12th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

PRIMARY PROCESS SELECTION AND PROCESS SEQUENCING AS THE PART OF PROCESS PLANNING

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ABSTRACT
The field of our research is defining the main criteria for selection of primary processes and types of operations in production. Selection of primary process is based on nature of material, quantity, form complexity of the part, part size/mass and some other factors. Type and sequence operation are results of influence different factors as product shape, surface roughness and tolerance. In application will be used some aspects of knowledge base. Application will enable users to better understand procedure of selection primary process and sequence operations with possible additional technological gradation support. Self learning and testing of students is included in application. In application are used IT technologies of Visual Basic.NET.
Key words: primary process selection, operations sequencing, process planning

1. INTRODUCTION
Process planning can be defined by a *sequence of activities.* A decision implementation has to be based on intuition , on partially estimated data or accurate data. The experienced process planner usually makes decisions based on comprehensive data without breaking it down to individual parameters. *Good interpretation* of the part drawing includes mainly dimensions and tolerances, geometric tolerances, surface roughness, material type, blank size, number of parts in a batch, etc. *Logical approach* of a process planning, as the very complicated, multilevel and comprehensive approach of generating alternative process plans would be discussed, in this work, through *few topics*: a) selection of primary processes, b) sequencing the operations, etc.
The process of the general model creation would be more complicated by reason of: 1) necessity for quantity the whole' history and sequencing the operations, 2) necessity for continuously precision monitoring (data acquisition), 3) ''rule creation'' (implementation of AI techniques) as the basis in the process decision support. The required quantity will be a major determining factor of process selection. The following factors would be the basis for decision support selection of the manufacturing process as the primary process (for example, forming by deformation) [3, 4]: a) *quantity*, b) *complexity of form*, c) *nature of material*, d) *size of part*, e) *section thickness*, f) *dimensional accuracy*, g) *cost of raw material*, h) *possibility of defects and crap rate*, etc [1].

4. DEVELOPMENT WEB APLICATION E-LAPP
E **–** *learning application for process planning* (E – LAPP) is created to help students to better understand a matter that has been thought on our university. It is conceived in three different modules: *Selection of Primary Process*, *Exercises* and *Solved Examples.* The first module *Selection of Primary Process* enables students to determine an appropriate primary process for manufacturing required part. There are two different methods whereby it is possible to select primary process. The first method is named by technician Gideon Halevi. During developing application for second method there were used ASM Handbook so it is called ASM [4], [1]. *Halevi* method [3] enables students to select a primary process only by knowing material, shape complexity and required quantity (Fig. 1). Based on

input parameters application lists a process sequence. The first listed forming process is the most acceptable, but if there are some reasons why this process cannot be used a student is allowed to choose the next one on the list. Application, also, offers student to infiltrate deeper in chosen process. For example, if student click on '*Forming from Solid by Material Removal*' and press button 'Next' it will open a new window where student can input required data about the part. By pressing a button 'Calculate' application will list required process sequences and part dimensions with tolerances and surface roughness on which required part has to be treated (Fig. 2).
ASM [4] method offers student to choose between two different approaches of primary process selection: *Simple Process Planning Method* and *Advanced Process Planning Method.*
Simple Process Planning Method is conceived in a way that on a base of input parameters such as material, surface roughness, dimensional accuracy, complexity, production rate, production run, relative costs and size (projected area) makes a first selection and lists possible operations. In the next step application asks student to rank offered criteria: cycle time, quality, flexibility, material utilisation and operating costs and demand a last condition in order to make a last selection. The required condition is 'shape'. After the last selection is made, application lists possible solutions in table with adequate explanations. There is also a graph of process acceptability. It is important to mention that graph only suggest student which process is the most acceptable, but it is up to student and his knowledge to decide if that process is really the most acceptable (Fig. 3).
Advanced Process Planning Method [4] offers student a different approach to the problem. The first selection is, here, made only by material. Based on type of material application lists a basic operation for process planning: Forming from Solid by Material Removal, Welding, Forging, Forming from Solid by Deformation and Forming from Liquid (Casting, Moulding). Once a basic operation is chosen, all other calculation is made for that basic operation. First, application offers student to choose adequate shape according to table (Fig. 4). Next, application requires from student to input other necessary parameters and then is made a final, more deeply selection. The results are presented in graph of acceptability. It is important to mention that, same as in Simple Process Planning Method, graph only suggest student which process is the most acceptable, but it is up to student and his knowledge to decide if that process is really the most acceptable. Next, application requires from student to input other necessary parameters and then is made a final, more deeply selection. The results are presented in graph of acceptability.

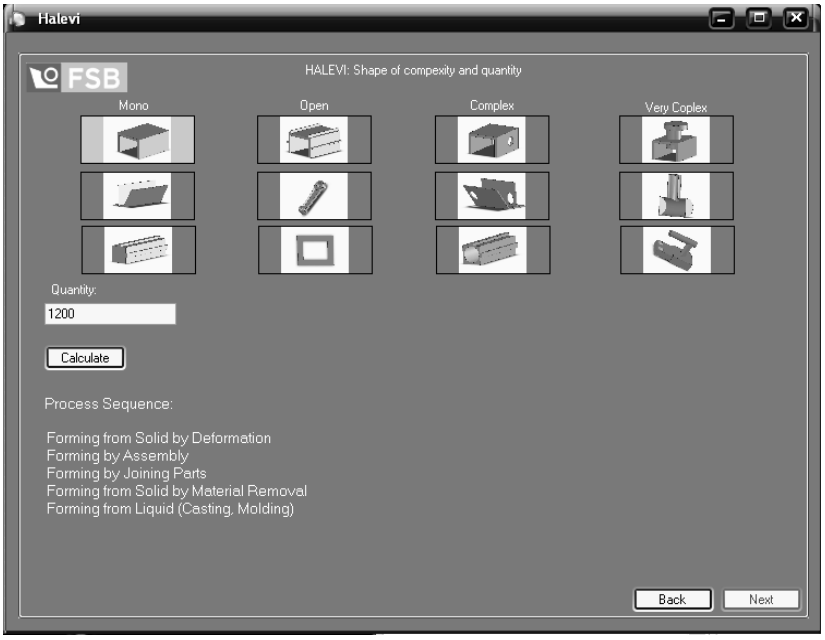

Figure 1. Primary process selection Halevi [3] - based on product shape and product quantity

It is important to mention that, same as in Simple Process Planning Method, graph only suggest student which process is the most acceptable, but it is up to student and his knowledge to decide if

that process is really the most acceptable. The second module is *Exercises*. It is divided into two entireties: *Exercise and Manager*. *Manager* enables tutors to give tasks that can be time limited. Running an option Exercise student can solve the tasks, which has been given by tutor. After every

Figure 2. Process sequence solution as result of shape complexity, basic dimension, tolerance, surface roughness and selection of geometric tolerance

solved task student gets feedback information about how successful he was in the form of won points. For every correctly solved step students get one point.

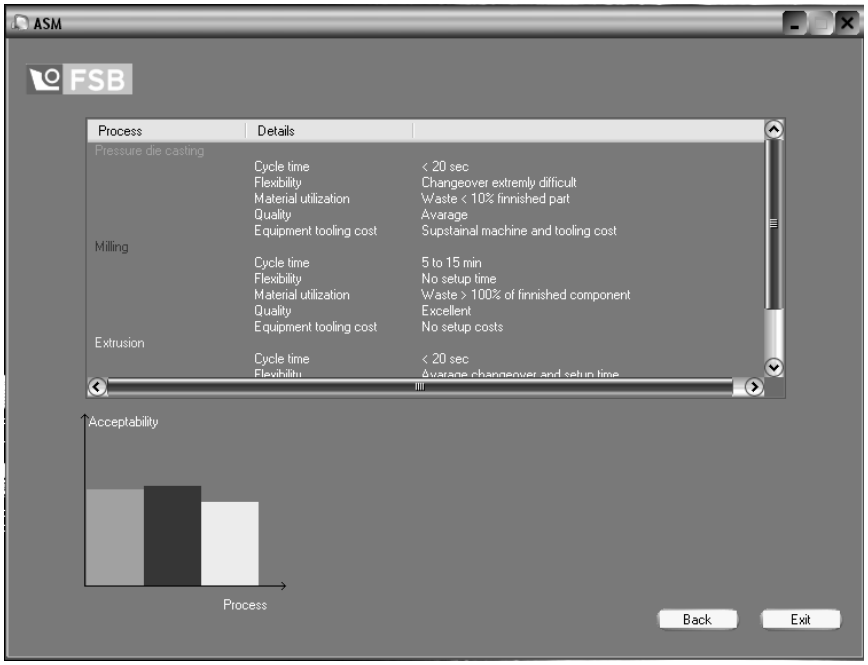

Figure 3. Suggested primary process (ASM) – Simple Process Planning [4]

Solved Examples is the third module in *On line Assessment module*. Here is shown few solved examples for both methods. For each example there is an explanation for every step and there are

given tables which are used in code with marked solutions. The biggest challenge, that we came across while we were developing application, *was how to enable student to rank offered criteria* (ASM method - *Simple Process Planning Method*), because in real manufacturing not every criteria are equaly ranked. So, we agreed to assign them weight. Primary criteria has weight 25, secondary 20, tertiary 15, quaternary 10 and quinary criteria has weight 5. Once criteria are ranked, application

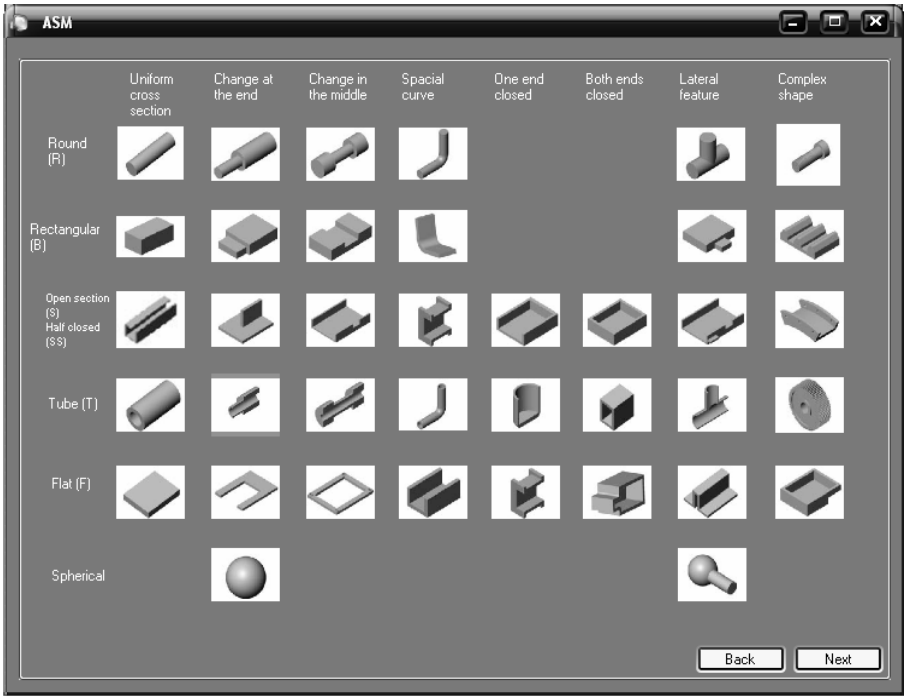

Figure 4. Suggested products shape for selection - Advanced Process Planning Method [4]

multiply each grade with weight of criteria, for obtained processes after final selections, and sum them up. In process of criteria ranking, users observed subjectivity, show on possibility using fuzzy logic in further development of our application. Sums are then compared and process that has the biggest sum has the biggest acceptability in graph (Fig. 3). Sums are then compared and process that has the biggest sum has the biggest acceptability in graph (Fig. 3).

5. CONCLUSION

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