THE CODING OF MANUFACTURING SYSTEM OBJECTS INSIDE THE NEW SOFTWARE APPLICATION

The article deals with the creation of the codes of manufacturing system objects inside of the new software application product for the little and medium-sized plants, developed at the Technical University of Košice, Faculty of Manufacturing Technologies, with the seat in Prešov. It enables computer aided process planning in several versions, the multivariant creation of process plans with the optimization according to the selected criteria, the creation of technological documentation and NC programs on the basis of hybrid approach, obtain production data holding and its processing with time and cost manufacturing savings. The results presented in the article are used in authors workplace conditions and they originate with the direct supporting of Ministry of Education VEGA č.1/0558/08.

Key words: the code, computer aided process planning, hybrid approach, multivariant creation

1. INTRODUCTION

To the systems, which aid the activities by means of computer within the process plan, belong the CAPP systems. The procuration of integrated CAPP system can be for little and some middle plants expensive, sometimes inaccessible investment with the long recoupment period. On the other hand also for these plants it is fundamental to be the manufacturing information saved digestedly and to be used in various forms (for example for the generation of technological information or NC programs) with the possibility to successive complement, editing and modification of necessary data.

The other important precondition for the successful company application in business environment is its ability to archive of relevant data in the long term on the basis of management quality systems in the sense of ISO standard, exactly according to the requirements specified in concrete conditions. For the originating product-business subjects is the selection of the system, which aids the using and the processing of information obtained inside technological

∗ Ing., PhD.} Faculty of Manufacturing Technologies, Technical University of Košice, Slovakia.
** Doc. ing. PhD.}
preparation of production, conditioned by financial possibilities and by the suitability for organization structure. For already existing plants, it is coessential the suitability of insertion such software product into already existing information structure without the needs of expansive interface – for example between CAD/CAM system and CAPP system, between CAPP system and the software for economical, wage and storage records.

One of the other demands for the choosing of suitable CAPP system or another software application is its flexibility and the possibility to adapt the user requirements. The solution of the problem in regard to the data storage, data processing and data exploitation within computer aided process planning in little and medium size plants is the creating new software application on Faculty of Manufacturing Technologies of Technical University of Košice with the seat in Prešov, which aids apart from the activities listed above also the multivariant creation of process plans with the optimization according to the selected criteria, the creation of technological documentation and NC programs on the basis of hybrid approach, comprehensible production data holding and its processing with time and cost manufacturing savings. The basic application menu is shown in the Fig. 1.

![Fig. 1. The basic application menu](image)

2. THE SUGGESTION OF CODING SYSTEM

The objects in machine engineering as are the parts, machines, equipments and other, it is possible to model on the various stages with various goals. These objects we can regard as the models (physical, simulation, computer, mathematical and other). Each of these objects can be considered as system, which consists of other features, respectively as the feature that is part of some system.
The mathematical model represents the substantial object properties by the numbers or symbols, thus by the mathematical means [2].

In the machine engineering we meet with numerical expression (for example at the part dimensioning, where conventional unit is millimeter), but we meet with non-numerical expression, too (for example at the coding of part in group technology).

In regard to a large number of parameters that are variable in consequence of the varied manufacturing process conditions, it is most suitable to use the type of code at which are the starting positions reserved for the characteristic properties of the object. Other positions are attached to the attribute part of code according to the need to define the classification of the object. On the basis of this structure it is possible the manufacturing system consider to be set, which is unification of subsets marked as subsystems (Fig. 2).

![Fig. 2. Manufacturing system](image)

The created system can be expressed by the relation:

\[ MS = S \cup E \cup O, \]

where \( MS \) – manufacturing system,
\( S \) – segment,
\( O \) – operation,
\( E \) – equipment.

### 2.1. The subsystem Segment

The basis of subsystem “Segment” is the classification code for the segment description, which represents the start point of whole system. The suggested coding system keeps the space for the process plans creating not only for cutting technology but also for other technologies. The codes cover the following characteristics:
- the geometrical shape,
- the class of part,
– the manufacturing characteristics,
– the class of dimensions.

During the creation of software application it was suggested several manners of the segment classification, for example according to the types of surfaces that didn’t comply from the view of the classification complexity. The example of generated code and the structure of this code are shown in the Fig. 3.

In this code, for example, the 4-th part of code describes the raw product size. This part of code is created by 4 positions. The first position is defined by alphabet letter, which determined the kind of raw product (for example into the group “A” fall the sheets, steel strips …). The second, third and fourth position give the standard sequence for specific kind of raw product in database module. It is possible for the plant to register till 1000 standards for one kind of raw product.

The coding of the Segment in this software application go out from the assumption that the data registered in this module will be next used at the creation of technological or drawing documentation and the parameters already once defined will be possible to record by another database module. Therefore the Segment code can to appear too difficult on the first sight, but at the work in user interface it is its creating very simply and it is aids by already partially charged by data bank.

2.2. The Structure of operation subsystem

On the basis of suitable code definition for the Structure of operation subsystem it is possible to determinate three stages [1]:
– The class of the machining,
– The type of the machining,
– The process of the machining.
The coding of manufacturing system objects inside the new software application

It is possible to specify the concrete machining operation by means of these three stages. The example of the Structure of operation coding is shown in the Fig. 4, which shows the code meaning.

<table>
<thead>
<tr>
<th>1 code digit</th>
<th>The class of the machining</th>
<th>2 code digit</th>
<th>The type of the machining</th>
<th>3 code digit</th>
<th>The process of the machining</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>rotary machining</td>
<td>0</td>
<td>lathe work without thread</td>
<td>thread cutting internal</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>facing</td>
<td>1</td>
<td>lathe work without thread-cutting</td>
<td>thread cutting external</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>drilling and boring</td>
<td>2</td>
<td>grinding</td>
<td>thread milling internal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>manual work generally</td>
<td>3</td>
<td>treading</td>
<td>thread milling external</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>surface treatment</td>
<td>4</td>
<td>autorm, lathe work with thread</td>
<td>thread rolling internal</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>inspection, checking</td>
<td>5</td>
<td>lathe work with thread</td>
<td>thread rolling external</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>heat treatment</td>
<td>6</td>
<td>gear cutting</td>
<td>thread grinding internal</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>non-cutting processes</td>
<td>7</td>
<td>vacant</td>
<td>thread grinding external</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>metal joining</td>
<td>8</td>
<td>vacant</td>
<td>warm machining</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>casting, etc.</td>
<td>9</td>
<td>vacant</td>
<td>other</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4. The example of the structure of operation coding
Fig. 4. Przykład struktury kodowania operacji

Inside the created software application exist also other technologies and so this subsystem is expanded to the stages:
- The technology,
- The technological class,
- The technological type,
- The technological process.

2.3. The subsystem Equipment

The term “Equipment” is, in this case, used for the cover of wide spectrum of various product equipments, such as [1]:
- The production spaces (the halls, workshops, ...)
- The equipment for the energy production and energy distribution
- The machining equipment
  a) The tools
  b) The jigs and fixtures
  c) The machines
  d) The machining equipment
  e) The equipment for the workshops of manual operations
  f) The equipment of assembly plants
– The measuring and testing equipment
– The conveying devices
– The equipment for storage
– Other devices (for example computer techniques, ...)

The subsystem „Equipment” represents very large, rugged and heterogeneous structure of individual objects. Therefore it was used at the suggestion of the coding the hybrid type of code.

The example of the some machining equipment dividing can be following:

**The machines.** The machines it possible to divide from various aspects, the most advantageous is the classification on the basis of used technology. In this case we can speak for example about the machines for:

– Machining,
– Moulding,
– Casting,
– Welding,
– Assembly and other.

The next distribution is possible within the machining:

I. The turning machines,
II. The milling machines,
III. The drilling and boring machines,
IV. The centres of machining and other.

**The tools**
– The tools are very important part of production process. For exact coding it is necessary to regard:

– The technological operation that the tools are able to execute,
– The technological and geometrical limitation,
– The maximal and minimal values of the working parameters,
– The type of the work holding,
– The environment, which can be tools used in.

**The jigs and fixtures.** It is needed to determinate at the coding of jigs and fixtures:

– The devices, which can be used on,
– The maximal and minimal values of the working parameters,
– The environment, which can be jigs and fixtures used in.

**The accessory equipments.** The accessory equipments are often essential and necessary for the flow of some operation. It was possible to choose the hybrid type of code in regard to the ambiguity of its using definition (for example the same medium can be sometimes used as the cooling mixture and some other time as oil).
3. CONCLUSIONS

One of the most time consuming phase of manufacturing process is the Process planning. It contains many of partial tasks and it has great impact on new product rise time and on the cost decreasing, what expresses in the product price. It influences so economic and time aspect of the manufacturing, the precision and quality of manufacturing part. The analysis of technical-engineering activities in process planning shows that most of these activities are routine character, and only a little part of them has intuitive character. It is possible these monotonous and mentally laboured works to effective, to speed up, to make objective by means of algorithmization and sequential computer aid, and so to respond on varied conditions not only customer, but to manufacturing, too [6].

The suggestion of new philosophy and the development of new software product for the creation of multivariant process plans is the intent of submitted project. This approach enables to increase of effectivity already at the beginning of its design and to improve the process of technological documentation creation without of the influence on its complexity. Generated application will be built by modular manner to allow flexible adapt data structure to user specific conditions and to satisfy the specification of simple implementation into already existing information structure of the plant. The output data of the system will be able to utilize not only for the generating of technological documentation but also to the processing of details for manufacturing, store, economic and wage records, thereinafter for the creating and archiving of NC programs and for the data registration, too. It is assumed the practical verification of the final product in real conditions of manufacturing plants.

REFERENCES

KODOWANIE OBIEKTÓW SYSTEMU WYTWARZANIA Z WYKORZYSTANIEM NOWEJ APLIKACJI

S t r e s z c z e n i e

Artykuł dotyczy tworzenia kodów obiektów systemu wytwarzania z wykorzystaniem nowego oprogramowania, przeznaczonego dla małych i średnich przedsiębiorstw, opracowanego na Wydziale Technologii Wytwarzania Uniwersytetu Technicznego w Koszycach z siedzibą w Preszowie. Oprogramowanie to pozwala na komputerowe wspomaganie projektowania procesów technologicznych w kilku wersjach i wielowariantowe tworzenie procesów technologicznych z optymalizacją stosownie do wybranych kryteriów. Ponadto można tworzyć dokumenty technologiczne oraz programy na obrabiarki sterowane numerycznie na podstawie hybrydowego podejścia, a także pozyskiwać dane producyjne i je przetwarzać z uwzględnieniem minimalizacji czasu i kosztów. Wyniki przedstawione w artykułach są wykorzystywane w praktyce. Badania były realizowane dzięki wsparciu Ministerstwa Edukacji Republiki Słowackiej – numer projektu 1/0558/08.

Słowa kluczowe: kod, komputerowe wspomaganie projektowania procesów technologicznych, podejście hybrydowe, tworzenie wielowariantowe