11th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2007, Hammamet, Tunisia, 05-09 September, 2007.

ADVANTAGES OF GROUP TECHNOLOGY IN INJECTION MOULDING

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ABSTRACT
Group technology principles offer great potential for cost saving in product development process. One of the techniques used for parts grouping is classification and coding. A group technology code is an alphanumeric string, which represents critical information about the part. Comparing the group technology codes of two parts is quick and efficient method for estimating part similarity in selected attributes. The paper describes the elements of the coding system by developing the code for injection moulded parts and its belonging moulds.
Keywords: group technology, injection moulding, coding

1. INTRODUCTION
It is generally known, and in literature presented in numerous examples, that high rationalisation of the overall operation process in production companies can be achieved by applying the group technology concept. The essence of this concept lies in the procedure of standardisation and rationalisation, which is based on the determined similarity of the observed objects. [1]
Finding of a group of similar products, parts, fabrication plans, assembly plans and similar, is performed with different objectives. For instance, the objectives may include: reduction of costs in construction and/or production preparation and/or production, reduction of the number of moulds and other tools and instruments as well as their standardisation. [2]
The group technology concept is widely used in the production branches such as machining and casting, whereas in the field of injection moulding group technology has not yet experienced any major application, primarily because of the production structure itself. [3]
Injection moulding, namely, is a large batch production, and from the very definition of group technology it can be seen that this is a method for rationalising the small and mid-batch production. [2] Another reason is that most often every new injection moulded part requires fabrication of a completely new mould with all the new parts. Therefore, the group technology concept may be expected to find the greatest application in the development of polymeric moulded parts and the injection moulds design. [3]

2. INTRODUCTION INTO CLASSIFICATION AND CODING
According to the research carried out in [4] there are more than 40 commercially available software programs for the classification and coding developed at universities, in industry, and state institutions. In the area of injection moulding there have been only several attempts to develop the software for classification and coding of moulded parts and the respective moulds. One is described in [3].
Different methods are applied for the classification and coding, whereas the numeric systems are the most represented ones. They can be applied in all areas of moulded parts development, design and fabrication of moulds. The actual code can consist of the identification and the classification part. The

identification part allows identification and addressing of various objects. The unambiguous identification requirement is important precisely in repeating assemblies and parts. The classification part allows inserting of objects into the assumed content by forming families. [5]
The identification and classification systems allow, first of all, fast re-finding of the already archived documents for certain polymeric moulded parts or moulds, but they do not provide additional information. Therefore, additional information has to be assigned to certain parts, assemblies or finished moulds that are required either for re-application in the same department or for the continuation of work in the next part. Therefore, a special system of the so-called complete/full codes is introduced. Complete/full codes understand generally codes, which describe the object regardless of its purpose. Unlike numeric systems, full codes define the geometrical and physical properties of parts, assemblies or materials. Full codes allow combining, analysing and selecting of material and non-material parts which are similar. [5]

3. DEVELOPMENT OF NEW MOULDED PARTS AND CONSTRUCTION OF MOULDS BY CREATING THE MOULDED PARTS FAMILY

The designer needs to connect every new design task with the already finished solutions of similar tasks, and to apply the old design solutions on a new task, to a greater or smaller extent, which will depend on the level of similarity. In case of smaller similarity, the designer can still accept partial solutions, i.e. solution parts. Such a procedure needs to be carried out systematically. Systemic consideration of every new task includes analysis, which determines similar moulded parts and the respective solutions (mould design). [1]

The text further gives a proposal of the coding method of thermoplastic moulded parts and the respective moulds, not including the elastomeric and thermoset plastic moulded parts due to the specific characteristics of their development.

4. CODING OF THERMOPLASTIC MOULDED PARTS

The actual code of thermoplastic moulded parts has been divided into two parts (Figure 1). The first part of the code, the identification part, consists of five characters, four digits and one letter ("P" stands for part). The first part of the code insures the uniqueness of every moulded part (e.g. when two "similar" moulded parts appear in the base). In the second part of the code, the moulded part is classified according to the criteria explained further in the text. The coding of the thermoplastic moulded parts is based on the ideas from [6].

The moulded part criterions are presented:

- size of the moulded part
- material of the moulded part
- volume of the moulded part
- height-width ratio
- composition of the moulded part
- cross-section of the moulded part
- geometry of the moulded part
- undercuts on the moulded part
- threads on the moulded part
- inserts in the moulded part
- special design of the moulded part

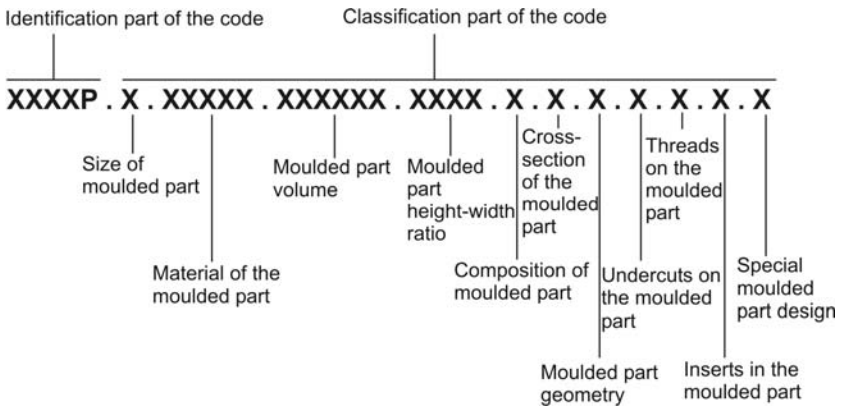

Figure 2. Classification code of the moulded part

5. CODING OF THE MOULDS FOR INJECTION MOULDING OF THERMOPLASTICS

The classification code of the mould is not as complicated as the code of the moulded part since a part of the classification code itself of the moulded part describes the respective mould. Like the code of the moulded part, the classification code of the mould is divided into two parts (Figure 3). The first part of the code is the same as the code of the respective moulded part with one difference, and that is that the fifth character "P" has been replaced by "M" ("M" stands for mould). In the second part of the code, the mould is classified according to the characteristics presented in Figure 2.

The moulded part criterions are the following:

- type of mould base
- mould width, length and height
- number of mould cavities
- type of the runner system
- type of demoulding system
- type of heat exchange system
- special mould design

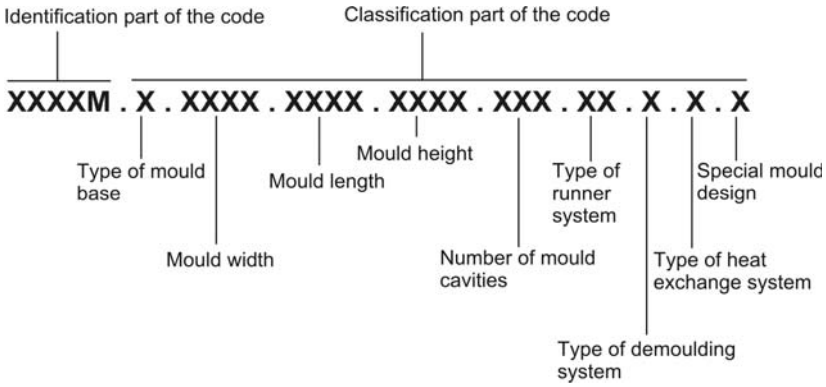

Figure 3. Mould classification code

6. EXAMPLE OF CODING THE THERMOPLASTIC MOULDED PART AND RESPECTIVE MOULD

Because of the increasing presence of thin-wall food packaging, a thin-wall case and the respective mould have been selected for coding. This refers to the margarine case developed at the Chair of Polymer Processing, at the Faculty of Mechanical Engineering and Naval Architecture in Zagreb. The specific characteristic of the case and the respective mould is the wall thickness of 0.45 mm, application of hot runner system and mechanical-pneumatic demoulding system. Figure 3 shows the moulded part and the injection mould, and Tables 1 and 2 show and explain code symbols for the moulded part and the injection mould.

Table 1. Code of the thin-wall food packaging

Code	**0001P . 3 . 001 . 0002 . 0284 . 0 . 1 . 1 . 0 . 0 . 0 . 0**
Meaning of the code	*moulded part ord. no. 1, thin-wall, material of the moulded part polypropylene - BJ360MO (entered into base of materials under ord. no. 001), volume of the moulded part ~ 2 cm^3, height-width ratio of the moulded part 0.284, composition of the moulded part homogeneous, compact cross-section of the moulded part, geometry of the moulded part plate, without undercuts, without threads, without inserts, classical design of the moulded part*

Table 2. Code of the injection mould of the thin-wall food packaging

Code	**0001M . 1 . 0156 . 0206 . 0189 . 001 . 12 . 4 . 1 . 0**
Meaning of the code	*mould for the moulded part ord. no. 1, mould with N type of base plate, width of mould 156 mm, length of mould 206 mm, height of mould 189 mm, one mould cavity, liquid runner system – system with hot-runner channels, combined demoulding system, over pressure heat exchange with medium at temperature over 0º C, classical mould design*

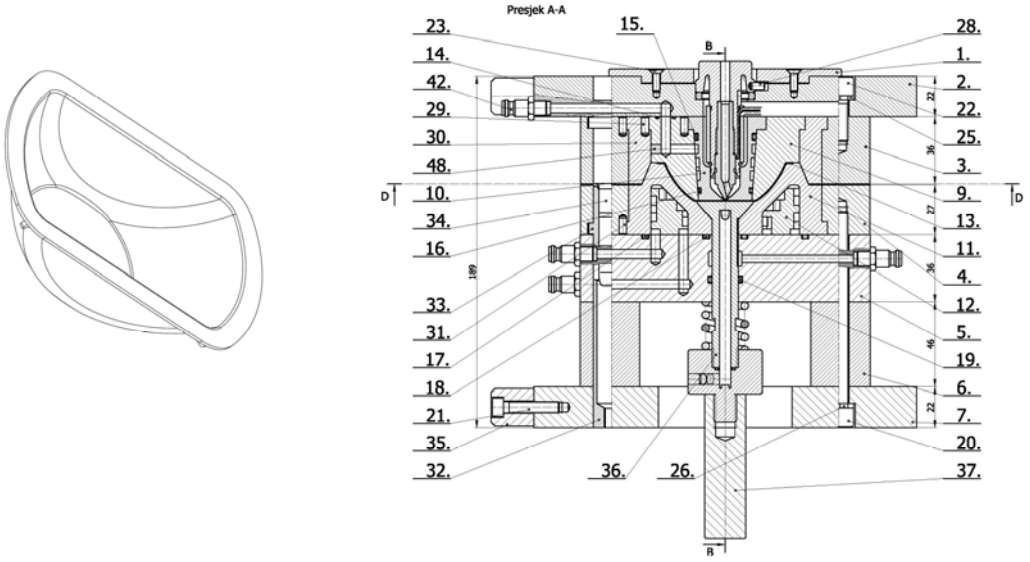

Figure 4. Example of thermoplastic moulded part and the respective injection mould [7]

7. CONCLUSION

Every mould regardless of its design has to fulfil the same functions. It is therefore possible to determine the universally applicable design guidelines by analysing the design process. For a successful analysis of the polymeric injection mould design it is recommended to perform the classification and coding. With the possibility of using previous solutions as part of the version and adaptable thermoplastic injection mould design, the process of the design becomes simpler.

The method of classification and coding of the moulded parts and the respective moulds presented in this paper is only a proposal of the method of classifying the moulded parts in the families of moulded parts. It should be noted that the work has included only thermoplastic moulded parts and that the entire classification and coding system has been conceived and designed as one of the aids that would accelerate the very development of the thermoplastic moulded part and the injection mould design thus facilitating the designer's work. The application of the group technology concept in injection moulding from the aspect of the tool-shop has not been analysed here.

8. REFERENCES

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Acknowledgement

This work is part of the research included in the project *Increasing Efficiency in Polymeric Products and Processing Development* supported by the *Ministry of Science, Education and Sports* of the Republic of Croatia. The authors would like to thank the Ministry for the financing of this project.