of the object, production times can be as a few days, especially with complex parts or when long cooling times are required. This may seen slow, but it is still much faster than the time required by traditional production techniques. This relatively fast production allows analyzing parts in a very early stage of designing, which decreases the resulting design cost. The use of RP in product design and development has had a significantly positive effect and has been shown to reduce development costs by 40 to 70% and the time to market by as much as 90 % (Dominique et al., 2007), (Hague et al., 2004).

The techniques of RP contribute to minimizing the risks of project failures. The economic stakes are a key factor.

2. SUBTRACTIVE RAPID PROTOTYPING

Subtractive Rapid Prototyping (SRP) is a process who transforms 3-D digital models content into physical objects. The term subtractive suggests that taking away material during the process. This is precisely what CNC RP does. The original source model can be of any 3-D content or software origin. Any CAD, CAM, or 3-D modelling can be machined (Patrik et al., 2005).

SRP is a low cost prototyping and parts manufacturing process. The digital model is recreated an transformed into a real world physical object that can be held in the hand. The final milled parts can be used for preproduction models ready for manufacturing, product prototypes, sales samples, proofs, displays and concept development.

SRP provide many benefits some of them are as follows:

- increase productivity and save cost
- no more wasted internal resources and man-hours
- wide variety of material can be machined
- high tolerance machining

surface quality rivals any other RP system on the market (Patrik et al., 2005).

This paper presents a description of how CNC milling can be used as a rapid prototyping process. Subtractive prototyping is another way to create prototypes in which material is removed from a larger piece of material. Subtractive prototypes are typically created using more traditional manufacturing processes. These include standard machining process such as milling, turning or drilling and more modern tools like CNC machining. So with subtractive prototyping, we might start with a block of metal or plastic and cut away material until the prototype part is created.

In RP, there are advantages and disadvantages to any choice of technology. Subtractive prototyping is limited to relatively simple shapes –complex geometries are not possible. The material must be readily available in the size and shape needed. And SRP usually takes longer. Its main advantage is that is made in the final production material. Others advantages: accuracy- machine tools are more accurate than RP layer-by-layer or drop-by-drop methods, finis- machine tools can produce a very smooth finis, mass production, more materials- many different materials can be machined (Hague et al., 2004), (Patrik et al., 2005).

3. CASE OF STUDY

In this chapter is presented an algorithm to obtain parts through rapid prototyping techniques. The algorithm that we propose is presented in figure 3.1.

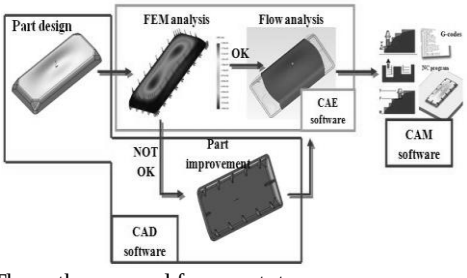

Fig. 1. The path proposed for a prototype

3.1 Part design

The first step is to design the part, which was created in CAD software.

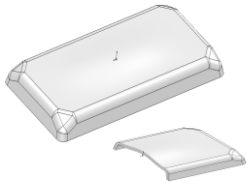

Fig. 2. The 3D model

To see what are the effects of forces acting on this part, was performe a static simulation with a force up to 20 kgf.

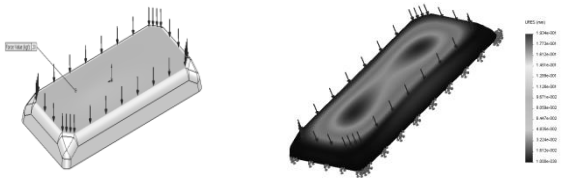

Fig. 3. FEM analisys

After the virtual simulation we notice that the edges from the interior of the part are high solicited so we apply stiffening ribs, which will absorb the forces from the walls. The part will become stronger.

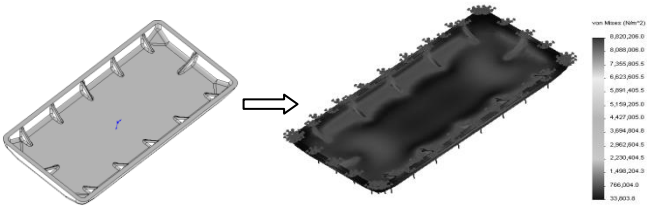

Fig. 4. Part improvement and FEM analisys

3.2 Mold injection study of the part

The part must have a draft at least 3^0, for extracting the part from the mould. After this the part is analyzed in terms of suitability for the operation of injection, but its complexity also.

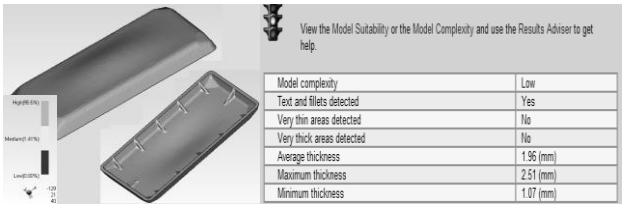

Fig. 5. Results of part analisys of model complexity

Filling analysis is the next step, where is examined the entire time cycle of filling, the quality of surface, pressure during filling, melt temperature, air voids and weld lines.

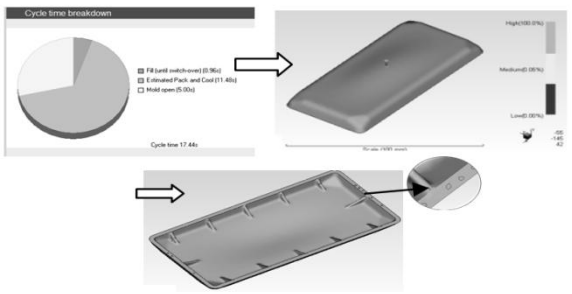

Fig. 6. Time cycle of filling, surface quality and air voids

The part will be injected in to a single cavity mold using pin injection system.

3.3 The design of 3D mold cavities

The mold cavities are designed in CAD software.

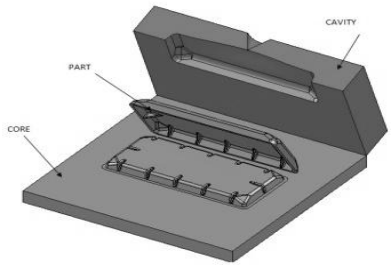

Fig. 7. Mold cavities

3.4 Manufacturing strategies in CAM

In modern CNC systems, end-to-end component design is highly automated using CAD/CAM programs. The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine, and then loaded into the CNC machines for production. The proliferation of CNC led to the need for new CNC standards (Sotiris et al., 2007).

One the geometrical model is finished and all the simulation are done we can start the procedure for making the NC program for cavitie and core. For creating the NC program we must choose the strategies for the milling operation, tools and milling parameters.

4. CONCLUSION

This paper presents an algoritm for making a virtual part into a prototype using CAD/CAM/CAE softwars. It will explain the origin of this need of computer use in design or manufacturing, and the need of Rapid Prototyping in different domains

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5. ACKNOWLEDGEMENTS

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