New aplications in technological preparations for investment casting production

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Abstract

Nowadays, foundries do not sufficiently utilizes computer support during the creation of technical documentation. Instead of computer documentation is used classical method for designing technological documentation and the use of computer support is only discrete. For the area of casting technology is not appropriate to use conventional CAPP systems with use of group technology because they work with a simple representative selection from the database according to the characteristics. The submitted article shows a solution for systems interconnection and the possibilities of using the concurrent engineering. In our department was designed system serving as the creation tools for technological documentation, whose role is to effectively benefit from group technology.

Key words: Aluminium alloys, reoxidation, gating system, numerical simulation, bifilm

1. INTRODUCTION

Quality requirements in engineering works is constantly escalating. Quality criteria in foundries are - the accuracy of the results and time horizon needed for implementing a successful solution.

By use of computers in engineering production we can achieve shortening of the time for development and production. CAx systems are computer systems designed to support activities at all stages of production, i.e. design of components, production planning, actual production and assembly, warehousing and shipping.

During the creation of technical documentation, is found a large number of routine activities and the calculations, searching, grouping, sorting data, and much smaller amount of intellectual activity. It means that most of the documentation is build up on the basis of known and precise algorithms (based on pre-known technological rules and regularities obtained by exact methods and many years of practice). Selection of right technology is based on the various data that can provide manufacturing drawings, as well as the specific conditions of production. Results of the decision are built to a certain sequence of commands that should guarantee the most beneficial method of producing parts under its specific conditions.

2. TECHNICAL PREPARATION OF PRODUCTION (TPP)

Progressivity of automation in engineering works is striking not only in sphere of preparation (reduction in labor content within technological preparation, reducing the number of engineering staff), but of course also in the sphere of production (cost reduction, increase labor productivity). By automatization of engineering calculations it needs to be included sophisticated methods to achieve correct results.

Variation of automation resources for engineering sphere is very wide. It covers the entire spectrum of engineering activities required for design, planning and construction - technological tasks.

Fig. 1 shows the simplified model of production preparation with the support of computer technology, where are marked mutual cooperation nodes (S1, S2, S3) of individual modules (design production preparation - KPV, technological preparation of production - TgPV, project preparation manufacturing - PPV, production planning and control - RDP), which is based on the basic philosophy of CIM (Computer Integrated Manufacturing - Computer Aided Manufacturing).

In the non-cutting technologies such integration is lacking. There are only a discreet use of CA systems. An exception is the integration of CAD and simulation programs.

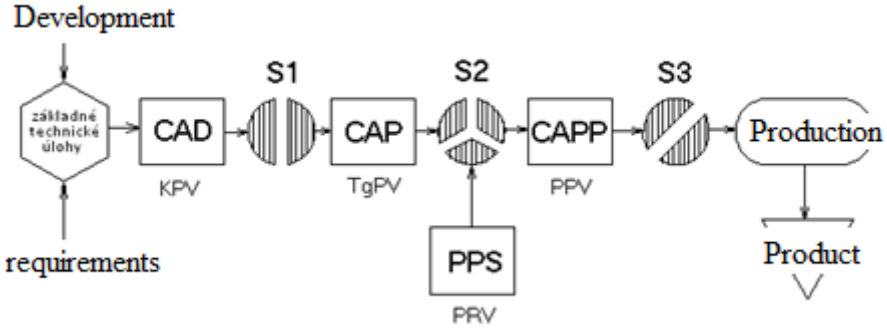

Fig. 1 Scheme of production preparation

2.1 CAD Systems

Computer aided systems supporting engineering design works for the production preparation. In companies focused to produce components by non-cutting technologies are generally used conventional CAD systems which are used also by companies for focused on production of machined parts.

There is a large number of CAD systems. The reason for placing these systems into production is their direct support by the foundry simulation programs (Unigraphic → MAGMAsoft, PRO / Engineer → WinCast), or their practical use (CATIA). All of these systems are fully associative and change at each stage of development results in a change of all related data and parameters.

It is possible to use CAD systems also in less conventional manner, for example. within the AutoCAD system is located a special programming environment VisualLISP enabling

comfortable working with AutoLISP programming language where possible using simple functions to automate tasks solved in a listed technical design (calculation of gating system, risers, etc..). You can also use special files created by CAD systems (eg *. Mpr, *. M_p - Fig.2.) to describe the shape complexity in creating the classifications of group technology then saving to the castings database for further use in the design of the technological process.

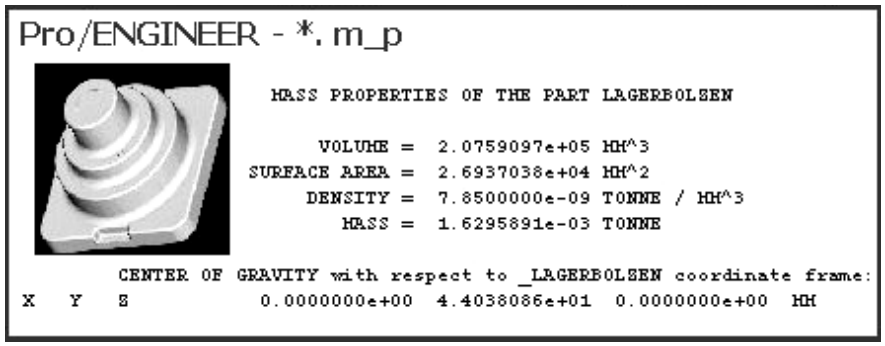

Fig. 2 Listing information related to the mass and surface

It should be noted, however, that the shape complexity is not always directly proportional to the complexity of the production and it cannot be in all situations exactly describable.

2.2 CAE systems

These are systems that support virtualization of technology processes (computer simulation). In a computer simulation there are visible phenomena taking place in the gating system and the casting mold during filling by molten metal and during its solidification. I tis possible to monitor not only the filling of the mold, but also solidification and cooling of the whole system. The advantages of using computer simulation is essential to reduce the time and financial costs for the development of new product technologies, increasing the technical, quality and price parameters of foundry production with a substantial reduction on financial demands - supply management and also with education of foundry workers so they can deeper understand of the phenomena that take place in mold during the pouring and solidification. Computer simulation of casting gives almost all the information needed to optimize the gating system and the whole process of casting and solidification. Gating system optimization using computer simulation is based on a comparison of different variants of gating systems. Comparing takes into account price, advantages, flow of metal, metallurgical structure, etc... At figure 3 is presented cast lid made of carbon steel. In the originally proposed structure is a cross-sectional micro porosity, which was confirmed by the simulation calculations. By changing the dimensions of the gating system was achieved better micro porosity conditions, which was also confirmed by simulation calculations. Figure 4 presents the results of simulation calculations of the optimization.

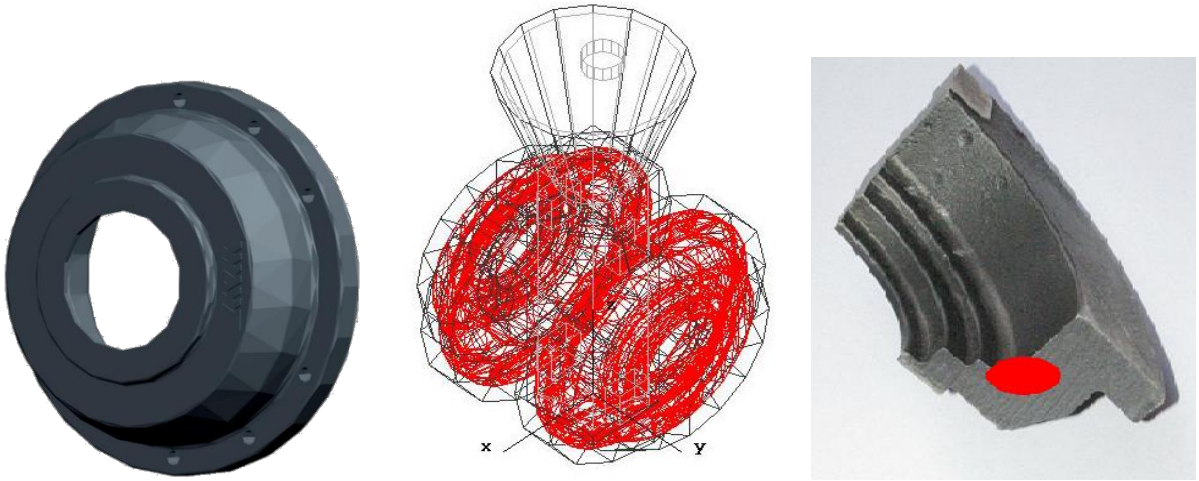

Fig. 3 Casted cover: a) 3D model, b) model of the shell, c) the area of micro porosity

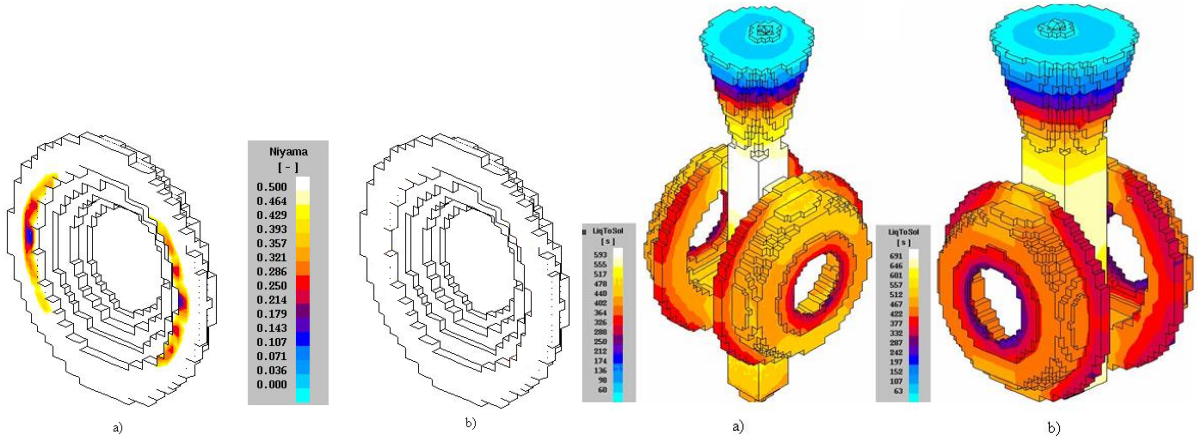

Fig. 4 Results of the simulation calculation: a) initial design, b) modified design

2.3 CAPP systems

These are systems based on the principle of classifying objects of type and group technology in which it is processed methodical process solutions.

Manufacturing equipment available in a company determine the spectrum of the produced parts, is likely to produce components that can be classified into groups, in which components are similar. Sorting of parts can be carried out according to different criteria (in terms of geometry, material, technology, etc...). Each group has its representative and the corresponding technological process.

CAPP systems implemented to increase the level of efficiency and technological preparation of production by:

• use technological standardization,

• use of inheritance and similarity of parts of their production technology,

• allow computer aiding to the preparation of design through manufacturing Bills of materials.

Among the most famous CAPP system in Slovakia and the Czech Republic belongs SYSKLASS. This system implements activities from design development components through design and technological preparation, as well as choosing the optimal tools. System ASEPO (compilation of Automation of technological procedures) is a modular integrated system working with graphical support and exploiting technological database and knowledge. Sirius TPV is part of an integrated information system SAFÍR designed to manage production. Due to its complexity is suitable for use in small batch production.

2.4 GCAPP systems

Generative CAPP systems (GCAPP) are much more complex than CAPP systems operating on the principle of group technology. The preparation of the technological process planning is a challenging engineering task. Engineer design "good" production process by his own thoughts. These human thought processes are very difficult to put into algorithms. The computerized system could similarly design and compile technological process, but it is necessary to thoroughly describe all activities undertaken by the engineer. Systems of this kind are very difficult in terms of programmer's implementation. Compared with the variant CAPP systems they has not found widespread use. Because of its complexity and extensiveness are mostly dedicated to one type of part. Generative CAPP systems based on the analysis of CAD data are able to generate technological process.

2.5 Information Systems

The only information system intended for foundries system is OPTI. It focuses mainly on planning, management and costing activities in companies, its use in the design or support the design of technology is rather limited. The analysis system is based on two basic sources:

• Referrals from DGV to the price calculation of the casting (used to determine the selling price)

• from materials REFA (includes methodology of casting description to provide information for the production and supply data to calculate their own costs).

Use of OPTI can be divided into the following areas:

For the materials management, software includes solution for operational areas such as Sales, Purchasing and Warehouse. Thus offering a complete system for business organizations.

In the TPP software represents a complete solution for the companies in areas such as costing, work preparation - technology, quality management and tool registration.

In the field of production scheduling is software designed so that in the given production contract is generating data needed for production planning in the field of TPP, which are then available for further processing according to the production order.

3. CREATING THE CAPP SYSTEM

It is not appropriate to use the classical method of selecting representative from the database when creating CAPP system for non-cutting technology, so in our department was

designed CAPP system based on the idea of group technology with dynamic sorting system. In this system, the sorting of castings according to the parameters:

• technology

• material

• geometry of the casting.

Optimal selection of production method is among the most important factors for the classification of castings since all parameters are dependent on chosen technology (accuracy, size, function, economic demands) cast.

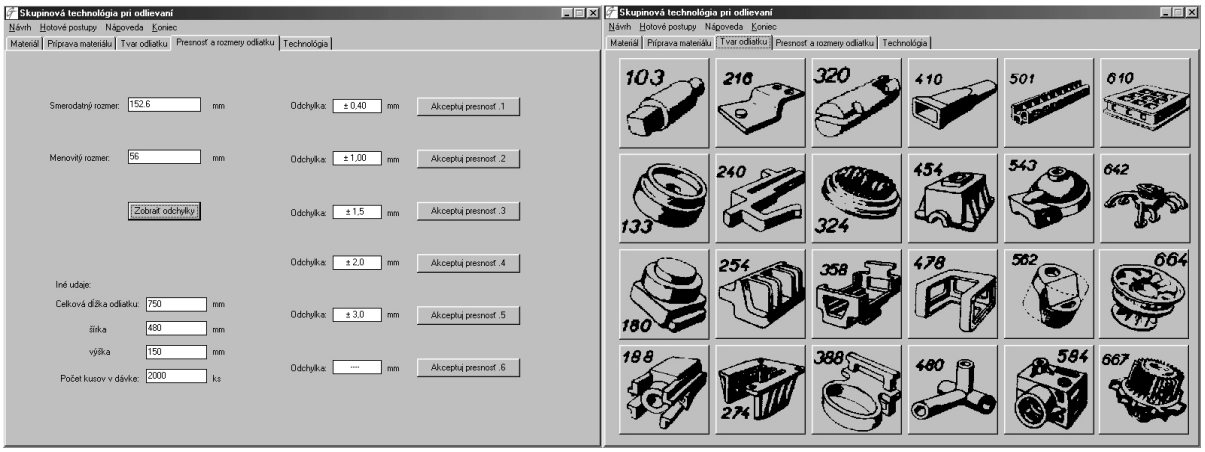

Fig. 5 The created environment for sorting the casting technology by precision, dimensions and shape of the casting

Another parameter is the categorization based on the shape of the castings. In the software is used categorization based on anthology POPV 21-01-01. This anthology refers to the shape with help of a three-digit number. The main purpose of all digits, is described in online Help or the anthology itself. Since there is a large number of shapes, in the program online help is used only a few examples.

Classification system for material includes:

• iron,

• steel castings,

• non-ferrous metal alloys.

The system contains a database of information about the mechanical properties, the use of the material and method of preparing a melt of the correct composition and temperature.

The main goal of the proposed solution is the interoperability of the systems and the possibility of using the idea of simultaneous engineering.

4. CONCLUSION

Despite the digital age, nowadays is still a large amount of information (know-how) stored in the heads and minds of employees (employee departure means the loss of knowledge

within the company). The specific amount of knowledge is contained in the documentation, but most likely the paper form slightly outweighs digital form. It is still the lowest percentage of knowledge stored in the knowledge database systems enabling their efficient processing in future.

The main purpose of technological preparation is the creation of technical documentation for newly produced components. The proposed solutions can be designed in interactive mode between technologists and computer to achieve optimal results. The aim is to compile a framework of technological processes in digital form. First step is to verify this proposal by using simulation software and find critical points before beginning production of new components by casting.

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