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DEVELOPMENT OF THE PROGRAM TO PREPARE TOOL SETS IN FLEXIBILE MANUFACTURING SYSTEM

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Abstract: *For every NC program to be implemented in the production of flexible manufacturing system (FTS), there must be a list of sets of tools to prepare for the machining process . The flexible technologies that are implemented through the execution of thousands of different operations in the processing parts of the complex geometry of the problem is relatively small series of settings of the tool is very important .*
This paper presents the concept of software systems for automated preparation of sets of tools for the production process in the FTS- in . The structure of the programming system is based on technology -based data elements set of tools and geometric parameters of technological processes contained in the NC program. Developed an original algorithm for forming sets and tools based on modern theories in terms of reduction of uncertainty , which allows for the practical application of software systems in the design of technological processes for FTS .

Keywords*: software systems , software , FTS , composing tools, theory uncertainty*

1. INTRODUCTION

Management tools in the FTS-in consists of drafting tools, determining its characteristic geometric size, selection of elements to compose a set of tools, his system of identification and monitoring, and its decomposition after completion of the technological operation. Management tools is done according to different criteria, monitoring their condition using a sensor (overheating, wear, deformation, fracture), and integrated monitoring system "Tool Management System" is included. In section preparation tool on the tool data are entered into the contactless memory element and reads a special reader connected to computer control system tools. Each set of tools must be measured and adjusted and his parameters entered into the memory element after which they are ready to be in the order of the executive program of NC machining processes involved in FTS-cell according to the instructions of the controller. Reduction of the settings tools in flexible technologies, increasing produc-tivity.

2. STRUCTURE OF TOOLSETS

Tool set is a single integrated functional unit consisting of elements: mount, extension, reducer, accessories and cutting tools (Figure 1). The elements are modularly designed, so you can compose in different ways depending on the requirements of machining processes and unit operations which the tool is running. Each set must have high rigidity and to ensure dynamic stability of the cutting part of the tool at various cutting conditions. Compatibility Toolkit elements are determined based on their dimensions.

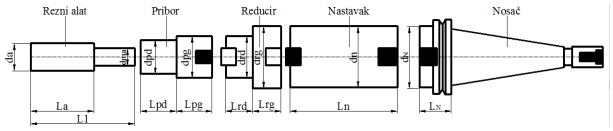

Fig. 1. The general structure of the toolbox.

Carrier establishes a connection with the main spindle can accept gripper changer in the cycle of automatic tool change and provides a number of extensions and other elements in the toolbox . Rack has a front cylindrical part of the standard diameter (dn) length (ln) that can be placed below or reducers or probor . In one set can be only one tool holder .
Continued used to it extend the total length of the set , to give the cutting tool with a grip material. Geometric size , length of process (ln) and the diameter of the tip (dn) , determine compatibility between the elements of the toolbox. As part of a set of tools can be more extensions of the same or different diameters. The diameters of the two sustedna elements must be equal. In technological practice to avoid tool kits with multiple extensions, because it reduces the dynamic stability of the machining process.
Reducer is used when you need to reduce the diameter of the set, to the cutting tool through the hole previously processed smaller diameter than the diameter of the tip (dn) or to avoid collisions of the body with a set of tools Dole workpiece under the cutting process . The reducer has a higher (drg) and lower (drd) diameter and length that fits most (Lrg) and a length that corresponds to the lower (lrd) diameter.
Accessories and accepts tightening tool. The clamping mechanism Probe must be adapted to handle, type and method of rapid contraction and release of the cutting tool. Accessories with one hand accepts cutting tool (dpd) on the other side has a connector for other elements (dpg).

Cutting tool and all its characteristics as determined by the design of the technological process , and specify the stage of the NC program . Based on NC program tool performs technical operations . Each sequence of NC programs covered by the technological cycle of an operation , execute a tool that is placed in the set . One and the same cutting tool in the set can perform multiple operations if its geometirjske and cutting performance and durability designed to allow.
Toolset is postavjla the warehouse tool machining center which has a fixed distance between the neighboring seat of tools and a maximum diameter of the cutting tool is limited. Limited by the maximum diameter and maximum length of cutting the design parameters of the machining center to automatic tool change cycle is performed without collisions .

3. FORMALIZATION RULES COMPOSING TOOLSETS

Management tools in the FTS-in consists of drafting tools, determining its characteristic geometric size, selection of elements to compose a set of tools, his system of identification and monitoring, and its decomposition after completion of the technological operation. The input data for the composition of the toolbox are: machine, tool type, diameter (d), the length of treatment (l), the values of the NC program X, Y, Z. On the basis of an intelligent machine system selects which carrier must have tool sets. Based on the type of tool for a given diameter (d) and length of treatment (l) intelligent system selects tools with diameters equal diameter hole or holes to be processed:

$$d=da \tag{1}$$

Of the selected tools so choose the one whose payload length (la) with the length of treatment (l) the smallest real positive difference:

$$\min\left[\left(l_{ai}-l\right)>0\right] \tag{2}$$

For this chosen tool holder and there are now two cases. The first case is when the Z coordinate of the NC program is less than useful tool length by:

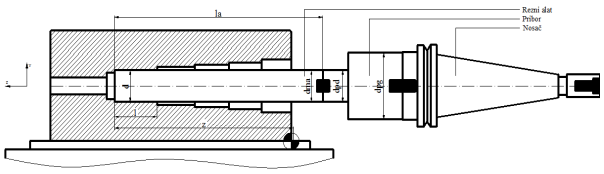

Fig. 2. Set of tools in which the Z coordinate is less than the length of useful tools.

In this case, intelligent systems have the task to choose the accessories that must be compatible with the diameter of the tool diameter to merge dm:

$$dma=dpd \tag{3}$$

and diameters dN:

$$d_N=dpg \tag{4}$$

In this case () tool sets include: tools, accessories with a reduced role and the frame. Such a set must be chosen to satisfy the condition that half of the greatest diameter of the larger set of Y coordinates of the hole or holes to be processed in order not to touch the elements of a toolbox with a desk or accessories:

$$\frac{dpg}{2}<Y \tag{5}$$

and that the total length of a set of minimum:

$$\min\left(l1+lpd+lpg\right) \tag{6}$$

In the second case, Z coordinates from the NC program is more than useful tool length by:

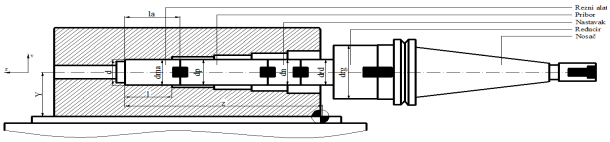

Fig. 3. Set of tools which is a useful tool length is less than Z coordinates.

In this case also an intelligent system based on machine selects carrier who must have all the tool sets. Then, based on the type of tools, processing diameter (d) and the length of time (l), the system selects the tools with diameters equal to the diameter of processing:

$$d=da \tag{7}$$

and then chooses the one whose useful tool length (la) forms a minimal positive difference to the length of treatment (l):

$$d=da$$
$$\min\left[\left(l_{ai}-l\right)>0\right] \tag{8}$$

For this chosen tool holder on the basis of known Z coordinates system checks what is the difference between the Z coordinates of the NC program tool length in the set. The size of these differences should be filled with accessories, socket, reducer. Selected accessories must have a smaller diameter equal to the diameter of the tool for connecting a larger diameter equal to the diameter of the connection of the bracket:

$$d_N=dpg$$
$$dma=dpd \tag{9}$$

If the total length of the set is still not greater than the Z coordinates of NC programs vacancy shall be filled in the set extensions. The goal is to find the continuation of which the total length of the toolbox with the lowest Z coordinate real positive difference:

$$\min\left\{\left[\left(Z-l1\right)-\left(lpd+lpg-l_N\right)\right]>0\right\} \tag{10}$$

Rules of composing sets of tools are presented algorithm:

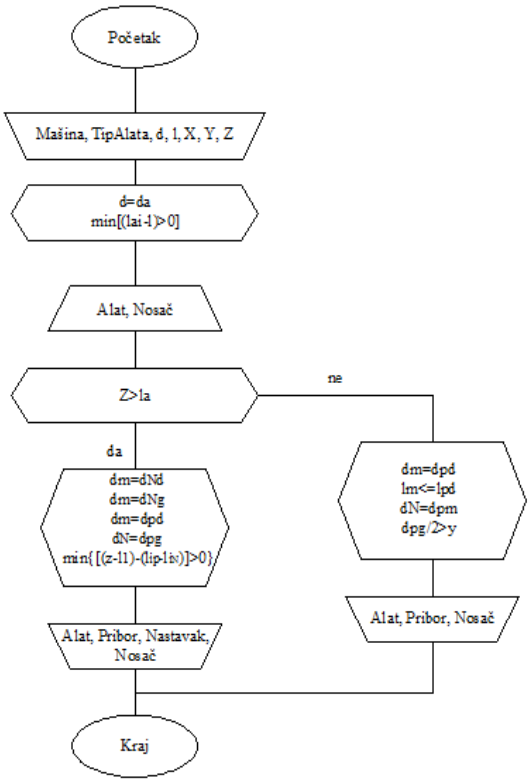

Fig. 4.The algorithm by which the set broadcasting tools.

4. TECHNOLOGICAL DATA BASE OF ELEMENTS TOOLSETS

Database technology data elements of the toolbox consists of nine buildings with attributes like this:

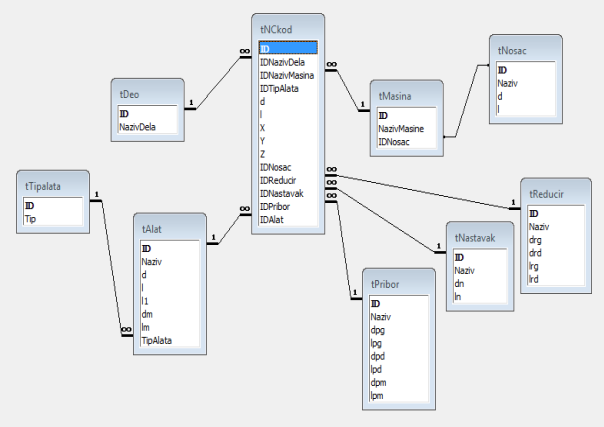

Fig. 5.Objects and attributes database

Objects or tables: TalattPribor, tNastavak, tReducir, tNosač contain information about the elements of the toolbox, tMašina object contains information about the machines that are available, and the facility tDeo contains information about workpiece.

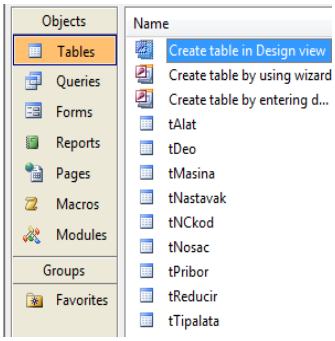

Fig.6.Objects - a table that contains an intelligent database system

Tables: TalattDeo, tMasina, tNosac, tPribor, tReducir, tNCkod, tTipalata make a database based on an intelligent system that composes tool kits. Talat table contains information about tools for drilling, milling and zabušivanje. The last column shows the type of which the tool works. If you have more than three types should only be entered in the table tTipalata other types.

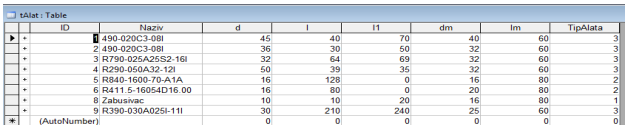

Fig.7.Table Talat with information on tools

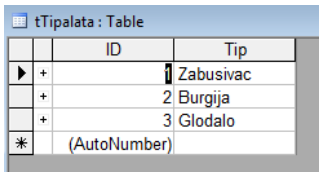

Fig.8.Table tTipalata

Form tNCkodSarz input field value from the NC code (X, Y, Z), the input field label machine, called the workpiece, tool types for fields with a diameter and length of treatment.

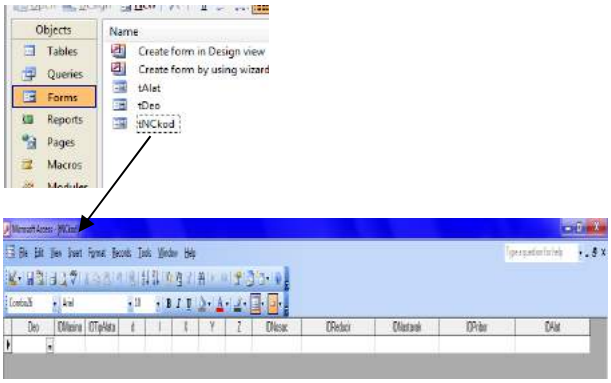

Fig. 9.The form in which the fields are created with the rules that are set broadcasting tools.

After entering the data intelligent system populates the I IDNosač, IDReducir, IDNastavak, IDPribor, IDAlat Rule for composing a set of tools.

5. INTELLIGENT AUTOMATIC SETTING TOOLS

Intelligent system for automatic setting tool includes data fields (machine name, type of tool, the diameter and length of treatment, X, Y, and Z values in the NC code), and the fields that I filled system based on rules that contain the results displayed as separate list of tool kits complete with labels of each element of the toolbox. Rules by which an intelligent system sets the tools, as given algorithm, the entries using VBA code (Visual Basic Cod). In this way, acces-this database is part of an intelligent system based on the entered rule sets the elements.

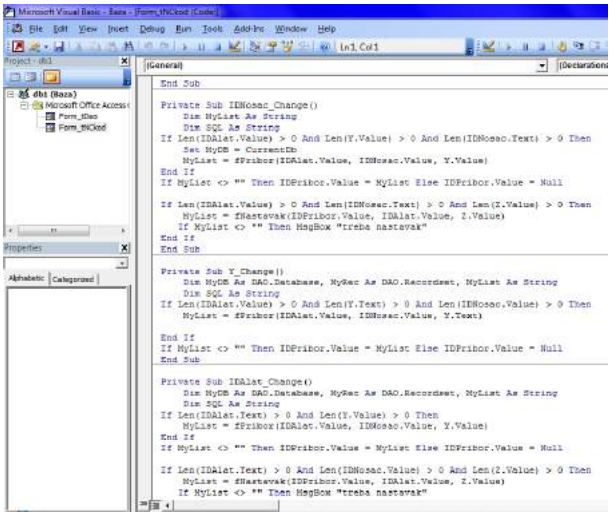

Fig. 10.VBA code by which the written rules settings tool

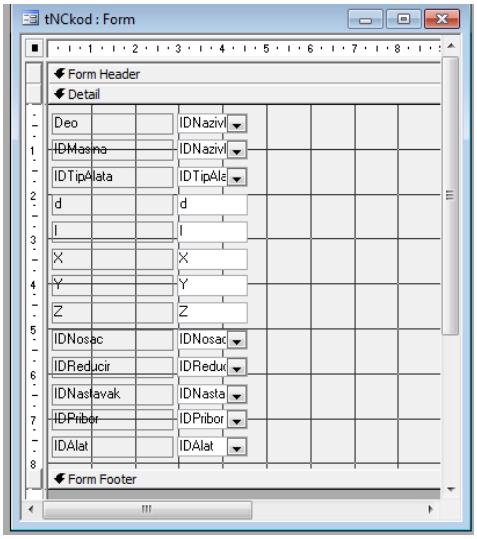

Fig. 11.The form that defines the fields and rules that the user fills and intelligent system.

6. APPLICATION SOFTWARE SYSTEM INDUSTRIAL APPLICATION

For prismatic workpiece, which is produced in large-scale volume production, using intelligent systems is made a list of sets of tools used for the implementation of the NC program.

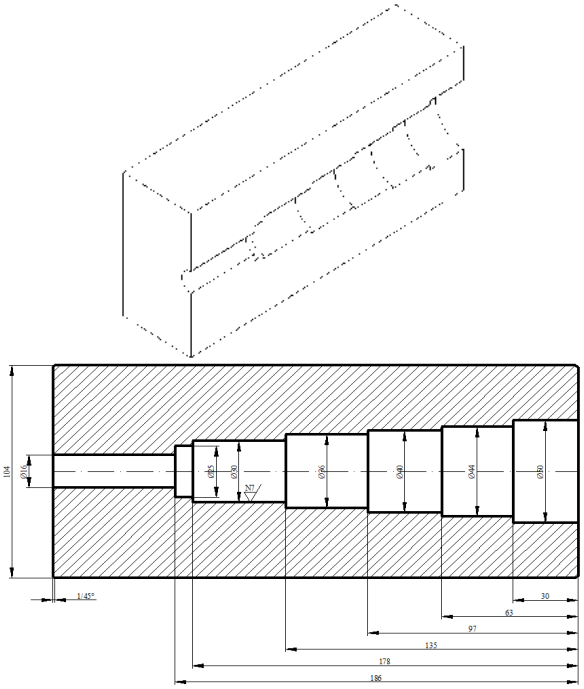

Fig.12.Prismatic workpiece which should make a list of sets of tools.

First, enter the name of the workpiece and the machine where the workpiece being processed. Based on the sequence of technological operations that are executed based on NC code on the selected machine, enter the diameter and length of treatment, type of tools and an X, Y and Z coordinates of the NC program. Based on the type of tool system knows which group of tools to choose the tool diameter and length equal to or greater than entered.

Workpiece is processed on the machine HMC 500 It is a horizontal machining center with three NC controlled axes and rotation of the desk. Treatment consists of 13 technological operations. These data into the fields shown in Figure 13 and for the past five fields I filled an intelligent system.

Fig.13.Data fields.

Based on the data entered the system selects the elements of the toolbox Rule settings.

For example, for the operation 30: rough milling holes Φ30x177 mm. First, the intelligent system enter the name of the workpiece (Part column), choose the machine on which the processing is performed (column IDMasina).

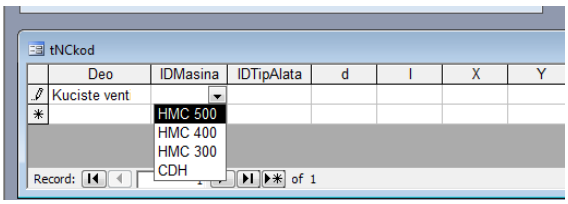

Fig.14.Filling in the fields of intelligent systems

Intelligent system based on tag machines selected carrier (ISO50, ISO40, ISO30...) which must have a set of tools.

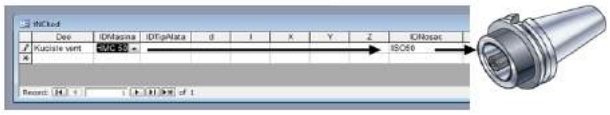

Fig.15.Intelligent choice of carrier systems.

Then enter the data on the type of tool diameter (d) and length (l), respectively, and X, Y, Z values in the NC code of the operation. 40 type of intervention tools and the cutter, turning diameter is 32 l = length of processing 178 mm useful tool length by an intelligent system chooses the la = 210 and Z coordinates of 200 mm. From data intelligent system first determines if it is the case that Z is greater than the value set by and tools to do more accessories and gear. Based on the diameter and the length of time an intelligent system selects the appropriate type of tool with a diameter equal to the diameter di whose cutting length with a minimum length of time a real positive difference. So now that the system selected tools and accessories:

Fig.16.Selection of other elements of the toolbox.

For surgery: fine milling holes Φ32x43, First enter the name of work, name of machine, tool type, diameter and length of treatment, X, Y and Z coordinates of NC code. Length of treatment was 43 mm and Z = 180 mm, so this case Z> l and intelligent system selects: rack, tools, accessories, and continued with the proviso that the total length of the set at the lowest Z coordinate a real positive difference.

Fig.17.Selection of elementsof the toolboxin case Z>l.

The data in this way, we bring to all eight of technological operations and the system makes a list of all the elements of sets of tools with catalog name element sets that are needed in order to perform technological operations workpiece system displays in the form of a report like this:

Petrebni setovi alata

ID	Deo	IDMasina	IDTipAlata	IDNosac	IDReducir	IDNastavak	IDPribor	IDAlat
1	Kuciste ve	HMC500	Zabusivac	ISO50	-	-	C3-391.05-16030	Zabusivac
2	Kuciste ve	HMC500	Burgija	ISO50	-	-	C3-391.05-16030	R840-1600-70-A1A
3	Kuciste ve	HMC500	Glodalo	ISO50	-	-	C6-391.20-06055	R390-020A020-11L
4	Kuciste ve	HMC500	Glodalo	ISO50	-	-	C6-391.05-25030	R390-030A025I-11I
5	Kuciste ve	HMC500	Glodalo	ISO50	-	C3-391.05-16060	C3-391.05-16030	R390D-032C6-11L165
6	Kuciste ve	HMC500	Glodalo	ISO50	-	C3.391.02-32070A	C6-391.05-32030	R350-036C5-11L
7	Kuciste ve	HMC500	Glodalo	ISO50	-	-	C6-391.05-16040	R390-040A32-11L
8	Kuciste ve	HMC500	Glodalo	ISO50	-	-	C6-491.02-040040	R390-044C4-18L080
9	Kuciste ve	HMC500	Glodalo	ISO50	-	-	C6-491.02-50080	R390-050C4-18L060

Fig.18.List elemeanta set of tools for machining prismatic workpieces.

7. CONCLUSION

Intelligent model for composing sets of tools implemented in a relational data base technology and knowledge developed in Microsoft Access - in . The database contains data tables on Alatalo , fixtures , extensions , reducers and mounting tools. It also contains information about the machines on which they can process workpieces , workpiece data and fields in which employee I entered the parameters in the NC program , the type of tools needed for proper operation and choose the machine on which to perform processing . Reduction of the tool settings directly affect the productivity of production. The elements of the intelligent system is chosen to make the tool kits are certainly those elements that are in stock and which best meet the necessary requirements komonovanja geometric elements of the toolbox . This is very important if we take into account that the flexible technology implemented through thousands of different operations in the processing of parts with complex contours.

The selection criteria machines where processing is performed in this paper is discussed . This problem occurs if you have a range of several workpieces at certain shows and more machining centers available and it is necessary to choose those machining centers are the most suitable for the processing of the workpiece . Theory of belief functions and systems of record or evidentiary networks allow the expert knowledge that is needed in the choice of machining center for a given range of workpieces describe the functions of beliefs and engage in an evidence network that will, based on the entered knowledge to select the machining center that is best suited for making [3] .

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