ENERGETIC CONSUMPTION REENGINEERING APPLICABLE TO ENERGETIC INDUSTRIAL SYSTEMS

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Abstract: New problems developed in comunication reffer to the following : mecano-energetic systems' optimizing patterns in operational research with reference to the concept of total energy, value engineering mathematical patterns, reengineering of optimization in the concept of total energy, conclusions bibliography

Key words: mecano-energetic systems, operational research, concept of total energy

1. MECANO-ENERGETIC SYSTEMS' OPTIMIZING PATTERNS IN OPERATIONAL RESEARCH WITH REFFERENCE TO THE CONCEPT OF TOTAL ENERGY

- **Optimizing theory of mecano -energetic systems in the concept of total energy**

The concept of total energy regards finding the best choice of conceiving the new objectives and rational exploitation on working facility between provider and consumer. This way in designing the new aims. According to the new objectives' conception, the type of energy production and consumption organising type has to be chosen so that it allows access to every enterprise on the same level to all the energy types in the needed quantities and quality for the optimal functioning of the technological processes. The energotechnical directions for implementing the concept of total energy , both of the new objectives and those still in working, as they were anticipated by scientists can be exemplified as follows.l

- determining the cumulated energy demand of the products and establishing exactly the needed quantity and quality of energy for planed production.

- the sources production and capacities for all the kinds of energies needed in the analysed production process(electricity, thermal energy, comprised air, water, gases)

- measuring the thermal and electrical networks within the platforms so that there are minimal connection roads between consumer and source

- the complex use of energy produced within the platform and harnessing the entire energy bearers' potential from the analysed processes.

- the unitary linking of the platformes to the national energy system and energy reserves to the consumers' reliability is respected at the pre-determined level and the saving is legal.

The total energy descriptor can be found both in the general feed system of the mecano-energetical equipment and in the structure of management operators of the energetical systems. In this context the energy spendings must be quantified at the following operational levels;

Developing activities.

Commercial activities

Energy production and transport activities

Activities from the structure of the human resources operators

Economical-financial activities corelated with decision and communication

- **Mechanical energy systems' development patterns integrated in the structure of the energy system**

$$C_{DD}^{(d)} = b_{tac}\left(\sum_i C_{cautare} + \sum_i C_{prognoza} + \sum_i C_{risc} + \right.$$
$$\left. + \sum_i C_{catastrofa} + \sum_i C_{haos}\right)$$

$$C_{DD}^{(d)} = b_{tac}\left(\int_t C_{cautare} + \int_t C_{prognoza} + \int_t C_{risc} + \right.$$
$$\left. + \int_t C_{catastrofa} + \int_t C_{haos}\right)_{dt}$$

In which: C_{DD} – effort value of development optimization in the discrete (d) and continuous (c) mechanical energy systems bearing the development expenses of the mentioned events in mind plus the efforts with the injected total energy, b_{tac} = updating binomial $b_{tac} = \sum_i (1+r_a)^{-i}$; r_a = updating rate.

Mathematical stock optimization patterns in the descrete and continuous structure:

$$C_{tac}^{(d)} = b_{tac}\left[C_{c+s} \cdot t_s \sum_{c=0}^{B} (B - 0{,}5c)p(c) + \right.$$
$$+ c_{c+s} \cdot t_s \sum_{c=\Delta B+1}^{\infty} \frac{\Delta B^2}{2c} + c_p \cdot t_p \sum_{c=\Delta B+1} \frac{(c-B)^2}{2c} p(c) +$$
$$+ c_{am} p_{iB}^{(d)} \cdot i_{aaB}(B + -\Delta B)$$

$$c_s^{(c)} = b_{tac}\left[C_{c+s} \int_0^B \left[B - \frac{c(t)}{2}\right] pc(t) \cdot dc(t) + \right.$$
$$+ \int_{\Delta B+1}^{\infty} \frac{\Delta B^2}{2c(t)} pc(t) \cdot dc(t) +$$
$$\left. + cp \int_{0=\Delta B+1} \left[\frac{c(t) - \Delta B^2}{2c(t)}\right] pc(t)dc(t) + p_{iB}^{(c)} c_{am} i_{spB}(B \pm \Delta B)\right]$$

In previous relations the following sizes intervene: I, C –investments and expenses generated by putting stock theory (I_s, C_s), expectancy theory (I_A, C_a), equipment theory (I_E, C_E), ordering theory (I_{OR}, C_{OR}), human engineering (I_{iM}, C_{iM}), search and risk (I_{CAT}, C_{CAT}, I_{RS}, C_{RS}) and decision theory (I_{DD}, C_{DD}) in practice; c_{c+s}; specific fuel and resource storage costs t_s – storing duration; B – system fuel quantity including storage ; c – resource demand; p(c) – deman probability; ΔB –fuel feed at an order; c_p, t_p – penury cost and duration; $p_{(d)}^{iB}$ $p_{iB}^{(c)}$ - probability of accomplishing the planned investments in the descrete (d) and continuous (c) structure; I_{spB} – specific investment of resource management subsystem ; c_{am} – resourece investment redemption quota. esuring stock levels and continuous purchasing of deficitary materials

Optimizing mathematical models in which expectancy in the discreete and continuous structure intervienes:

$$C_A^{(d)} = b_{tac}\left[t_c K_1(n-S)p(n) + t_c K_s\sum_{n=0}^{S}(S-n)p(n) + + c_{am}p_{iA}I_A\right]$$

$$C_A^{(c)} = b_{tac}\left[K_1\int_{n=s+1}^{m}[n(t)-S]p[n(t)]d[n(t)] + + \int_{n=0}^{S}K_2[S-n(t)]p[n(t)]d[n(t)] + c_{am}p_{iA}I_A\right]$$

where K_1, K_2 are expectancy consits in the time unit; p(n)expectancy probability of the (n) units in a row ; m – number of total units in the examined system; c_{am} – investment redemption quota(I_A); p_{iA} – probability of materialising of these investments. Restrictions mainly reffer to ensuring continuation in the functioning plants (S) that serve the units (n) from the waiting line and diminishing down time caused by the lack of system units. To these general restrictions the priority ones are added, the work force restrictions and the ones required by the – technology regimes—(S) in (t_c) time

Mathematical patterns connected to the equipment in discreete(d) and continuous (c) structure:

$$C_E^{(d)} = b_{tac}\left[\sum_j c_{aj}p_{aj} + \sum_j\sum_k c_{jk}p_{jk} + \sum_v\sum_j c_{vj}p_{vj} + + c_{am}p_{iE}I_E^{(d)}\right]$$

$$C_E^{(c)} = b_{tac}\left[\int_{t_s}^{t_i}C_{aj}^{(t)}p_{aj}^{(t)}d\left[p_{aj}^{(t)}\right] + \int_{t_s}^{t_s}C_{jk}(t)p_{jk}^{(t)}d\left[p_{jk}^{(t)}(t)\right] + + \int_{t_s}^{t_s}C_{vj}(t)p_{vj}d\left[p_{vj}(t)\right] + c_{am}p_{iE}I_E^{(c)}\right]$$

In which: b_{tac} is the updating binomial; c_{aj}, p_{aj} are equipment purchasing costs and the probability of the action being accomplished in time; C_{jk}, p_{jk} – repair and maintainance expenses for the equipment and probability of accomplishing the demanded quality; c_{vj}, p_{vj} –failure costs and costs of harm conditioned by probability values p_{vj} occurance of failure and harm similar to the redemption quota ; p_{iE} – probability of accomplishing investments (I_E). Restrictions mainly reffer to ensuring a good quality of the equipment and in the needed quantities, supporting the maintainance pace of the equipment by purchasing replacements in due time; assuming failures in the analised system without losses, running the equipment in the normal limits of wear. Minimizing expenses (c_E) allows finding the best level of equipment running safety in the analized system.

Mathematical patterns of optimal ordering of production in systems with discreet (d) and continuous (c) systems:

$$C_{OR}^{(d)} = b_{tac}\left\{\sum_{t=1}^{p}f_t(x)p(x) + c_s\sum_{t=1}^{p}(P_t - C_t + S_t)p(C_t) + + c_p\sum_{t=1}^{p}(C_t - P_t + S_t)p(C_t) + c_{am}\cdot p_{OR}I_{OR}^{(d)}\right\}$$

$$C_{OR}^{(c)} = b_{tac}\left\{\int_0^T f[x(t)px(t)]dx(t) + c_s\int_a^b[P(t) - C(t) + S(0)] d[C(t)] + c_p\int_c^d[C(t) - P(t) + S(0)]dC(t) + c_{am}\cdot p_{OR}I_{OR}^{(c)}\right\}$$

in which: f(x) production function, c_s, c_p are storage and penury costs; P_t resource production; C_t – resource demand; $S_{t=0}$ stock at the initial moment; c_{am} – investemnt redemption quota; I_{OR}, p_{OR} are investments and the probability of achieving the investments necessary for ordered production; p(C_t) probability of acchieving the required conditions when ensuring demand (C_t). Restrictions reffer mainly to the succesion of the operations according to different degrees of priority of the operations, non-interference of works, complete usage of production capacity according to the degree equpment usage tollerance and the usage durration of the equipment. Through minimizing expenses (C_{OR}) the correlations between the resource generator, stock deposit and consumers' demand are optimizes so that losses are optimal.

- **Modeling the human resources activities**

Mathematical patterns for optimal human engineering practical use in systems with discrete and continuous structure operating with the following formulas:

$$C_{im}^{d(c)} = b_{tac}\left[C_{pp} + C_{01} + C_{nr} + C_{0c} + C_{sjk}\right]^{d(c)} = minim$$

$$C_{pp}^{d(c)} = b_{tac}\left[I_{pp}^{d(c)} + C_{pp}^{d(c)}\right] - \left[R_{act_{pp}}^{d(c)}\right]$$

$$C_{01}^{d(c)} = b_{tac}\left[I_{01}^{d(c)} + C_{01}^{d(c)}\right] - \left[R_{act_{01}}^{d(c)}\right]$$

$$C_{0c}^{d(c)} = b_{tac}\left[I_{0c}^{d(c)} + C_{0c}^{d(c)}\right] - \left[R_{act_{0c}}^{d(c)}\right]$$

2. MATHEMATICAL PATTERNS OF VALUE ENGINEERING

The mathematical patterns for putting value engineering and analysis in practice are as follows"

$$C_{IAV}^{d(c)} = \left[C_{RPP}^{d(c)} + C_{ESC}^{d(c)}\right] = minim$$

$$C_{RPP}^{d(c)} = b_{tac}\left[c_{am}I_{RPP}p_{RPP1} + C_{RPP}p_{RPP2}\right]^{d(c)}$$

$$C_{ESC}^{d(c)} = b_{ESC}\left[c_{am}I_T^{cap}p_{ES1} + C_T^{cap}p_{ES2}\right]^{d(c)}$$

In which: $C_{IAV}^{d(c)}$ total expenses for applying value engineering and analysis; $C_{RPP}^{d(c)}$-total expenses for redesigning products and equipment; $C_{ESC}^{d(c)}$ - total expenses for cost advance, p_{RPP}, p_{ES} – probability of meeting the redesign and cost advance conditions, I_{RPP}, C_{RPP} –investments and expenses for redesigning the

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analysed products and equipment, I_p, C_p –total investment and expenses, b_{EBC} cost advance binomial.

$$b_{ESC} = \sum_{i=1}^{n} (1+\gamma_{ESC})^{+1}$$

γ_{ESC} – cost advance rate

Restrictions mainly reffer to respecting the functions of a product, of the redesigned objective and the required technical level

Decision patterns- communication within mechanical energetic systems

Decision mathematical patterns can be as follows:

$$C_{DD}^{d(c)} = b_{tac}\left[c_{am} I_{DD} p_{DD} + C_{DD} p_{DD1}\right]$$

$$H_i^{(d)} = K_t \left[\sum_j \sum_k \sum_l \left(p_{jki} \lg \frac{1}{p_{jki}} + q_{jki} \lg \frac{1}{q_{jki}} \right)\right]$$

$$H_i^{(d)} = K_t \left[H_{tj} + H_{tk} + H_{ti}\right]^{(d)}$$

$$H_j^{(c)} = K_t \int_{t_s}^{t_s} p_j(t) \lg \frac{1}{p_j(t)} d[p_j(t)] + \int_{t_s}^{t_s} p_k(t) \lg \frac{1}{p_k(t)} d[p_k(t)] + \int_{t_s}^{t_s} p_1(t) \lg \frac{1}{p_1(t)} d[p_1(t)] + \int_{t_s}^{t_s} q_j(t) \lg \frac{1}{q_j(t)} d[q_j(t)] + \int_{t_s}^{t_s} q_k(t) \lg \frac{1}{q_k(t)} d[q_k(t)] + \int_{t_s}^{t_s} q_1(t) \lg \frac{1}{q_1(t)} d[q_1(t)]$$

In which: $C_{DD}^{d(c)}$ updated total expenses for building and applying decisions for certainty, risk and uncertainty; I_{DD}, C_{DD} –investments and expenses for building and applying, p_{DD}; p_{DD1} – probability of achievement for pre-established conditions both on the level of investments (p_{DD1}) and expenses (p_{DD2}); $H_i^{d(c)}$ the entropy of the system designed in the two structures: discrete(d) and continuous (c); K_t = 3,32 transformation factor of the logarithm from base 2 to base 10 ; p_{kji}; q_{kji} – success and failure probabilities of the equipment(j);regarding production objectives.

3. REENGINEERING OF OPTIMIZATION PATTERNS OF ENERGETICAL OBJECTIVES ACCORDING TO THE CONCEPT OF TOTAL ENERGY

The first phase meant innovating the structure of optimizing patterns and led to new patterns based on multicriterial decisions. The main criteria such as: the useful effect of energy. Quality etc. were arranged according to their utility in the process and the contribution of each in diminishing catastrophic effects. The structure of these models based on costs can be written as follows:

$$C_{tan} = C_{combustibil} + C_{\substack{materiale\\auxiliare}} + C_{amortizare} + C_{salarii} + C_{diverse}$$

$$p^{prețul}_{\substack{produsului\\realizat}} = \frac{C_{tan}}{V^{volumul}_{produselor}} = \frac{C_{comb} + C_{materiale} + C_{amort} + C_{sol} + C_{dv}}{V^{volumul}_{produselor}}$$

The second phase uses operational research patterns, anticipated by equipment, performances such as: the constant development operator, commercial operator, system operator, human resource operator, economic-financial operator and the decision-communication operator, integrated in a holistic system on source-transport-account relation.

Economic-financial efforts divided among real events of the operators mentioned before can be written as follows:

$$C^{cercetare}_{\substack{operationale\\anuale}} = \left[C^{dezvoltare}_{durabile} + C^{activitate}_{comercială} + C^{activitate}_{de producție} + C^{resurse}_{umane} + C^{activitate}_{\substack{economico\\financiară}} + C^{decizie}_{comunicare}\right]$$

$$C^{tac}_{cop} = \sum_{i=1}^{dv} (1+r_a)^{-i} C^{cercetare}_{operationale\,anuale(i)}$$

$$p^{pretul}_{\substack{produsului\\realizat}} = \frac{C_{tac}}{g_i V^{volumul\ produselor}_{tac} dv} = \frac{\sum_{i=1}^{dv} (1+r_a)^{-i} C^{cop}_{anuale(i)}}{g_i V_{tac} dv}$$

in which: r = updating rate; g_i = degree of hardness if the, dv = lifespan of equipment.

Restrictions required by the operators' events reffer to the quality of the information researched and applied to the quantum prognosis and energy producing sources, risk undertaking, resource purchasing in favourable moments; market condition; technology innovation on the entire electrical network, economical running of functioning equipment(efficiency inventory, 90% loads and continuous running all year long)

.

The third phase of reengineering the optimizing patterns of the energetic systems that feed energy consumers entails a change in the structure forming the optimizing concept of the entire system thus hindering restrictions being included in the performance function. These patterns are based on evolutionary algorithms in the genetic

The mathematical structure of the new patterns including the price of the product can be written as follows:

$$C^{\text{algoritmi}}_{\substack{\text{evolutiv}\\ \text{(genetici)}}} = \Big[\Big(C^{\text{dezvoltare}}_{\text{durabilă}} + C^{\text{activitate}}_{\text{comercială}} + C^{\text{sistem}}_{\text{integrat}} + C^{\text{calitatea}}_{\substack{\text{resursei}\\ \text{umane}}} + C^{\text{actitivitate}}_{\text{economica}} + C^{\text{decizii}}_{\text{comunicare}}\Big) + C^{\text{coeficient}}_{\text{depenalizare}}\Big(R^{\text{dezvoltare}}_{\text{durabila}} + R^{\text{activitate}}_{\text{comercială}} + R^{\text{sistem}}_{\text{integrat}} + R^{\text{calitatea}}_{\substack{\text{resursei}\\ \text{umane}}} + R^{\text{actitivitate}}_{\text{economica}} + R^{\text{decizii}}_{\text{comunicare}}\Big)\Big]$$

$$p^{\text{pretul}}_{\substack{\text{produsului}\\ \text{realizat}}} = \frac{C^{\text{algoritmi}}_{\text{evolutivi}}}{g_i V^{\text{volumul}}_{\text{productiei}}} \cdot \frac{1}{dv}; p^{\text{pretul optimal}}_{\substack{\text{produsului}\\ \text{realizat}}} = \frac{C^{\text{algoritm}}_{\text{evolutiv tac}}}{\left(g_i V^{\text{volumul}}_{\text{productiei/rod}} \cdot dv\right)}$$

- **Software products dealing with optimizing energy consumption**

a) Software product for operational research application the goal being optimizing the product-consumption correlation in arhemo-systemic conception

Stock theory application	Cost and value engineering theory application
Expectancy theory application	
Equipment theory application	Investments and connecting
Ordering- theory application	and colateral expenses theory application
Prognosis theory application	Equalization theory application
Decision theory application	Subroutine makes the graph of a function

4. CONCLUSION

There is a 50% energy consumption reduction in different industrial processes if the software products from above are used on the entire production-consumption tap.

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