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Psychological Aspects of Labour Organization in Automated Production Processes

Labour organization, particularly under conditions of automated production, includes also an analysis of the psychological factors of work.

The Party and State documents endorsed in recent years lay stress on the necessity of permanently supplying production with the best achievements of science, particular attention being paid to the mechanization and automation of the production processes. By raising productivity between two and ten times, or even 500 times, automation (when accompanied by renewal of technological processes) is an important factor for increasing output. The organizational aspect of labour in the automated industry is, therefore, of outstanding importance.

To make up an optimum mode of labour organization at the control panel it is necessary to solve such matters as the number of work hours and work in shifts as, in most of cases, the automated works operate in continuous flow with three shifts. These problems, of major importance for labour organization in automated industry, cannot be solved without getting acquainted with the psychological factors which affect this work.

A vast research work has been dedicated to these problems (J. Walker, S. Wyatt, O. Banks, C. Well, W. Bloom and others) which often yielded inconclusive results; most of it concentrated on the psychological factor of fatigue. The research was aimed at establishing an optimum duration of work hours and the most advantageous rotation of shifts so that the reliability level of the operator's activity should not decline, and the risks of injuries and breakdowns due to the human factor be reduced to the minimum.

The research workers of the Institute of Psychology have approached these problems at request of the productive sector, by making use of some original methods and techniques [1].

The elaboration of a special methodology of investigation into the sphere of fatigue, the variations in the capacity of maintaining a good level of alertness and other labour parametres covered an important part of the research work. To this end, functional tests have been envisaged that would be directed to those characteristics of the activity which appear to be most vulnerable in conditions of fatigue.

Results have been obtained with perceptual tests which consisted of exposure to the electronic tachistoscope of sets of signals similar to those used at the control panel. Another test consisted of the recording of the reaction time to signals of diverse colours which appear in different space positions. A special alertness test was also employed to watch the quickness and precision of the reaction to sparse and irregular signals, which must be differentiated from the succession of indifferent signals.

The tests proceeded in three stages: at the start, in the middle and at the end of the shift. The results were corroborated with the other indicators surveyed, namely with the quality indices. (At the "Brazi" refinery the deviation of the finished products from the quality standards has been studied over a 4-month period, and at the Grozăveşti combined heat-and-power station the breakdowns and faults occurred during the three shifts have been studied over a period of two years).

Other indices of the technological process have been surveyed in the course of their evolution per shifts: the swiftness in regulation at the control panel of the technical parameters that deviated from the standard, and the modifications of the entropy when being on duty.

It has been noticed that fatigue is clearly reflected on the production indices of lesser importance, while the production indices of major importance, on which full attention is centred, are less affected due to the motivation factor which brings about additional efforts.

The breakdowns and faults caused by the personnel, or whose expansion was possible because of deficient interventions have been appreciated in the electric power sector as indirect indices of productivity [2].

In contradistinction to the petrochemical industry, where the results of the functional tests evinced their growing deterioration from the first shift to the third shift, in the electric power sector it has been noted that the major factor which exercises an influence on the degree of fatigue is the activity strain which shows important fluctuations caused by the specific nature of work.

The strain does not differ significantly in the petrochemical industry from one day to another, while in the electric power industry the strain presents important fluctuations.

A much higher deterioration of the results of tests carried out in the third shift has been noted on the days with growing strain. This is expressed in production by a higher percentage of breakdowns or expanded breakdowns during this shift. The effort to overcome fatigue is more efficient in the petrochemical industry sector due to a steadier activity and less frequent emergencies.

Strains exceeding the permissible level — conducive to important material losses — have been noted in the power sector, in the second and third shifts. These overstrains occur in a proportion of 20 per cent.

The evolution of the work capacity has been surveyed at the Brazi refinery along a full 18-day cycle. On the basis of the results, a more frequent rotation of shifts has been recommended, which proved satisfactory when applied in production.

The study of the quality indices at the Brazi refinery showed a higher probability of occurrence of deviation from the quality standards in the second shift, though the functional capacity appears more reduced in the third shift.

It has been pointed to the necessity of a more active control of work efficiency in the second shift, taking into account the fact that the enterprises concentrate all efforts of supervision and control on the third shift.

The rational organization of labour in automated production during a work day supposes the knowledge of the operator's strain level and the modification of the reliability level of his activity during a work day.

To determine these factors use has been made, besides diverse psychophysiological tests, of the information computation applied to the data obtained by photographing a work day. It has been thus estimated the informational input and the information omitted by the operator during the work day.

The investigations conducted in diverse automated enterprises of the chemical and power industries spotlighted a number of factors which are to be taken into consideration in the rational organization of labour:

a) The reliability level of the operator's activity is determined to a great extent by the type of the informations system. The analogical system enabling a forecast of the subsequent evolution of the technological parameters ensures a higher degree of reliability than the two-position signalling system. Sensible higher losses of critical information have been noted at the latter towards the end of the work day compared to the first work hours. In order to prevent these decreases of the reliability level, the introduction of a break every two hours of work is recommended [3].

b) The reliability of the operator's activity can be related not only to the volume of information input at the panel but also to the nature of operations. Thus, a drop in the reliability degree is noted in case of monotonous activity, which is reflected in low values of the selective supervision entropy (1.10 binary units) the under-arousal state drops under the alert level.

A diminution of the reliability level is also noted when higher values of the general supervision entropy appear (4.75 binary units). In the first instance the introduction of an additional task is recommended, and in the second, the decrease of the number of apparatus per each operator and the increase of the personnel on duty.

c) The very activity of surveying the panel entails an organizational factor which is reflected in the strategy of this activity. The research showed that the supervision strategy and the extent of intervals between two consecutive supervisions are determined by the functional importance, the frequency of faults, the rational organization of the control panel, the possibility of detecting the breakdowns and the operational conditions.

It has been possible to study the dynamics of these factors by means of mathematical methods, with estimates of the length of the average interval (τ) between two breakdowns of parameters, by the following formula [4]:

$$\tau = \frac{T}{\frac{1}{n}\Sigma ki} = \frac{n}{N} T = \frac{\text{total supervision time}}{\text{total number of breakdowns}}$$

(T being the work hours of a shift, k = the number of breakdowns noted in a shift, and ε the reliance level or carefulness degree). For a given τ, t_0 is introduced, i.e. the interval between two supervisions, expressed as a function of the reliance level E, thus:

$$t_0(\tau) = \tau \log_e (1 - \varepsilon)$$

In this way, there is the possibility to compare the length of theoretical intervals of supervision and strategy of an ideal surveyor, with the strategy used by the operators under survey. It has been thus noticed a non-concordance between the theoretical supervision strategy and the strategy of operators in production, which is conducive to rather a large number of neglects and delays in the elimination of breakdowns. In exchange, the operator's behaviours are sometimes those which a computer would miss: anticipation of some signals, correlation of parameters, etc.

An organizational factor occurs in the activity of power dispatchers. A survey carried out on individuals in two dispatcher sections of two power plants and two chemical plants showed the existence of key moments in the activity of solving situations, at most of the subjects [5], [6].

In the research has been used the method of graphic comparison of the real operation sequences with the logical sequences elaborated by expert engineers (the development of the Whitefield-Sokolov method).

The analytical and synthetical curves resulting from the superposing of the individual solvings have been drawn. A discrepancy has been noted between the real solvings and those indicated from the logical viewpoint, and the premises established for an optimization of the succession of thinking operations, in the work at the control panel.

The relation between information and decision, and the types of decisions in the work of power dispatchers were also studied [7]. The results achieved through the method of work day photographing in two dispatcher departments under subordination relation were statistically processed, and thus, the structure of the activity as a whole and the share of each type of activity in the dispatchers' work (request, reception and supply of information, decisions) have been established. It has been thus noticed that in the structure of decisions of the superior system prevail the information requested from the system (relation 2: 1), while in the subordinated system prevalent is the information received from the system against that requested.

The investigation led to the theoretical conclusions on the relation between information and decisions as well as on practical recommendations with regard to the organization of dispatchers' work. So, following a notification through a proceeding of the undue psychoneurotic strain degree of

power dispatchers, the Council of Ministers adopted a decision establishing the work time of this category of employees to six hours.

Other recommendations included in the proceedings addressed to IPA (Institute for Automation), ISPE (Power Study and Design Institute), The Direction of the Power System under the Ministry of Electric Power, IDEB (The Bucharest Enterprise for the Electric Supply), and the Grozăveşti combined heat-and-power station have been aimed at the improvement of working conditions from the organizational point of view, of the current activity of dispatchers and shift foremen in electric power plants.

In all these instances, a better organization of labour based on psychological data may bring about increased labour efficiency and increased output.

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ASPECTS PSYCHOLOGIQUES DE L'ORGANISATION DU TRAVAIL DANS LA PRODUCTION AUTOMATISEE

Cet ouvrage s'occupe de certains aspects de l'organisation du travail dans l'industrie automatisée, considérés au point de vue psychologique: le travail par équipes dans les usines à flux continuel, l'organisation du travail de l'opérateur au tableau de commande pendant la durée d'une équipe, l'organisation du travail des dispatcher. Les auteurs indiquent les méthodes de recherche utilisées et font certaines recommandations fondées sur les conclusions tirées.

ПСИХОЛОГИЧЕСКИЕ СТОРОНЫ ОРГАНИЗАЦИИ ТРУДА В АВТОМАТИЗИРОВАННОМ ПРОИЗВОДСТВЕ

Эта статья касается некоторых сторон организации труда в автоматизированной промышленности, оцененных с психологической точки зрения: труд по сменам на заводах, работающих беспрерывно, организация труда операторов командных щитов во время одной смены; организаторские вопросы труда диспетчеров. Указываются использованные методы исследования и даются некоторые рекомендации, сделанные на основе полученных выводов