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INCREASING COMPETITIVENESS OF SMALL AND MEDIUM ENTREPRISES BY APPLICATION OF THE VALUE ENGINEERING IN PRODUCT DESIGN

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În acest articol ne-am propus să continuăm prezentarea rezultatelor obținute în urma cercetărilor desfăşurate de noi, cu privire la potențialul pe care îl reprezintă Ingineria Valorii (IV) pentru creşterea competitivității agenților economici. Dacă în numărul 1/2007 al revistei am prezentat metodologia de aplicare a IV la proiectarea/reproiectarea proceselor tehnologice de fabricație, în acest număr vom expune metodologia de aplicare a IV la proiectarea/reproiectarea produselor şi, totodată, vom demonstra fezabilitatea şi eficiența acesteia folosindune de un studiu de caz. Aplicația vizează produsul industrial ,, Menghină paralelă de banc", pentru care sunt prezentate atât rezultatele îmbunătățirii funcționalității după reproiectare, cât şi eficiența economică înregistrată.

In this article we aim to present the findings of our researches regarding the potential of Value Engineering (VE) in increasing the competitiveness of economic agents. After we have presented in the 2007/1st issue of this publication the methodology of VE application in designing/redesigning of technological fabrication processes, in this issue we shall expose the methodology of VE application in designing / redesigning of products and meanwhile, we shall prove its feasibility and efficiency by using a case study. The application envisages the industrial product "Parallel Bench Vice" , for which we present both the improved functionality results and the economic efficiency, which we found after the redesigning process.

Keywords: function, function cost, use value, brainstorming, importance level

1. Introduction

1.1 Specific elements for Value Engineering

The Value Engineering method is fundamentally different from the classic ones which are still utilized for cost cutting. Whilst most of these methods analyze the product as a physical object and pursue the most cheaply fabricating solutions, VE studies goods starting from its social needs, from the functions and services

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they provide to the final user. Not the product, as a physical object, is important for the final user, but the services it provides. We do not buy medicines but health; we do not buy flowers but perfume and beauty. The VE study starts with establishing the necessary functions of the product for meeting the consumer needs and goes further with the identification of minimum costs for its production. Each cost not contributing to functions fulfillment is removed in the redesign stage, which finally leads to important savings.

If the reader is interested in analyzing, the products near at hand, through this perspective, he would be surprised to learn that for most of those a significant part of production cost is not related at all to its functions, or he would find out that its cost was exaggerated compared to its needed functions, which means over-evaluation and over-quality in case of these products and consequently, a waste of social labor.

Thus, unlike the classic methods which aim to improve existing products, VE conceives or re-conceives the good depending on the needs, aiming to fulfill a function with no regard to current solutions. This approach allows establishing a direct link between the product's functions and the necessary costs for its production. Between a function's importance level in achievement of the product's general application value and the required cost's importance level, there should be a proportional ratio.

As we already showed, VE studies do not exclusively aim to cut the costs, but also to improve the goods' application value, and consequently to better satisfy the consumers. Therefore, this method got recognition as a quality management specific method.

1.2 Area of spreading and the application stage of this method at global level

The Value Engineering method is currently practiced by the leading firms within the developed countries, and whose organization structures include offices and services or even directions in charge with products' VE studies. They also carry out an intense scientific activity with a view to optimize and extend this method application area, both by professionals and by university researchers, organized in national societies for Value Analysis or Value Engineering.

In France (where is better known as Value Analysis), the Value Engineering method is widely used in the country's economy and, as it was inserted in the national education programmers, this country entered a new stage in VE evolution. The technical superior education adopted the VE study since 1983, as well as the technical high-schools and the special post-high-schools in the year 1984.

Also, as an official recognition of VE method at international scale, we mention issuing the two standards, ISO EN 1325 – 1:1996 and EN 1325 – 2:2004, through which the International Standards Organization established a unique way of interpretation and application of the Value Analysis method within the European countries.

1.3 Perspectives for Value Engineering application in the Romanian economy

In order to adequately assess the VE perspectives in our economy, we should start from its current development level and from the objectives set by the post EU accession economic and social development strategy. We also have to consider the difficulties faced by the economic agents, especially the SMEs, in the field of efficiency and competitiveness within the internal and external markets, given the economic and political environment governed by market economy laws and the increased globalization trends. The lack of efficiency and competitiveness of most of the Romanian economic agents has its source the high costs and inadequate quality of products fabrication. On the contrary, as we showed above, cutting costs and increasing quality of products and services are just the main objectives pursued and achieved by VE study.

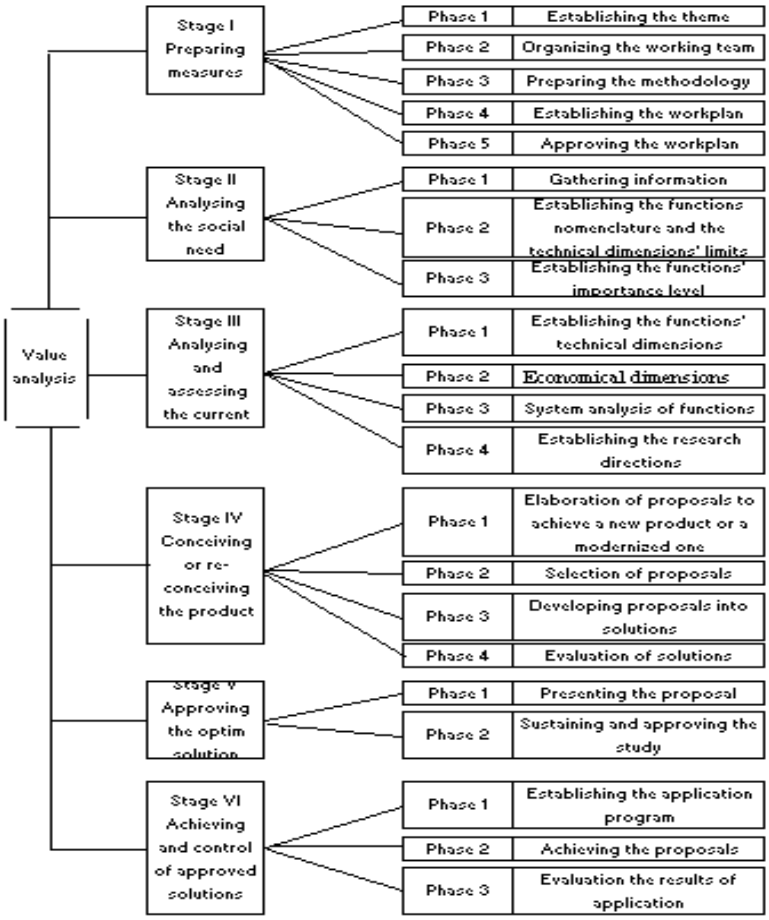
For a general implementation of the VE application in Romanian economy, it could be very helpful to set up specialized compartments at economic organizations level, whose exclusive task should be VE designing and redesigning of products. The said compartment could be included within the research-development service, and its activity can be decided based on plans with concrete objectives, taken out of the organization's development strategy. Thus, not efficient products could be redesigned and new products could be designed, according to the organization's restructuring programme.

In order to achieve the global of VE application in Romanian economy, the organizations' managers need to initiate and coordinate two certain actions. First of them consists in VE training of all organization's engineers and economists, by adequate educational means. Part of them must be specialized at such level to allow them becoming Value Engineering Analysts. The second action aims to establish working teams whose members to acknowledge VE methodology. These teams would be lead by VE Analysts. The teams would work within the above mentioned compartment in elaborating VE studies for the products proposed by the organization's management.

An essential contribution in this respect could come from the national education system, which could enclose VE study as a study matter in the university programmes, similarly to other European countries.

2. Methodology for Value Engineering application in products designing / redesigning

Using an application plan is one of the VE most important features, which ensure a systematic and planned activity. The products' design methodology elaborated in 1979 (STAS 11272/1-1979 and STAS 11272/2-1979) was improved and developed, based on the experience gained by studying a large number of products, as well as from the theoretic researches developed in order to improve and extend the VE application area. This new methodology we propose is presented by Scheme no.1 and includes six stages and 21 phases.



Scheme no.1 – Source: Ion Ionita, 2000, Ingineria valorii

In order to prove the methodology's feasibility and efficiency, we shall use the following case study.

3. Re-design Parallel Bed Vice by using Engineering Value Concepts

The product which will help us in testing the presented methodology is the Precision Parallel Vice, with 75 mm distance between jaws, used in endowment of file bench. The product is also used in endowment of machines such as milling machines, shaping machines, drilling machine etc. The study is applied for the entire product, selected on the basis of economic and technical criteria, as well as for its importance within the turnover of the producing firm. Meanwhile, we considered that through certain transformation adjustments aimed to improve its application value, the product could be provided also on the external market, where certain demand exists. The previous analysis showed that the product is on its main life curve, considering the marked demand is guaranteed for the next decade. The analysis also showed the product is fabricated with very high costs, considering the planned unitary cost was exceeded with 30.8 lei. That was caused by the brutish foundry technology for the two cast iron parts (fixed jaw and displaceable jaw); by the expensive material the spindle-nut is made of (foundry Bronze14) and by extension of the cutting operation aimed to achieve the dimensions provided by the technical documentation. It was also concluded that the product, which is used also in the firm's locksmith-shops, does not technically meet the workers' requirements. Therefore, the firm decided redesigning the vice by using VE concepts.

Based on previous analysis of the product's state, the possibilities for improving and for cutting costs, the research collective proposed as objectives the following limits:

- increasing the application value of the product (utility) by 1,4-1,5 times;
- reducing the material costs with minimum 30, 8 lei/pc.;
- reducing the production costs with 12-15%;
- improving the application value /costs ratio by 1,5-1,8 times;
- improving the application value by adding new function.

3.1 Technical presentation of the product

The product is composed by the following parts: the vice's body (fixed jaw); displaceable jaw; guiding screw; special spindle-nut (Bz 14 ZnT); sliders; clamping handle and the nuts attached at its ends; resort; other five standardized parts. The product has a quadrangular guiding sled, the slides are thermo treated, and the fabrication process ends by primering and painting the whole product.

3.2 Establishing the function nomenclature and function classification

Questioning the design and production specialists, as well as the users, revealed that the application value of the product is: „to ensure the adequate position for

materials, through manual fixing, in order to be mechanically processed". To fulfill this social requirement, the existing product has the following functions:

Table no.1

Symbol	Function name	Function category	Interdependency
	To tighten pieces by clamping	Objective	
B	To ensure precision of tightening	Objective	
C	To endure dynamic shocks	Objective	
D	To allow engaging with the bed	Auxiliary	Condition for function A
E	Long term safe functionality	Objective	
F	To allow facile maintenance	Auxiliary	Condition for function E
G	Ergonomics	Objective	
H	Aesthetics	Subjective	
I	To endure external agents action	Objective	

* Functions of the existing product

3.3 Establishing the functions' importance level

The table no. 2 presents the result of this stage.

Table no .2

Function	A	B	C	D	E	F	G	H	I	Total
Importance level	6	7	4	6	5	5	3	1	2	39
Proportion (%)	15,3	18,0	10,2	15,3	13,0	13,0	7,6	2,5	5,1	100

3.4 Economic dimension of functions

In order to distribute the material expenses of the pieces production, we utilized the key formula resulted out of the functions' importance level matrix; for distribution of workforce cost, we started from a technical and engineering analysis, which was based on each operation's role within the fabrication technological process, in achievement of the product's functions.
The centralization of all the costs regarding the product functions is presented in table no. 3.

Table no. 3

Riper	Type of cost	Total	The cost of the function (RON)								
			A	B	C	D	E	F	G	H	I
Fixed jaw	Mat.	63	9,69	11,31	6135	9225	7680	X	6885	6270	6840
	Man.	105	21186	27456	11712	15354	7020	X	X	7992	2895
	Tot.	168	30411	38196	17847	24579	14700	2364	16611	14262	9735
Displacea ble jaw	Mat.	46	10420	10926	X	-	8070	X	-	5652	2154
	Man.	62	17790	19380	-	-	8430	903	-	5028	264
	Tot.	108	28210	30306	-	X	16500	903	19146	10680	2418
Special spindle-nut	Mat.	86	25500	29850-	-	21270	X	X	-	-	8490
	Man.	13	4128	5130	-	X	1620	1134	2034	-	645
	Tot.	99	29628	34980	-	X	22890	1134	2034	-	9135
Guiding screw	Mat.	24	4728	5601	-	X	3756	3771	2658	X	-
	Man.	27	7035	6075	-	X	3852	2649	5535	2805	-
	Tot.	51	11763	11676	-	X	7608	6420	8193	2805	-
Sliders	Mat.	5	1110	1260	480	X	810	810	-	159	X
	Man.	20	5388	4929	3054	X	2583	639	1929	2196	-
	Tot.	25	6498	9189	3534	X	3393	1449	2250	2355	-
Clamping handle	Mat.	3	840	-	-	X	660	-	90	90	-
	Man.	4	597	-	-	X	882	1713	1200	351	-
	Tot.	7	1437	-	-	X	1542	2373	1290	441	-
The nuts (two pieces.)	Mat.	1	378	-	-	X	255	-	81	81	
	Man.	8	1569	-	-	X	1380	2205	1620	2130	-
	Tot.	9	1947	-	-	X	1635	2460	1701	2211	-
Resort	Mat.	0,3	-	-	-	-	-	-	780	-	-
	Man.	0,7	-	-	-	-	-	-	1122	-	-
	Tot.	1	-	-	-	-	-	-	1902	-	-
Saab AM 17	Mat.	0,2	-	-	-	-	-	-	210	-	-
	Man.	0,8	-	-	-	-	-	-	816	-	-
	Tot.	1	-	-	-	-	-	-	1026	-	-
Guiding M6 (2buc)	Mat.	0,5	210	255	105	-	-	-	-	-	-
	Man.	0,3	123	90	30	-	-	-	-	-	-
	Tot.	0,8	333	345	135	-	-	-	-	-	-
Guiding M5 (two pieces)	Mat.	0,4	270	-	-	-	-	-	-	-	-
	Man	0,3	243	-	-	-	-	-	-	-	-
	Tot.	0,7	513	-	-	-	-	-	-	-	-
Splint	Mat.	0,1	150	-	-	-	-	-	-	-	-
	Man	-	-	-	-	-	-	-	-	-	-
	Tot.	0,1	150	-	-	-	-	-	-	-	-
Assembla ge general	Mat.	-	-	-	-	-	-	-	-	-	-
	Man.	88	6267	25815	3438	X	8424	4689	8400	11721	19350
	Tot.	88	6267	25815	3438	X	8424	4689	8400	11721	19350
Total product	Mat.	229,5	51837	58632	6720	9225	42501	5496	21183	12252	17484
	Man.	318	64326	70875	18234	15354	34191	16302	41370	32157	23154
	Tot.	558,6	117157	147507	24954	24579	76692	21792	62553	44475	40638
The ratio in the total productio n costs (%)		100,00	20,90	26,31	4,45	4,37	13,68	3,87	11,16	7,92	7,24

* The centralization of all the costs regarding the industrial product ”Parallel Bench Vice” functions

3.5 System analysis of functions

To analyze the correlation between application value and costs at functions level, the regression function method should be applied. In order to draw the chart, we calculated the quotients a_1, a_2, regression right lines (D_1 and D_2) and estimators S_1, S_2, with and without the auxiliary functions. Here are the results:

$$a_1 = \frac{5255,71}{920,44} = 5.71; \qquad a_2 = \frac{5817,18}{920,44} = 6.32$$

Based on these quotients values, the D_1 and D_2, coordinates are calculated and the rectangular axes system is drawn.
Analyzing the chart no.1 we observe that all functions, except one, have important gaps between their contribution to achieve the general application value of the product and their proportion among its costs. Thus, excepting C, all the other functions are over-evaluated.
Out of the calculation of estimators S_1 and S_2, whose difference shows the same disproportion, we obtained the following results:

$$S_1 = \sum_{1}^{7} (y - a_1 x_i)^2 = 351.30 \; ; \; S_2 = \sum_{1}^{7} (y` - a_2 x_i)^2 = 445.79$$

Given the large influence of the auxiliary functions (S_1-S_2 = 94.49), the product must be redesigned in such manner that this difference to tend towards zero.

3.6 Setting the research direction

Based on the conclusions of the system analysis of functions, the research team formulated the following directions to follow in order to redesign the product:

- add new functions in order to increase the product’s utility;
- reduce the gap between the brute pieces and the processed ones; the team aims to find solutions for precision foundry, which should decrease the foundry surplus;
- constructively modify the foundry turned pieces; for all these adjustments aimed to simplify the processing operations, the team shall pursue not to

change significantly the existing SDV (tools, devices, verifiers), which are still new;
- reduce the costs designated to achieve the aesthetic function (primer-painting);
- replace the material for execution of the special spindle-bolt; the team shall study the possibility to replace bronze, an expensive material, with a cheaper one.

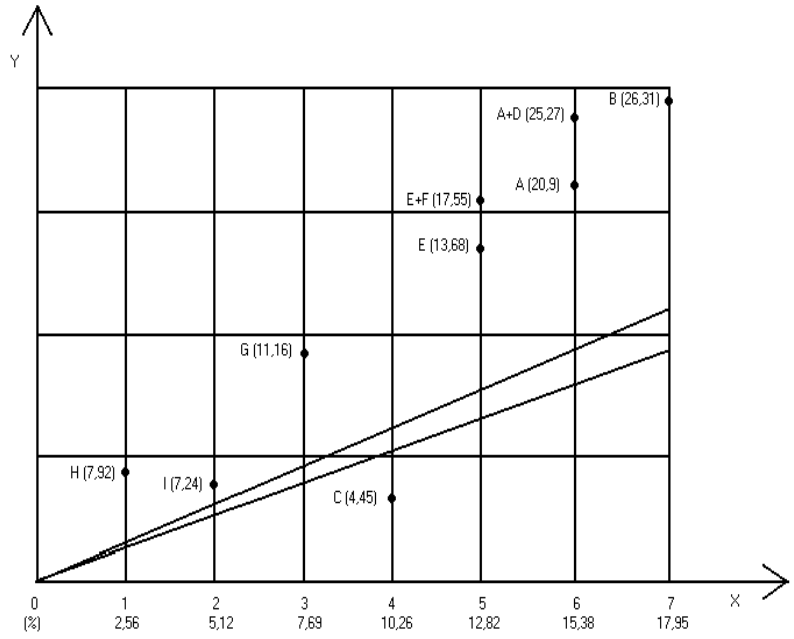


Chart no.1

During the following stage, the team shall analyze these new directions for product redesigning; for each direction the team shall search for solutions which once applied, would lead to improving the product's utility and to reducing the fabrication cost.

3.7 Proposals for modernizing the product.

The research team organized a brainstorming meeting, attended by specialists representing the producer, the beneficiaries and design-research specialists. Out of the discussions, the following redesign proposals resulted:

- The product's functionality could be improved by mounting such jaws to allow clamping cylindrical pieces, given the functions A and mostly B ensure presently good conditions for flat pieces clamping only.

- Adopting a fixing device which would allow the vice a circle motion for increased commodity of the user.
- Adjusting or removing the anvil, given the precision feature of the vice.
- Execution of guiding screw out of two pieces. This will substantially reduce the scale of turn cutting operation and, consequently, will reduce the high material and workforce costs;
- Fabrication of the special spindle-bolt out of grey cast iron.

3.8 Developing the proposals and its concretization into solutions.

All the precedent proposals were selected, considering the fact that each of them could have an important contribution to increasing the product's application value, as well as to reducing fabrication cost.

The proposals took the shape of technological solutions that, following its application, allowed the fabrication of a product with superior functional characteristics and a lower unitary cost than the former product's ones. The new product, provided with two new functions aimed to increase its utility according to beneficiaries' request, was named „*Precision Parallel Vice with flat jaws, jaws for griping round materials and rotating plate*".

The table no.4 shows the functions nomenclature of the redesigned product and its technical dimensions.

Table no.4

Symbol	Function name	Function category	Technical dimension
A	To tighten pieces by clamping	Objective	DN
B	To ensure precision of tightening	Objective	Mm
C	To endure dynamic shocks	Objective	DN
D	To allow engaging with the bed	Auxiliary	Mm
E	Long term safe functionality	Objective	Years
F	To allow facile maintenance	Auxiliary	-
G	Ergonomics	Objective	DN
H	Aesthetics	Subjective	-
I	To endure external agents action	Objective	Years
K	To allow rotating on vertical axe	Objective	360 degrees
L	To allow tightening of cylindrical pieces	Objective	Ø mm

The importance levels of the new product's functions were established within the table no. 5

Table no.5

	A	B	C	E	G	H	I	K	L
A	1	1	0	0	0	0	0	0	0
B	0	1	0	0	0	0	0	0	0
C	1	1	1	1	0	0	0	1	1
E	1	1	0	1	0	0	0	1	1
G	1	1	1	1	1	0	0	1	1
H	1	1	1	1	1	1	1	1	1
I	1	1	1	1	1	0	1	1	1
K	1	1	0	0	0	0	0	1	1
L	1	1	0	0	0	0	0	0	1
Level	8	9	4	5	3	1	2	6	7
Proportion %	17,8	20,0	8,9	11,0	6,7	2,2	4,4	13,3	15,7

The auxiliary functions are D, which conditions the function A (so, D = A = 8) and F, which conditions the function E (so, F = E =5). Further, the proposed variant is analyzed according to 1 – 3 phase, within the methodology's third stage.

In order to study the proportionality of the use – cost value for each function, as well as to analyze how functionality of the new product was worked out, we built a linear graph and calculated the regression right lines D1 and D2. From the calculation there resulted: a_1= 2,954 and a_2 =3,321, the levels of deviation quotients S1=136,317, S2 =139,000. The influence of the auxiliary functions on the new product significantly decreased, from 94,490 to 2,783.

The chart no.2 presents the linear graph of the regression right lines for the new product.

4. Economic assessment of the proposed solution

The considerable improvement of the proportionality deviation quotients shows that the new product will have better efficiency and functionality than the current product.

The table no.6 presents the synthesis of the improvements applied to the redesigned product.

Table 6.

Specification	Former product	New product
A_1	5,71	2,94
A_2	6,32	3,32
S_1	351,30	136,31
S_2	445,79	139,00
S_2-S_1	94,49	2,78

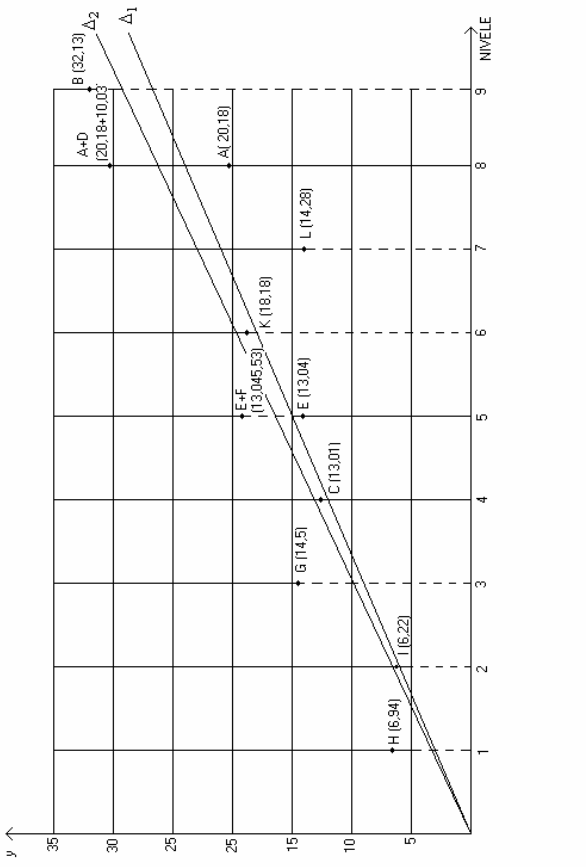


Chart no.2

After verifying the achievement of the proposed study objectives by the research team, it results:

- The application use value of the new product ($V\hat{i}_n$).

Is calculated through the formula:

$$V\hat{i}_n = \sum_{i=1}^{n} KixFi \text{ , where:}$$

Ki - importance level considered for function i;

Fi – number of functions with K level.

* The result shows an increasing to 58 levels, compared to 38 for the former product. Consequently, the increasing index for application value ($iV\hat{i}_n$) is 1,487, which exceeds the level proposed by the study's objectives.

* The new product's cost reduced with 238.26 lei, and represents just 0.855 out of the former product's cost.

Due to these results, the increasing index for the Vî/Ct ratio is 1.73. The calculation used the formula:

$$iV\hat{i} / Ct = \frac{iV\hat{i}_n}{iCt} \text{ , where:}$$

iVî/Ct – increasing index for application value / cost ratio;

$iV\hat{i}_n$ – increasing index for the new product's application value;

iCt – cost reducing index

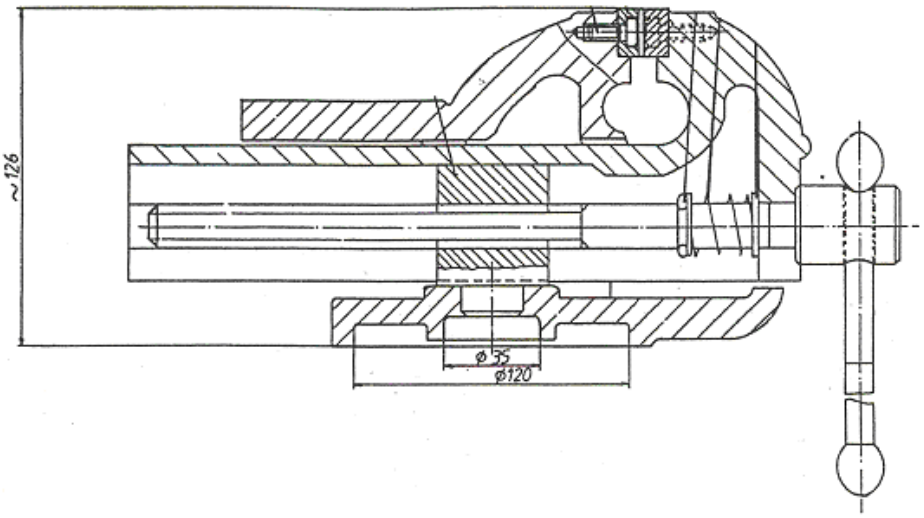
5. Conclusion

We can not achieve a sustainable macroeconomic durable stabilization, elimination of the current account deficit and equilibration of the commercial balance without improvement of the production quality, through assimilation of products concentrating a large amount of added value for each input unit. In this respect, the most important aspect economic agent must focus on is obviously saving the social work, which supposes reducing the specific consume, as well as a significant progress related to products' quality and utility. This problem could be better and faster resolved by adopting certain analysis methods which enable us to identify solutions for cutting costs and for increasing products' utility. As the theoretical exposure's and the case study's results showed, IV method is able to ensure substantial cost cutting, with maintaining or even increasing the products' and services' technical and functional parameters. The IV method uses the

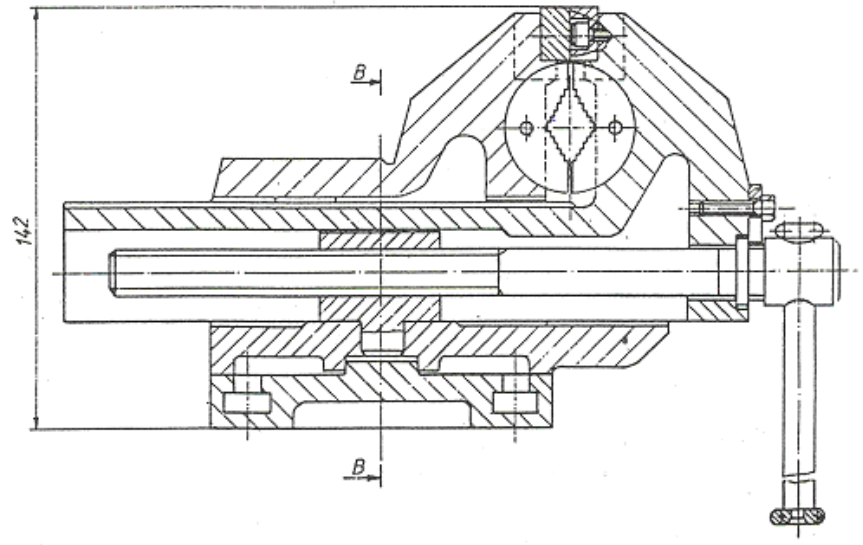
interaction between technical and economic criteria to stimulate specialists' creativity and to optimize the resources used for goods production.

The figures show the two product's configuration

Current product



Redesigned product



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