DESIGN OF CASTING BLANKS IN CAPP SYSTEM FOR PARTS OF PISTON-CYLINDER ASSEMBLY OF INTERNAL COMBUSTION ENGINES

Development of information technology industry provided great possibilities in the area of integration of different CAx systems, such as CAD, CAM, CAE and others. In order to successfully link systems of automated-design (or Computer Aided Design - CAD) with automated manufacturing systems (or Computer Aided Manufacturing - CAM), automation of manufacturing process planning is needed, i.e. CAPP (Computer-Aided Process Planning) systems can bridge a gap between design and manufacturing. In this paper is shown design of casting blanks in CAPP system for parts of piston-cylinder assembly of internal combustion engines in a manufacturing system.

Key words: casting blank, design, CAPP system

INTRODUCTION

Modern market conditions require high quality and low prices simultaneously with short product manufacturing and delivery times. Also nowadays, small series of products are more frequent than large volume series. This requires high flexibility of the manufacturing system, as well as the whole production process [1].

In this kind of environment, manufacturing systems with high level of automation are essential. New technologies are being introduced on a daily basis. Many of them are based on flexible automation and other high technologies [2].

In the recent years, researchers put a lot of effort in the integration of different CAx systems to achieve optimal and efficient use of intelectual and other engineering resources.

Team work, computer support and standardized integrated model for process planning and manufacturing, are highly appreciated. Design and manufacturing standards development is also based on the integrated approach to activities like concept development, design, manufacturing, and complete product life cycle [3 – 5].

Advanced CAx tools merge many different aspects of the product lifecycle management (PLM), including design, analysis using finite element analysis, process planning, manufacturing, production planning, product testing using virtual lab models and visualization, product documentation, product support, etc. (Figure 1). CAPP systems have one of the key roles in the integrated environment of CIM and bridge between CAD and CAM systems. However, CAPP systems are not yet developed as CAD, CAM and CAD/CAM systems [6].

One of the obstacles of CAD/CAPP systems integration is in the fact that technological meaning of geometrical shape is lost during classical CAD modelling. Intelligent interface linking CAD and CAPP systems would be an ideal solution. That was not done because of the presentation limits of CAD model. To enhance that feature, CAD system manufacturers have created feature-based CAD systems (Figure 2).

Design features are different than manufacturing features, since manufacturing features are defined by the type of manufacturing operation and operation’s schedule. Integration of CAD/CAPP/CAM systems based on STEP standard uses interface for standardized access to STEP databases (SDAI) for data exchange between application protocols and STEP database [10].
MODEL OF INTEGRATED CAPP SYSTEM

Model of this systems is based on the general settings for specialized integrated CAPP systems, using general purpose software. This setting are:

- System allows 3D modelling and production of 2D drawings for the manufactured parts and their casting blanks,
- System allows casting process simulation of blanks based on 3D models and known manufacturing parameters,
- System allows geometric and technological recognition of manufactured parts, as well as selection of standard manufacturing processes in given conditions,
- System allows automated process planning for given part as well as generation of NC programs for manufacturing operations, including process simulation.

An specialized and integrated CAPP system based upon these settings was developed. It is shown in Figure. 3. It was designed for automated process planning of internal combustion engine’s piston assembly parts manufacturing. Assembly parts include pistons, cylinder liners, ribbed cylinders, etc.

This system is vario-generativ integrated CAPP system. Model of this system, encompasses three basic modules:

- Parts and casting blanks modelling, CAD module,
- Casting process simulation, and
- Manufacturing process planning, CAPP/CAM module.

In the CAPP integrated system, module for parts and blanks modelling is one of the most important elements.

This also applies to the module for casting process simulation of blanks.

DESIGN OF CASTING BLANKS

The first module allows determination of the typical part or blank group. This is usually proceeded by parts geometric recognition. If a corresponding typical part cannot be found, modelling is done instead of group determination.

Every type of a part and a blank has corresponding 3D model with parameters. These models are designed in CAD module. In Figures 4, 5 and 6 are shown 3D models of casting blank for some piston-cylinder assembly parts.

Working conditions of the piston-cylinder assembly parts, as well as conditions which come out from dy-
namics of the motor mechanism put higher require-
ments for some parts materials: good mechanical prop-
erties at higher temperatures, high resistance to wear, 
good sliding properties, small specific weight, homoge-
ny, good machineability etc. Due to this material used 
for casting this parts must have high mechanical, phy-
sical and other properties [13, 14].

Materials for casting the cylinder liners are special 
low alloyed and alloyed gray casting which meet the
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standards of the most eminent motor manufacturers. 
Observed production system casts them centrifugally 
on the multi-position machine or on the particular ma-
hines for casting. Heat treatment is performed after 
casting in order to remove strains occurred within the 
process of casting.

Materials for casting the ribber cylinder are special 
modified casting CSL-1 to manufacturer local standards 
which fit to eminent motor manufacturer standards. Pis-
tons are casting from specially chosen alloys of aluminium 
and silicon of eutectic and overeutectic composition, by die casting.

For cylinder liners, eleven different types of groups 
were defined (Figure 7). For ribbed cylinders and pis-
tons corresponding blanks are being modelled on a one-
by-one basis.

Blank precision for ribbed cylinders and pistons 
definition encompasses determination of blank dimen-
sion by adding or subtracting dimension additions for 
parts’ manufacturing. Programme determines this blank 
dimensions by using developed knowledge database 
given parts’ dimension.

Blank precizion for the cylinder liner is made on the 
basis of the developed knowledge base. Knowledge 
base allows it to on the basis of a given type of liner and 
its dimensions determine the appropriate type of group 
blanks with specified dimensions.

In Figure 8 an example of cylinder liner Ø98,48 
PERKINS KS which belongs to the type SVDI is pre-
sented with its dimensions.

Blank dimensions for observed cylinder liner Ø98,48 
PERKINS KS, type IV are presented in Figure 9. Figure 
10 show a 3D model of the blank of this cylinder liner.

Defined 3D blank model with other given parame-
ters allows simulation of casting manufacturing process 
with the use of appropriate software (programmes). 3D 
part models and their blanks, with manufacturing con-
ditions allow automated manufacturing process plan-
ing of the piston-cylinder assembly parts in the pro-
posed CAPP system [11, 12].
CONCLUSIONS

Specialized and integrated CAPP system, that was developed by using general use software allow automated product design and manufacturing process planning in a given manufacturing system. This manufacturing system is specialized for production of large series parts of piston-cylinder assembly of internal combustion engines.

Developed CAPP system provides part and casting blank modelling which in turn provides basic inputs for simulation of the casting process and manufacturing process planning observed parts.

REFERENCES


Note: The responsible translator for English language is J. Bajkin, Faculty of Technical Science, Novi Sad, Serbia