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TOOL PRODUCTION VIA RAPID TOOLING

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ABSTRACT

Nowadays, it is vital for a producer to launch on the market as fast as possible his new products or the improved alternatives of the existent ones, before the competitors. This fact obliges him to make use of modern developing and making methods, which will make possible the accomplishment of this fact by reducing the developing and making time, even through their overlapping. However, we have to mention that these methods have to provide a high qualitative level of the products, but with minimum costs, by respecting the ecological conditions, so that the product should be as competitive as possible.

As part of the category of the above mentioned methods are also those which are based on the *Rapid X* methods, such as the **R**apid **P**rototyping (RP), the **R**apid **T**ooling (RT), and the **R**apid **M**anufacturing (RM).

The Rapid Tooling reduces the making time especially by diminishing the making time of the tools necessary for the implementation of the product. It also provides a checking of the product technological aspects and it permits the re-designation of the product from this point of view, allowing he rapid making of the possibly new necessary tools.

Usually, through Rapid Tooling there can be obtained tools called “soft” – of modern conception – which resist only at small or middle making series. While these tools are made, the “hard” tools can also be finished – the classical ones – which already allow big series productions.

1. GENERALITIES

As it is known, in order for a producer to survive, it is very important that he launches on the market as fast as possible the new product or the alternative of the existent one. This fast launch can not be at the cost of quality or product price because then, this would mean the failure of the product launch on the market.

In these conditions, the producers are obliged to make use of modern developing and making methods, which will provide the obtaining of competitive products in short periods of time. As part of these methods are also those based on the so-called *Rapid X*

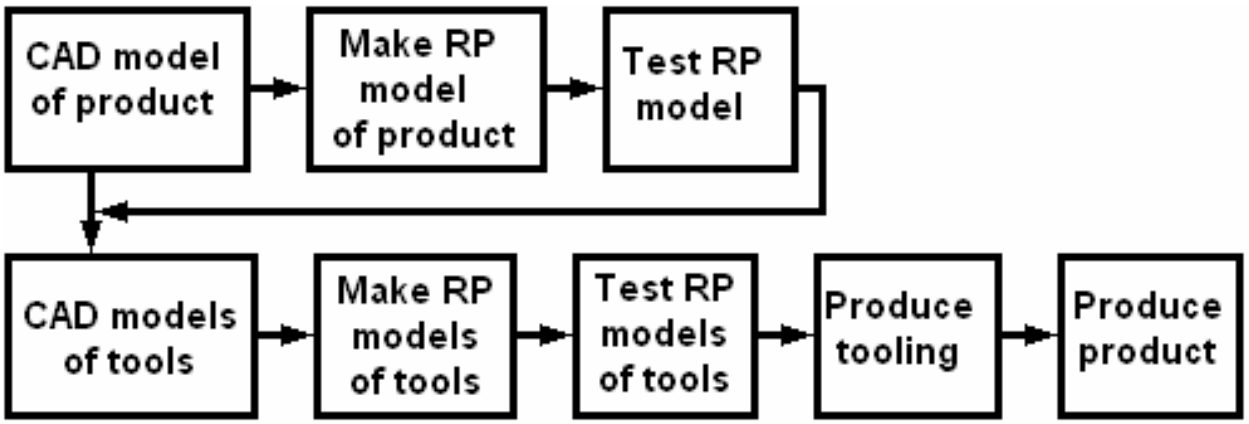

Fig. 1.1.

methods, such as the **R**apid **P**rototyping, the **R**apid **T**ooling, and the **R**apid **M**anufacturing. The shared characteristic of this method is that it provides an integrated CAD/CAM making of the products, as presented in figure 1.1.

As we can notice in the figure, an overlapping between the finishing of the product and the studying and making of the necessary tools is provided. This process is very much helped by the Rapid Tooling, which is the theme of this paperwork.

2. THE CLASSIFICATION OF THE RAPID TOOLING TECHNOLOGIES

We can't make a very precise classification of these relatively new technologies, because different interferences appear between different areas. 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.

A possible classification is presented in figure 2.1.

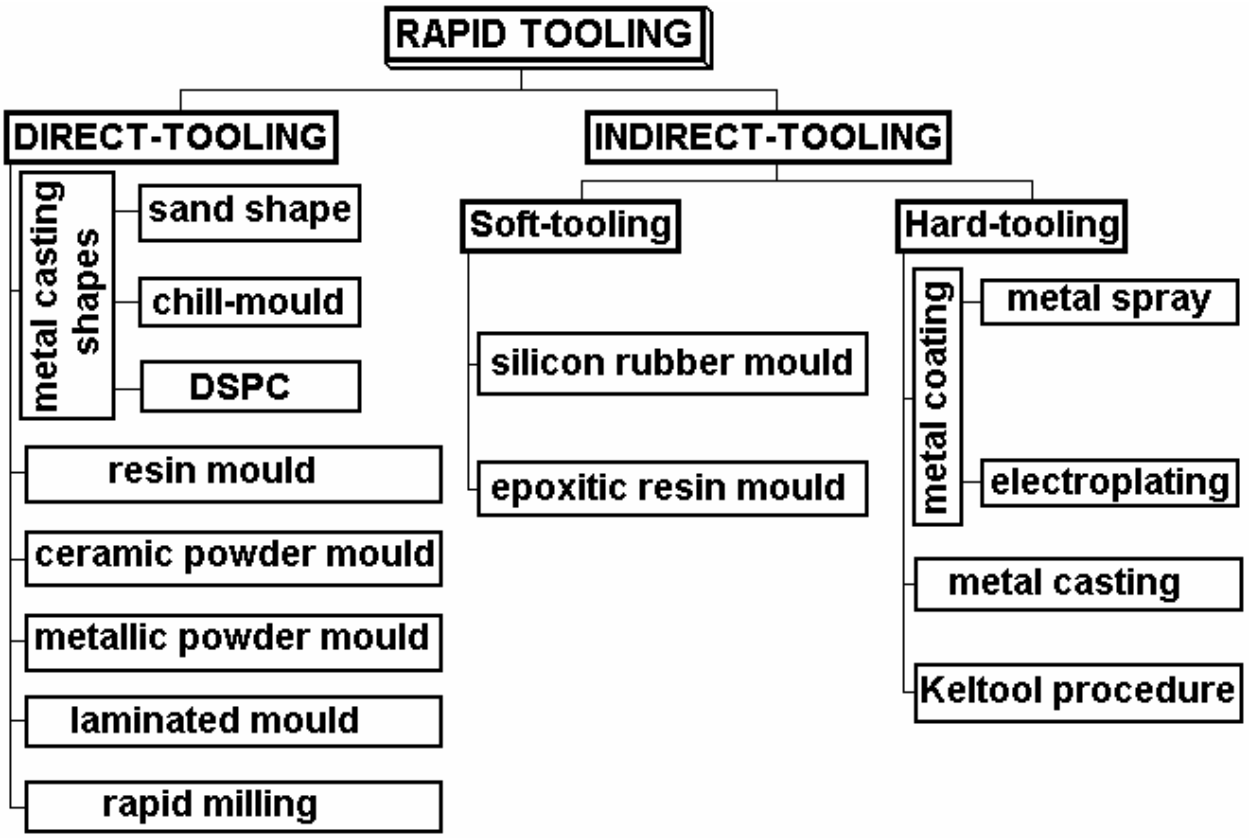

Fig. 2.1.

3. DIRECT-TOOLING

As we can notice in the classification presented in figure 2.1., through this type of Rapid Tooling, more types of tools can be made, used for different purposes.

3.1. METAL CASTIING SHAPES

The making of the casting shapes is one of the most important RT applications, because more types of shapes can be made, such as the sand ones or the chill ones.

3.1.1. The making of the sand shapes and cores

The most known procedure for the making of mould shapes and cores is the one patented by the German company EOS-GmbH. This is based on SLS procedure and it is made on machines especially developed by EOS-GmbH.

Through this procedure, shapes and cores of a great geometrical complexity and minimum contractions can be made in a very short time. They provide for the moulded tools a quality of the surface identical with the classical process and they can be used for a very large series of alloys, starting with the aluminum ones to the steel ones. As exemplification, a few tools obtained in such shapes are presented in figure 3.1.

Fig. 3.1.

3.1.2. The making of the chill moulds

Being metallic mould shapes, the chill moulds can be made through different methods, such as those presented at 3.4., 3.5., 3.6.

3.1.3. The making of the shell-shapes

This is a 3D Printing application developed by the American company SOLIGEN with the name of ***D**irect **S**hell **P**roduction **C**asting* (DSPC). The DSPC procedure combines the advantages of the moulded metallic tools procedures with the procedures of mechanically made tools. A product made through this procedure is presented in figure 3.2.

Fig. 3.2.

3.2. RESIN MOULDS

The making of the resin moulds is an application specific to SLA (Stereolitography). The moulds thus obtained can be best used for castings made at the ambient temperature or at the injection of polyurethane resins up to a maximum series of 100 pieces.

3.3. CERAMIC POWDER MOULDS

The making of ceramic powder moulds is also an application of 3D Printing, that is the one for which ceramic powder is used as basic material. The construction on CAD pattern of the supplying and degassing is recommended. The mould can be used immediately after the removal of the excessive powder and calcinations.

3.4. METALLIC POWDER MOULDS

As generally two RP procedures use metallic powder, respectively SLS and 3D Printing, this is an application of the mentioned procedures. Moreover, the D-M-E company has developed its own procedure based on 3D Printing,

a) *b)*

Fig. 3.3.

named *MoldFusion*^{TM} *3D Metal Printing*. In order to exemplify this, a mould made through SLS together with the pieces made in it is presented in figure 3.3.a, while in figure 3.3.b elements of *MoldFusion* mould are shown.

3.5. LAMINATED MOULDS

The making of this type of tools can be considered as an application of LOM process, but it is more an application of STRATOCONCEPTION process, which actually works with metallic laminas. The main advantage is the fact that in the case of dismantling connection of the constituent plates, flexible tools can be made through their changing.. The making modality of such a tool is presented in fig.3.4.

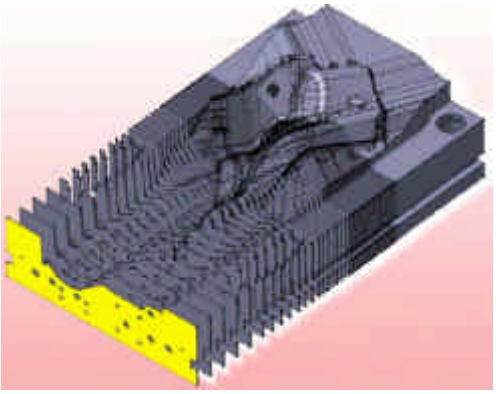

Fig. 3.4.

3.6. RAPID MILLING MODELLING

Metallic and non-metallic tools can be obtained through this procedure. The characteristic fact is that it is made on tool-machines with more numerically axes, with intensive regimes. It is preferred that the manufactured material should be easily workable through cutting.

4. INDIRECT-TOOLING

As we can notice in figure 2.1., this group is divided into two main secondary groups: *the soft tools* group and *the hard tools* group.

4.1 SOFT-TOOLING

In this category we mention the making of two types of tools, especially moulds, which, due to the material they are made of, can be used only in well-defined circumstances.

4.1.1. Silicone rubber moulds

This is an RT procedure which is very widely used for the making of some flexible moulds from all points of view. These moulds have a very advantageous applicability in small and very small series production of plastics. Usually, two types of silicone rubber can be used, a transparent one and an opaque one, which also differentiates the making method of the mould. 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 pattern. Such a mould can be seen in fig. 4.1., together with the product made in it.

Fig. 4.1.

4.1.2. 4.1.2. Epoxitic resin moulds

Usually, the active surfaces of these types of moulds are

metallic ones – generally made through metal-coating – only the mould body being made of epoxitic resins. In order to ensure the mechanic and technical properties, metal under the shape of splinters or grains is mixed in the resin. The thermal conductivity can be improved with pipes of fluids

4.2. HARD-TOOLING

More procedures are part of this category and usually metallic moulds are made.

4.2.1. Tools obtained through metal coating

The two methods of obtaining the tools through metal-coating are the *metal-spray* and electroplating, because these methods provide the necessary properties.

4.2.1.1. The metal coating through *metal spray*

Through this procedure – presented in figure 4.2. – dimensions of 2mm metallic layer can be obtained, and it is used for tools with big surfaces.

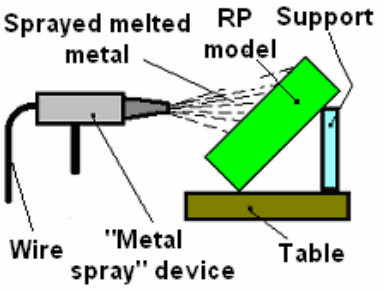

Fig. 4.2.

4.2.1.2. The metal coating through electroplating

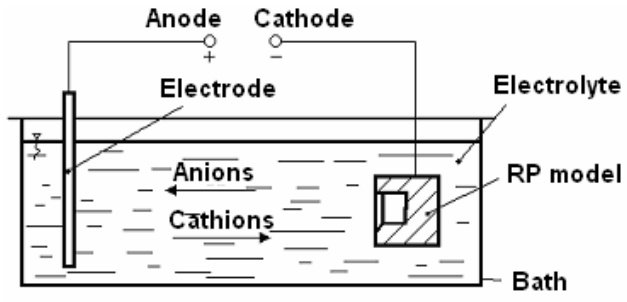

Fig. 4.3.

This procedure – presented in figure 4.3. – is used for the making of small and very small tools. Before galvanization, the non-metallic surface of the master (RP) model must electrically be disabled. Several methods can be applied for this.

4.2.2. Tools obtained through metal casting

It is the case of the tools obtained through casting in shapes made at their turn through *rapid procedures*, such as RP. It is the typical case of casting making of the complex electrodes for EDM.

4.2.3. Tools obtained 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.

5. CONCLUSIONS

As we can notice from the above-mentioned facts, there are already many new procedures for the making of different tools, which will offer reduced making time,

respectively the possibility of removing the problems that may appear.
However, we must take into consideration the fact that these new procedures, besides the mentioned advantages, also present many disadvantages, like many "surprises", due to the fact that they are still very new procedures.

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