Process planning in developed knowledge database

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Abstract - **This work is a part of the project creating the WEB application necessary for improvement of process planning education and industry application in Internet environment. Here we have elaborated some problems of variants of machining in process plans, selecting tool machines (drilling machines) and manufacturing processes on the basis of the chosen criterions. We have especially emphasized interactions between, machine tools, cutting conditions of tools, part, number of holes, maximal diameter of holes, chucking type, time, and production times through process of machine tools selection.**

Keywords: process planning, knowledge database.

I. INTRODUCTION

In the process production, the most important step is making a process plan. In spite of the importance of process planning in the manufacturing cycle, there is no formal methodology, which can be used, or can help to train personnel for this job. As different process planners have different experience, it is not wonder that for the same product, different process planners will create different processes [7].

II. PROCESS PLANNING - INTUITIVE AND ALGORITHM APPROACH

Process planning is a decision-making process. The most frequently approach is intuitive approach with the all results of this approach. The objective is to devise an economic process plan. Possible parameters to consider are: part geometry, part raw material, part dimensional accuracy, part surface finish, part geometric tolerances, part heat treatment, quantity required, etc. The constraints can be: the part specification and strength, the available machines, the available tools, the available fixtures, chucks, clamping devices, the available technology.

The decisions to make are: select type of metal removal process, select machine for the job, select chucking type and location, select detail operations, select tooling for each operation, select path for each operation, select cutting conditions for each operation.

Wrong sequence of decisions may result in artificial constraints, because if the sequence of decisions were different, the constraints might not have existed.A selected tool imposes constraints on (for example in drilling) : the maximum cutting speed, maximal diameter of holes and tool life. The real constraints should be technological constraints and should be independent of the sequence of decisions. Better way to handle this type of problem is to use an algorithm based on metal-cutting technology. The main problem in constructing the algorithm is to decide which parameter to begin with. Once parameter is set, it limits the others etc. So, this approach aims for use AI methods [2].

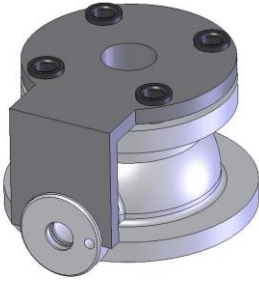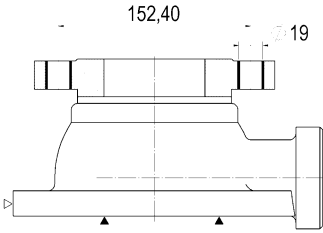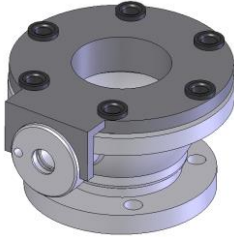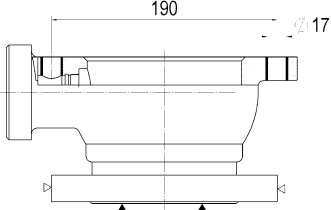## III. PRODUCTION COSTS AND VARIANTS OF MACHINING

Forming material removal is a most comprehensive process. There is great number combination of machine and tools that will produce the part as specified by the drawing. However, cost and machining time will vary substantially according to the selected process. Therefore, it requires a skillful handling of the operating conditions in order to arrive at the economic optimum.

The recomended process is not only a result of the process planner's experience, but also an outcome of the sequence of decision made. Once a decision is made, it imposes constraints on the decisions following it. Such decisions reduce both flexibility and economy of processing and should be avoided. Cost estimation is an essential part in the design, development and use of products. In the development and design of a manufactured product, phases include concept assessment, demonstrations of key features, and detailed design and production. The focus is on products defined by dimensions and tolerances, made from solid materials and, fabricated by some manufacturing process. As more details of the product are specified, the cost estimates should become more accurate. In our work, we would use empirically based method of cost estimating. Our manufacturing cost estimation is based on machining time t_t, preparatory time t_{pzs}/n, auxiliary time t_p (setup, tooling time) and estimated costs of machine tools per hour. Costs production and the quality are strongly influenced by the process plan. Creation and analysis of different process plans can improve process planning by fast and simple calculation of machining time, overall times and costs.

IV.   STEPS OF DEVELOPMENT WEB ORIENTED DATABASE

For the criteria of selection machine tools, for example, drilling, we have chosen: the *way of tightening and processing (drilling shape)*, the *required quality of the treated surface, the dimensions of the workpiece* and the *technological data*, number of holes, maximal diameter of holes including performance (n, s, P) which together form the basis for further elaboration in the following phases of the database development. All selected machine tools have possible intervals of cutting condition values (feeds, cutting speeds, revolutions per minute) [4, 5]. Evaluation in the selection process of the suitable machine tools would be defined by help of different judgement (0,1, 3, 5). Final result in machine tool selection is represented by section of the five sets (source of data) for shapes, way of tightening, number of holes, maximal diameter of holes, and surface rough. Example for that procedure is represented for drilling on Figure 1 [1, 4]. The most frequently case for one operation machining is machining in more phases. Table 1 overview machining variants for selected example and variants of machining: variant 1 (drilling with special drill jig) and variant 2 (drilling by help multispindle headstock). This application displays the descriptive and the pictorial illustration of the processing so that the user decides what the union of the possible shapes best corresponding to own product (Figure 2). As the second (left window side), we get selected hole shape. The outcome of this phase is display of the *resulting groups of the machines* with the rankig values of the criteria (*excellent - 5, good - 3, accepted - 1*). We usually select the maximum sum of the mentioned criteria. It is important to stress that it is possible to choose only one from the given options about the way of tightening [3, 4, 5]. As the second, after input process of cutting date (Figure 2; l_1-length of entrance part of tooling, l_2 – length of exit part of tooling, i-number of passes, , etc) result would be all types of times. As the third, after shape selection for this phase, definition type and number of operation, cutting parameters (left side of window), we would obtain all necessary dates for survey of all operations, phases, and machining, setup times (Figure 2). Size of the batch influences very critically the choice of machine tools and associated equipment. So, we come to the *final choice* of the machine through *economic analysis*, which consists of the synthesis of the price of the machining work (price of machine tool, profit rate during a given period of time, the price of the human resource, indirect expenses), price of material and the price of the tools. Furthermore, geometrical properties of the drilling machine would be next step in the selection process (relation between power of drilling machine and maximal diameter of holes, maximal distance between worpiece and headstock, etc).

TABLE I.
OVERVIEW OF MACHINING VARIANTS

Description of variants	1) *Variant 1* 2) *drilling with special drill jig*	3) *Variant 2* **drilling machine provided with multispindle headstock**
Operation 10 Drilling four drills Ø 19		
Operation 20 Drillng six drills Ø 17		
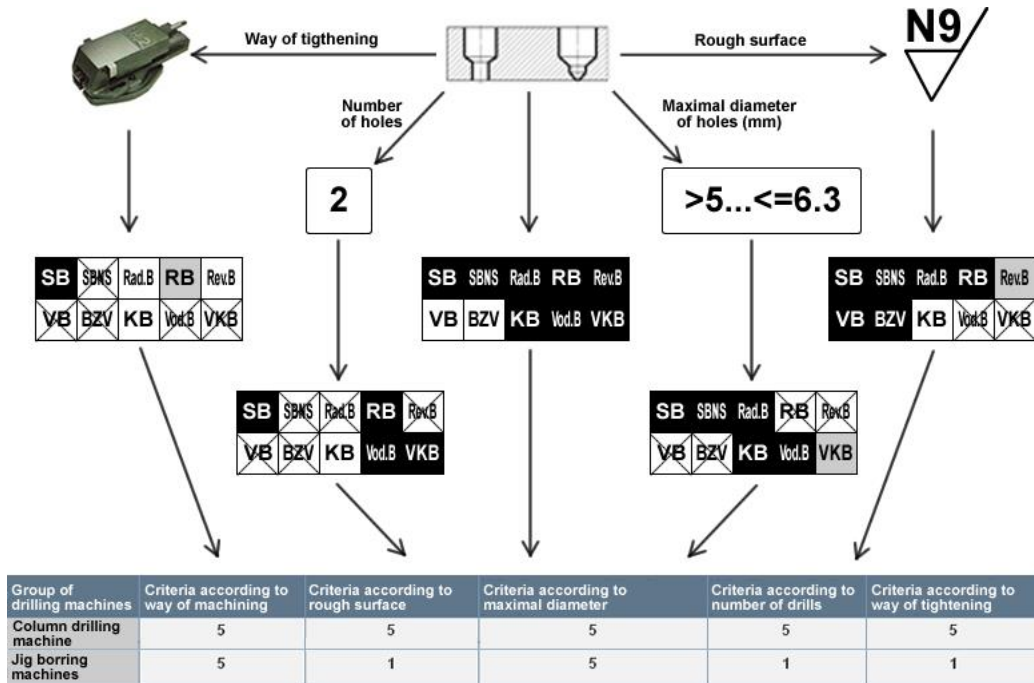
Figure 1. Relations of drilling – selection of drilling machine

Figure 2. Phase 10 of operation named drilling number 30 with cutting parameters and times

V. CASES OF WEB APPLICATION

With applied WEB application for two selected cases (Variant 1 - Figure 3 and Variant 2 - Figure 4), we show some of the application possibilities. We have selected these two cases: two type of drilling process (drilling with special drill jig and drilling provided with multispindle headstock), with two operations in drilling. selection machine tools with different number of solution (Figure 5), therefore they have strong significance. As we can see on Figure 5, for the observed case, the best of the possible process plans is selection drilling with multispindle headstock. Estimated partial times are situated for preparatory time between (variant 1/variant 2) ½ , for auxiliary times between 2.98/3.38 and for machining times 2.42/0.49. As we can see, the most important significant influence is result of use multispindle headstock. The most important part of significance indicate ratio of machining time (variant 1/variant 2). This observed influence is the result of the drilling proceeding (machining times), parallel and overlaying activities/processes of drilling. As we can expected, manufacturing costs can represent be by ratio 15.48/11.64 currencies per unit (pie and histogram description, bottom side of the window, Figure 5). Variant 1 with, with constant influence of tools, tooling, raw materials, etc. is cheaper than variant 2 (in the field of machining) 24.81 %.

CONCLUSION

The considered work presents the development of the variants of the technological process through the criteria of selection, the mechanism of processing, logical approach and database. The accent is placed on the selection of the tool machines (drilling machines) with the use of the ranked criteria of selection (shape of the workpiece, selection of the way of tightetning, number of holes and maximal diameter of holes). With selected drilling machines, we define cutting data, get prepared, auxilary and machining times and costs of the operations processing. Realised comparison for two variants of macining (drilling with special drill jig and drilling provided with multispindle headstock) indicate the most strong significance of machining time. It can be observed much more influnce for machining time than preparatory and auxiliary times. The next phases of the project would lead toward higher level of process planning automatization [2, 7], determination the level of the significance observed variables and determination possible relationship between variables and integration with production management concept [6].
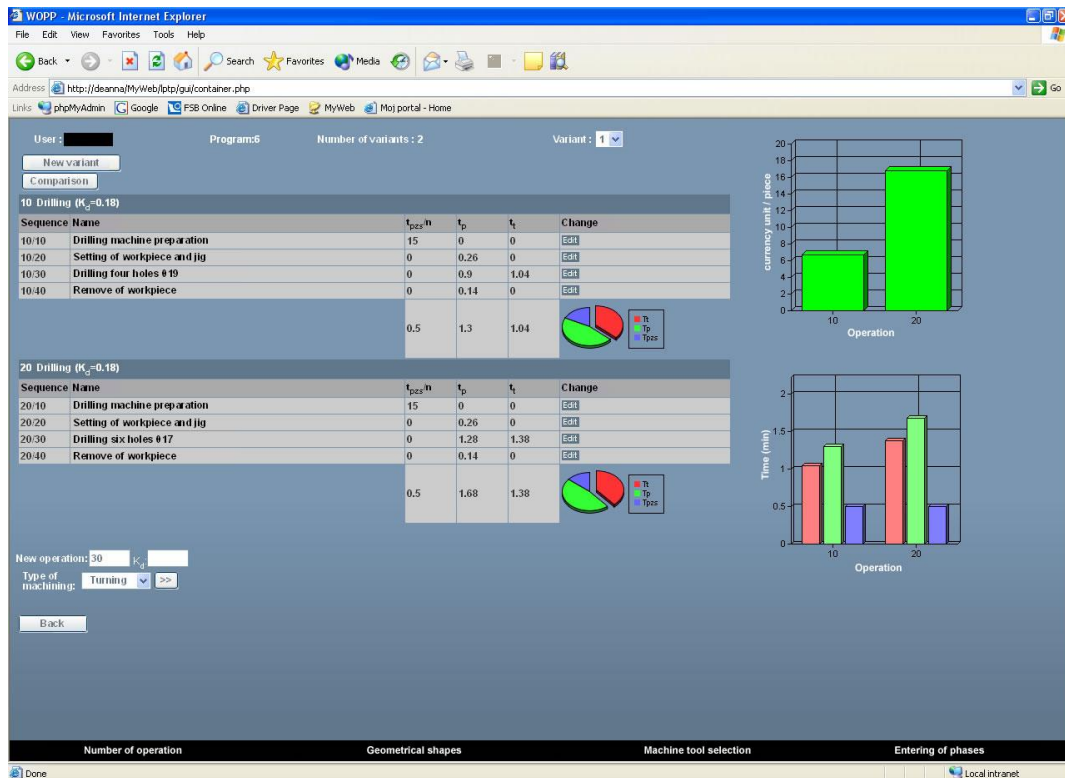
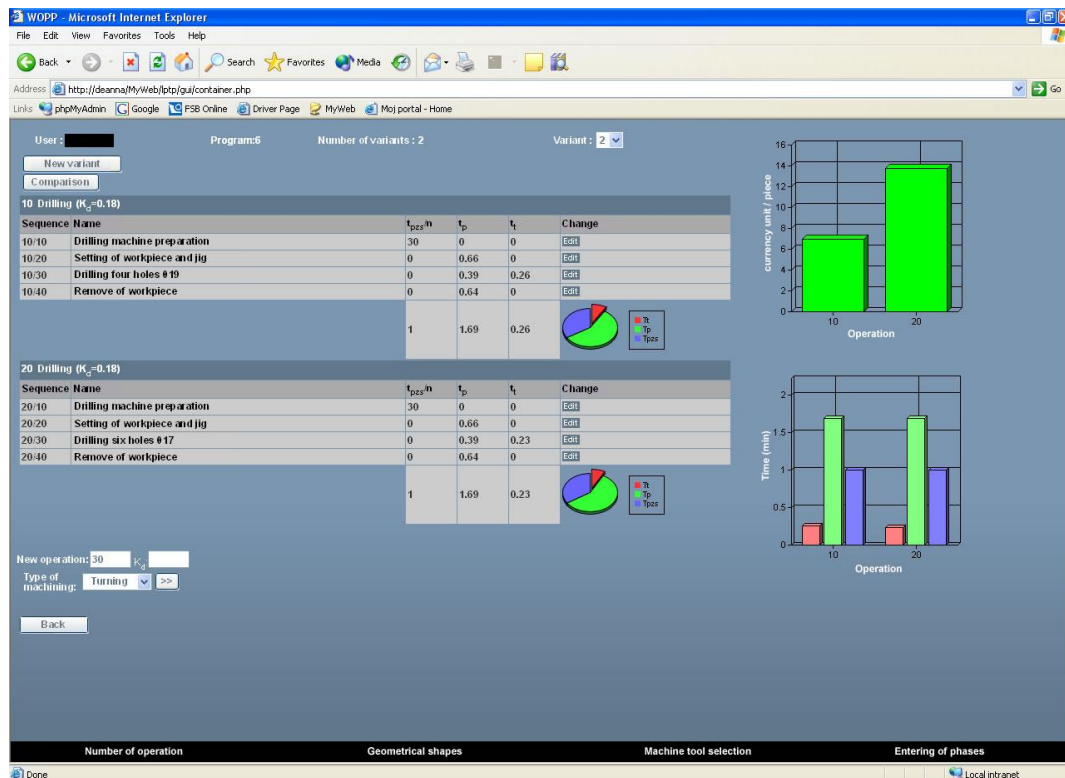**Figure 3.** Variant 1 of drilling operation and times (machining, date)

Figure 4. Variant 2 of drilling operations, costs and times

Figure 5. Result of comparison variants of machining in drilling operation

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