Improvement of corporate foundry planning system by choosing the effective cost unit

Natalia Anatolyevna Zharina, Lilia Raifovna Mullina, Lenar Nurgaleevich Shafigullin, Albina Nurgaleevna Shafigullina

Naberezhnye Chelny Institute (branch) of Kazan (Volga) Federal University, pr. Mira 68/19, Naberezhnye Chelny, 423810, Russia

Abstract. The paper demonstrates the need for improving the existing corporate foundry planning system in the context of total quality management by implementing the effective cost unit. It reveals the importance of qualimetrics approach for development of effective casting quality factors. According to the suggested approach a system of technical and economic indicators which can be used for corporate foundry planning has been developed and validated.

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Introduction

The global financial crisis in the early 21st century affected the Russian industrial sector resulting in significant decline in production, rise in unemployment and rapid drop in economic indicators, especially for foundries. The problems have been piling up for foundries in the manufacturing sector for decades due to underinvestment in production upgrading, personal training, shop rebuilding and building, outdated technologies and materials [1].

Russia's accession to the WTO made the foundry problems worse. The adaptation of foundries to global standards requires adjustment of all factory planning system, including cost accounting, development of new document and standard forms to reflect new business trends. Russian products may enter the global market only if competitive production is managed efficiently according to the requirements of total quality management (TQM) [2], as a result of which all company operation, its structure, management and planning are driven by a need to deliver the required product quality. That's why, production plants need the corporate planning system which addresses and stimulates growth of production and product quality in the most efficient way [3].

Main body

The efficiency of corporate production planning affects various economic indicators, and while identifying these it is necessary to aim at unbiased evaluation of not just product quantity characteristics but also quality ones. Therefore, a foundry cost unit should be validated together with simultaneous improvement of casting quality.

Quality is the collection of characteristics and their quantitive values for a given type of industrial product which are able to meet applicable and anticipated requirements [4]. A level of casting quality depends on its purpose, reliability requirements, state of foundry equipment, process capabilities, customer's requirements and economic characteristics. Therefore, real casting quality can be evaluated only in respect to actual manufacturing environment.

Modern casting quality management system should meet consumer's applicable and anticipated requirements. The criteria of casting quality should have a quantitive nature.

One of the most important tasks to be done for the purposes of selection of effective foundry cost unit is to identify a quantitive criterion for evaluation of casting quality level [5]. This criterion should reflect the current state of international and European casting quality standards and take into account the primary groups of factors which define marketability of casting. That's why, for the purposes of selection of effective cost unit it is important to find the right quality factor which reflects operational value of products and drives the transition to their more advanced types. So it may consist of product of the several factors which define various product properties.

A casting is the blank used for manufacturing a machine part and can be described fundamentally by listing its various integral properties. It has mass, grade, chemical composition, density and microstructure of material. The geometric shape of casting is accordingly symmetrical and complex. The process of casting and measurement of casting parameters has its own peculiarities which depend on the quantity of castings in the lot and their use for manufacture.

The existing procedure for calculation of production capacity and production output figures for foundry shops uses a physical indicator – metric tonne – which does not take into account complex casting configuration (geometric shape), process peculiarities (material grade, dimensional tolerances, casting weight, etc.). Usage of this indicator makes it difficult to plan and manage a foundry, has negative impact on fairness of personnel performance evaluation in foundry shops and operations.

Selection of effective foundry cost unit has been investigated by various scientists including V. M. Shestopal, Yu. S. Perevoshchikov, G. E. Kalinkina, S. Ya. Gershtenkern, Ya. A. Golbin, A. F. Asabin, P. G. Luzin, V. Ya. Klebaner, A. S. Shirobokov and others. The following units has been suggested as a cost unit: metric tonne of castings by theoretical mass, metric tonne of machined castings, individual casting, tonne equivalent represented by different indicators (labor intensity, wages, average mass of overall casting volume, etc.), ideal designed tonne, reduced product and others [6, 7].

The various investigations in this area showed that casting prime cost and labor intensity are mostly influenced by castings mass, complexity, alloy grade, volume, special requirements [6, 8].

The comparative analysis of the units used for measuring production volume and output in foundry shops shows that finding one measure universal for all foundry shops is the difficult but critical task.

In order to solve the problem of science-based selection of foundry cost unit the qualimetrics approach [9] has been suggested as it helps the transition from physical units to effective (qualimetric) units. Qualimetric index of castings is the integral quality factor of casting which quantifies various design- and process-related features and properties specific for a given type of casting. Qualimetric index is the factor used to convert physical casting mass to its qualimetric mass.

It is recommended to use the qualimetric index of castings for identifying a cost unit to calculate prime cost, and also introduce it as the main indicator for technical and economic foundry planning according to which production volume and capacity in qualitons are determined, labor, material, energy intensity and other indicators are calculated.

The physical mass of casting is converted to qualimetric (reduced) mass by:

$$m_q = m \cdot K_q, \quad (1)$$

where m_q is the qualimetric mass of a casting in qualikilograms (qua kg) or qualitons (qua t); m is the physical mass of a casting in kg or t; K_q is the qualimetric index of a casting, dimensionless unit.

The qualimetric index of casting used to calculate production output in (1) is expressed by the following functional relationship [10]:

$$K_q = f(S, m, \delta, R, \gamma, \rho, \eta, Пa, в, \nu, u, \mu, n) \quad (2)$$

where S is the complexity of casting geometric shape (configuration); m is the mass of casting or final part; δ is the dimensional casting tolerance grade; R is the roughness degree; γ is the characteristic of ultimate stress against GOST ultimate stress for steel castings; ρ is the casting density; η is the output factor of good casting; $Пa$ is the impermeability test (pressure in Pa); $в$ is the melting in electric arc furnaces; ν is the standardization of toughness at minus 60˚C; u is the ultrasonic testing; μ is the magnetic permeability testing; n is the number of castings in annual order.

Calculated by (2), K_q covers the casting process adequately and take into account the design- and process-related properties of casting.

Production output in effective, i.e. qualimetric, units (Q) will be defined using quality factor K_q:

$$Q = ВП \cdot K_q , \quad (3)$$

where $ВП$ is the production output.

Based on the investigations and analysis of existing company performance indicators in terms of combined interests of its external and internal environment it has been suggested to use a system of technical and economic indicators which use a qualimetric tonne as the measure (Table 1) [11].

Table 1. The system of technical and economic indicators for corporate foundry planning

#	Name of indicator in corporate planning system	Unit
1	Production output	quat
2	Annual machine capacity	quat/e.p.c. (repair complexity unit)
3	Labor intensity	man-hour/quat
4	Wages	thousand RUB /quat
5	Production prime cost	thousand RUB /quat
6	Capital output ratio	thousand RUB /quat
7	Material intensity	thousand RUB /quat
8	Labor cost	thousand RUB /quat
9	Energy intensity	J/quat
10	Net profit	thousand RUB
11	Profitability of production	%

This system of indicators is based on the qualimetrics approach which has invaluable role in enabling the transition from extensive variables of company performance evaluation to intensive ones. Changing “tonnes” to “qualitotonnes” in the system of company indicators makes it possible to evaluate not only quantity but also quality of products which is one of the priority indicators of product competitiveness in the market.

Conclusions

Thus, the resulting technical and economic indicators may be used effectively to develop the system of industrial production standards and requirements in corporate planning system.

The transition to planning in effective units does not involve extra expenditures; it can be performed for various product types progressively as quality factors are being identified for them. This way of planning eliminates various contradictions, gives a strong impetus to product quality improvement and accelerates the development of a company as well as industry and the whole economy.

Corresponding Author:
Dr.Zharina Natalia Anatolyevna
Naberezhnye Chelny Institute (branch) of Kazan (Volga) Federal University
pr. Mira 68/19, Naberezhnye Chelny, 423810, Russia

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