



## PROCESS PLANNING BY WEB APPLICATION - CRITERIA FOR PROCESS IMPROVEMENT

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### ABSTRACT

The field of our research is creating learning materials for defining the main criteria for selection of primary processes and types of operations in production. Selection of primary process is based on material nature, quantity, form complexity, part size and some other factors. Type and sequence of operation are results of influence different factors as product shape, surface roughness and tolerance. The application enables users to fully understand the procedure of selecting primary process and sequence operations through step by step tutorials. One of the modules gives user the ability to estimate primary processes and types of operations for any problem of this type. Another module enables users to create, share, and solve custom made tasks. The base programming language of E-Lapp application is Visual Basic.Net, tools used to create e-learning materials are Microsoft PowerPoint 2007 and iSpring Presenter (Adobe Flash).

**Keywords:** e-learning, selection of primary processes, sequence of operation

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### 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. As different process planners have different experience. So, it is no wonder that for the same part, different process planners will design different processes. The experienced process planner usually makes decisions based on comprehensive data without breaking it down to individual parameters. There is no time to analyse the problem. 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 choice of processes should be made with precision, economic and technological factors. The following factors would be the basis for decision support selection of the manufacturing process as the primary process and process sequence [1]: a) quantity, b) complexity of form, c) nature of material, d) size of part, e) section thickness, f) dimensional and geometrical accuracy, g) surface roughness, h) cost of raw material, i) possibility of defects and scrap rate, etc [2].

The objective of our work and research was to develop web application for the fast and simple primary process selection and sequence operations. These criteria are the most important for processes improvement and costs reduction in production.

### 2. NEW CHALLENGES IN EDUCATION FOR MANUFACTURING

It is observed that high education does not completely reflect real needs of the industry that faces problems of integrative nature across the traditional disciplines, such as: a) working globally in a multicultural environment, b) working in interdisciplinary, multi-skill teams, c) sharing of work tasks on a global level, d) working with digital tools for communication, e) working in a virtual environment [3].

Therefore special efforts would be done to integration technical, humanistic field (sociology, economy, history, culture, psychology, etc.), skills of IT and web technologies.

As through a long time it is observed decreased interest for studying technical and natural sciences (especially in developed countries – the northeast part of Europe), serious efforts were done in process of questionnaire development, data collecting, analysis and development of new

curriculums with great influence of interest, motivation, learning [4], multimedia, Internet, IT and web technologies (Projects PISA, ROSE), [5]. It is accepted new approach to learning, assessment, personal communications between users and tutor, importance of psychological relationship between user and tutor (“blindly”), etc. Choice of material and design solution cannot be done on purely technical and economical criteria, but must also take recycling, pollution and disassembly and reuse concerns into account.

### 3. E-LAPP APPLICATION DESCRIPTION

E – learning application for process planning (E – LAPP) [6] 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 e-learning as it is shown on flowchart below (Fig. 1.).

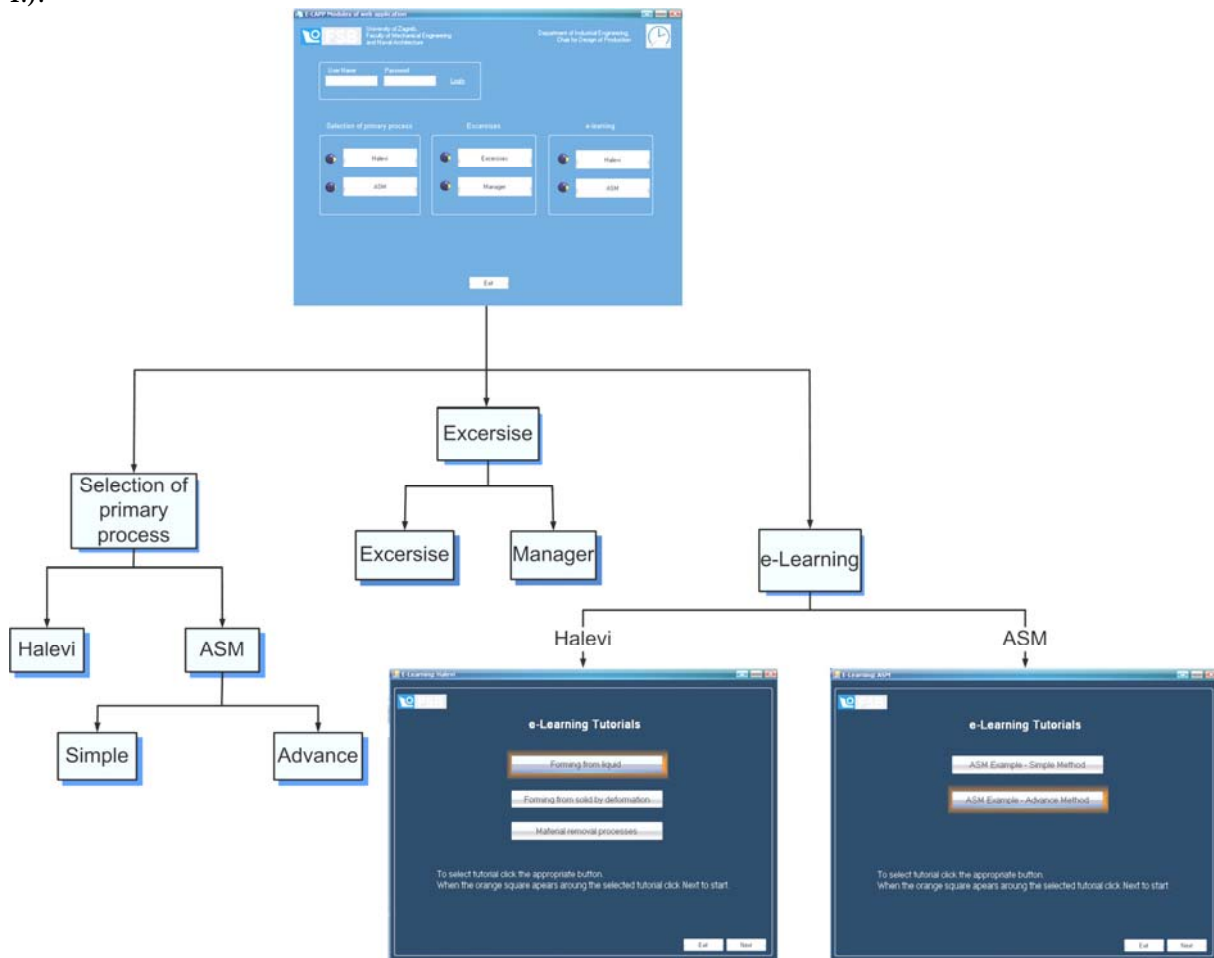


Fig. 1. E-LAPP flowchart [5]

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 development of application for second method there were used ASM Handbooks [7] so it is called ASM (<http://ptp.fsb.hr>).

*Halevi* method enables students to select a primary process only by knowing material, shape complexity and required quantity. 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 e-LAPP [6], also, offers student to infiltrate deeper in chosen process. For example, if student clicks on ‘*Forming from Solid by Material Removal*’ and presses button ‘Next’ a new window will open 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.

ASM 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 utilization 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. 2.).

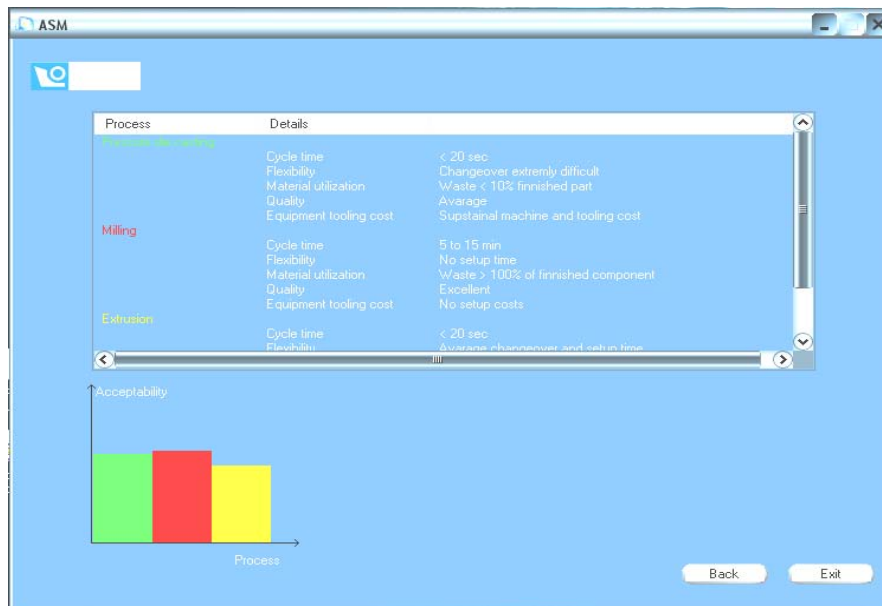


Fig. 2. Suggested primary process (ASM) – Simple Process Planning

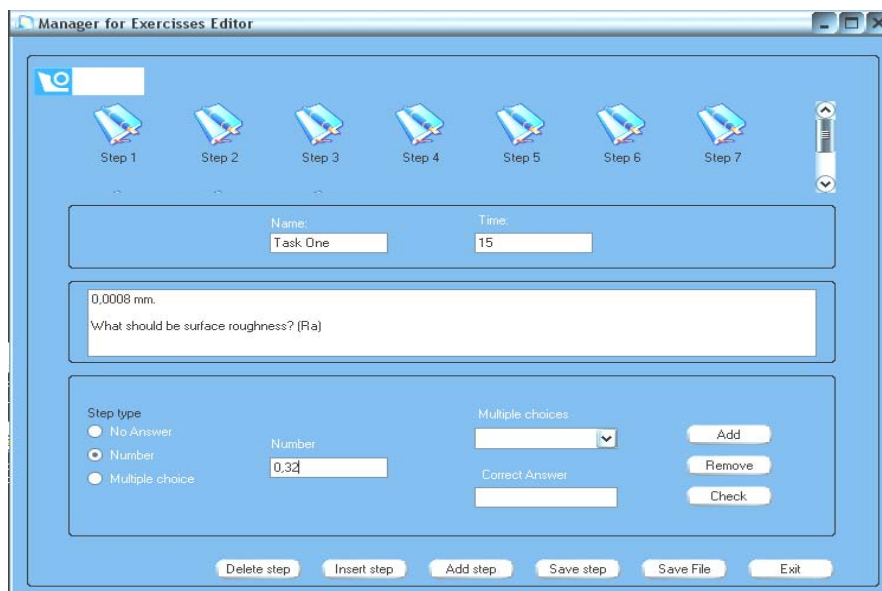


Fig. 3. Example of Manager Module work

*Advanced Process Planning Method* 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, Molding). Once a basic operation is chosen, all other calculations are made for that basic operation. First, application offers student to choose adequate shape according to table.

Next, application requires student to input other necessary parameters and then is made a final, deeper 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.

The second module is *Exercises*. It is divided into two entireties: *Exercise* and *Manager*. *Manager* (Fig. 3.) enables tutors and students to create tasks that can be time limited. When tutor creates a task, he uploads it on internet on page created for E-LAPP [6]. Task can be created as an exercise. After the tutor uploads the task on web page students can download it and input it in application. Running an option *Exercise* student can solve the task, which has been given by tutor or another student. After every 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. When the application is connected to the internet and student is logged on, application saves results that can be later reviewed by both student and tutor. (Self Learning as Formative learning)

The third module is *e-learning*. It enables students to understand a core of the task problem, because the aim of this application is not to teach students how to input values into the software and get a solution. Application is created, in the first place, to help students to better understand problems that occur in production almost every day.

Module is divided into two entireties: *Halevi* and *ASM*. [1, 7] Every entirety has few solved examples that show background of the task. The examples are created as short tutorials (Fig. 4.) which present a task solution step by step with all necessary explanations and tables used in a process of decision making. Every step is no longer than a minute, so that student can stay focused on the subject if he misses something when he plays the step again. There is high possibility of students losing interest for this type of learning if the e-learning tutorials are too long, especially if they have to watch it several times. During the tutorial development special attention was paid on duration and dynamics. Students are able to stop, pause, rewind and fast forward the tutorial so that they can scrutinize every aspect of tutorial.

**Example 1**

A quantity of 2 500 complex parts made of bronze, weight 4 kg, minimum section thickness 1.2 mm, minimum dimension tolerance  $\pm 0.10$  mm, and minimum surface finish of  $2 \mu\text{m } R_a$  is ordered. Recommend a process to manufacture this part and prepare a quotation.

Selecting the molding method

|                                 | Sand             | Permanent           | Die                 | Investment                       |
|---------------------------------|------------------|---------------------|---------------------|----------------------------------|
| Material                        | All              | Almost all          | Light materials     | Al, Cu, Zn, Mg, Sn and Pb alloys |
| Size or weight                  | Any size         | Limited up to 25 kg | Limited up to 10 kg | Limited up to 40 kg              |
| Section thickness               | 3 - 5 mm minimum | 2.5 mm minimum      | 0.6 mm minimum      | 0.75 mm minimum                  |
| Accuracy                        | $\pm 1.5$ mm     | $\pm 0.4$ mm        | $\pm 0.05$ mm       | $\pm 0.12$ mm                    |
| Surface Ra finish $\mu\text{m}$ | 6.25 - 25        | 2.5 - 6.25          | 1 - 2.5             | 0.25 - 2                         |
| Tool costs                      | Low              | Medium              | High                | High                             |
| Tool change                     | low              | medium              | high                | high                             |
| Setup time                      | 6:20 - 30        | 3:30 - 6:30         | 1:15 - 3            | 0:30 - 1                         |

Permanent casting can provide the accuracy, but **not the surface finish and section thickness.**

Fig. 4. E-learning tutorial

#### 4. SEQUENCE OPERATIONS

Fundamental idea for sequencing operations [6] (Fig. 5, 6) is shape recognition, determination between dimensional & geometrical tolerance with requested process roughness, calculation tolerance and cutting addition and final sequence operation (Fig. 6).

To assist in making this decision, the basic material removal processes are classified according to their capability to machine a group of parts to a required shape (round symmetrical, prismatic, superimposed – holes and threads) shapes. The final selection of the basic processes depends on the accuracy of the part. Concerning selection of machining technology the most important parameter is the surface roughness required, followed by the geometrical and dimensional tolerances.

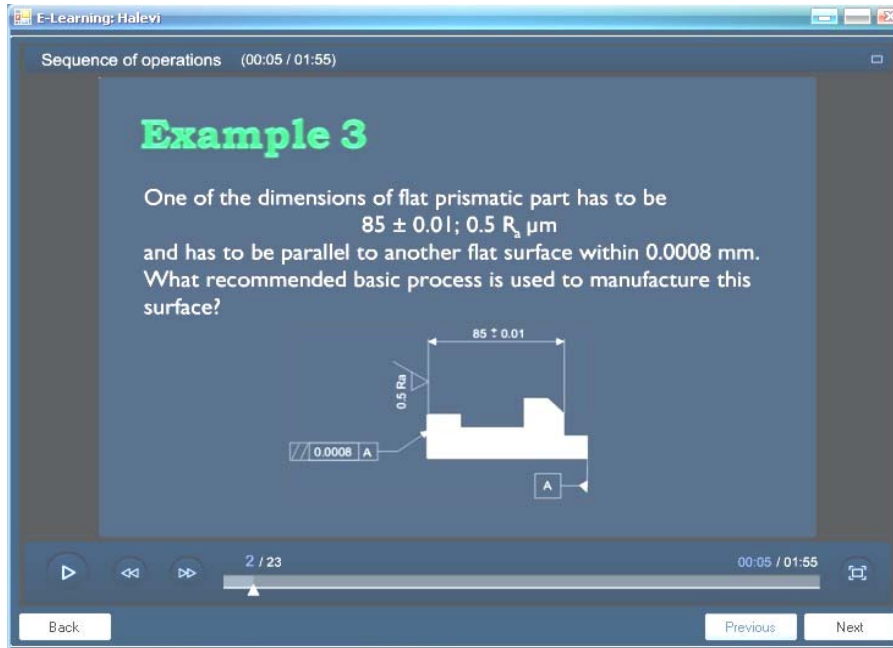


Fig.5 Example of development sequence operations

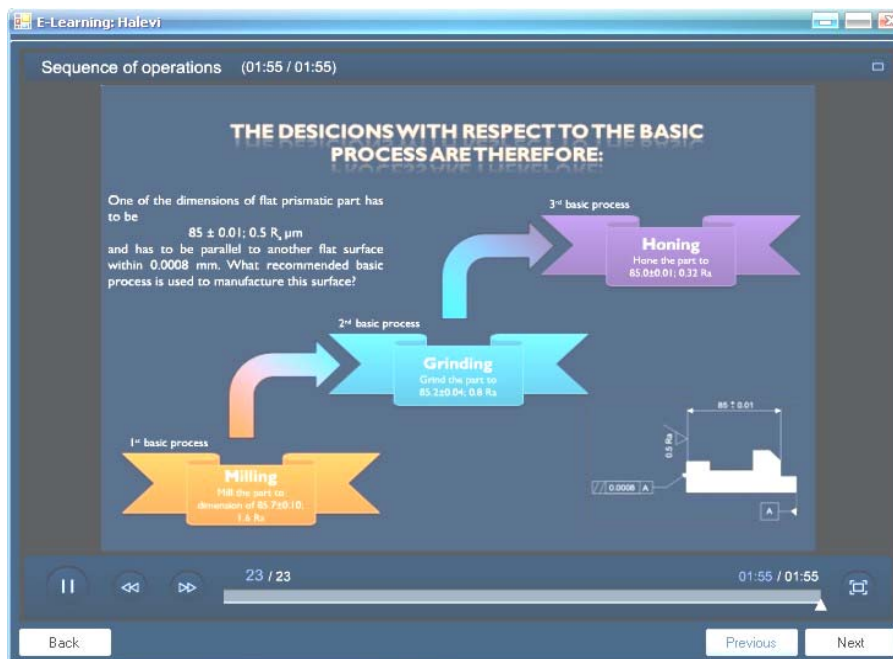


Fig.6 Final solution of sequencing operations

## 5. CONCLUSION

This is a time of modern technology that changes rapidly. We believe that education has to keep up, so we decided to offer students from our university one modern aspect of learning. Writing tests and homework on computers are becoming an everyday practice, because it saves time to professors, results are available immediately and professor's prejudice is excluded. Also, e-learning animated tutorials are quite hit these days because people are mostly visible beings, so it is easier for us to learn something and understand it if it is vividly presented.

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