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RAPID PROTOTYPING AS PROGRESSIVE METHOD OF MASTER-MODELS FORMING

Modern technology is impossible without the foundry production. The foundry shop is among the main shops of any engineering or metallurgical plant. Technical progress in foundry industry allows casting parts with minimal weight and significantly reducing allowance for machining, and in some cases getting ready parts, which are used for assembly.

The traditional technology for producing castings is carried out under the scheme: development of design documentation, production of the master model, making the sand mold and pouring molten metal into molds. The most time-consuming part of the process is the production of master models in accordance with the requirements of the future casting.

Models are classified according to the material, accuracy and structural characteristics. According to the nature of the material models are divided into wood, metal, non-metallic (plastic, plaster, polystyrene, wax, etc.). Accuracy of models depends on the required dimensional accuracy of castings [4].

Master models are made in different ways: on some enterprises milled parts are made of plastic, soft metal or wood on CNC machines, on the other – are hand-made by master modeler. But all these methods require the involvement of production capacity, the use of highly skilled manual labor and they are usually time-consuming. Today it is possible to produce master models of new products quickly, efficiently and inexpensively [3].

Rapid Prototyping (RP) is progressive quick method of forming models of a part or finished product, using computer-aided design (CAD) software.

The scheme of this process includes:

– 3D design or prototyping parts in any CAD-system;
– computer optimization of foundry technological process parameters, calculations, allowances for machining, casting solidification, etc.;
– separating layers of 3D model on a set of 2D models;
– development of programs for laser and materialization of model.

The advantages of RP technology are speed, accuracy, and cost reduction in the manufacture, research and individual sketches, no special equipment, the minimum amount of manual work [4].

Models are made by the RP, can be made of different materials (depending on the applied technology equipment). Different modeling materials are used in 3D printers, such as: plastic ABS, ABS Plus, ABS-M30 and ABS-M30i, polycarbonate, plastic – a mixture of PC and ABS, polyphenyl PPSF (PPSU). The advantage of these materials is that they all are used in the production of finished products, and thus differ

by their manufacturing accuracy, durability and thermal stability, they don't deform, shrink and absorb moisture. Constructing process are significantly automated and allow to obtain high-quality and relatively inexpensive models, spending for their manufacturing hours, but not days and weeks, as when traditional methods are used.

Another forming method is based on a cutting a path of cross-section of model on paper or plastic by laser beam. Then, the bonding layers of two-dimensional contours and making of three-dimensional model is done. The disadvantage of this system is that grinding, polishing, protection from moisture of model surface is necessary. Accuracy of surface model configuration is determined by the thickness of paper.

Different versions of RP technologies allow making models from powder materials by using the laser beam energy; applying molten material with the help of many inkjet heads (like inkjet printers); filamentous polymer layer deposition; stratified "gluing" particles of powder materials using a connecting composition that is fed through jet head.

Application of some alloy powders as a material during selective laser sintering allows receiving finished products immediately with high purity of surface and the proper physical and mechanical properties. However, the technology of producing alloys of dispersed powders is expensive and time consuming process. So in each situation it is necessary to do technical and economic evaluation of the method of obtaining the foundry model.

The most economical method of producing master models in the foundry industry is the technology of Fused Deposition Modeling (FDM). FDM is a laying the molten material. The principle of creating FDM technology prototype models is layered building of molten polymer thread to semiliquid state in accordance with the mathematical model detail geometry developed in the CAD system. Mathematical model in STL format is transferred in a special software Insight, which automatically orients its to the installation work area and breaks down into horizontal layers. Then, in Insight (also automatically) the need of using a supporting element for the overhanging parts of the model is determined. The generated data are transmitted to the facility and the process of creating layered model is begun [1, p. 198].

A variety of computer graphic editors are used to create a computer 3D prototypes of the master models. They allow doing the volumetric 3D modeling and storing the image in the STL format. Integrated, design and technological systems are used in most enterprises and allow modeling and solving technological problems up to the program for the realization on CNC machines. Computer engineering graphic systems have the ability to produce the design on a "computer engineering" as an initial source of information for further development either already established or created by the developer of the volume model of the product [2, p. 186].

Technology of master models and castings includes the development of a 3D model to give the mathematical model parameters in the absolute coordinate system, which eliminates the error of dimension chains at the design stage. After that the technical documentation in accordance with the rules of SYSTEM DESIGN DOCUMENTATION and UNIFIED SYSTEM OF TECHNOLOGICAL DOCUMENTATION which includes 2d drawings is desined. Application of rapid

prototyping technology is the next step. ABS-plastic master model are created on 3D printer.

The next step is the application of the semiforms filled with molding sand, for sand casting. The box with the mold halves is assembled and the process of filling the sand mold with molten metal is begun. The sand blasting machine is used after removing the casting from the mold halves for cleaning parts from moldable mixture and then the sprue is removed. The technical control of geometrical parameters of the finished part is done at the final stage [1, p. 198].

The advantages of ABS models are increased accuracy, simplification of preparatory and auxiliary operations, reduction of production time and tool costs.

So application of ABS models provides a number of advantages in compare with traditional casting technology on wax models:

– significantly reduces the time for preparation of foundary production, as there is no need of designing and manufacturing equipment for the production of wax models;

– strength and thermal stability of ABS simplifies the requirements for the models transportation;

– it is possible to create thin-walled parts;

– the scope of the final product due to the possibility of more accurate models of manufacturing expands;

– greater efficiency at small-scale production is achieved.

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