

A Formalised Description of Foundry Production Program

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Abstract

Rational designing of foundry enterprises is based on a program allowing for both the quantitative and qualitative aspects of production. Studies carried out in this respect are mainly oriented at the task of establishing a classification system of castings and formalising their description. This article refers to the absolute classification and technological classification of castings existing so far; some principles of the formation of a model of the data on production program have been presented as well. The program was written by the technique of relational databases with description of the documents and diagrams of relations existing between the data.

Keywords: Classification systems, Castings

1. Introduction

Identification of a set of castings and formulation of this set into a production task is the condition necessary to undertake the following activities:

- analysis of producibility and choice of technology to produce a casting,
- preparation of an assembly of machines and transport facilities integrated into the system of mechanisation and automatization,
- organisation of production planning and control system.

In industrial practice the program of production is usually multi-faceted and covers different types of products. The supplied information is not ordered which, already at the very beginning, makes designing of the foundry production capacity very difficult. Ordering of data is the task of a classification system, while an outcome of this activity is dividing one large and disordered set of the data into subsets ordered according to some strictly determined rules and criteria. For the purpose of casting designing, the classification of castings usually means putting them in order according to some criteria, like the technological features, similarity of shape and dimensions, the weight, and applications. In both casting practice and design work this

problem has been so far rather underestimated. Some attempts have only been made at creating the classification systems based on the studies and publications already available in Western literature. Here, attention deserve two main systems of the casting classification, i.e. the system of absolute classification [2, 3] and the system of technological classification [5]. Some attempts at the development of a technological classification of castings can be traced also in Polish reference literature [1].

2. The system of absolute classification

In this system, the classification is based on the geometrical parameters of a casting. By transformation of these parameters, done with the help of mathematical formulae, some characteristics typical of a given class of castings are determined. In the classification system developed by Czikiel [3] the following criteria have been adopted (Fig. 1):

- proportionality factor P_F , which expresses the degree of surface development,
- volume factor P_K which expresses the core-to-casting volume ratio (without core prints).

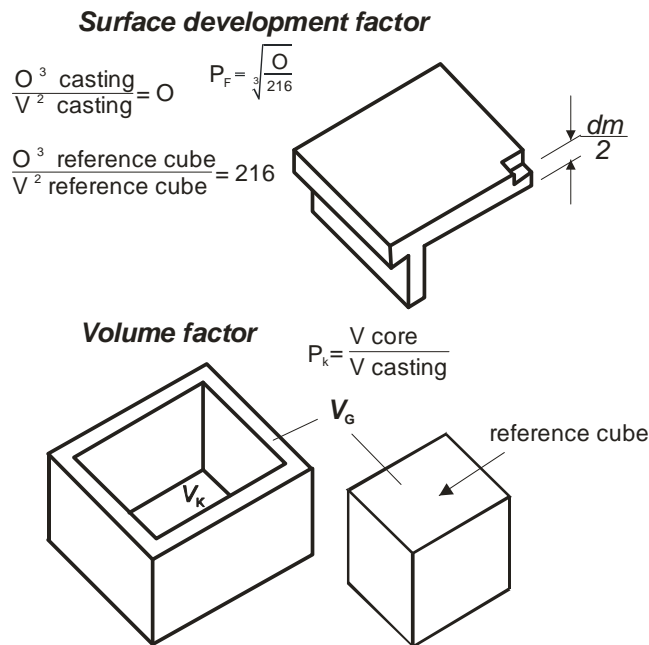


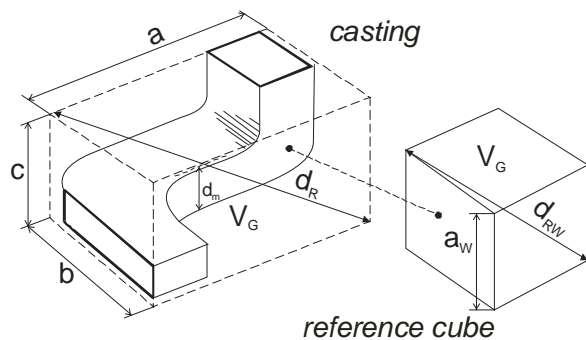
Fig. 1. Czikiel's classification and its main coefficients

The classification described above does not take into account the space layout of the individual casting elements, which is of primary importance in the technology of moulding and casting.

On the other hand, Pacyna [2] developed a space classification of castings in which he took into account the following coefficients:

- oblongness G ; which is a ratio of the diagonal of a cuboid circumscribed on the casting to the diagonal of a reference cube of the same volume as the volume of the casting (Fig. 2, equation 1),
- wall thickness D ; which is a quotient of the casting wall mean thickness divided by the side of a reference cube of the same volume as the volume of the casting (Fig. 2, equation 2),
- compactness Z ; which is a ratio of the casting overall volume a, b, c to the volume of a reference cube (Fig. 2, equation 3).

Besides shape factors, the system includes a number of the coefficients describing the type of material cast, moulding technique, fettling, batch size and manufacturing costs.



$$a) \quad G = \frac{d_R}{d_{RW}} = \frac{\sqrt[2]{a^2 + b^2 + c^2}}{1.77321 \cdot \sqrt[3]{V_G}}$$

$$b) \quad D = \frac{a_w}{d_m} = \frac{\sqrt[3]{V_G}}{d_m}$$

$$c) \quad Z = \frac{V_U}{V_G} = \frac{a \cdot b \cdot c}{V_G}$$

Fig. 2. The method to determine coefficients used in Pacyna's system: a) oblongness, b) wall thickness, c) compactness

3. The system of technological classification

The system of technological classification was created by Malek [6] and Rosenberger [5]. Malek's system anticipates the classification of castings according to their shape with division into the six main groups:

1. massive castings,
2. simple castings without cavities,
3. complex castings without cavities,
4. simple castings with cavities,
5. complex castings with cavities,
6. flask-moulded castings with cavities.

These groups are next divided into subgroups depending on the geometrical configuration of castings (Fig. 3).

$l > 4b$	Flat	$l \leq 4b$	$h \leq \frac{l+b}{4}$	
0-oblong	1-rectangular	2-rounded	3-frame-shaped	4-combined
	Hollow	$l \leq 4b$	$h \geq \frac{l+b}{4}$	
	5-rectangular	6-rounded	7-frame-shaped	8-combined

Fig. 3. Subgroups according to Malek's classification

Like in the system of absolute classification, also in this system the division allows for the type of metal cast, weight ranges, wall thickness, etc.

Rosenberg's classification is based on:

- a) the degree of mould work intricacy,
- b) the degree of core work intricacy,
- c) overall casting shape.

The classification scheme covers three group levels:

- I. the degree of mould work intricacy (base group),
- II. the degree of core work intricacy in mould making (group),
- III. overall casting shape (subgroup).

In determination of the degree of intricacy the following terms are used: very simple, simple, intricate, very intricate. To make the task of grouping easier, the author prepared 49 pictorial tables in which he included several hundred of the three-dimensional drawings of castings. However, the classification has been made by a subjective method, basing on an analysis of the drawings and looking for technological similarities, and as such it does not always render the expected substantial effects.

The correct classification system should be based on objective data and - besides grouping of castings - it should also give answer to the following questions: how to select the production technology, which technology will be an optimum one, how to choose a production program to make it most profitable to a foundry? A good classification system should also provide for the possibility of including the data into a database and making relevant calculations on computer.

4. A draft data model for description of the production program

At present, strong emphasis is put on the need of having a formalised description of castings, which can be an object of classification. The complexity of relationships between the casting features and their technological parameters prompts the use, as a tool for data modelling, of an Entity Relationship Diagram (ERD) which serves for designing of the relational databases.

The approach described here does not exclude any other arbitrary implementations of the system of automatic description of the production program, as it is possible to make transposition of ERD models to UML class-diagrams and to the DDS document description schematic, characteristic of XML language. For example, Figure 4 shows an ERD diagram for the description of foundry production program. An assumption has been made that all foundry attributes can be comprised in one entity. The main attributes are the following ones:

CastProperties. Their definition is comprised in the entity **Properties**, which holds all notations, like wall thickness, compactness, tensile strength, and also e.g. the batch size.

PropertyType (e.g. shape, mechanical properties).

In a similar way the classes of castings are defined. The adopted solution makes the model fully flexible and enables various production programs to be defined in an arbitrary way, irrespective of the product type, technology of fabrication and commercial conditions. This approach also enables exchange of information with automatic classification systems and computer aided design, e.g. through the choice of a best technology.

Using production program described in this way it is possible to convert the data to a XML format, which nowadays is a standard tool for the exchange of commercial and production-related information. Some elements of a formal casting description in XML language are presented in Figure 5.

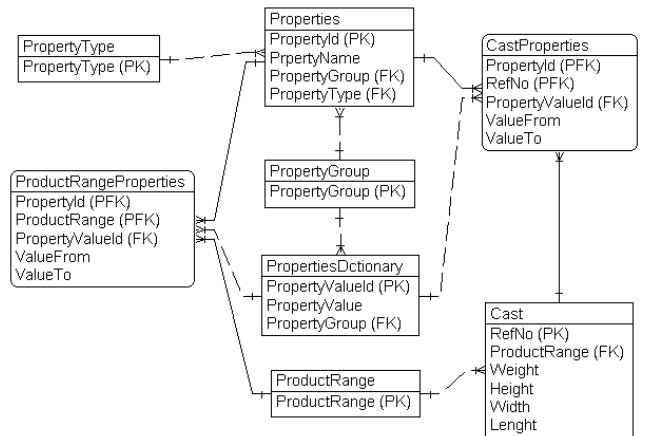


Fig. 4 ERD diagram for the description of foundry production program

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<casting>
<drawing href="D400.gif" />
<name>hatch D 400</name>
<terms of sale>
<demand per year>1200</demand per year>
<batch size>100</batch size>
</terms of sale>
<size>
<finished weight>13.22</finished weight>
<dimension>
<height>120</height>
<width>250</width>
<length>425</length>
</dimension>
</size>
<material>ZS 400-15</material>
<tolerance>0.04</tolerance>
<roughness>15</roughness>
<finishing>painting</finishing>
.....
</casting>

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Fig. 5. Formal description of casting in XML language

5. Final remarks

Basing on the studies carried out so far on the problems of casting classification, some assumptions have been made as regards the procedure which may help in the development of a rational system of the casting classification. The assumptions are as follows:

- the aim and rationality of casting classification should be subjected to the demands of technology and production specialisation, which means that the classification should be of a "technological" nature,
- the first levels of division should be devoted to the shape characteristics grouped according to the features of direct similarity of the cast parts, which means that an absolute classification should be made,

- c) in basic classification the most universal features should be described, while more detailed data and information should be expressed in additional codes,
- d) the computer-aided process of classification requires switching over from the traditional system of databases to the description of data in a dialect of the XML language.

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