International Conference on Economic Engineering and Manufacturing Systems
Braşov, 25 – 26 October 2007

THE MAIN APPLICATIONS OF RAPID TOOLING

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Abstract. Because of the technical and scientific discoveries, nowadays the different processes and technologies are continuously developed and improved. Consequently, their application potential is widening, arriving even to some strange applications.

That can be told also about the Rapid Tooling (RT) which can be considered as a special, larger application of the Rapid Prototyping (RP), because it is based on the RP models.

The main applications of Rapid Tooling are those intended to obtain flexible tools. Through such methods, the active parts of different dies for plastics forming or entire silicon rubber dies, used for the fabrication of small series products, can be manufactured.

Through Rapid Tooling also massive electrodes for Electro Discharge Machining (EDM), or monobloc or hybrid patterns for casting can be manufactured.

Keywords: rapid tooling, rapid prototyping, rapid manufacturing, rapid moulding, product development, CAD-CAM

1. Introduction

Now, at the beginning of twenty-one century, the most essential feature of modern science and technique resulted from adaptation to mankind needs, wishes and requirements in a continuous evolution, is looking for new. This led to an essential change of market conditions. In this direction, it can be said that on the market there are required products in small series, possible middle in combination with a very quick change in demand regarding the type and degree of development/improvement of respective products.

Under these circumstances the producers want to launch and sell new products on the market in the shortest time possible but, anyway, before competition and the best ones as the quality is concerned. However, this is not always possible because it can occur problems (errors) both from projection and production which require corrections and involve further expenses and delays that can decrease customers confidence in that product and possible, in other products. That's why, there are preferred those technologies that make possible the products manufacture in small and very small series at low prices, maybe unique, for tracking and remedy possible errors of projection and/or production and for marketing research.

In order to make it possible, it has to be adopted a new product development strategy with minimum cost and time for this activity.

From the category of these strategies are also part the ones based on *Rapid X* procedures, such as the Rapid Prototyping (RP), the Rapid Tooling (RT), and the Rapid Manufacturing (RM). This happens because they provide a high CAD-CAM integration, schematically presented in figure 1, and by this providing an overlapping between the finishing of the product and the study, respectively the making of the necessary tools, this way considerably reducing the time of fabrication preparing. This process is very much helped by the Rapid Tooling, which is the theme of this paperwork.

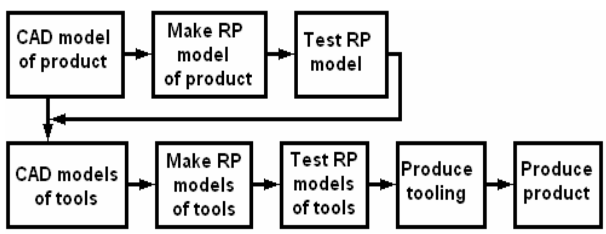

Figure 1. The CAD-CAM integration

2. The classification of Rapid Tooling Technologies

In fact, the Rapid Tooling is a specific application of Rapid Prototyping, better said a development dedicated to the latter one. And we must not lose sight of this when we refer to it.

Having in view the facts presented previously, we have to mention that there can't be made a precise, unanimously adopted classification of these new technologies. This is due to the fact that between the different elements which are at the basis of the classifications, there appear a lot of interferences. Thus, the classification can be made according to the application field, the used materials, the type of production for which the tool will be used and the making method.

As an example, figure 2 presents an alternative of possible classification.

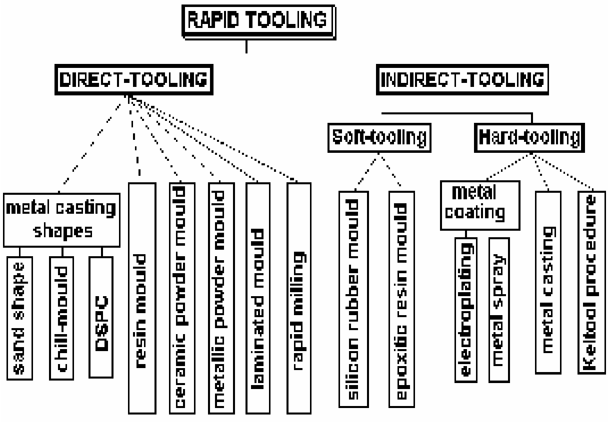

Figure 2. Classification of the Rapid Tooling

3. Applications of the Rapid Tooling

As we can notice in figure 2, the Rapid Tooling has a lot of applications. And the number of these applications is in continuous growth due to the development of some new procedures, meaning the improvement of the existent ones. Thus, this application area expands from the shaping tools, such as different moulds, up to removing material tools, such as the electrodes for EDM or even splintering tools. But up to the present, mostly moulds are the ones made through these procedures. This fact is also explained through the present tendencies of material using, meaning in small series.

These moulds are also made in flexible alternative, in the proper sense of the word, as well as in the technical sense. Thus, only the active parts of some modularized moulds are made, this way providing the flexibility regarding the rapid change of the tool and the passing to another product. Respectively, flexible moulds in the true sense of the word are made, meaning they are made of silicone rubber. For these latter moulds, at the evacuation of the product, the flexibility of the silicone rubber is used, thus the complex systems of evacuation not being necessary anymore.

We also have to mention the fact that the Rapid Tooling is usually applied to the making of some very geometrically complex tools.

3.1. The making of the moulds

From the beginning we have to mention that through RT there can be made moulds of different materials, with different properties. Also through different methods, meaning through direct-tooling and indirect-tooling.

The making of the moulds through direct-tooling

Thus there can be obtained metallic moulds, as well as non-metallic moulds, but also their combination. Usually it is about an RP procedure or one of its developments. Thus, non-metallic moulds can be made of resins through SLA, respectively of non-metallic powders through SLS, respectively 3D Printing. Through the last two methods, metallic moulds can also be made, if metallic powders are used as basic material. Even more, 3D Printing has a development in this respect, made by the D-M-E company, under the name of *Moldfusion™ 3D Metal Printing*, through which complete moulds can be made or just elements of moulds, which are component part of the flexible moulds. Examples can be seen in figures 3 and 4.

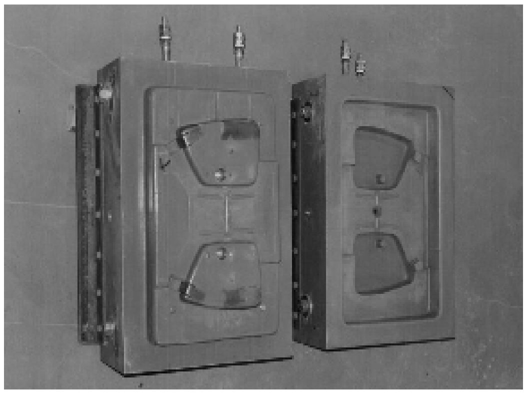

Figure 3. Metallic mould made through SLS

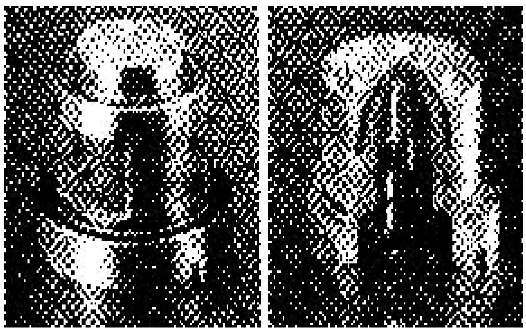

Figure 4. Mould elements made through *MoldFusion*

Metallic moulds can also be obtained through layering, as an application of STRATOCONCEPTION procedure, exemplified in figure 5. The advantage of this method is that it provides the mould with great flexibility.

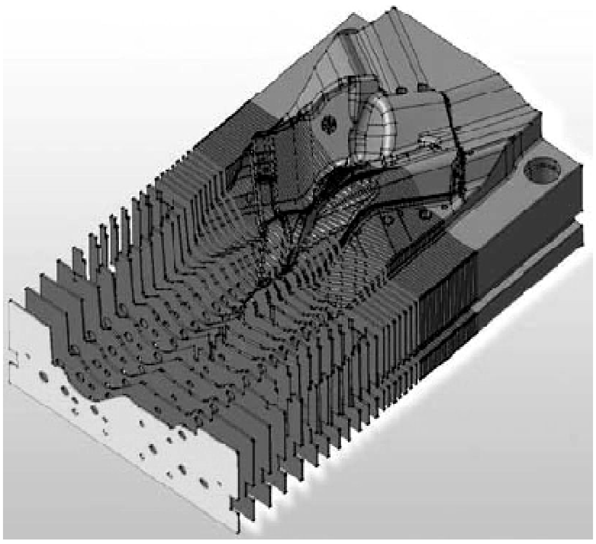

Figure 5. The obtaining principle of layered moulds

Last but not least, there can be obtained both metallic and non-metallic moulds through rapid milling on numerically axes machine tools, with intensive regimes.

The making of the moulds through indirect-tooling

This is another method of obtaining metallic and non-metallic moulds, respectively their combination. Usually, the starting point is an RP procedure through the pattern thus obtained this way, but not necessarily, because the starting element can also be an existent product.

Maybe the most used method of making the flexible moulds is the one of making them of silicone rubber, which has a very advantageous applicability in small and very small series production of plastics products. These moulds are flexible in both meanings of the word, hence the great advantage of this type of moulds, meaning that the flexibility of the silicone rubber is used at the evacuation of the products. These moulds are made through vacuum casting on specialized machines (e.g. machines of MCP Company) around a master pattern, which can be an existent product or an RP model. As exemplification, figure 6 presents such a mould, together with the product obtained in it.

Through these methods there can be also obtained moulds from epoxitic resins, respectively from ceramic materials by moulding around a master pattern, which can be an existent product or an RP pattern.

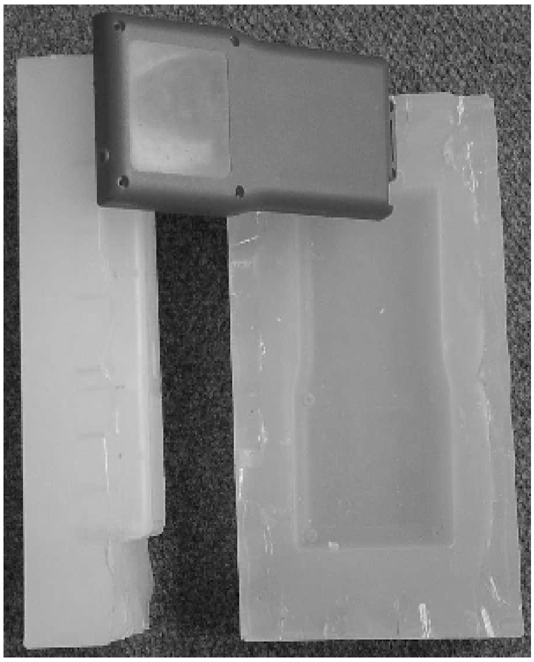

Figure 6. Siliconic rubber mould

The composed moulds are also interesting, their active part being metallic, while the body of the mould is non-metallic, usually made of epoxitic resins. But we have to mention that even these moulds bodies may contain metals under the shape of powders or splinters for the improvement of the thermal transfer, or even pipes of the heating-cooling system, respectively pipes with consolidation role (for very big moulds).

In the case of these moulds, the metallic active parts are obtained through metallization, which can be made in more alternatives: the metal spray through which thickness of 2 mm metallic layer can be obtained, and it is used for tools with large surfaces, and the galvanization, used for the making of small and middle-sized tools. Before the galvanization, the non-metallic surface of the master pattern (RP) must be electrically passivated. There are several methods for doing this, but they don’t constitute the object of this paperwork.

The integral metallic moulds in the category of these procedures can be obtained by pouring, in which case the pouring shape was made through rapid procedures, also presented here.

A special case is the category of moulds made through *Keltool* procedure. This procedure, developed by 3D SYSTEMS Company is a combination of the classic sintering technologies and the new RT technologies. More specifically, a metal powder is sintered around a pattern obtained through *rapid procedures* and after-processed in order to obtain the necessary properties. Thus, injection moulds with extremely complex active surfaces can be obtained, which will resist up to 1 million cycles.

3.2. The making of the casting shapes

Another important application of RT is the making of casting shapes and cores. Thus there can be made sand cores, chill moulds or even shell-shapes.

The chill moulds, being metallic, can be made through different methods, already presented in this work.

The best known and maybe the most important procedure of obtaining sand casting shapes and cores is the one patented by the German company EOS-GmbH. This procedure is actually a SLS application. The machine used is a specialized one, developed by this company, which also provides the consumable articles. The procedure presents the following great advantages:

- the possibility of making the shapes and cores of great geometrical complexity in a very short time;
- provides minimum contractions;
- provides the moulded tools with a surface quality identical with the ones made through classical processes;
- the shapes and cores thus obtained can be used for a very large series of alloys, starting with the aluminium ones to the steel ones.

In order to exemplify the above-stated facts, figure 7 presents several pieces casted in shapes obtained through this procedure.

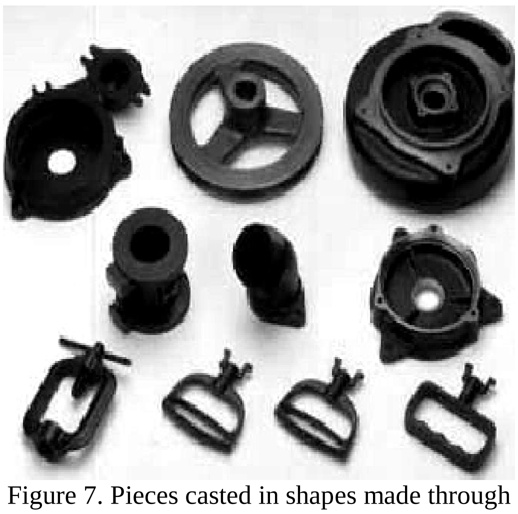

Figure 7. Pieces casted in shapes made through Rapid Tooling

For the making of the shell-shapes there is an application of 3D Printing developed by SOLIGEN Company (SUA) under the name of ***D**irect **S**hell **P**roduction **C**asting* (DSPC). This procedure combines the advantages of the obtaining procedures of metallic tools made though casting with the ones of the obtaining procedures of the tools through mechanic processing. A products made through this procedure are presented in figure 8.

3.3. Other applications of the Rapid Tooling

Besides the ones presented before, the RT has a series of other applications, some of them even being strange.

The electrodes for EDM can be made through rapid milling or through other RT successive procedures, such as the moulding of copper through RT-made shapes.

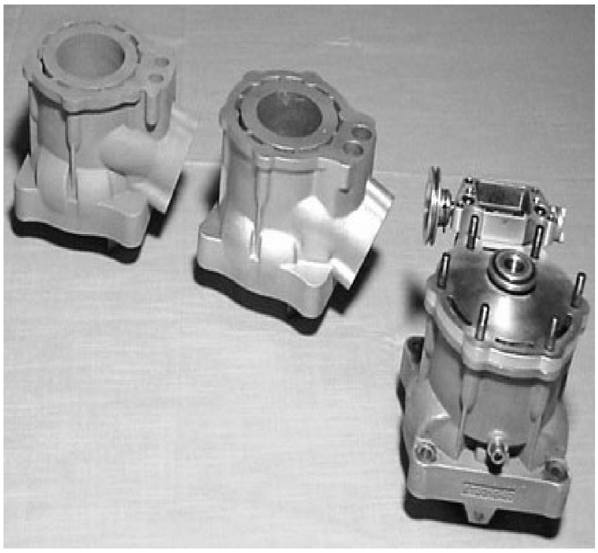

Figure 8. Pieces obtained through DSPC

Another application is the making of the marking stamps through metallization.

Another application is the production of the hybrid patterns for casting (see figure 9).

As strange as it sounds, splintering tools are also made through these methods. It is about metallized tools with complex edge, used for soft materials forms, such as wax. We have to mention that the sharpening is usually made manually.

4. Conclusions

As proven in this paperwork, there are many Rapid Tooling procedures, some of them even strange, and others with strange applications. And due to the continuous developments and research in this field, their number is growing. Thus, the area of new product development methods becomes larger and larger, a fact which allows a fast launching on the market.

Figure 9. Hybrid pattern produced through Rapid Tooling

At the same time, we have to mention that besides the advantages presented in this paperwork; these methods also have disadvantages that are not well-known yet, as these methods are still new. From this point of view, using these methods in an excessive way can be harmful.

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