ROLE AND SIGNIFICANCE OF MECHATRONICS IN MACHINERY PRODUCTION (DEVELOPMENT OF THE ECONOMIC MODEL)

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Abstract- This article studies the role of mechatronics introduction (novations, new technologies) in the industrial field. The economic optimization model of factor dependence on mechatronics introduction, introduction efficiency, and dependence of costs on introduction is developed. The model involves close cooperation of planning and operating entities of the industrial field and science, planning of the science research depending on needs of the field, activity of introduction and use of science results and targeted training of the employees, who are able to provide the introduction and appliance of scientific achievements in practice.

Key words- Mechatronics, innovative model, cost optimization model, mathematic economic modeling, resources distributive mechanism, interpolation, flexible resources distributive mechanism, elasticity coefficient, calculation algorithm, economic mathematic interpretation.

I. INTRODUCTION

Carried out in the countries reorganizations in the industry involve the creation of new economic entities and new production management system. So far the powers and responsible persons for reliability and efficiency of the industry production are not completely determined in this system, there are no accurate developed principles of management activity of new conditions for the development of complex production facilities.
But at the same time new economic enterprises are formed, resulting in unmanageability of the industry that causes unexpected effects. So far the competence plays very important role in order to provide efficient development of industry production. There occurs quick development of the relevant coordination and management bodies.

To combine the work of industry reliability and efficiency providing in the countries, it is needed to learn how to negotiate about common joint goals, to provide mutual exchange of the information required to achieve specific goal, be able to develop innovation technologies, general criteria of reliability, to develop and to agree principles and required combining rules. In the old system of hierarchy, this complex was solved effectively, there were developed required rules and regulations, definite programs and facilities during the planning of development and functioning. So far the most important thing is to combine technology and industry. That is why the question arises as to whether mechatronics effects on industry.

II. STUDY OF THE QUESTION

Unusual solvings of the problems, which earlier appeared to be unsolved, typically appear at the interface of various scientific and technical disciplines. Mechatronics stays exact at this interface of mechanics and electronics. The existing term “electrical engineering”, externally similar to mechatronics, but, actually, they are different. The difference is in the technique organization levels. The appearance of mechatronics is connected with the development and formation of “microelectronics” and “microprocessor technology”. Mechatronics, combining mechanics and electronics, takes from them the best [1].

The main advantage of microprocessor systems is in flexibility and universality. Mechatronics system includes executive devices, “electronic control boxes” and “detectors” which perform feed-back. The demonstrative example of mechatronics system is automotive systems of fuel injection (injectors). Mechatronics gives to light consumer many positive factors in comparison with the technology of previous generation. For example, decrease of weight and linear dimensions, increase of reliability of some units and the machines, the easiest technology of repair and maintenance, increase of intermaintenance period. Also one can say that introduction of mechatronics in production activity is especially profitable for small and medium business organizations, where the bigger part of the equipment is adjusted according to the definite and usually regular orders. The appliance of flexible electronic management systems allows doing it in a short time as possible, convenient and cheap.
In this article we will develop mathematic model of mechatronics appliance in the industry. Let us study the changes of the industrial field with mechatronics appliance. How efficient is the production activity with mechatronics appliance. For this purpose it is needed to develop gradual management of the facilities and environment surrounding them in “digital reality” that is regulated by the intellectual resources (and artificial intelligence).

Innovative model shall involve close cooperation of planning and operating entities of the industry and science, planning of science research depending on needs of the field, activity of introduction and use of science results and targeted training of the employees who are able to provide introduction and appliance of scientific achievements in practice.
In this research we will develop the cost optimization model and introduction of mechatronics (novations) in the industrial field, we will select optimal variant, and for this purpose we will apply method of economic mathematic modeling that always was efficient tool for the increase of its work[1].

Further it will be reasonable to study models of planned work types. Costs for planned works could be substantially changed dependently on the program, labor efficiency of executed works, amount of factory workers, change of materials price factor, tariff rate, quality indicators of reserve use.
To develop mathematic model, we will study the resources distribution mechanism that can be divided into three types (figure 1)

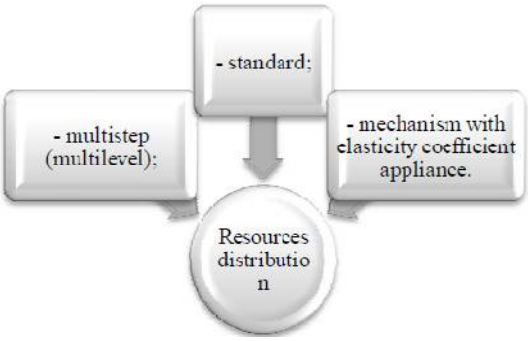


Figure 1 - Types of resources distribution mechanism

Multilevel costs are developed usually for various production scopes or "economic activity" levels according to planned form [3]

This type of flexible mechanism of resources distribution is not very convenient in use. The form of resources distribution mechanism, if it has values for many levels of production activity, looks very complicated, because actual execution does not correspond to accepted resources distribution mechanism to the level, that is why it is required to carry out estimations on interpolation. But this type of resources distribution mechanism is indispensable, if the transformation of separate groups of cost from the category of regular to variable can occur in planned period with specific range of accepted for estimation systems of production indications.

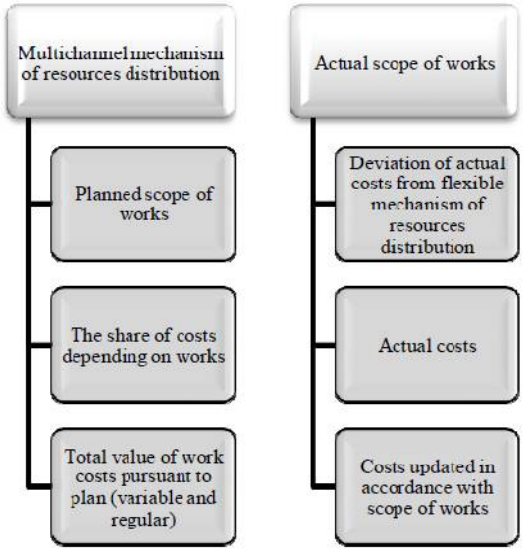


Figure 2 :Standard mechanism of resources distribution in the industry

Application of this type flexible mechanism of resources distribution allows defining quickly planned costs with any scope of work.

When studying flexible mechanism of resources distribution it is possible to apply the method of elasticity coefficient, being one more type of flexible mechanism of resources distribution that can be taken as the basis in activity optimization practice on the basis of mechatronics appliance. This resources distribution mechanism requires preliminary coefficients calculations, which show for how much percent scope of production, scope of work for 1%. In its purpose elasticity coefficient is identical to the share of costs of this group, which depend on production scope [2].
Further we will study calculation algorithm with the following order.

Calculation of wages fund for the introduction of nanotechnologies in the industry field:
$WF1 = xn * Cun1$,
where WF1 - wages fund;
xn – program of planned types of repairs and works;
Cun1 - costs per unit for the wages fund.
Let us determine the costs for allocations for social needs using a formula
$Cun2 = Cun1 * k$,
where Cun2 - costs per unit for allocations for social needs;
Cun1 - costs per unit for the wages fund,
k1 – 0.267.
We will determine costs for materials using the following formula
$Cm3 = CunC * xn$,
where Cm3 - costs for materials;
Cun3 - costs per unit for the materials;
xn – program of scope of work.

We will determine costs for fuel using the following formula [3].

$Cf4 = Cun4 * xn,$

where Cf4 - costs for fuel;

a32 - costs per unit for the materials;

xn – program of scope of work.

We will determine costs for electrical energy using the formula

$Cel/e5 = Cun5 * xn,$

where Cel/e5 - costs for electrical energy;

Cun5 - costs per unit for electrical energy;;

xn – program of scope of work.

We will determine other material costs using the formula

$Cot6 = Cun6 * xn,$

where $Cot6$ – other material costs;

$Cun6$ - costs per unit for other material resources;

xn – program of scope of work.

Let us define amortization using the following formula

$Zam7 = Cun7 * xn,$

where $Cam7$ – amortization;

$Cun7$ - costs per unit for amortization;

xn – program of scope of work.

We will determine other costs using the formula

$Cot8 = Cpu8 * xn,$

where $Cot8$ – other costs;

$Cun8$ - other costs per unit;

xn – program of scope of work.

Let us form general model of discussing costs for novations introduction [4].

$C = WF1 + SN2 + Cm3 + Cam7 + Cot8,$

where WF1 - wages fund;

SN2 - allocations for social needs;

Cm3 - material costs;

Cam7 - amortization allocations;

Cot8 - other costs.

Thus the optimal model of costs calculation is formed at first glance - the multichanel mechanism of resources distribution.

Let us develop standard flexible mechanism of costs resources distribution, that can be updated for the scope of executing works.

Initial data for the development of this resources distributions mechanism is: planned and actual scope of works, planned and actual costs value for the scope of works for every type [4].

The share of works depending on the scope, depends on costs value. Share of costs depending from the scope of work can be changed on all types of works.

Let us study total value of costs pursuant to the plan[2].

Total costs

$C0 = Ckr + Cdr + Ccr,$

where C - total costs;

Ckr - costs for introduction;

Cdr - costs for repairs;

Ccr - costs for current repairs.

We will calculate variable costs using the formula

$Cvar = Ct * \gamma 1,$

where Cvar - variable costs on types of works;

Ct - total costs on types of works;

γ 1 – share of costs depending on scope.

We will determine fixed costs using the formula

$Creg = Ct * \gamma 1,$

where Cfix - fixed costs on types of works;

Ct - total costs by types of works;

γ 1 – share of costs depending on costs.

Let us calculate costs updated in accordance with scope of works

$Ct* = Cvar* + Creg*,$

where $Ct*$ – general value of updated costs on types of works;

$Cvar*$ - variable updated costs by types of works;

$Creg*$ - fixed updated costs by types of works;

We will determine fixed costs updated on the scope of works in the following way [7].

$Cvar* = Ct * \frac{x1n}{x2n},$

where $Cvar*$ – variable updated costs by types of works;

Ct - variable costs by types of works;

$\frac{x1n}{x2n}$ - reflection of actual scope of repair for planned scope of work.

Fixed costs remain constant

Further we will represent deviation of actual costs from flexible mechanism of resources distribution by type of works

$C1n = C1n* - Ct*,$

where $C1n*$ – deviation of actual costs by types of works;

$C1n*$ – general value of updated costs by types of works;

$Ct*$ - fixed costs by types of works;

We will determine deviation of actual costs in the following way

$\sum_{n=1}^{3} P1n,$

where $P1n$ – deviation of actual costs by types of works;

Further it is needed to study the model of flexible mechanism of costs resources distribution with elasticity coefficients use. When applying this method, we will determine indications with the help of which the model will be developed. Such indications are planned scope, actual scope, planned and actual costs indications, including wages fund and materials.

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We will calculate other costs in the following way

$$COot = Ct - WFt - CmC,$$

where $COot$ – other costs by types of works;

WFt - costs for wages fund by types of work;

CmC- material costs by types of works;

Elasticity coefficient of wages fund is calculated using the formula

$$an = \frac{\frac{WF1n}{WF0n}}{\frac{x1n}{x0n}} - 1.$$

where an – elasticity coefficient for wages fund;

$\frac{WF1n}{WF0n}$ - relation of actual costs of wages fund for planned costs of wages fund;

$\frac{x1n}{x0n}$- relation of actual scope of works for planned costs of wages fund.

We will determine the elasticity coefficient of materials in the following way

$$bn = \frac{\frac{Cm1n}{Cmn}}{\frac{x1n}{x0n}} - 1.$$

Where bn – elasticity coefficient for materials;

$\frac{Cm1n}{Cm0n}$ - relation of actual costs for materials for planned costs on materials;

$\frac{x1n}{x0n}$- relation of actual scope of works for planned scope.

We will calculate execution of works program using the following formula

$$C = \frac{x1n}{x0n},$$

where C - coefficient of works program;

$\frac{x1n}{x0n}$- relation of actual scope of works for planned scope.

Let us update resources distribution mechanism in the following way

$$\sum C = WG* + Cm* + Cot*,$$

where ∑C – total sum of updated mechanism of resources distribution by types of works;

$WF*$ - updated wages fund;

$Cm*$ - updated costs for materials;

$Cot*$ - updated other costs.

$$Sum.u.r.d.m. = \sum_{x=1}^{1} C,$$

where $Sum.u.r.d.m.$ – summary updated resources distribution mechanism;

C – updated resources distribution mechanism by types of works;

$$WF\,u.m. = Cpl.wf.* (c-1) * an,$$

where $WF\,u.m.$ – updated resources distribution mechanism of wages fund;

$C.pl.wf.$ - planned values of costs for wages fund;

c - coefficient of works program execution;

an – elasticity coefficient for wages fund;

$$M.u.m. = C.pl.m.* (c-1) * bn,$$

where $M.u.m.$ – updated resources distribution mechanism of costs for materials;

$C.pl.m.$ - planned value of costs for materials;

c - coefficient of works program execution;

bn - elasticity coefficient of materials.

We will calculate other actual costs in the following way

$$C.ot,act. = \sum Cot. - WFu.m\ . - M.u.m.,$$

where $Cot.факт.$ – other actual costs by types of works;

$\sum Cot.$ – general amount of actual costs by types of works;

$WFu.m.$ - updated resources distribution mechanism of wages fund by types of works;

$M.u.m.$ – updated resources distribution mechanism of costs for materials by types of works [8].

Let us calculate deviation of actual costs from flexible mechanism of resources distribution

$$\sum_{n=1}^{C} P1n = \sum C - C,$$

where $P1n$ – deviation of actual costs by types of works;

∑C – total sum of updated resources distribution mechanism by types of works;

C – summary updated resources distribution mechanism by types of works;

$$C1* = \sum C1n,$$

where $C1*$ – deviation of actual costs from flexible mechanism of resources distribution;

$\sum C1n$ – deviation of actual costs by types of works;

Let us study the mechanism of costs resources distribution using multiply update base.

Elasticity coefficient of wages fund is calculated using the formula

$$dn = \frac{\frac{WF1n}{WF0n}}{\frac{t1n}{t0n}} - 1.$$

where dn – elasticity coefficient for wages fund;

$\frac{WF1n}{WF0n}$ - relation of actual costs of wages fund for planned costs of wages fund;

$\frac{t1n}{t0n}$ - relation of actual labor-intensity of scope of works for planned costs of wages fund.

Elasticity coefficient of materials is determined using the formula

$$bn = \frac{\frac{Cm1n}{Cm0n}}{\frac{x1n}{x0n}} - 1.$$

Where bn – elasticity coefficient for materials;

$\frac{Cm1n}{Cm0n}$ - relation of actual costs for materials for planned costs on materials;

$\frac{x1n}{x0n}$- relation of actual scope of works for planned costs of wages fund.

Let us calculate execution of labor-intensity by types of works

$$en = \frac{t1n}{t0n},$$

where en – labor-intensity coefficient by the types of works;

$\frac{t1n}{t0n}$ - relation of actual labor-intensity of scope of works for planned costs of wages fund.

Let us update the resources distribution mechanism in the following way

$WF.u.m. = Cpl.wf.* (en - 1) * an,$

where $WF\,u.m.$ – updated resources distribution mechanism of wages fund;

Зпл.фзп. - planned values of costs for wages fund;

c - coefficient of works program execution;

en – labor-intensity coefficient by the types of works;

$M.u.m. = Cpl.m.* (c - 1) * bn,$

where $M.u.m.$ – updated mechanism of resources distribution of materials costs ;

$C.pl.m.$ - planned value of costs for materials;

c - coefficient of works program execution;

bn - elasticity coefficient of materials.

Thus, we will calculate the deviation of actual costs from flexible mechanism of resources distribution with labor-intensity.

Finally, we can suppose that in this case the variant of studying all models of optimization mechanism of costs for novations introduction is possible:

The first model:

$C = WF1 + SN2 + Cm3 + Cam7 + Cot8,$

The second model:

$C = (Cpl.wf.* (en - 1) * an) + (Cpl.m.* (c - 1) * bn),$

The third model:

$C = (Cpl/wf * (c - 1) * an) + (Cpl.m.* (c - 1) * bn),$

Developed models of costs for novations introduction can be applied in practical activity.

CONCLUSIONS

Thus, developed mathematic model of dependence of costs for arrangement of novations introduction depends on types of works, reserves, quality of repair execution, variable expenses and etc. Criteria of exposures inclusion into mathematic model are justified. Influence degree of every exposure on effective indicator and joint impact on it are determined. That is why, in the result of economic mathematic interpretation it is found that the model is reflects studying process rather adequate. Above studied formula helps to update these indicators. It can be applied as the optimization variant during introduction of technologies in industrial field.

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