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Dharan Srinivasan Dharani - st. gr. IMP-33
Ternopil Ivan Puluj National Technical University

INVESTIGATION OF 3D TECHNOLOGIES IN CASTING TECHNOLOGY MANUFACTURING

Supervisor: Ph.D., Assoc. Prof. Assoc. Prof. D.L. Radyk

Срінівасан Дхарані Дхаран
Тернопільський національний технічний університет імені Івана Пулюя

ЗАПРОВАДЖЕННЯ 3D ТЕХНОЛОГІЙ У ПРОЦЕСИ ЛИВАРНОГО ВИРОБНИЦТВА

Науковий керівник: к.т.н., доцент Радик Д.Л.

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Urgency of the research is that the production of one-off parts with a complex form is highly expensive and metal-intensive process. For the manufacturing the parts with closed geometry to the final form the casting methods are used. New technologies make it possible to simplify and increase the accuracy of casting patterns and workpieces.

Foundry production is one of the oldest technological processes for the manufacturing of the parts. At the present stage with the advent of digital modeling and the accelerated development of additive technologies, cardinal changes have emerged.

The main traditional casting methods are green sand casting and casting in skin-dry molds. Green sand casting is the most common and mature technology, and in terms of functionality - the most advanced. Production, using it, equipped with automatic molding and die lines, apply automatic charging of the hot metal. Production, using it, equipped with automatic molding and die lines, apply automatic charging of the hot metal. Green sand casting is featured by the inventory of multiple-used metal or wooden pattern equipment. Casting mold is expendable and made of special sand-clay molding commixture. Currently such molds have become possible to make on 3D printers. In this case CJP technology is used (color ink-jet printing of plaster based composite). Casting in skin-dry molds is performed by two methods: investment casting or cavityless casting. The main feature of this technology is that each pattern is used once to cast one part, and the mold that is obtained from it is also expendable.

When implementing 3D methods on the production of this type, it is used: wax printing – for investment casting; photocurable resin printing - for cavityless casting. Growing patterns and molds by 3D printing allows to obtain results that cannot be achieved by means of traditional technological processes. An important advantage is also in time saving for the manufacturing of pattern equipment. Reducing the deadline for prototyping and ability to make changes in construction design opened the wide range of features for pilot production.

Thanks to the introduction of 3D processes it became possible to forget about all disadvantages of traditional casting (Fig. 1), which include: long manufacturing lead time; high labour intensity; poor accuracy; human factor effects [1].

Green sand casting process using 3D technologies begins with the mathematical modelling of pattern. Engineering and foundry technologists determinate the parting line, shrinkage, downward slope of the mold and other parameters. Consider an example of

printing on a 3D printer, the operative principle of which is based on color ink-jet printing (CJP) [1]. The main advantage of this technology is that if the pattern geometry is placed in the construction chamber, then several patterns can be printed in one operation at once. The next step is the treatment of the pattern. To material saving the pattern is made by hollow with internal fins. If necessary, the empty volume is poured by simple epoxy resin to give greater toughness of structures. Since the plaster is not a structural material, the pattern is impregnated with a resin. After that, the surface is hardened by selected method of strengthening [2] and processed (putty & peel), then covered with special paint for patterns. The entire production cycle of the green sand casting process takes no more than a week.

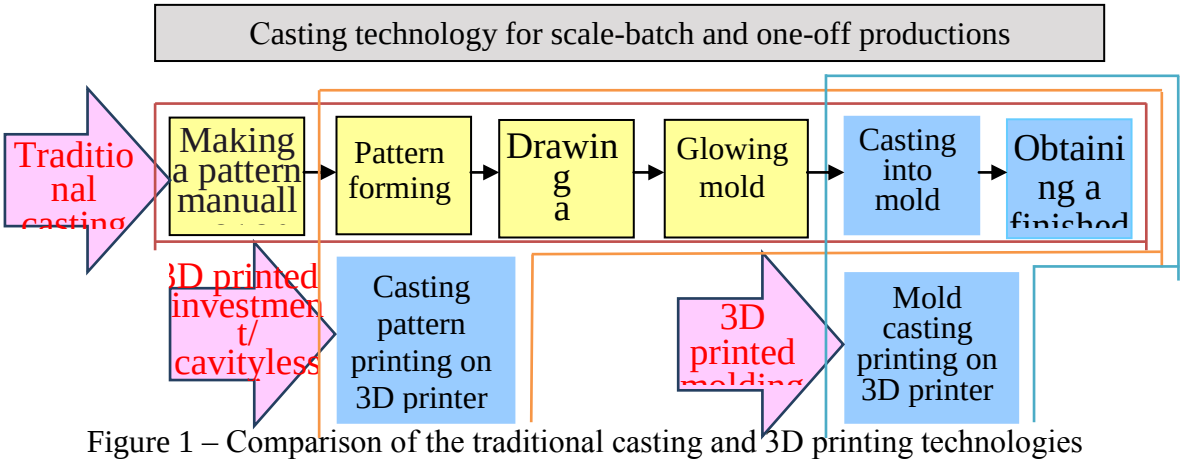

Figure 1 – Comparison of the traditional casting and 3D printing technologies

Thus, green sand casting using 3D technologies has the following advantages compared to classical methods: significant reduction of the production cycle; reducing the number of engineers and technologists involved in the production process; ability to print on 3D printer several products at the same time.

In the traditional casting process, the master-pattern can be made manually or using machining. Some molds are possible to implement manually. For the manufacturing the master-patte five-axis CNC machining centers are used, which significantly increases the possible variety of molds, but also the cost of s waxing or master-pattern increases significantly. Such the method of obtaining castings is relevant for mass production, but for scale-batch production it is often cost-inefficient - the use of 3D printing is a more rational method.

Conclusion: 3D printing in foundry technologies of manufacturing the parts is additive method that allows many times to reduce economic and time inputs (Fig. 2), as well as decimate the metal intensity in one-off and low-rate productions of complex workpieces.

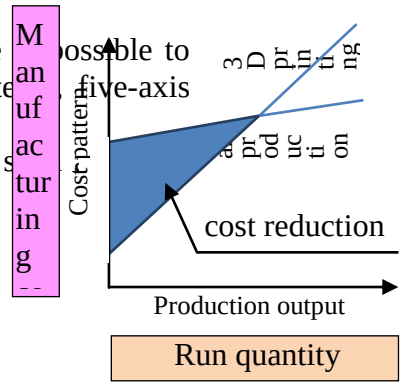

Fig. 2 - Cost-benefit comparison of the traditional casting and 3D printing technologies

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