ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume IX (XIX), 2010, NR4

MODERN SOLUTIONS FOR CONCEPTION, DESIGN AND MANUFACTURING TECHNOLOGY IN THERMOPLASTICS INJECTION

ILIE Sorin
S.C. PLASTOR S.A.
sorin_ilie@plastor.ro

Keywords: design, injection, thermoplastic, computer, simulation

Abstract: Extraordinary development of thermoplastics processing industry and in particular the injection processing technology has led to molded parts with very complex geometric shapes and having more high quality requirements coming for the clients. In mean time, new thermoplastics with superior features, with higher prices, more advanced injection machines and more complex injection molds were development. All this led to the exponential increase of complexity for the plastic engineers. To help them have appeared a lot of number of expert computer-aided programs to assist the engineers from design to all manufacturing processing.

1. Introduction

Especially plastics and thermoplastics are part of our everyday life and unite them everywhere around us. From packaging to food, to very sophisticated part of a car: packaging, high precision industrial components, furniture, windows, pipes, decorative items and many other products are now manufactured from materials which, after several generations of us, they could not imagine. Extraordinary development of thermoplastics processing industry and in particular the injection processing technology has led to molded parts with very complex geometric shapes and having more high quality requirements coming for the clients. In mean time, new thermoplastics with superior features, with higher prices, more advanced injection machines and more complex injection molds were development. All this led to the exponential increase of complexity for the plastic engineers. To help them have appeared a number of experts computer-aided programs to assist the engineers all the way, from design to manufacturing processing. They are so called; CAD, CAM and CAE expert's computers programs.

Plastics available today in an extraordinary variety, more successfully compete with traditional materials. Physical qualities (hardness, resistance to corrosive agents, processability, and transparency) allow many applications to replace wood, natural textile fibers, glass and even steel. Chemical processing have determine two major classes of plastics: thermoplastics and thermosetting. The main market segment, which addresses plastic articles are: packaging and construction, amounts used in other areas such as automotive or electronics industry is not far from negligible. In the Fig.1 it can see same examples of different plastics parts using in different sectors of industries, housekeeping, goods consumer or different sports domains. (Fig.1.).

2. Using CAD computer programs for design plastic parts and complex products

Due to new clients demands, all thermoplastic are more complex, more sophisticated, surfaces and increasingly sophisticated forms of product. These demands require using CAD computer aided design in 3D. These computer aided design programs are very necessary because, they are enabling a best design for geometry and shape of parts injected in 3D. This is very helpful tool for engineer designer, for viewing the smallest details of all elements of track geometry design. Another great advantage of using these programs is that you can design sub-assemblies and assemblies of either injected and metal pieces or any other allowance enabling the verification of assembly, chain size, the interactions of some parts of sub-assembly moving. (Fig.2.)

Fig.1. Examples of plastics parts from different fields

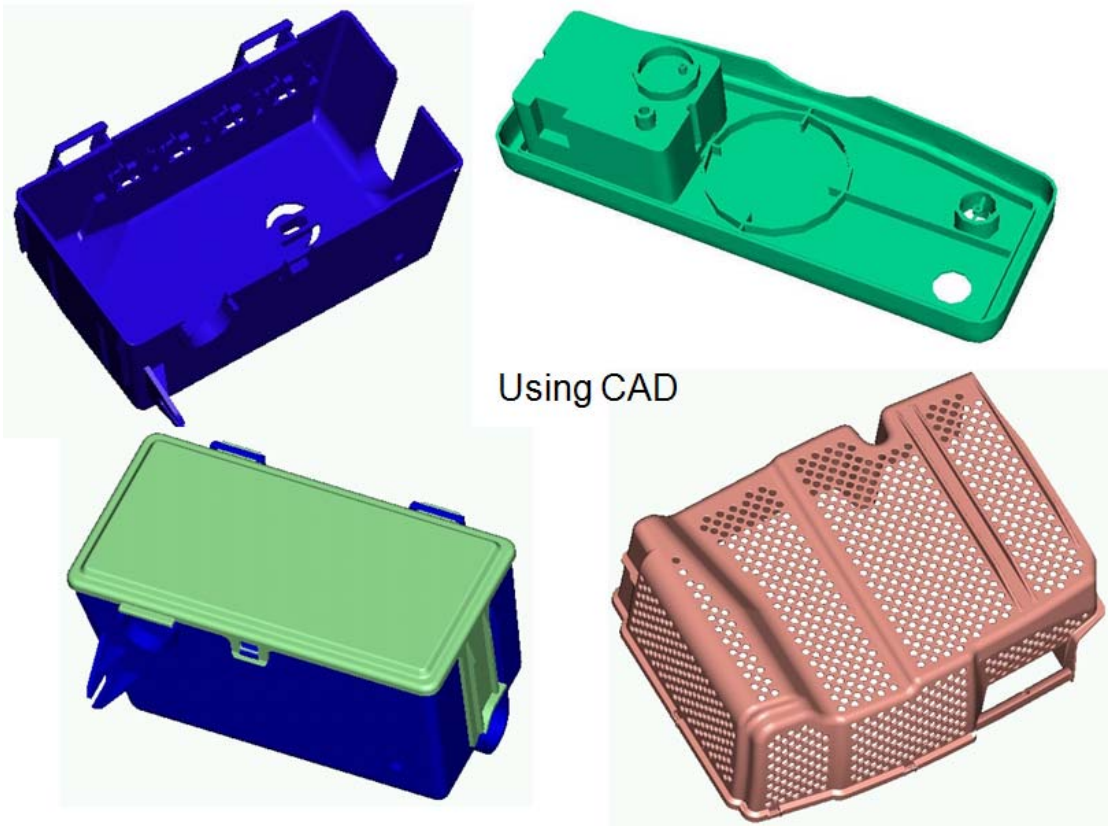

Fig.2. Examples of plastics parts designed with the CAD computer program: ProEngineer200i

3. Using CAE computer programs for injection process simulations

3.1. Mold filling analyze

Using a C.A.E. program the designer engineer can simulate the dynamic process of filling the cavity of the injection mold design for the complex parts.. Flow simulation analysis requires a model surfaces that are meshed. The mesh comprises triangular elements and each element has three nodes. Thermoplastic flow simulation analysis for filling process provides us the optimum processing condition like best melt temperature, best mold temperature and best injection time for a chosen plastic material. Using the optimum processing condition for running a filling simulation process we can verify that the optimized processing conditions are correct and to verify if all the flow fronts are balanced, that means all the extremities of the cavity are filling in the same moment at the lower pressure. Also, filling analysis provides information's about the behavior of the melt flows during filling the cavity of the mold. (Fig.3.) A filling analysis considers the filling phase from the start of injection to when the cavity is filled with plastic material. The simulation of the filling process in injection of plastic parts are used to obtain information about the optimum injection location and number of injection gates, to determined the optimum molding conditions like best injection time, best mold temperature and best material temperature and using this best conditions to provide information on the balance of melt flow in the cavity. To obtain all this optimum information's in this study we like to presents which are the steps which are necessary to run until the flow results are optimum

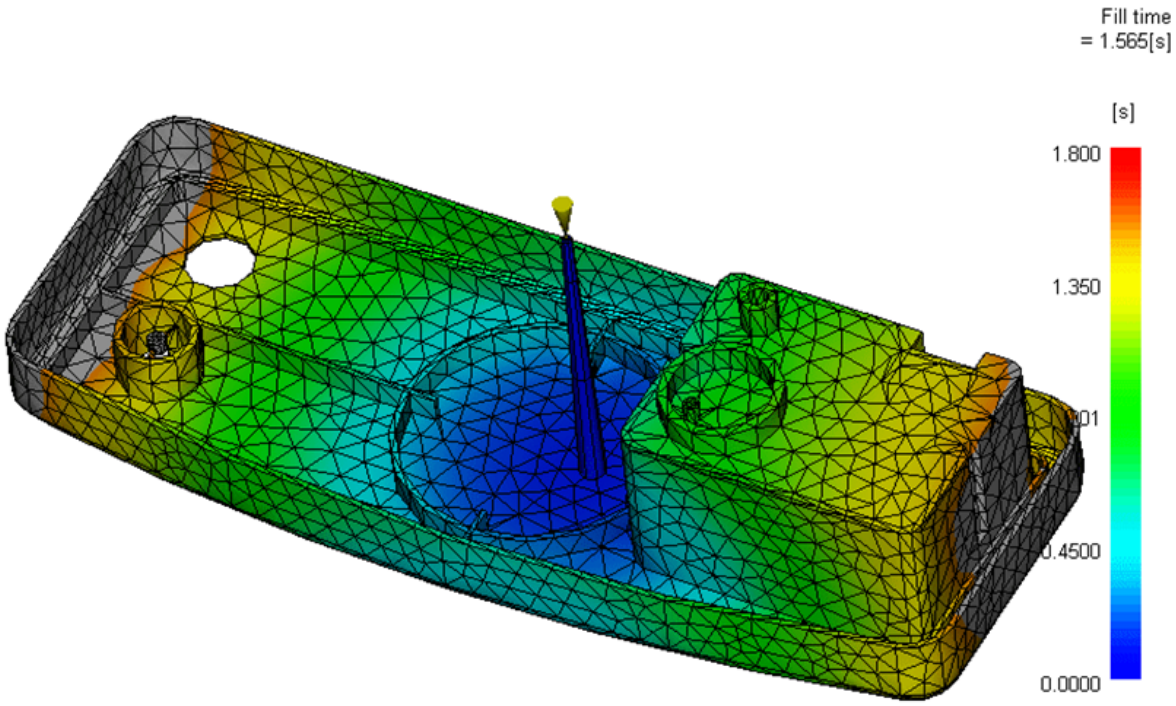

Fig.3. Mold filling analyze of a plastics parts using CAE programs

3.2. Cooling analyze

The cooling time is often, the biggest time of a cycle time in injection technology. Very often the cycle determines the cost of injected parts. The cooling time is the time required for extracting injected part from the cavity into full play safe and meets quality requirements. The temperature at which injected piece mold can be evacuated from the cavity is influenced by many factors. Part injected must be dimensionally stable enough to withstand:

1. trend of thermal deformation and residual stresses due to shrinkage volume change

2. local forces acting on the piece when injected into the mold by drawing from the nest by throwing system

Depends on the application field of play is injected compromise between a uniform cooling as providing a high quality injected parts for cooling but a very large and so expensive and a rapid cooling to minimize cooling time and therefore cost production. Design a cooling system should be taking into account the following design criteria:

1. Ensure as uniform cooling of the part injected;
2. Ensure a uniform temperature and mold as desired value for the next injection cycle;
3. Minimize cooling time and cycle time.

Physical design of the channel geometry is restricted by moderation mold cavity of tanks and cores, the planes of separation and the injection mold throwers. This together with the fact that most parts of the injected have variations of wall thickness, ribs, bosses, corners, edges, stiffening causes hot spots on the surface of injected parts. For disposal is recommended: (Fig.4.)

1. Temperature near the channel closer to the hot zone;
2. Temperature increase channel.

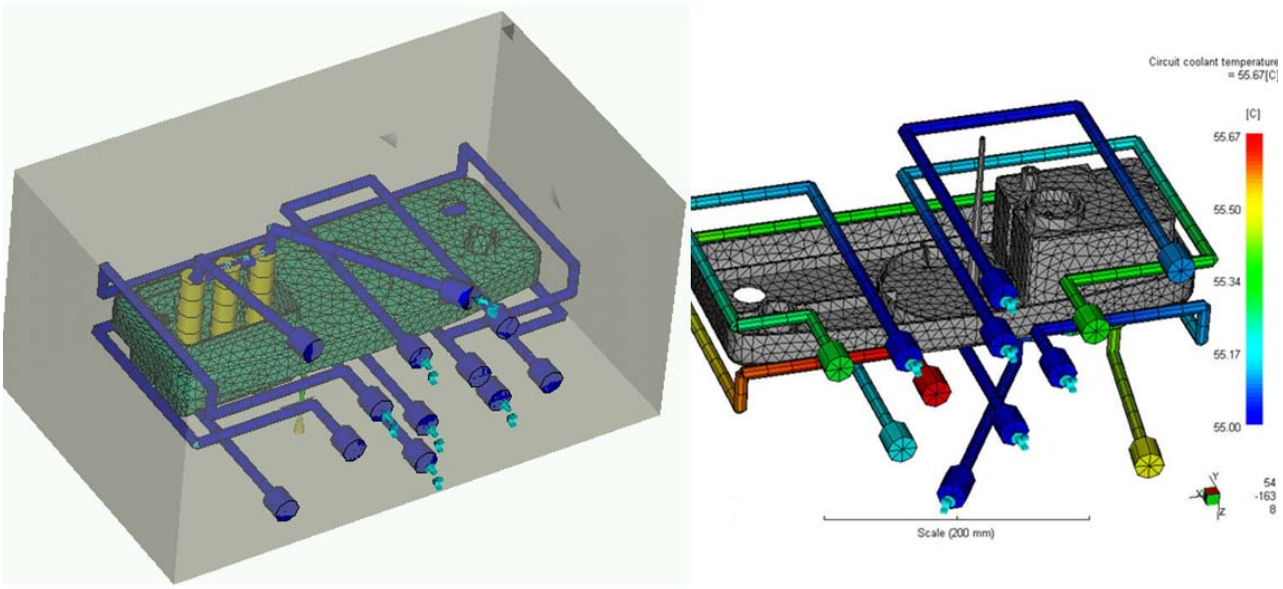

Fig.4. Mold cooling analyze of a plastics parts using CAE programs

3.3. Warp analyze

Theoretically a homogeneous and uniform piece injected volume will shrink as the relationship of nature PVT. Specific thermoplastic material from has been injected. This would mean that each size will decrease in proportion to the specific volume contraction. Practically, however, several factors significantly influence the volume contraction leading to contractions very different from one area to another to play important leading to further strain injected parts.(Fig.5.)

Factors which have a considerable influence on volumetric shrinkage are:

1. Cooling rate
2. Orientation of the macro molecules thermoplastic material during the injection track;
3. Keep forcing shape mold injected parts;
4. Temperature differences between parts of the injected part of the nest due to uneven cooling of the injection mold.

The main causes underlying the differential volume shrinkage and deformations influence the post-injected parts are:

1. Non-uniform cooling of the part injected;
2. Volumetric shrinkage variation of injected parts of one area to another;
3. Different molecular orientation on the plastic material injected directions parallel or perpendicular to the direction of flow.

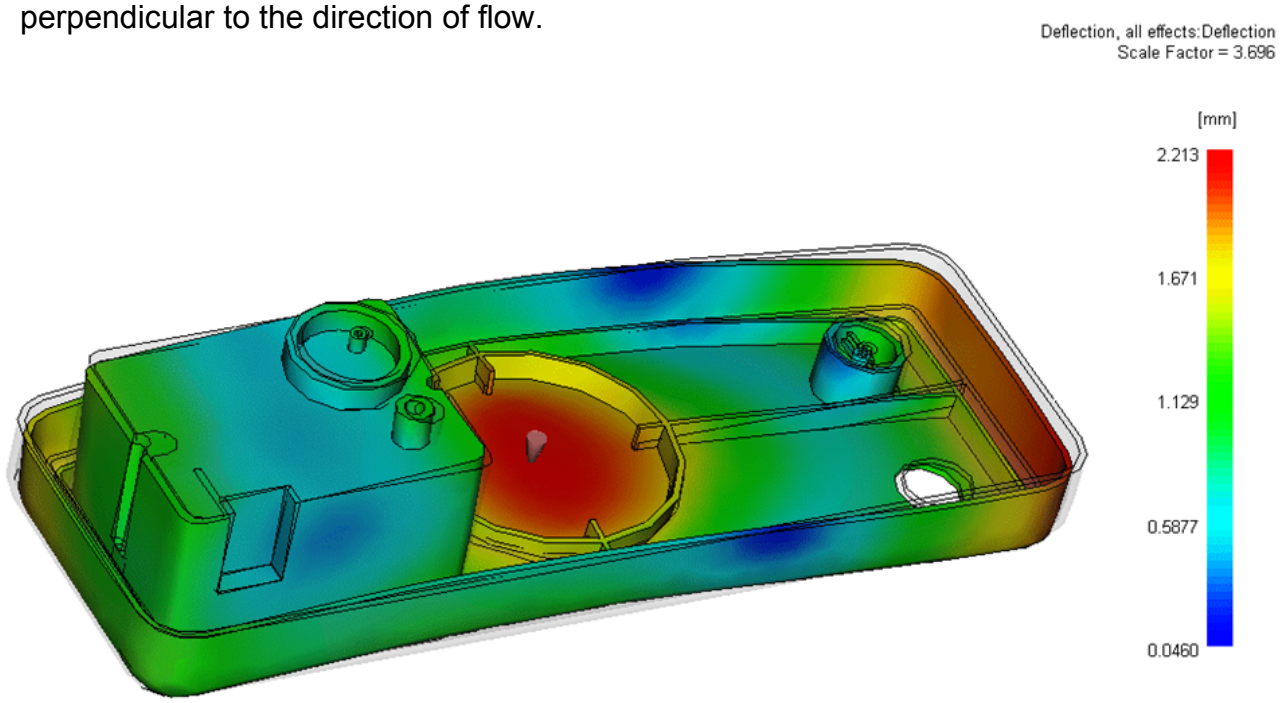

Fig.5. Warp of plastic part calculated by CAE programs

3.4. Design of the mold for injection the plastic part

An optimum injection profile during filling stage and an optimum packing profile should minimize warpage and surface defects and maintained dimensional tolerance in the optimum profile. The purpose of the simulation program is to overcome molding problems predicted the optimum injection parameters in order to produce the best part quality at the minimal cost and more important these processing parameters, can be set only for the chosen injection molding machine. Using all the results of different CAE programs, the designer engineer can start to design the injection mold for the plastic part. Because of the complexity of the new mold, this can be done only using CAD expert programs like ProEnginner 2000i. With the help of these kind of computer experts programs for design, the engineer can more easy to manage all the details of the mold, all the component parts of the mold in 3D. Working like this, it is easier to avoid mistakes and fatale errors. At the end of mold design, after assembly all the components of a mold, a virtual 3D image of the mold has been created with all geometries and surface details.(Fig.6.). This virtual 3d image of the mold it is transferred at the mold department, to start executions of the mold. In this way, for all peoples who are working in mold department it easier to better understand the construction and the functionality of the complex mold.

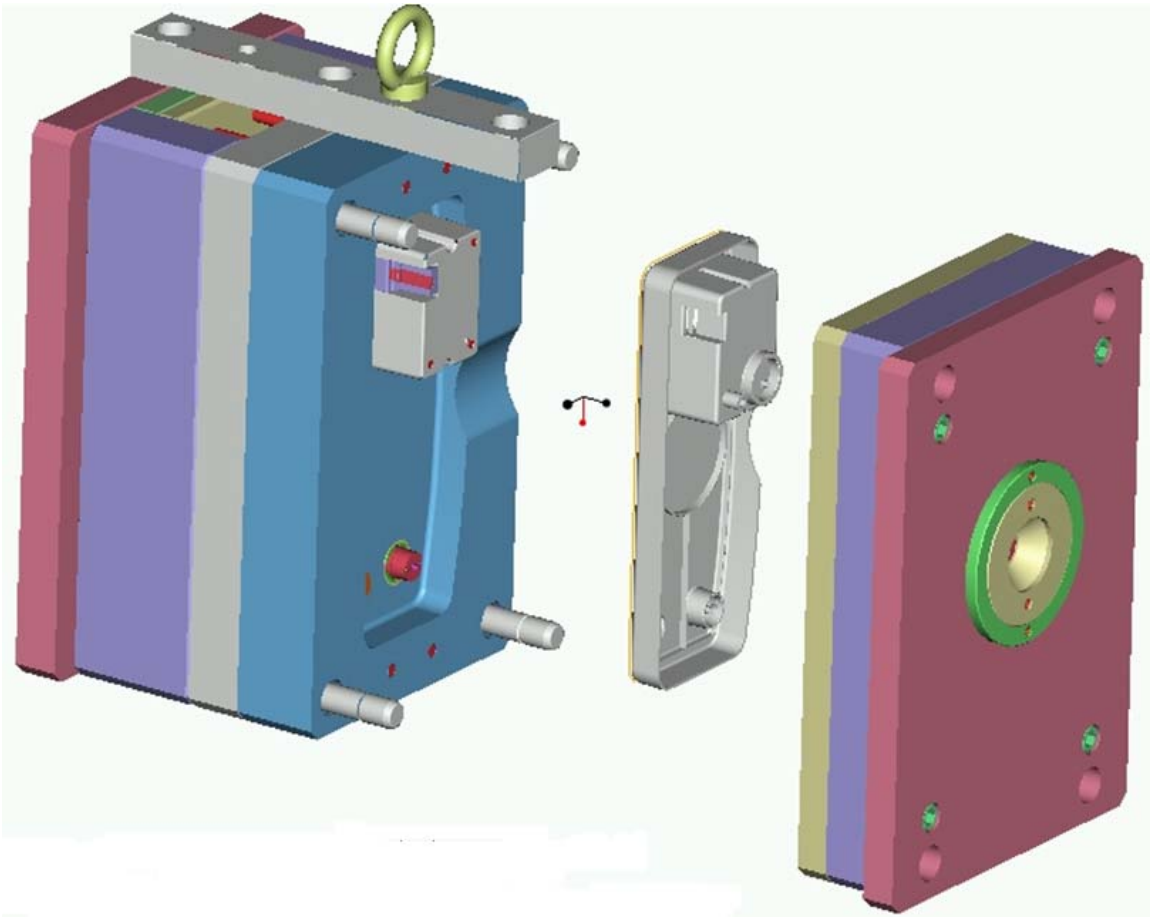

Fig.6. Example of a mold design with the CAD program: ProEngineer 2000i

4. Conclusions

Using CAD/ CAM and CAE experts computer programs, it is only way to achieve the best quality of an injected complex plastic part. Because of new demands of the clients more and more complex part must be produced. In same time, the conception, design and manufacturing of these parts became also more and more complex work to be done. In our days, using performance computers with performance expert programs are absolute necessary to achieve at the best performance in injection plastics technology.

REFERENCES:

[1] Rosato, Donald; Rosato, Dominique –Injection molding handbook, Chapman&Hall, New York, 1995
[2] Seres, Ioan- Injectarea materialelor termoplastice, Imprimeria de Vest, Oradea, 1996
[3] ***,Combimelt: Composite injection-molding technique for hard-soft material combinations, Technical Information by Engel
[4] ***, Examples of multi-component mould designs, ARBURG processing technology
[5] ***, MPI/FLOW training course Release 2.0
[6] Sorin, Ilie- Soluţii moderne de conceptie şi proiectare a matriţelor de injectat, Referant Nr. 3, Oradea, 2008
[7] Menge, G., Mohren, P-How to make injection molds, Hanser/Gardner Publications,Inc.,Cincinnati,1993