Integrated CAPP System for Plastic Injection Molds Manufacturing

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Production process of plastic products depends significantly on cost of quality, time to market and cost to produce appropriate molds. Basic course of improvement and rationalization of production process for plastic injection molds is directed on automation design mold and their process planning. Working area of process planning in large number of cases is the bottleneck in production systems, because of impossibility of development multipurpose program system which would be effective in planning and designing a huge number of activities that makes process planning. The model and program system for automated process planning for plastic injection molds manufacturing have been developed, in order to solve this problem. This solution presents integrated CAPP system, which is based on integration of CAD, CAPP and CAM activities.

Keywords: Plastic injection mold manufacturing, CAPP, Data base, Knowledge base

Along with the growing life standard in world, there has also been growing demand for various products, among which plastic and its byproducts hold significant place. Relatively simple forming and less density compared to metals, great capability in esthetic and modern design of products with wide range of colors, are just a few of properties that have a significant influence on the expansion of plastic applications in all the fields where strength, rigidity and other advantages of metals are not overly significant. In past few decades, with emerging of new plastic materials with better properties, the process of their application in manufacturing of products with complex demand in exploitation started; all of this significantly influenced the growth of plastic products manufacture. Table 1 shows application of certain technologies for manufacturing plastic products, in regards to equipment price, productivity, mold price and volume of production.

Injection molding or injection forming, with extruding and blowing, presents the most spread technologies for manufacturing of plastic products. According to table 1, technology of manufacturing plastic products by injection molding – means application of very expensive production equipment and adequate tools (molds), with achieving of high productivity/capability.

Table 1
COMPARISON OF CERTAIN TECHNOLOGIES FOR MANUFACTURING OF PLASTIC PRODUCTS [1]

Technology of manufacturing plastic products	Equipment price	Productivity	Mould price	Volume of manufacturing plastic products (Pieces)						
				10^1	10^2	10^3	10^4	10^5	10^6	10^7
Thermo-forming	Low	Low	Low							
Blowing	Medium	Medium	Medium							
Injection molding	High	High	High							
Rotary casting	Low	Low	Low							
Extruding	Medium	High	Low	Continual process						
Forming	High	Medium	High							
Machine cutting	Medium	Medium	Low							

Although costs of mold making can represent a great share of the total cost of plastic products production, beginning of its production depends greatly on tool making time and its delivery time. Getting products in time on market has significant influence on the reduction of total costs, mainly because products reach the market before competition, and that has influence on favorable product price, faster investment return, longer product life cycle and bigger profit.

In manufacturing process of plastic product, significant part of time is that spent for mold design and process planning for their manufacturing. However, design and manufacturing of molds are mostly based on individual approach, which has as consequence low output techno-economical effects on their manufacturing and applications.

Beginning with the mentioned fact, that molds for injection molding of plastic products are very expensive, leads to idea of their standardization and switch to serial production. Practically, majority of parts, more exactly mold positions, can be classified according to type, excepting positions, which have direct influence on product shape. Classification of mold tool parts for plastic according to type, as form of standardization, enable the application of standard and group technologies for the design and production of molds.

It is generally known and in many cases proven, that rationalization of the whole work processes in production systems can be reached applying concept of standard and group technologies, which is based on principles of products similarity and their process planning similarity [2, 3].

Lately, there have been great efforts in systematization and grouping the products of plastic and their corresponding molds, on the basis of constructional-technological similarity, which has for a goal to improve design, process and production of injection molding tools for plastic products [4, 16, 17].

Applying the concepts of standard and group technologies, serial production of parts is being greatly increased, which provide transfer to high level productions, and also to the application of technological systems with high level of efficiency, based on application of NC machine

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systems, group fixtures and modern flexible tooling systems. This practice shortens technological and production cycle of manufacturing mold tools for injection molding of plastic.

Because of the tool making and delivering time and the quality and mold manufacturing costs, not every tool and die workshop is able to produce standard mold parts. However, standard mold parts made by world-renowned toolmakers have a relatively high price in domestic economic conditions. That is why many small tool producers, which have stable mold production, are introducing own standardization of mold tool parts on the basis of existing standards from world-renowned toolmakers, first of all because it is easy to replace parts which are critical in exploitation, and also to produce complete molds or certain integral parts. This represents rational solution for tool rooms, which following series production of certain mold tool for injection molding of plastic [5].

Wide application of injection molding technology in manufacturing of plastic products, caused a reaction from producers of CAx program systems who in last ten years developed program systems which allow progress of design process, analyses, simulations and manufacturing of molds for injecting molten plastics. Extremely great improvements are achieved in some commercial program systems in which producers started to develop special modules for design of plastic products and molds for their manufacturing. That is in regard to CAD program systems for design product from plastic and appropriate molds, CAM or CAD/CAM program systems for simulation of manufacturing processes and generation programs for execution of operations for manufacturing of mold parts, and also specially CAE program systems for simulations and analyses for process of injection molding plastic [7].

The technological preparing for production, which efficiency is reflected on design of quality production process planning, has become a bottleneck in functioning of production system for manufacturing molds for injecting molten plastic. Aiming to rationalize and improve systems for technical preparation of manufacturing molds for injecting molten plastic, a model was set and program solutions of system for automatic process planning of their manufacturing were developed, in other words integrated CAPP system which is based on integration CAD, CAPP and CAM activities [13].

Basic characteristic of CAPP system

Before introducing system for automatical design of technological process planning (CAPP-Computer-Aided Process Planning), it is noticed that design of process planning is one of the most important activities for the reducing of the production time, production costs and other techno-economical effects of production.

General classification of the methods for design of process planning in accordance with many authors, can be executed, according to figure 1, on classic or manual and automatic or computer aided process planning. In accordance with many authors CAPP systems are divided in two main categories, variant and generative CAPP systems. The third category is various-generative CAPP systems, as combination of the last two mentioned categories. In last time, appear also new categories under name New generative CAPP systems.

Systems for process planning, and also CAPP systems can be understood as “bridge” between product design and their manufacturing processes. Automatization of product design is successfully solved with application of

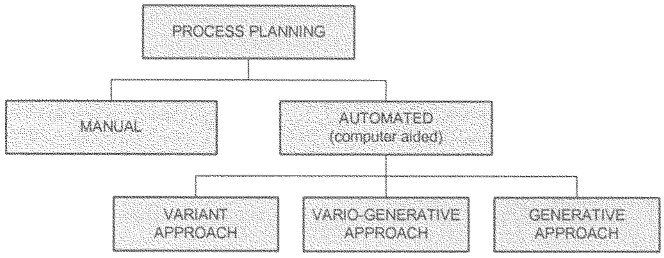


Fig.1. Methods of process planning [8]

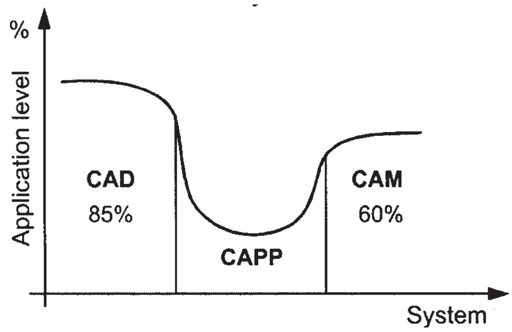


Fig.2. Level of application of certain automatization systems [9]

develop CAD/CAE systems. Application of modern CAM systems and introduction of NC machine systems with diverse purpose in production has as result its increased productivity and flexibility. The problem appears in phase of process planning design, which, on one hand must be able to satisfy all demands from product designer, and on the other, to be able to accept technological possibilities of their production. In figure 2, it is introduced an approximate level of application for CAD, CAPP and CAM systems.

Beginnings of development for automatic design of process planning, more exactly, first ideas for development of CAPP systems are from middle 60‘s of the last century. After that, during 70‘s appeared an idea about using CAD data for process planning design. During the 80‘s, CAPP systems started to develop with integration of CAD and CAM systems, and later in the 90‘s application of methods with artificial intelligence in field of development CAPP systems was intensified [10].

Beginning of development of CAPP systems was based on classic algorithmic programming, in contrast to today’s CAPP systems, which development was based on artificial intelligence tools, for example expert systems, neuron nets, fuzzy logic, in other words, with application of object oriented programming techniques, STEP standards, etc.

The goal for automatization of process planning is to design a high-quality process plan from assembly of great number of possible variants in definite time period. Development of CAPP systems has the following goals [11]:

· reducing of manual work for process planning activies which are not creative and which are burden for process planning designers;

· optimization of process planning using the accessible information about production resources;

· systematization and standardization of high-quality process planning for product manufacturing in the scope of production system, which make possible the transfer of knowledge and experience from process planning designers;

· systematization of production time and manufacturing costs.

Model of program solution for specialized CAPP system

Because of wide range of the products and the impossibility for developing a universal program system which could be efficient in design and planning for a huge number of activities which are integral part of process planning, the solution is often the development of specialized system for automatically process planning for product manufacturing, through application of appropriate program systems for general purpose. Developed program systems intended for automatic process planning for product manufacturing are based on integration with appropriate CAx systems, and they usually consist of several modules. In such manner, the specialized system for automatically design of process planning for mold plastic manufacturing is based on integration CAD, CAPP and CAM systems, in other words, based on development of integrated CAPP system.

As starting position for development system of automatical design of process planning for mold plastic manufacturing for injection molding, is set a model e.g. algorithmic system structure, which consists the of following parts, according to figure 3:

·input data;

·design of mold plastic for injection molding and selecting of standard mold parts;

·design of process planning for manufacturing of mold's parts.

Specialized program solution according to presented model, has as goal making solution for certain tasks, which are connected with:

<u>Design of molds and selecting of standard mold parts</u>

- Modeling of mold plastic assembly
- Modeling of standard mold parts and raw materials
- Selecting of standard mold parts
- Selecting the category and material type of raw material for mold parts

<u>Design of process planning for manufacturing</u>

- Design of process planning for manufacturing standard mold's parts (a broken line)
- Design of process planning for manufacturing mold parts for certain mold (tool).

First task is solved with CAD module, and second with CAPP/CAM module.

For the development of program solution of this system available program systems for general purpose are being used, which are applicable in certain phases (table 2).

Input in system consist model of plastic product and setting production conditions, for example volume of mold production, available technological equipment in production system, and other conditions in production process.

In first step, as part of CAD module can be used design of mold for plastic products using appropriate program systems, and that is not the aim of this paper, but results from this activity will be used as input data in CAPP/CAM module. In the second step of this module recommended standard molds' parts are being selected with appropriate marks and basic overall dimensions.

Mold lifetime, as one of the basic characteristic of his quality, to great extend depends on selecting quality materials for certain integral parts. That is the reason way when selecting mold's parts, materials are selected for their manufacturing. Certain knowledge and rules are integrated in the system as a support for process of selecting materials for mold parts. Necessary material selecting data for mold parts are the type of thermoplastic and category of mold part for which is need to select material.

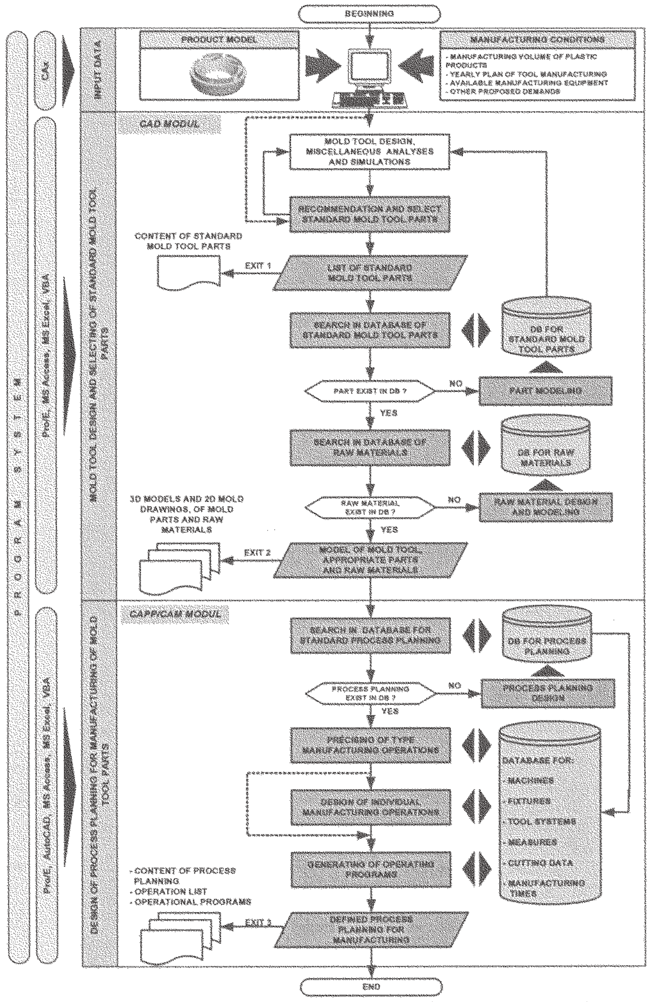


Fig.3. Basic algorithm structure for automatic design of process planning for mold plastic manufacturing for injection molding [12, 13]

Table 2

PROGRAM SYSTEMS USED FOR DEVELOPMENT OF PROGRAM SYSTEM SOLUTION

Program system role	Program system
System for design, e.g. modeling of molds, parts, mold parts and raw materials	Pro/ENGINEER
System for creating of operating programs for processing at NC machine systems	Pro/ENGINEER
System for development and management of relational data bases	MS Access
System for development of knowledge bases and integration of system	VBA

First output from this model is a list or review of recommended standard mold parts with adequate mark.

After selecting a standard mold parts the selecting of appropriate raw materials is performed. Usually, for production of prismatic mold parts are used steel plates or bars with rectangular or circular cross section.

Other alternative outputs from CAD modules, are 3D models and 2D mold drawings, and respectively theirs parts and raw materials. Designed mold for plastic, e.g. its parts, and other output data from this model, are input data in mold parts production process planning module. Above-mentioned module will not be described in details in this paper, just its outputs.

Second CAPP/CAM module has its purpose for automatic design of process planning for manufacturing molds for injection molding of plastic, including creating operational programs for manufacturing operations that are executed on NC machine systems.

Organization and data management for this system require development of database, which is in this case based on relational principle and present one of the key elements of this program solutions. Inside this integrated database also exists a database for standard process planning, drawings and models of mold parts, database for machines, fixtures, system of cutting tools, manufacturing treatments and measures.

Knowledge base which is used for this system consists of production rules and facts for automatic selecting of process planning and also for its complete definition, in other words, making operations precisely for the process planning. Knowledge base for process planning consists of: standard process planning and rules for their selecting, manufacturing operations and rules for their selecting, standard technological forms and rules for their recognition, manufacturing sub-operation and rules for their selecting, also rules for machine selecting, fixtures, measures, elements of flexible cutting tool system and cutting data.

Based on input data, through interaction with the user and with rules which are defined in process planning databases, process planning content for manufacturing of specific mold part from databases of standard process planning is being created. Next step of application of this program solution is to execute precisely defined manufacturing operations from process planning and making operational programs.

Outputs of this module are the defined content of process planning in form of pattern (map or flow) for process planning content, defined manufacturing operations in form of patterns (maps) for precise operations, and also appropriate operating programs for operations which are executed on NC machine systems.

Integrated database and knowledge base of this program solution

System development for automatic design of process planning requires the use of great amount of data which must be organized and memorized in adequate manner as a part of integrated database at level of whole system.

Structure of integrated database within the whole system is shown in figure 4 that shows single elements creating an integrated database with relationships among them. The development of integrated database, which is used in program solution of system, is realized in three stages, through conceptual, logical and physical design of database.

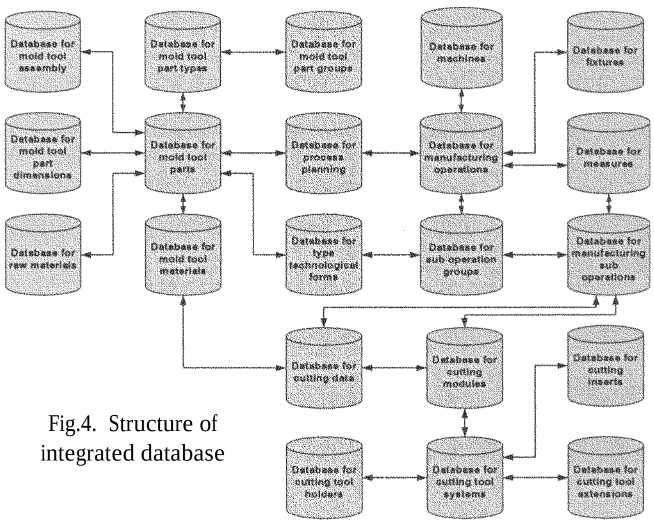


Fig.4. Structure of integrated database

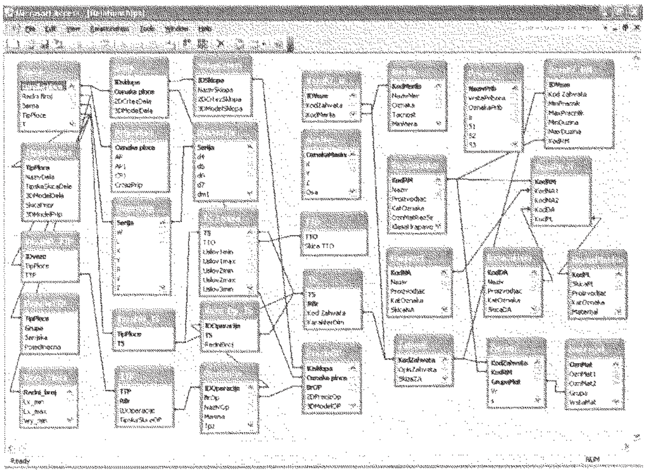


Fig.5. Review of relational model database of developing program solution in MS Access

Figure 5 shows a relational model of integrated database for program solution of system for automatic design of process planning for manufacturing prismatic mold parts for injection molding, which is designed in MS Access, showing achieved relationships.

Within the developed knowledge base, which is used in this system, knowledge is presented through the use of production system technique. Decision making and concluding performed based on input data given from user and data that are memorized in system database. The data is mostly referring to geometric and technological data. Input data, given from user, are being defined with support of restricted graphical user-oriented setting.

Knowledge base is integrated at the level of whole system out of which certain classes or knowledge base parts can be separated, where decisions-making process takes part (fig. 6).

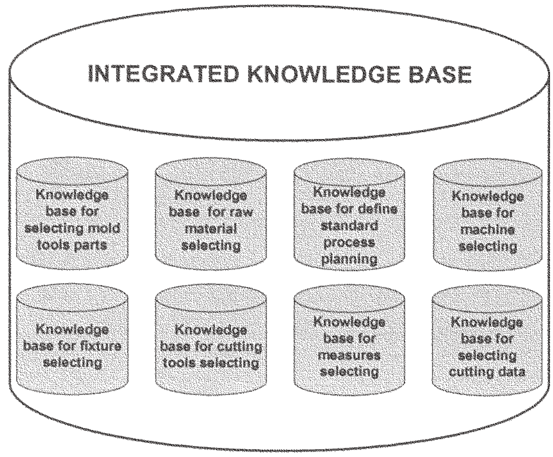


Fig.6. Classes of integrated knowledge base in system

Central entity represents an integrated database with production systems, which can be operated through well-defined operations of global management strategy, in other words, with management system. Therefore, basic elements of production systems are integrated database, assembly of production rules and management system. Integrated knowledge base within this system is developed through combination of structure data, which are memorized in database and procedures developed in VBA setting.

Database and knowledge base of process planning for manufacturing mold parts

The largest part of integrated database and knowledge base within this program solution is made of database elements and knowledge base for design of process planning.

Design of process planning in such developed program solution is executed for each individual mold part, and that is the reason why it is necessary to first select a concrete mold part and define appropriate raw material.

Developed database and knowledge base make it possible to achieve contents of standard, e.g. type process planning and precisely manufacturing operations for each mold part and appropriate raw material. Picture 7, shows an algorithmic flow of defining for process planning, which is executed in following stages:

· selection of standard process planning;
· selection of machines, fixtures and measures;
· selection of cutting tool system;
· selection of cutting data.

Standard that is, type process planning is defined for certain type mold parts. In any specific case, prismatic, that is standard plate mold parts with rectangle shape and appropriate process planning for their manufacturing in certain production conditions is being observed.

It must be mentioned, that in preparation stage of development for this system there is adopted the standard process planning for manufacturing certain mold parts in case of one-piece and serial production, and appropriate database and knowledge base are being defined.

Based on introduced algorithmic flow in figure 7, a part of solution related to development of knowledge base of defining process planning for manufacturing of prismatic parts batch of mold frame will be shown.

This database consists of:

· rules for defining the selecting contents of standard process planning,
· rules for selecting type manufacturing operation e.g.:
- rules for recognition of type process planning forms;
- rules for selecting group of standard manufacturing processes and
- rules for selecting and detailing of manufacturing process.

For observed mold part a content of process planning for their manufacturing based on developed production rules is being defined. These rules are defined in following form:

IF (Part Λ Material part group Λ Production type)
THEN (Type process planning)

Table 3, shows an example of production rules for defining contents of process planning for manufacturing for fixed mold plate, and also its type drawing and content of standard, that is type process planning.

After selecting of process planning content, next stage is its' detailing, including detailing of manufacturing operations. Depending on specific observed mold part and appropriate operation, the appropriate type of technological forms is also defined. These rules have following forms:

IF (Standard process planning Λ Type manufacturing operation)
THEN (Type technological form)

Table 4 shows, a part of supports for recognition of type technological forms, which are in relation with defining manufacturing operation drilling for fixed and movable mold plate for injection molding mold tool. In mentioned manufacturing operation, two type technological forms TTO84 and TTO86 are being manufactured. These rules have the following form:

IF (Type technological form Λ Characteristic of type technological form)
THEN (Group of type/standard sub-operation)

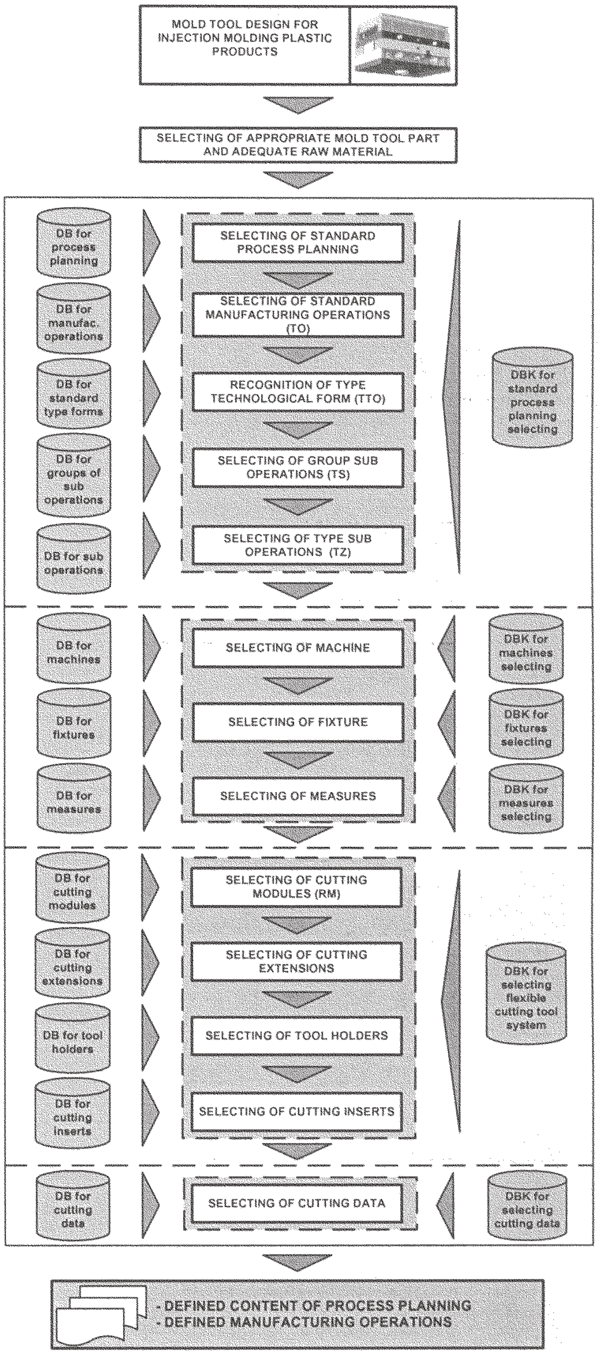


Fig.7. Algorithmic flow of defining for process planning [13]

After recognition of type technological forms, the next stage is the selection of appropriate group of sub-operation. Rules for their selection have the following forms:

IF (Mark of group sub-operation)
THEN (Order, category and code of type sub-operation)

Table 5 shows a review of two selected groups of sub-operations, which are necessary for processing of previously defined type technological forms TTO84 and TTO86, with appropriate characteristics.

Type sub-operations, which include manufacturing operations of specific individual type technological forms are coded, based on developed code system. Codes of type sub-operation make one of the most important input data for automated selection of flexible tool system and cutting data [14].

Next stage in defining of process planning, according to algorithm flow from figure 7, includes selection of machine tool, fixtures, measures, elements of flexible tool system, and cutting data for individual manufacturing operations and sub-operations.

Verification of developed program solution application

Table 3

SELECTION OF STANDARD PROCESS PLANNING CONTENT FOR MANUFACTURING OF FIXED MOLD PLATE N10A

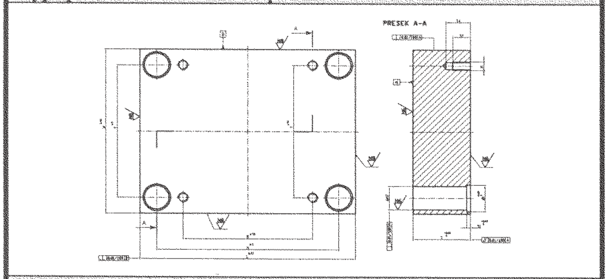
IF *Type part=N10A ∧ material steel 1.2718 ∧ Batch production* **THEN** *Standard process planning TTP 10A*			
Type part sketch: Fixed mold plate N10A			
			
Content of process planning:			
Op.	**Operation name**	**Machine**	**Tpz**
10	Oxy-fuel cutting	Oxy-fuel cutting	10
20	Tempering	Heat oven for tempering	30
30	Control	Control table	5
40	Debburing	Work table	10
50	Milling	NC milling machine	15
60	Grinding	NC grinding machine	15
70	Control	Control table	5
80	Drilling	NC Mill and Drill	30
90	Engravement	NC milling machine	30
95	Making slots for temper. Etc.	NC Mill and Drill	20
100	Hardening and annealing	Heat oven, anneal. bath	30
110	EDM	EDM machine	20
120	Debburing	Work table	10
130	Degreasing	Degreasing Bath.	5
150	Finish control	Control table	5

Table 4

REVIEW OF PART SUPPORT FOR DEVELOPING OF RULES FOR RECOGNITION TTF

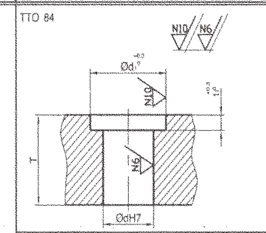
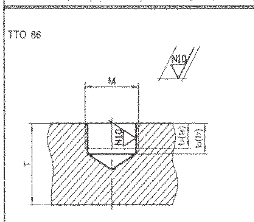
Mark of type part	Type technological form	Characteristics of type technological form	Mark of group sub-operations
N10A N10B		$14 \le d \le 18 \wedge 16 \le d_1 \le 22 \wedge 16 \le T \le 56$	TS 80.18
		$24 \le d \le 32 \wedge 28 \le d_1 \le 36 \wedge 17 \le T \le 146$	TS 80.19
		$42 \le d \le 50 \wedge 46 \le d_1 \le 54 \wedge 36 \le T \le 206$	TS 80.20
		$6 \le M \le 8 \wedge 12 \le t_2 \le 15 \wedge 17 \le t_3 \le 21$	TS 80.23
		$10 \le M \le 12 \wedge 18 \le t_2 \le 20 \wedge 26 \le t_3 \le 28$	TS 80.24
		$M=16 \wedge t_2=26 \wedge t_3=35$	TS 80.25

Table 5

REVIEW OF SUPPORTS FOR DEVELOPING OF RULES FOR RECOGNITION TTF

Mark for group sub-operations	Type of processing sub-operations	Code of type sub-operation
TS 80.19	- Countersink 4x∅4	BZ10
	- Drill 4x$\varnothing d_4$=	BS10
	- Rough Reaming 4x$\varnothing d_7$=	BP10
	- Reaming 4x∅dH7=	SC21
	- Counterbore 4x$\varnothing d_1$= on depth t_1=	BU11
TS 80.24	- Countersink 4x∅2,5	BZ10
	- Drill 4x$\varnothing d_{m1}$= on depth t_3=	BS20
	- Tap 4 thread M= on depth t_2=	UN20

Verification of application to develop CAPP system, its part which is related to defining of basic elements for process planning of manufacturing will be demonstrated through appropriate example as fixed plate of mold tool for injection molding of distributor body (figs. 8, 9 and 10).

After complete defining of mentioned mold tool, e.g. a

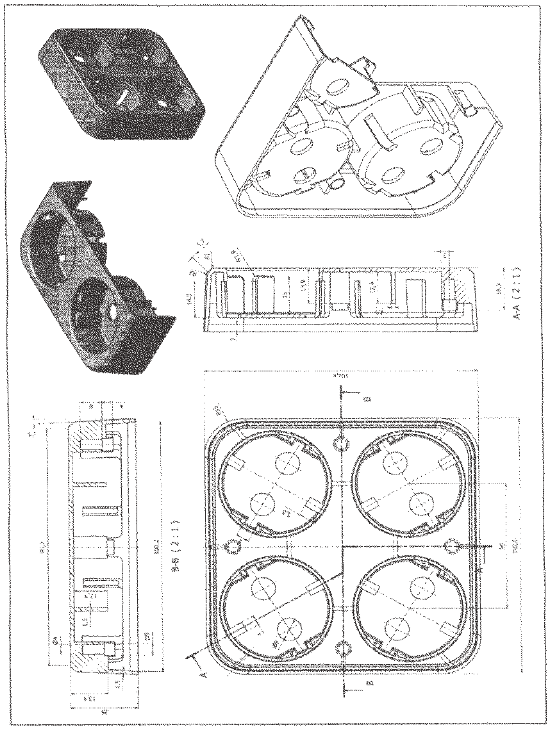


Fig. 8. Drawing of distributor body

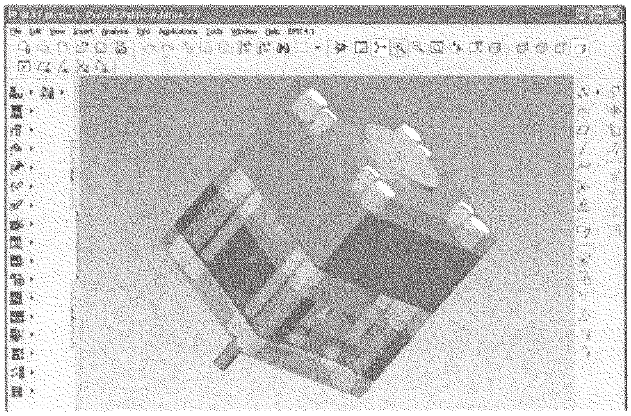


Fig. 9. 3D assembly model of mold tool for injection of distributor body

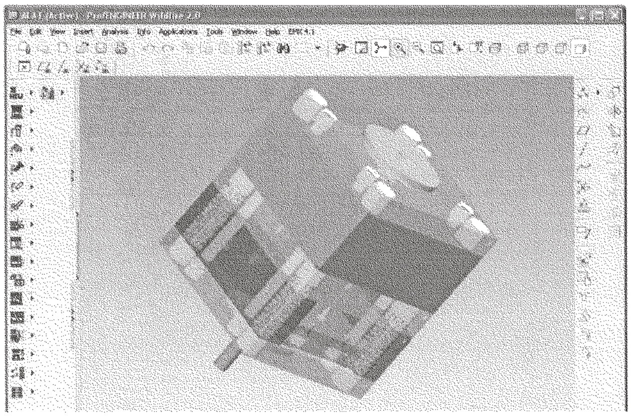


Fig. 10. 3D model of fixed mold plate

belonging fixed mold plate, as well as selection of raw material type and material for fixed mold plate shown in figure13, the following stagedesigned of process planning is designed for manufacturing of the fixed mold plate.

On the basis of developed production rules, which are defined in table 3, a content of process planning for manufacturing of selecting fixed mold plate for observed mold tool with mark TTP10A is being defined (fig.11). For this manner of selection of process planning content, within MS Access, a possibility of creating reports in printing form is utilized.

For verification purpose, two manufacturing operations

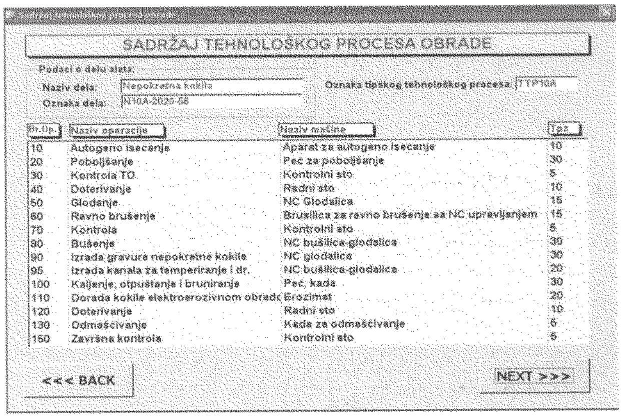


Fig. 11. General content of processes planning for manufacturing of fixed mold plate

are being selected, e.g. operation of drilling (OP80) and operation of engravement (OP90). Operation of drilling is a standard operation, which is completely defined in observed program solution, but operation of engravement belongs to individual operation, because the shape of engravement is limited by the shape of plastic product, and that is the reason way process planning of both processes realization is designed individually, for each mold tool, e.g. product, with application one of the CAD/CAM systems.

For selected operation of drilling, a new form for precisely definition of this operation is being opened from content of process planning (fig.12).

Fixed mold plate contains appropriate type of

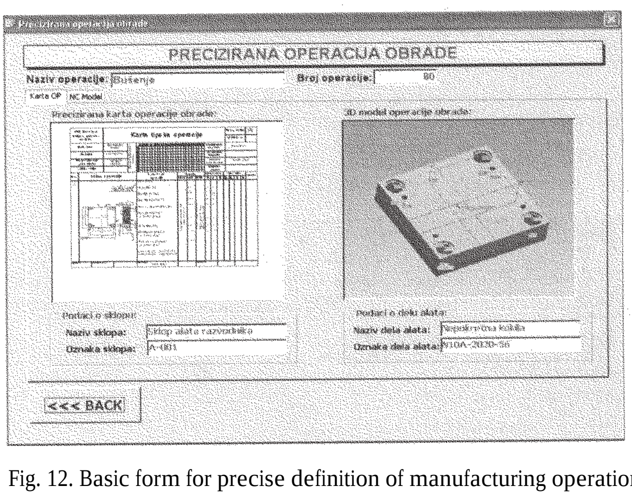


Fig. 12. Basic form for precise definition of manufacturing operation

technological forms TTO84 and TTO86, whose processing is executed in observed drilling operation (fig. 13). Rules for defining type of the technological forms are of following:

Processing of observed type technological forms are realized through application of certain group sub-operation, what is according to table 4, determined with production rules:

IF (TTO84, $24 \le d=28 \le 32 \wedge 28 \le d_1=32 \le 36 \wedge 7 \le T=56 \le 146$)

THEN (Group of type a sub-operation TS80.19)

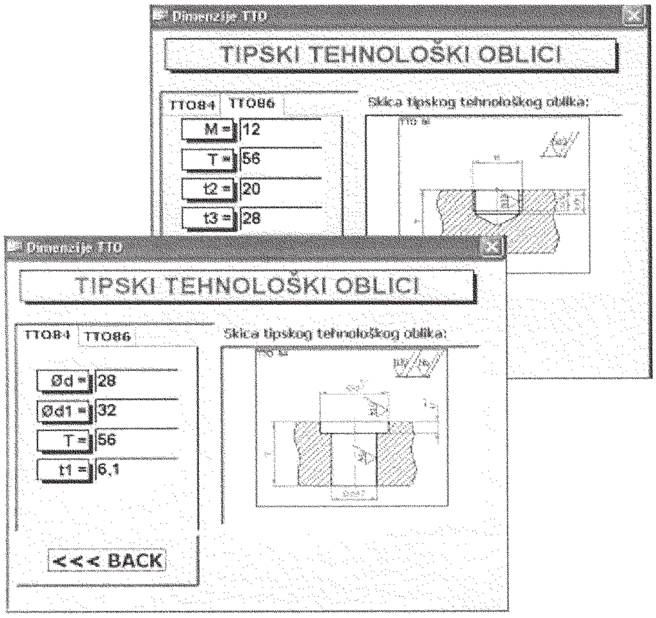


Fig. 13. Type technological forms in drilling operation for fixed mold plate

IF (TTO86, $10 \le M=12 \le 12 \wedge 18 \le t_2=20 \le 36 \wedge 26 \le t_3=28 \le 28$)

THEN (Group of type a sub-operation TS80.24)

Following step is defining of group sub-operation, which is necessary for their processing, on the basis of developed rules according to table 5, and also detailing of these manufacturing sub-operation in the true sense of detailing of dimensions and codes of sub-operation. The rules for precise determining of observed sub-operation are the following:

IF (TS 80.19)

THEN (Order, category and code of type sub-operation)

·*Countersink 4x∅4*	*BZ10*
·*Drill 4x∅d_4=26*	*BS10*
·*Rough Reaming 4x∅d_7=27,7*	*BP10*
·*Reaming 4x∅dH7=28H7*	*SC21*
·*Counterbore 4x∅d_1=32 at depth t_1=6,1*	*BU11*

IF (TS 80.24)

THEN (Order, category and code of type sub-operation)

·*Countersink 4x∅2,5*	*BZ10*
·*Drill 4x∅dm1=10 at depth t3=28*	*BS20*
·*Rough Reaming 4x∅M=12 at depth t2=20*	*UN20*

Figure 14 shows a part of program solution for detailing of manufacturing sub-operation with review of type fine-hole drilling sub-operation, with mark SC21.

After defining all data, which are connected with detailing of manufacturing sub-operation, machines, fixtures, measures, elements of flexible cutting tool systems, cutting data and time in the frame of appropriate operations, next step is detailing a form for operation as basic process planning document. Figure 15 gives a review for defining of drilling manufacturing operation for observed fixed mold plate.

In figure 15, a defined parametric 3D model of part is shown, which is produced, in mentioned drilling operation for observed fixed mold plate, which is connected using OLE technologies with model in Pro/E. This model, together with part model from previous manufacturing operation is used for getting a manufactured model in CAM module of Pro/ENGINEER and defining of operational program for drilling operation, which is realized at selected NC machine system.

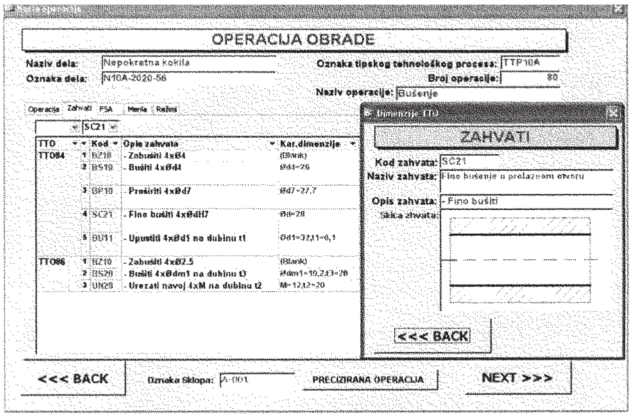


Fig. 14. Defined sub-operation for drilling operation and review of one type sub-operation

Fig. 15. Review of form for detailing of manufacturing operation

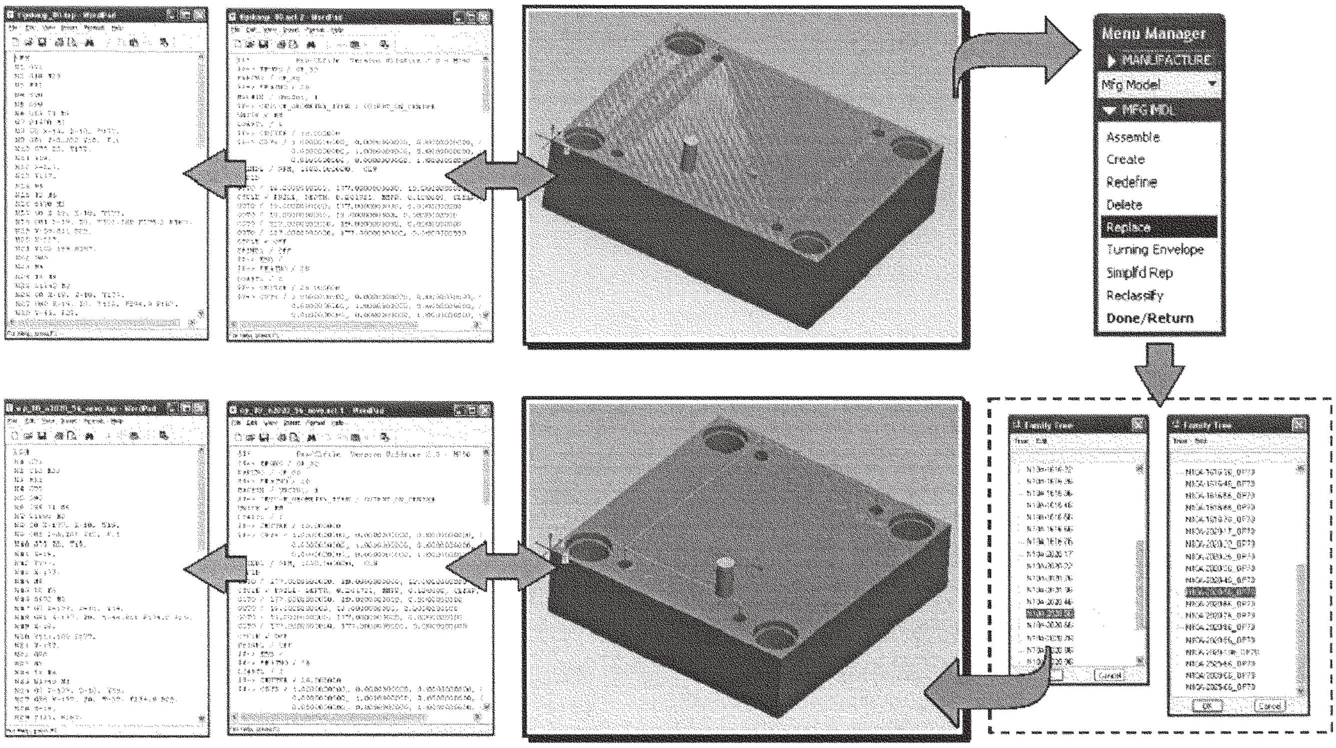


Fig. 16. Application of parametric programming for generating operational program of standard drilling operation for fixed mold plate [13]

Creating operational programs is being based on principle of parametric programming. On the basis of designed drilling operation for standard fixed mold plate and created operational program, automatically an operational program for this manufacturing operation for observed fixed mold plate is generated, and that is shown in figure 16.

Because the engravement, in other words mold tool hollow space is individual for each mold tool, also manufacturing operation of engravement must be designed individually. Design of manufacturing operation engraving in specific case is realized in Pro/MFG. In addition, a way to detail this operation in mentioned program solution will be shown.

Figure 17, shows a review of form related to operation definition of engravement process of observed fixed mold plate. Besides, 3D model of fixed mold plate that is generated from this manufacturing operation is also shown. This 3D model, together with 3D model from previous operation, makes a manufacturing model, which is used for this manufacturing operation design, in other words, for generating appropriate operating program.

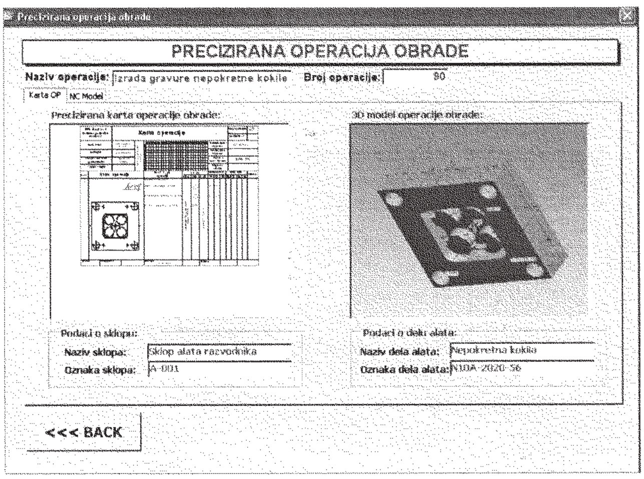


Fig. 17. Basic form for defining of manufacturing operations

Figure 18 shows a review of form for generating appropriate operating program for engravement process of observed fixed mold plate operation. After input of necessary data for manufacturing operation design, within

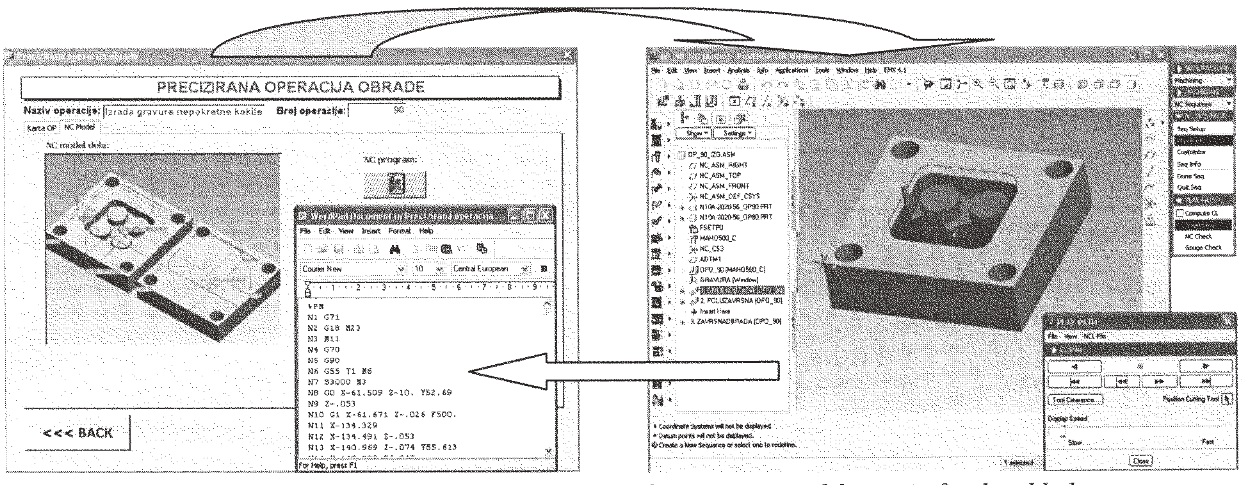


Fig. 18. Generating of operational program for processing of the cut in fixed mold plate

Pro/MFG a simulation of cutting process is performed as well as generating of appropriate operating program.

Conclusion

As result of all present aspirations to adapt to modern market demands, new and more complex demands are being presented to production systems. This can be seen in the need for high level of automatization of all activities, starting from development and product design to their production in the end. With application of available general purpose systems, in other words CAD/CAM/CAE systems, system for database developing and system for program application developing, it is possible to make program solutions which have a purpose to mechanize design process and manufacturing process of products.

Developed specialized program solution, in other words, integrated CAPP system, enable automatization of large number of activities in process of mold tool design for injection molding of plastic and their process planning, which has significant influence for advancement and rationalization of technical preparation work for production, especially for segments which are connected with technological manufacturing preparation.

Observed solution supports the direction of modern methods of development and modern product manufacturing application such as concurrent engineering, time-to-market. All this significantly influences work quality of production system for manufacturing of plastic products and appropriate mold tools.

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