

SOFTWARE PACKAGE "KROMA" FOR OPTIMIZATION OF MATERIALS CUTTING PROCESS

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Abstract: *The paper shows the software package "Kroma" for efficient use of sheet in the process of cutting materials. Software was developed at the Faculty of Mechanical Engineering in Kraljevo for the needs of companies in this region.*

Key words: *software, cutting, optimization*

1. INTRODUCTION

Metalworking firms, lumber industry and glass industry are often faced with the problem of optimization of the use of materials in processes of cutting several parts - which are either the same or different - from the semifinished articles - boards, rolls, pipes, bars, etc. As in the production practice of our firms these activities mostly depend on the knowledge and experience of technologists and often workers, the software package "Kroma", which solves the optimization problems of cutting rectangular elements from sheet¹, was developed at the Faculty of Mechanical Engineering in Kraljevo.

2. MAIN CHARACTERISTICS AND REQUIREMENTS IN THE PROCESS OF CUTTING RECTANGULAR ELEMENTS FROM SHEETS

Cutting is one of the most frequent operations of separation of materials. Semifinished articles for cutting are in most cases of rectangular form (sheet metal or plywood boards and strips) and the workpiece which arises after the operation of cutting is, as a rule, used as a semi-finished article for further processing.

¹ *In lumber industry this is plywood sheet and plywood, in metalworking industry this is metal sheet.*

2.1 Main Characteristics of Cutting Thin Sheets of Metal

In metalworking industry, separation by cutting can be done by removing the scissors with proper parallel (or proper leaned) knives or by melting of materials (gas cutting or laser cutting). Main characteristics of cutting with scissors are the following:

- the line of cutting (separation) is straight and it is spread over the whole length or width of the board or strip;
- the process of cutting is done by removing so that practically there is no width of the cut;
- thin sheet metal is without pattern and it is necessary to test the possibility that any position is turned by $\angle 90^\circ$;
- it is sometimes necessary to draw a border around the board so that it would be provided that the neighbouring sides are mutually direct.

Gas cutting and laser cutting melt the metal and depending on the thickness board and parameter of cutting make certain width of the cut which should be taken into consideration while making cutting plans.

2.2 Main Characteristics of Cutting in Lumber Industry

In lumber industry, separation by cutting can be executed by a circular saw. Laser cutting is a rarity. Main characteristics of cutting by a circular saw are the following:

- the line of cutting (separation) is straight and it is spread over the whole length or width of the sheet (or strips);

- it is necessary to draw a border around the plywood sheet so that it would be provided that the neighbouring sides are mutually direct;
- it is not necessary for the border around the plywood sheet over the length and width to be identical;
- separation by cutting can be executed by a circular saw and it is necessary to include the width of the cut;
- plywood sheet usually has a pattern and it is not possible to test all positions turned for $\angle 90^\circ$ in the process of making cutting plans;

2.3 Main Requirements in the Process of Optimization of Cutting Sheets

Main tasks of optimization in the cutting process are the following:

- minimization of time, and
- optimal use of material.

a/ Besides good organization of work in the process of cutting sheets, shortening of time is also possible in:

- the phase of making cutting plans², and
- in the phase of adjusting the machine (if a smaller number of different cutting plans are provided).

b/ Optimization of the use of material should satisfy the following criteria:

1./ Minimum surface of the waste - the cutting plan should make it possible for all elements that should be cut to be put on as small number of boards as possible;

2./ Minimum number of remainders- to give the priority to the cutting plans which have the minimum number of remainders;

3./ Usage of the remainder for making other cutting plans - it is necessary to make it possible that the remainders are approximately of square form, as the remainders which are narrow but long and whose dimension is narrower than the border of the waste cannot be later used for realization of other cutting plans;

4./ During the realization of cutting plans priority should be given to the use of remainders (which are a result of the realization of previous cutting plans) and after that the whole boards can be used;

5./ Minimum number of different cutting plans - because time for adjusting the machine and time for manipulation with board will be shorter.

3. SOFTWARE PACKAGE "KROMA"

In the technological preparation of production, the activities depend to a great extent on the knowledge and experience of engineers and also on the place and conditions of use, so that the application of

computers in this field is least developed. The software "Kroma" has been developed with the aim to enable optimization of the use of materials in the processes of cutting rectangular elements from a sheet, and in this case the criteria of optimization mentioned in Chapter 2.2 are satisfied. The software is usable in all firms in metalworking industry and in lumber industry which produce parts and structures from sheet metal or plywood sheet as well as in firms which provide services of cutting and enable this job to be done in a considerably faster, more easily and cheaper way.

Kroma offers the following possibilities:

- evidence of the stock of boards in the storehouse;
- making of the optimum cutting plan for input positions;
- correction of the stock in the storehouse after accepting of the cutting plan;
- evidence of the remainder which can later be used for production of other parts;
- making of the optimum cutting plan from remainders;
- memorising of input data and their later use again;
- printing of cutting plans, and
- production of price calculations with specification of cut positions, lateral tape and the others service;
- evidence of customers and suppliers, and
- the possibility of addition.

3.1 Main Menu

All bases and analyses are approached from the main menu whose window has the title "Data for Cutting". This window contains the following parts (Figure 1.):

- selection of storehouse (input storehouse, storehouse of presorted material or presorted- input storehouse);
- selection of materials (pattern of sheet);
- input of data about dimensions of boards from which positions are cut;
- input of data about the product which is produced;
- input of data about the dimension and number of elements which the product (structure) consist of;
- input of data about drawing of a border around the board, the width of the cut and the border of the remainder;
- input of data about the material price and service price;
- review and printing of price calculations and specification of the input data;
- evidence, review and change of the stock in the storehouse;

² Our experience shows that the job of making cutting plans, which lasted more than 10 hours, with the help of the programme "Kroma", can be done in less than 10 minutes ("Termoplastika", FVK, Kraljevo).

- making and printing of the cutting plan;
- Help, etc.

3.2. Storehouse - Review of Stock and Input of Data

By pressing the button "Storehouse", the window "Storehouse" is opened. In this window you can find the following parts:



Figure 1.- Software "Kroma" - Main Menu

- *Change of the stock* ⇒ Review of change of the stock in the storehouse and the date when the change is realised
- *Stock of the input storehouse* ⇒ Review of the stock in the input storehouse
- *Stock of the presorted storehouse* ⇒ Review of the stock in the presorted storehouse
- *Kinds of boards* ⇒ Review of dimensions of the board for corresponding pattern
- *Patterns* ⇒ Review of the patterns
- *Suppliers* ⇒ Review of suppliers and realized orders
- *Customers* ⇒ Review of customers and realized deliveries

button "Stock-Input" you can see the review of the immediate stock of all materials which are in the input storehouse. By pressing the button "Stock-Presorted" you can see the immediate stock of all materials which are in the storehouse of the presorted material.

By pressing the button "Kinds of Boards" you can input the next data:

- pattern
- thickness of the board
- length of the board, and
- width of the board

3.3 Input of Data for Cutting

For making optimal cutting plans, you can dispose of the next option:

- *Service* - for making optimal cutting plans from customer's sheets
- *Input storehouse* - for making optimal cutting plans from sheets which are in the input storehouse
- *Presorted storehouse* - for making optimal cutting plans from sheets which are in the presorted storehouse
- *Presorted-Input storehouse* - for making optimal cutting plans, the software firstly uses remainders which are in the presorted storehouse and then sheets from the input storehouse.

In the window "Data for Cutting" you can choose: a/ the storehouse (input storehouse, storehouse of presorted material or presorted-input storehouse)

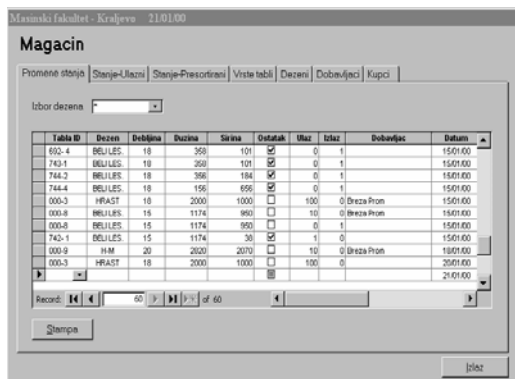


Figure 2. - Stock in the Storehouse

For easier inspection of the state in the storehouse, the storehouse is divided into "Input" and "Presorted". By pressing the

b/ patterns, and
 c/ dimensions of the board from which positions are cut

and the following data are input:

- data about the product which is produced
- data about dimensions and number of elements which the product (structure) consists of, and
- data about drawing of the border around the board, the width of the cut and the border of the remainder.

After the input, all data stay noted and can be later used again for repeating cutting plans.

3.4 Specification of Materials

The input data as well as the data of the circumference and surfaces of the positions can be seen in the window "Data". These data are especially important for the firms which do the service of cutting materials and which sell the cut elements (positions) per m² or kg. If the price of the material is also input, the specification will also show the total price. It is possible to print the shown data from this window.

3.5 Making of Cutting Plans

After the input of data, pressing the button "Cutting Plans" starts a programme which makes optimum cutting plans for the input data, which are shown in the window "The Plan for Cutting" in this window. Beside the appearance of cutting plans there can be seen data about the number of cutting plans, the number of boards needed to be cut on the base of the shown cutting plan, the total number of boards needed for production of all positions, the surface of the remainder for each individual cutting plan, the total surface of the remainder, as well as the total surface of the waste.

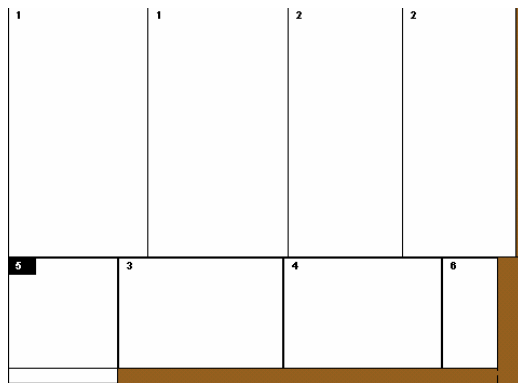


Figure 3. - Cutting Plans

The schedule of positions is drawn on the plan of cutting and each position is numbered with its ordinal number. The remainders are shown with grey colour and they are also numbered. If the

position is turned for $\angle 90^\circ$, the mark of the position is black. Directions of cutting in the production process of these positions are shown with a thick hidden line. The review of the cutting pictures goes by pressing the arrows in the left lower corner of the screen. It is also possible to print the cutting plans from this window.

After the accepting of the cutting plan, the stock in the input storehouse becomes smaller by the number of boards which are necessary for the realization of this job, and at the same time in the storehouse of "Presorted Material" data of the material and dimensions of the new remainders which appear after the realization of these cutting plans are input.

3.6 Minimum PC Configuration

The minimum configuration is IBM PC 586 compatible computer with 16 MB RAM memories. The operating systems under which the programme can work are: Windows 95, Windows 98, Windows 2000 and WindowsNT.

4. CONCLUSION

Modern business requires the use of modern means and tools for work. The use of computers is nowadays practically unavoidable in all kinds of business. The software package "Kroma" works in the "Windows" surroundings and it is simple for using. The main advantages of this software are the following:

- The time for making cutting plans is shorter and it enables more efficient work of engineers and technicians in the process of construction and production of parts and structures from sheet metal or plywood sheet;
- Saving of the material which can be seen, above all, in the forming of good cutting plans but also in the possibility to use for realization of the cutting plans, the remainders from the storehouse of presorted material first and then the boards from the storehouse of input material. We are going toward a total elimination of the storehouse of presorted material.
- The programme includes the option "Connection of Remainders" whenever it is possible and that is how shortening of the remainders which appear after the realization of cutting plans is avoided to a maximum degree;
- Quick making of cutting plans gives a possibility to design engineers and technologists to analyze a different concept of making definite products and to choose the best one from the viewpoint of minimum use of material and work, i.e. minimum expenses of making;

- It gives the possibility of connecting with other programme packages, the possibility of addition, etc.

5. REFERENCES

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