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SOFTWARE SOLUTION OF REENGINEERING MODEL OF TECHNOLOGICAL PROCESSES OF SMALL ENTERPRISES

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Abstract: *Constantly expanding market demands in terms of product range and product quality, price reduction and delivery times, are the basic requirements of small enterprises. How small business can respond to these requirements, or how fast, at a lower price and make the product quality, i.e. reduce the time and cost of processing, the answer is requested in the application of information technology and reengineering. The paper presents a software solution of reengineering model of technological process of small enterprises, and justification for its implementation. This solution enables reviewing the goals, minimizing time and cost of processing and maximizing productivity.*

Key words*: software solution, reengineering model, small enterprises*

1. INTRODUCTORY REWIEW

In domestic written and electronic media, at professional meetings on which different topics regarding solving issues of small enterprises survival in uncertain business environment are being discussed, reviews could often be read or heard, upon which the conclusion is drawn that small enterprises usually do not have their own development, and even if they do, they invest very little in it. That is resulting in the inability to adequately adapt to the environment demands, that is to say, the enterprises are unable to, on existing method of quality, quickly and efficiently respond those demands. In the enterprise the problems are created, related to both new product and technologies development and therefore technological processes as well, and also for redesign or restyling of already existing products and improvement or reengineering of already implemented technologies and technological processes. One way to solve the problem of development and reengineering of not only technological processes of small enterprises is in establishing innovation center, or knowledge incubator. The function and the main task of the center or incubator is solving problems in development and reengineering faced by small enterprises, as well as development of their own businesses and transfer of contemporary technologies, methods and procedures and adapting to domestic conditions, Fig.1. In small enterprises, as well as business systems, there are more or less different problems. They may be related to product design (design, modeling, engineering analysis, visualization etc.), procurement and supply, marketing, finance, informational systems, implementation of quality systems, design of technological processes, technology, etc. Many generated problems small enterprises solve by their own resources. However, huge number of problems, especially problems related to new product and technology development (and therefore the technological processes), remains unsolved what directly affects the competitiveness of small enterprises. Unsolved problems (●), from systematic point of view, seek for solution outside the space borders of small enterprises (●) and forming one new systematic space (●), space problem.

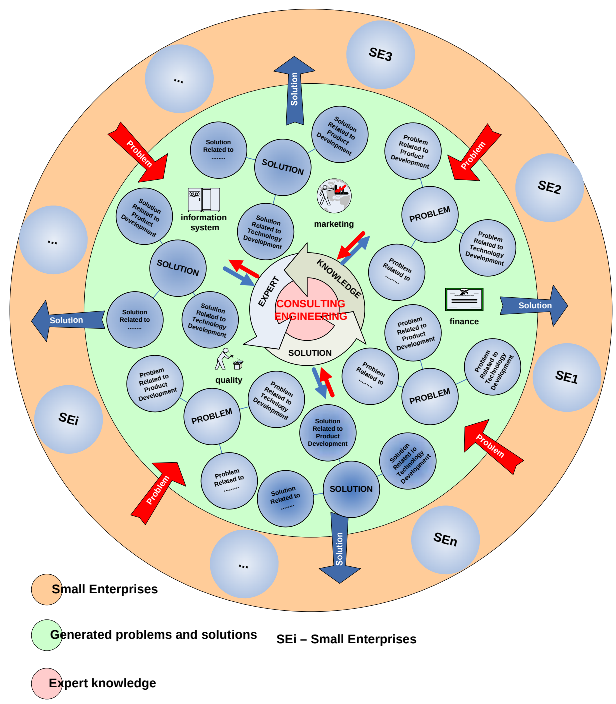

Fig.1. Space model architecture of generated problems and solutions

Part of system space problem, are also problems of improving the already developed products or reengineering of technological processes. For the solutions of these problems, systematic and expert knowledge are required (●) which are concentrated in Scientific-research Institutions. In the centers and

incubators of scientific institutions, along with experts from different fields, the solutions are generated (●) which fill in the space solution (●). From the space generated solutions, small enterprises use those solutions for their already generated problems.
Small enterprises in connection with research institutions (innovation centers (IC) and knowledge incubators (KI)) should find the way for profit implementation through results implementation of scientific and development researches, should find the way to solve not only problems of development and reengineering of technological processes, but also development problem of new product, improvement of existing one, they should find the way to solve the problem of professional training, etc. Basic advantage of this solution is not to solve the same problem in several places that small enterprises do not invest in development that is extremely expensive, to establish expert base for different fields in one place, and to take advantages of innovation centers and knowledge incubators.
A methodology for reengineering of technological processes has been developed for proposed solution [1]. Software "IM2RTP" has been developed for methodology (Informational development model and Reengineering of technological processes) with basic architecture and logical data model which are represented in work [2].

2. DESCRIPTION OF SOFTWARE SOLUTION

Three parts are combined through the module. OLTP (*On-Line Transaction Processing*) part of the software provides transactional data processing regarding technological data base, through function of input, alteration and review. GUI (*Graphic User Interface*) part of the software provides visual reengineering, designing variants of technological procedures and "piggybacking". OLAP (*On-Line Analytical Processing*) part of the software provides analytical processing of dimensional data. After starting software, the first (initial) form is shown (Fig.2.)

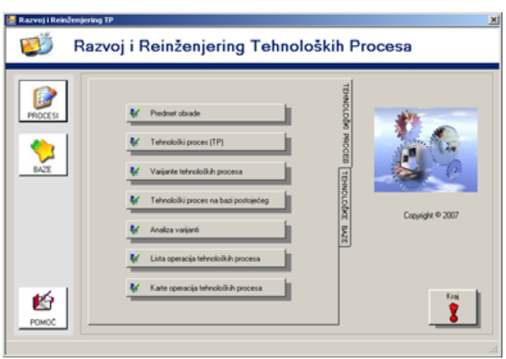

Fig.2 Initial software form

in which the icons are noticed:


for starting module to work with technological data base,


for starting module to work with technological procedures,


for starting assistance, and text box with basic information about software,


for competition of software work.

The same icon function as „**PROCESS**" and „**BASES**" also have cards „**TECHNOLOGICAL PROCESS** " and „**TECHNOLOGICAL BASES**".By choosing card „**TECHNOLOGICAL BASES**" the form in the shape of control board is displayed (Fig.3.). Cutting tools, measuring tools, tool machines, accessories, SHP, auxiliary time, preparatory finish time, and additional time are possible choices of this navigational form.

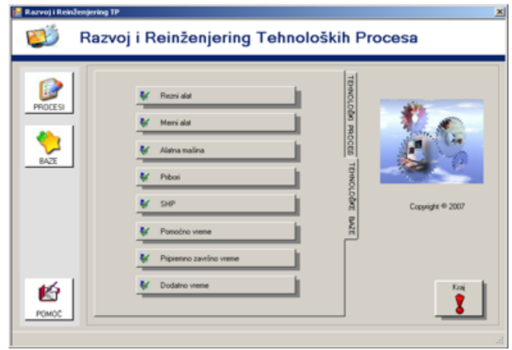

*Fig.3. Navigational form of „**TECHNOLOGICAL BASE**"*

This navigational form at the same time reflects the structure of technological data base. By choosing options "**Cutting tools**", the new form of MDI structure "**Cutting tools**" is obtained (Fig.4.). This is at the same time the mask for the input of basic data for cutting tools. Drop-down list "**Type of processing**" defines the type of tools. Other data that could be entered by using this mask are: Tolls marking, Standard, Technological marking, Name of tool, Tools name, Price (dinar and EUR), Number of sharpening, or number of cutting edges, Sharpening time if the tool is being sharpened, Time to change tools, Tools endurance, Personal income of workers, Marking of material and tool coating, Tools manufacturer marking.
Keys **Add**, **Modify**, **Delete** start the functions for adding new tool, editing and deleting existing tool. The delete function performs also the cascade deleting of other data concerning geometry of chosen tool. Key **Other** calls up a new form (Fig.5.) for defining geometry of chosen tool.

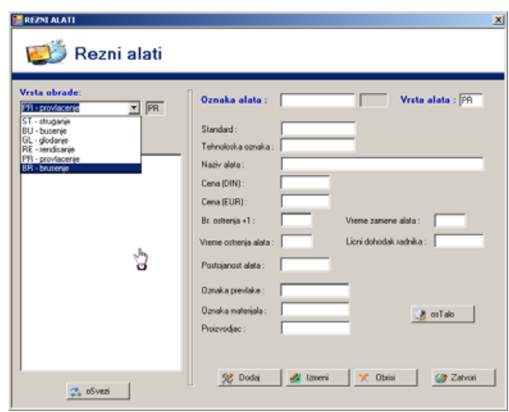

*Fig.4.Form appearance of „**Cutting tools**"*

For the type of milling processing, the data concerning geometry are: nominal diameter, Length of milling cutter, Breast angle, Back angle, Angle of the spiral, Cone angle, Width of milling cutter, Length of cutting part of milling cutter, Number of milling cutter teeth, and Image or sketch of milling cutter.

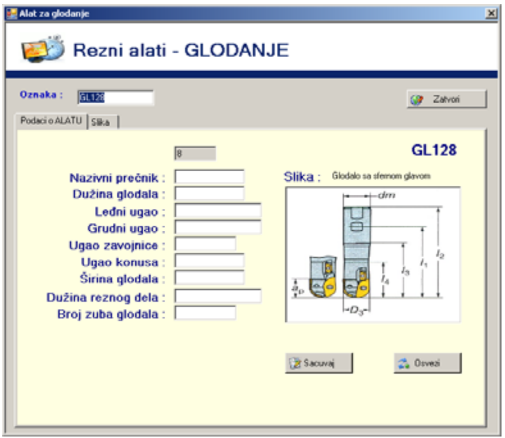

*Fig.5. Form appearance of „**Cutting tools - MILLING**“*

According to the same principle, the forms for other type of processing have been done (scraping, drilling, grinding, broaching, and planing). The tool geometry for chosen type of processing is defined on each form.

The remaining sections related to OLAP,GUI and the remaining part of OLTP, are chosen by using navigational form „**TECHNOLOGICAL PROCESS**“. This navigational form includes following options: “**The object of processing**” (OLTP); „**Technological process**“ (OLTP); „**Variations of technological process**“ (GUI); „**Technological process based on existing one**“(GUI) and ”**Variations analysis**“ (OLAP). Options „**Operation list of technological process**“ and „**Operations cards of technological process**” form technological documentation. The form “**Technological process**” (Fig.6.) is the first in a row of MDI forms by which the technological procedure is defined. From the drop-down list “**Technological process”,** that includes data: Marking_TP, Variation_TP, Type_variation_TP, Marking_PO, the technological procedure that could be changed is being chosen. For new technological procedure in the field “**MARKING**”, the new marking of TP is entered and in the field “**VARIATION**” the variant of TP is entered. Pressing the key “**NEW**” the new form to input other data, related to TP Description of technological procedure and the date of forming technological procedure, is being opened.

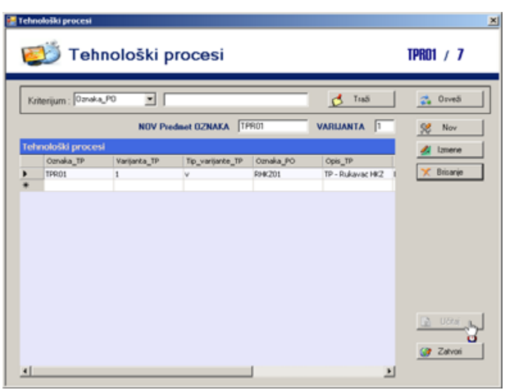

*Fig.6. Appearance of form „**Technological process**“*

Using the key „**Operation**“ the new form „**Operation**“ is opened (Fig.7.) by which operations of technological procedure is defined. The data being inputted are Marking and Operation name, and the quantity of SHP, if used in performing operation. The overlapping coefficient of the main time has the value 1 for orderly performance of the operations, with parallel and combined its value is less than 1. With click on the key “Image” the new form is opened by which the joining of image/sketch of operation is being performed (processing scheme). The image of the operation is a target model of technological model, and can be downloaded from CAD base of technological models.

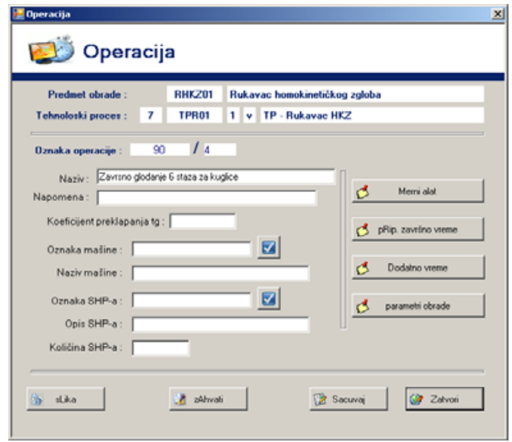

*Fig.7. Appearance of form ”**Operation**”*

The form is showed in Fig.8 obtained by click on the key „**Processing parameters**“ of form “**Operation**”. This form is used to display and input the data necessary for calculation of processing expenses. The data defined in technological data bases will be displayed and the remaining data are inputted through this form.

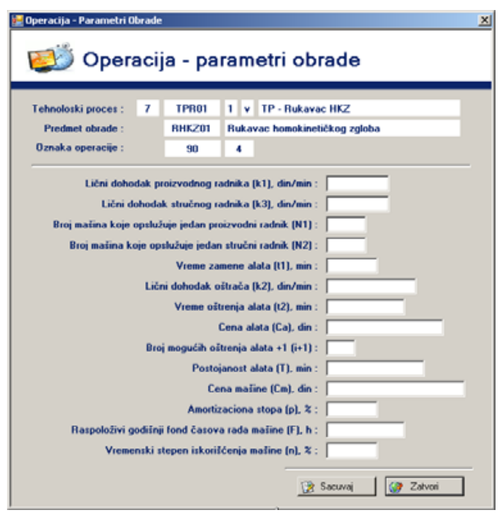

Fig.8.Form appearance for entering parameter values necessary for calculation of processing costs

The key „**Procedures**“ of form „**Operation**“ opens new form „**Procedures**“ Fig.9. The data entered are **Process marking,** and in the drop-down list **Type of processing** is defined as type of processing as well as **Process description**. By checking field , all tools are shown for chosen type of processing. Appropriate tool is chosen from drop-down list by checking. The main processing time and auxiliary time are defined with forms of clicking on the keys , .

Fig.9. The appearance of form for defining operation

On Fig.10. is shown the form for defining of processing parameters and calculation of the main processing time. The appearance of forms is depending on the type of treatment. In function **Save** (Sacuvaj) is built a mathematical model for calculating the main processing time depending on the type of treatment. In this case this function in addition to the role of storing data in the database has an function calculation.

Fig.10. The appearance of form for defining processing parameters

Part of the software with GUI interface and visual modeling is realized through the option **"Versions of technological processes"** and **"The technological process based on existing"**, Fig.11.

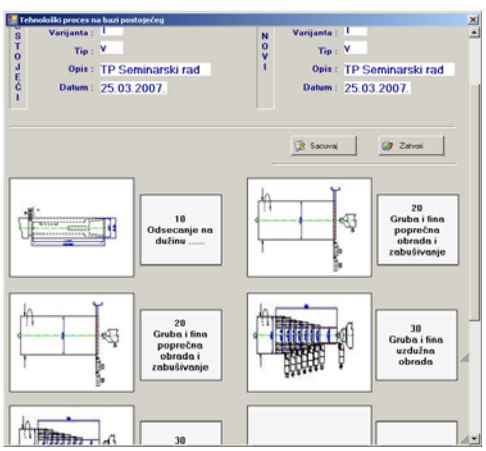

Fig.11. The appearance of form " ***The technological process based on existing*** *"*

OLAP software component is implemented through the **"Analysis of variations"**. Choice of production process for the three variants of its graphic display three-dimensional data as follows: During the processing, production and processing costs, Fig.12. In this way he realized the concept of multidimensional databases.

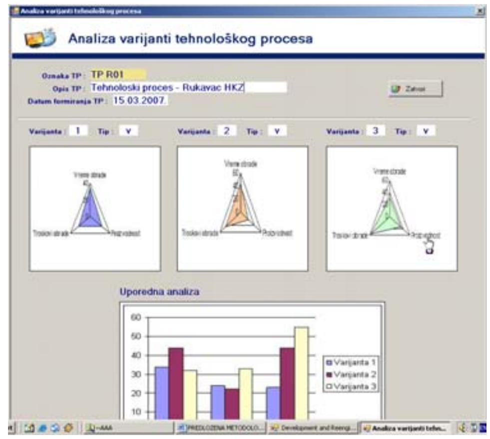

Fig.12. Output from the multidimensional database technology

Technological documentation, which is the carrier of technological information, is formed by using the **"List of the operation of technological processes"** and **"Maps of the operation of technological processes"**.

3. EFFECTS OF APPLICATION OF THIS SOFTVARE SOLUTION

Showing a software solution that supports the design and engineering and reengineering of the technological process has four primary objectives:
- reduction of manual work in the business of making the technological process that causes stress to the production engineers and experienced designers of technological processes,
- improvement / optimization of existing technological processes through the use of available information on the machines, tools, accessories, workability, etc.
- systematization of the best observed processes for families of components within an enterprise, thus ensuring the transfer of knowledge and experience of experienced designers,
- systematization of production time and costs as a precondition for the techno-economic analysis.

Advantages of the system, which allows the design of new and re-engineering of existing technological processes, are:
- reduction of design time,
- lower cost of designing and manufacturing,
- enables the design of technological processes of the same validity, quality,
- development of rational technological processes,
- increased productivity and so on.

Measurement of results is based on changes in values of those parameters, which are marked as the most influential for a given technological process, based on analysis of Ishikawa diagram, Fig.13.. On the basis of the projected software by reviewing the goals (to minimize time and cost of processing and maximizing productivity), using feedback and the appropriate models at the level of treatment and operation.

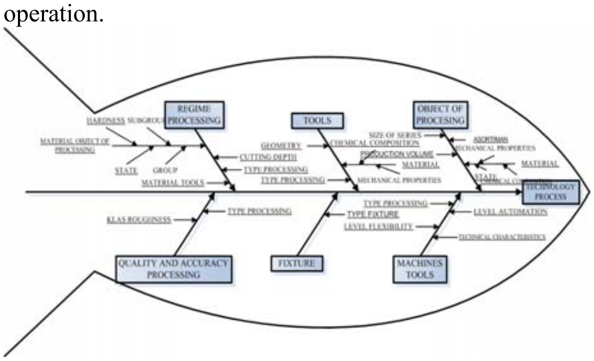

Fig.13. Ishikawa's diagram of technological process

In doing so, to change the corresponding parameter can be without any effect, with limited effect and with significant effect and the effect, which will provide a significant advantage over the other variants. Cost Benefit Analysis (analysis of cost-benefit) (C / B analysis) or cost-effectiveness analysis is an economic method of assessment of relative value changes to existing or proposed projects or situations, or to the methods of economic analysis that compares and evaluate the merits and shortcomings of a Project cost analysis (cost) and benefits (benefit). In this case, Cost-benefit analysis is to estimate the effect of using this model (re) engineering of the technological processes of small businesses that use software solutions "IM2RTP". On the one hand with the advantages (benefits) of the proposed model, and the other analyzes the costs and any potential negative consequences (cost) in order to assess the rationality of using this model. Affirmation of the need to prove that the benefits are large enough to justify the cost. In order to do C / B analysis using this software, defined as factors in the qualitative and quantitative terms should reflect certain changes (Table 1). That the final grade unified measurable and immeasurable factors are introduced weights or weight or importance factor (Z), (which is the sum of all the factors 1) which is multiplied by the subjective assessment (SA) which ranges from 1 to 5 Subjective value is defined for the case before and after application software and the technological complexity of different parts.

***Table 1** Ratings factor cost of application software "IM2RTP"*

Factors	Importance of Factors (Z)	Part/The technological cemplexity of part											
		A 0.7				B 0.8				C 0.9			
		Before		After		Before		After		Before		After	
		SA	SA *Z	SA	SA *Z	SO	SA *Z	SA	SA *Z	SA	SA *Z	SA	SA *Z
The share of the manual work	0.05	5	0.25	1	0.05	5	0.25	1	0.05	5	0.25	1	0.05
Information availability	0.10	2	0.2	5	0.5	2	0.2	5	0.5	2	0.2	5	0.5
Systematization of solutions	0.05	2	0.1	5	0.25	2	0.1	5	0.25	2	0.1	5	0.25
The transfer of knowledge and experience	0.05	2	0.1	3	0.15	2	0.1	3	0.15	2	0.1	3	0.15
Assumptions for the techno-economic analysis	0.05	2	0.1	3	0.15	2	0.1	3	0.15	2	0.1	3	0.15
The quality of technical documentation	0.10	2	0.2	5	0.5	2	0.2	5	0.5	2	0.2	5	0.5
Design time	0.30	2	0.6	2.1	0.63	2.8	0.84	3.5	1.05	3	0.9	4	1.2
The costs of designing	0.30	2	0.6	2.1	0.63	2.8	0.84	3.5	1.05	3	0.9	4	1.2
Σ	1.00		2.15		2.86		2.63		3.7		2.75		4

Graphic representation of the results is given on Fig.14.

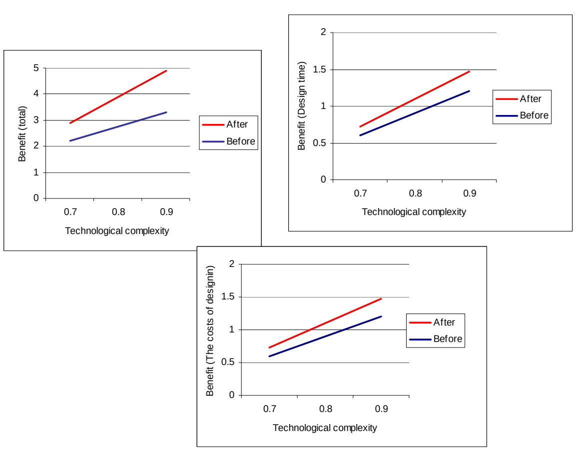

Fig.14. Graphic representation of dependence C/B of technological complexity

On the basis of cost-benefit analysis, three parts (A, B, C) with varying technological complexity (Part A has the lowest technological complexity is estimated at 0.7, part B is 0.8 and part of C has the highest technological complexity of 0.9), is concluded that the all three cases, it payable to use the proposed model, and that the greatest benefits are in the case of C. Based on the value of total benefits for at least part of the technological complexity of the cost of application software "IM2RTP" and about 33%, the middle part of the technological complexity of the cost of application software is about 40%, and the technologically most complex part of the cost of application software is 45%. If factors are considered during the design and cost savings would be at least for part A, 5%, then the middle part of the technological complexity of B about 25% and the technological complex of about 33% (Fig.15.).

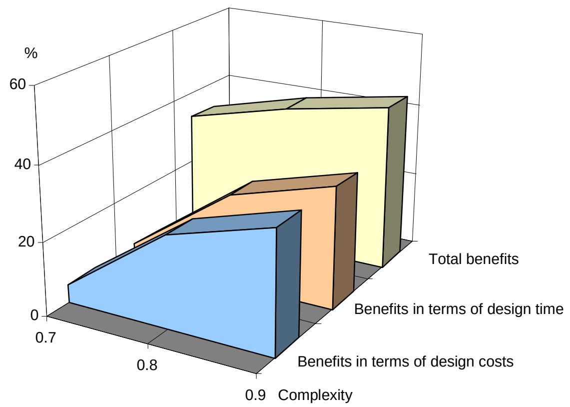

Fig.15. Graphic representation of cost-effectiveness of software in relation of technological complexity

Finally, we can conclude the following: the technological complexity of parts produced by small firms is higher, the higher cost of using the software.

4. CONCLUSION

Software solution, "IM2RTP", is intended for engineers, designers and technologists engaged in the development and reengineering of the technological processes. The basic idea related to this software is that it is a tool for engineers, who will in a simple and intuitive way for a relatively short time, through a very usable user (graphical) interface to develop a technological process, to implement re-engineering an existing or define a new technological process reengineering of existing and all fully documented. At the same time the projected database make it possible to preserve the experiential knowledge of designers as knowledge of the company internally.

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