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Applying the simplex method to optimize welding processes of welded constructions

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The paper contains a study on the optimization of the processes of electric arc welding of welded constructions. A measure of efficiency of the mechanical system has been developed so that it expresses an optimal function, which contains the variables of the system. By quantifying the simplex function, with data from a company with a mechanical profile, one can estimate the degree of success or failure in achieving the proposed purpose. The elaboration of an optimal function leads to a maximum benefit of the mechanical enterprise.

Keywords*: optimization, welding process, simplex method, quantification.*

1. Introduction.

A welded assembly is a system consisting of several subsystems, respectively welded components [1].

In the field of welded constructions, a system can be optimized if all the subsystems, respectively the welded components that make up the system, achieve maximum efficiency. In order to solve these types of systems, it is necessary to develop a model that includes as much as possible the variables of the system [2],[3].

During the operation of the system, the input variables may undergo minor changes in the values, by modifying them under certain conditions, so as to result in a methodology for calculating the optimal solution [4].

2. Case study

The criterion for establishing the mathematical model was made on a group of machines used in the process of electric arc welding.

The economic conditions of production of two point and line welding machines are shown in Table 1.

Every month, 3600 ores are available for the use of machine types. Under data conditions, it is a required elaboration of a monthly production program, in order to obtain the maximum benefit [5].

Table 1. Economic condition for the production of cars

Machinery type	The benefit lei/piece	Production capacity piece/month	Production time h/piece
Welding machine at points (A)	60.000	80	30
Welding machine at line (B)	80.000	60	40

In optimization calculations, all variables are treated equally, whether they are decisive, passive or artificial. With these conditions we arrive at the mathematical model presented in equations 1-4.

For drawing up the mathematical model, machine A with x_1 and machine B with x_2 were noted. As a result, Equations 1-4:

$$Z = 10^4(6x_1 + 8x_2) \quad (1)$$

$$x_1 \leq 80 \quad (2)$$

$$x_2 \leq 60 \quad (3)$$

$$30x_1 + 40x_2 \leq 3600 \quad (4)$$

The graphical method was used, within this linear programming problem, because we have two decision variables.

To solve the mathematical model, passive variables are introduced that transform inequalities into equals, resulting in solutions:

$$x_3 = 80 \quad (5)$$

$$x_4 = 60 \quad (6)$$

$$x_5 = 3600 \quad (7)$$

Because solutions must be integers, solutions that satisfy equality:

$$30x_1 + 40x_2 = 3600 \quad (8)$$

where:

$$x_1 = 40 \quad (9)$$

$$x_2 = 60 \quad (10)$$

Substituting in the formula of the optimal function Z, we obtain:

$$Z(SO) = \max \cdot Z = OPT \cdot Z = 10^4 \cdot (6 \cdot 40 + 8 \cdot 60) = 720 \cdot 10^4 \quad (11)$$

The graphical solution of the problem is shown in Figure 1.

In the x_1Ox_2 plane the restrictions were represented, thus obtaining a favorable domain DF, of the form of a KLMNO quadrilateral.

It can be seen that all points in the IM segment are optimal SO solutions.

If we consider that machine numbers A and B must be integers, we can calculate which are the optimal solutions.

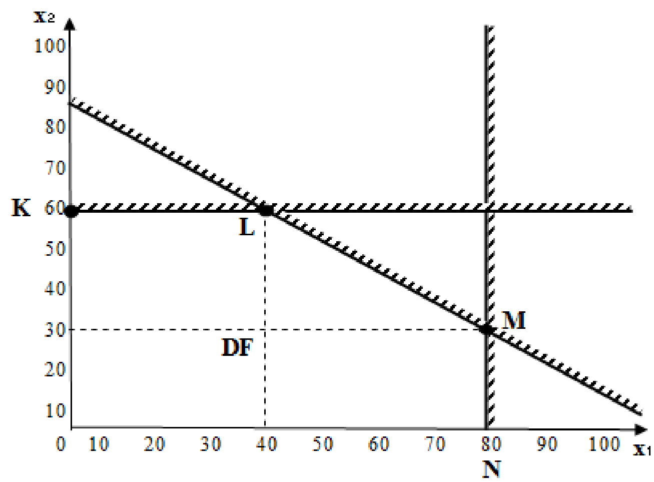

Figure 1. Favorable area of problem solving

For this from the equation of the LM line, x2 is expressed as a function of x1, resulting in:

$$x_2 = 90 - \frac{3x_1}{4} \quad (12)$$

The variable x_1 has on the LM segment, limits of variation between 40 and 80. For x2 to take integer values, x1 will take only divisible by 4.

Table 2 shows all the optimal solutions to the problem.

Table 2. Optimal solution

x_1	40	44	48	52	56	60	64	68	72	76	80
x_2	60	57	54	51	48	45	42	39	36	33	30

4. Conclusion

With the help of this method, a measure of efficiency of the system was developed. During the operation of the manufacturing process, by accumulating information, the variables of the system can be modified so that the optimal solution is the best variant of those analyzed as possible. The optimization of the system was done by maximizing the optimal Z function.

The simplex algorithm developed in this problem, can solve any type of linear programming problem, where with x1 and x2 the unknowns of the system were noted. In the KLMNO quadrilateral of the domain favorable to the optimal solutions, the points furthest from the origin of the O axes are the solutions of the system. Thus, the solutions resulted: K (0,60) with Optimal function Z(K)=480 x10^4; L (40,60) with Optimal Function Z(L)=720 x10^4; M (80,30) with Optimal Function Z(M)=720 x10^4; N (80,0) with Optimal Function Z(N)=480 x10^4.

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