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DESIGN OF MACHINE VICE BASED ON MORPHOLOGICAL MATRIX METHOD

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ABSTRACT
In this paper is analyzed one of the creative methods which is the main focus. Firstly, it has been discussed the concept of designing in general, then described the process of construction and the stages the process has gone through. In the designing process of a clamp, a machine vice respectively, has been included the morphological method of matrices. Also, it has been analyzed and assessed the variants in accord with the instructions of German VDI and it has been made the modeling of the machine vice with the help of advanced computer programs software.
Keywords: Design Methods, Decision Making, Optimization, Optimal Solution.

1. INTRODUCTION
Machine vice is a threaded transmitter mostly used to hold tight a work piece in order to be successfully realized mechanical processing operations, such as lathing, cutting, drilling, welding etc. Given the large number of products in use, which differ in size, destination and/or by the number of component parts, there is a need to accelerate the design process. Accelerating the design process can be achieved by relying on new design methods and with the help of computer programs. The advantage of using these options when design these product variants is the speed of manufacturing and time to market and the result is reduction of cost production. The overall process of design, from beginning to end, often defined as in figure 1. The process begins with identification of need and then making the decision. After many iterations, the process ends with the presentation of the project which fulfills the request.

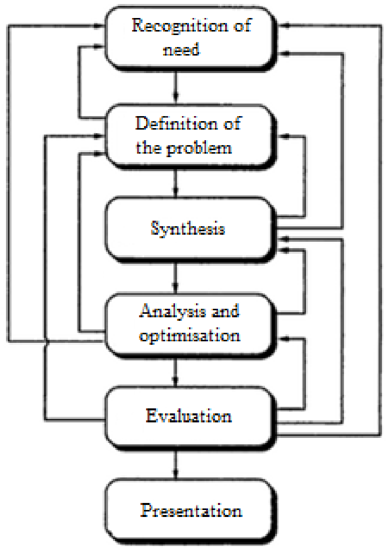


Figure 1. Phases in design process.

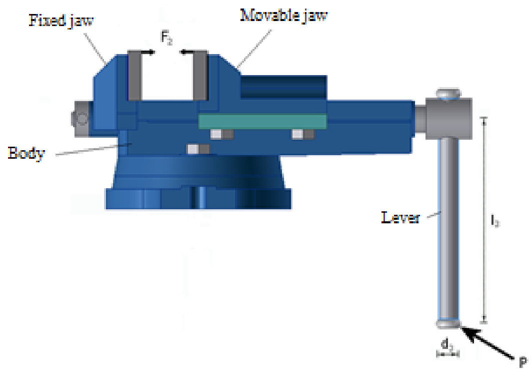


Figure 2. Machine vice components.

2. VARIANTS GENERATION – MATRIX MORPHOLOGY

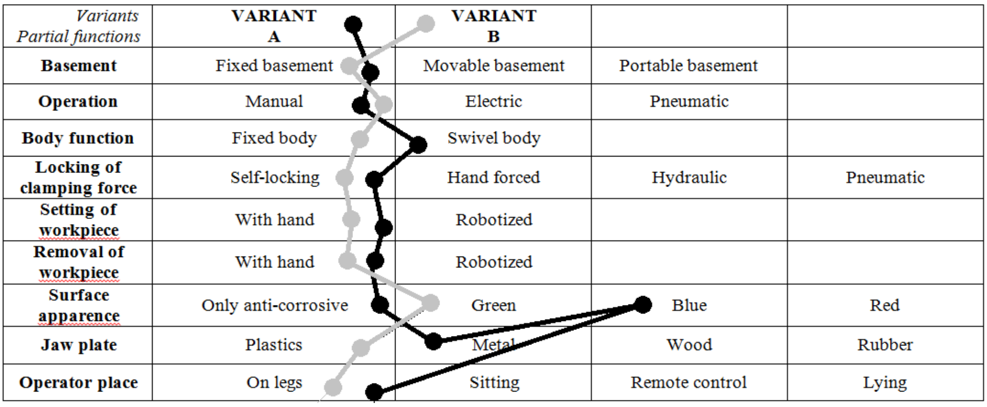
Generation of variants will be done with the help of morphological matrix, as this method is based on systematic research of possible alternatives (Figure 3). During this work, will be analysed several known variants, as well as new variants that during a spontaneous and random procedure nor will be noted. In general, from the presentation of some of the possible variants we can identify some essential features of a machine vice. These features should be common to all variants, although may have different ways to perform the function. From the matrix can be created many possible combinations and different solutions. Of course, some of these variants may not be practical solutions, or are only as inadequate, for example, the operator place can not be lie due to the specifics of the problem.

Variants *Partial functions*	**VARIANT A**	**VARIANT B**		
Basement	Fixed basement	Movable basement	Portable basement	
Operation	Manual	Electric	Pneumatic	
Body function	Fixed body	Swivel body		
Locking of clamping force	Self-locking	Hand forced	Hydraulic	Pneumatic
Setting of workpiece	With hand	Robotized		
Removal of workpiece	With hand	Robotized		
Surface apparence	Only anti-corrosive	Green	Blue	Red
Jaw plate	Plastics	Metal	Wood	Rubber
Operator place	On legs	Sitting	Remote control	Lying

Figure 3. Variant generation based on Morphological Matrix.

3. ANALYSIS AND EVALUATION - DECISION MAKING

The result of research and finding of problem solutions is the large number of variants of complete or partial solutions. Of all those solutions must be chosen one of them, which mostly respond to requests (goal). The value of a variant is expressed as the rate of fulfilment of the requirements relevant to the criteria set expressed in the points (assessment points). The evaluation model described is processed and recommended by the VDI Guidelines 2225 (*VDI – Verein Deutscher Ingenieure*), where the five-points system used.



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Operator place	On legs	Sitting	Remote control	Lying

Figure 4. Analysis of variants and selection of partial functions.

Based on the evaluation of variants under the Table 1, it is concluded that **Variant A** with the combination of possible options presented, meets the conditions to produce. After selection of optimal variant, then is the order of design calculations of machine vice components (Figure 2), with the given data:
Force exerted by the operator: P = 300 N, length of lever: l_3 = 260 mm, screw rod: Sq25x4, yield strength of jaw: 480 N/mm^2, yield strength of lever: 250 N/mm^2, yield strength of pin: 250 N/mm^2, internal and external diameter of the collar: Ø18 respectively Ø40, coefficient of friction between screw and collar: 0.15, coefficient of friction between nut and screw: 0.12, presion between screw and nut: p_b = 2.2 N/mm^2

From the results of calculation can be seen:

$$\text{Diameter of lever: } d_3 = \sqrt[3]{\frac{32 \cdot P \cdot l_3}{\pi \cdot \sigma}} = 22 \text{ mm}$$

$$\text{Maximum direct stress on screw: } \sigma_{max} = \frac{1}{2} \cdot \left[\sigma_a + \sqrt{\sigma_a^2 + 4 \cdot \tau_p^2}\right] = 55{,}967 \text{ N/mm}^2$$

$$\text{Maximum shear stress on screw: } \tau_{max} = \frac{1}{2} \cdot \left[\sqrt{\sigma_a^2 + 4 \cdot \tau_p^2}\right] = 29{,}643 \text{ N/mm}^2$$

Table 1. Analysis of cost and function

According to VDI 2225 Guidelines the five-points system will be used: 0=Unsatisfactory, 1=Acceptable, 2=Satisfactory, 3=Good, 4=Very good.								
Partial functions	**Variant A**	Cost	Function	*Points*	**Variant B**	Cost	Function	*Points*
Basement	Portable	x	x	x	Fixed	x	x	x
Operation	Manual	x	x	x	Manual	x	x	x
Body function	Swivel base	1x2=2	2x4=8	2+8=10	Fixed base	1x3=3	2x2=4	3+4=7
Locking	Self-locking	x	x	x	Self-locking	x	x	x
Setting of workpiece	With hand	x	x	x	With hand	x	x	x

Removal of workpiece	With hand	x	x	x	With hand	x	x	x
Surface apparence	Anti-corrosive+Blue	1x3=3	2x4=8	3+8=11	Green	1x4=4	2x1=2	4+2=6
Jaw's plate	Metal	1x4=4	2x4=8	4+8=12	Plastic	1x3=3	2x1=2	3+2=5
Operator place	On legs	x	x	x	On legs	x	x	x
	Total Points			**33**	**Total Points**			**18**

4. CONCLUSION

By utilizing the knowledge of morphology matrix method are determined different variants of threaded transmitter, their evaluation is done after which a decision was taken to select the optimal variant. Method of evaluation and decision making supports in design method, guide designer to include all variants and resolve it the optimal (with minimum error).

5. REFERENCES

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