PROJECT AND PROGRAM MANAGEMENT

УПРАВЛІННЯ ПРОЕКТАМИ ТА ПРОГРАМАМИ

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THE PROBLEM OF STRESS RESISTANCE IN HUMAN RESOURCE MANAGEMENT

Г.В. Мигаль, О.Ф. Протасенко. **Проблема стресостійкості в управлінні людськими ресурсами.** Розглянуто проблему врахування та управління людським фактором для забезпечення надійності, безпеки і життєздатності складних динамічних систем, керованих людиною в стресових умовах діяльності. Урахування індивідуальних особливостей реагування людини на стрес-фактори його діяльності спрощує оптимізацію діяльності і знижує ризики, зумовлені людським чинником. Показано, що без системного вивчення стану стресу людини-оператора залишається не вирішеною проблема стресостійкості. Необхідний пошук методів і засобів оцінювання стресостійкості та визначення її «ціни». ***Мета:*** Метою роботи є розробка методу моніторингу, прогнозування і оцінки стресових станів людини-оператора з метою підвищення керованості динамічних ергатичних систем. ***Матеріали і методи:*** Для дослідження застосовано методи психофізіологічної діагностики. Вимірювали сполучені ємність і опір у змінному полі репрезентативних біологічно активних точок і «точок стресу». Додатково визначали психофізіологічні характеристики організму випробовуваного за тестами Люшера і Спілбергера. Для оцінки ступеня впливу стресових умов діяльності на динаміку функціонального стану студентів визначено кількість кореляційних зв'язків між вимірюваними параметрами. Було побудовано графи кореляційних зв'язків функціонального стану. ***Результати:*** Розроблений метод побудови графів кореляційних зв'язків функціонального стану дозволяє виявити стресовий стан у людини, а також встановити, що є основною причиною його виникнення. Даний метод можна використовувати для визначення «ціни» адаптації людини до стресових умов діяльності.
Ключові слова: людина-оператор, стрес, стресостійкість, управління персоналом, людський фактор.

G.V. Mygal, O.F. Protasenko. **The problem of stress resistance in human resource management.** The problem of accounting and management of the human factor for ensuring the reliability, safety and viability of complex dynamic systems managed by a person under stressful conditions of activity is considered. Taking into account the individual characteristics of the human response to stress factors it simplifies optimization of activity and reduces the risks caused by the human factor. It is shown that without systematic study of stress state of the human operator the problem of stress resistance remains unsolved. It's necessary to develop the methods and tools for evaluation of stress resistance and determining its "cost". ***Aim:*** The aim of this research is to develop methods for monitoring, forecasting and evaluation of stress states of the human operator to improve manageability of the ergatic dynamic systems. ***Materials and Methods:*** For the study the methods of psychophysiological diagnostics are used. Measured the following electrophysical parameters of representative biologically active points and "stress points" – capacitance *C* and resistance *R* in the variable field. For more complete information about the functional state of the experimental subject the physiological characteristics of his body determined by two tests – Lüscher color test and Spielberger test. To assess the degree of influence of stress conditions on the dynamics of the functional state of the students we determined the number of correlations between the measured parameters. The correlation graphs of functional state were built. ***Results:*** The developed design method of "correlation graphs of functional state" allows to identify stress in humans and determine which is the main reason for its occurrence. The proposed method can be used to determine the "cost" of human adaptation to stressful operating conditions.
Keywords: operator, stress, stress resistance, personnel management, human factor.

Introduction. The intense pace of life, highly intensified production processes, necessity every day to solve hundreds of problems of varying complexity, actively participate in the various fields of human activity together with the further complication of dynamical systems "man — technology — environment" has led to the appearance of the problem of reliability of the man-leader, of the operator who is control element in the dynamic systems. This problem in its turn, is part of a complex system problem to ensure the safety of complex ergatic systems [1], which now attracts more attention because of the constantly growing number of industrial accidents and disasters, the occurrence of which in most cases is associated with the "human factor".

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Term “human factor” is known in connection with the problem of human interaction with man-made environment in such areas of human activities as aviation, nuclear power, transportation management and others. Define the term differently. Thus, *J.M. Christensen* determines the human factor as a multivalued term that describes a person possibility to adopt false or illogical decisions in specific situations. *A.N. Liberman* reveals the human factor as a systemic phenomenon, as a source of human failures. From this perspective, the human factor is ability of man to act deliberately irregular and unpredictable or knowingly make wrong and unforeseen decisions [2]. However, despite the variety of definitions, they have a common point – the need to consider human factors and its management at all stages the life cycle of ergatic systems. Without this there can’t be solved a set of problems (reliability, safety, efficiency of management, etc.) which provide viability of any complex technical systems. Statistics shows that 80...90 % of all accidents and disasters in all sectors of activity occurring through the fault of man. About 70...80 % of all accidents that resulted in injury getting most performers or people around them occur because of erroneous human actions [3...5]. An important point is that the majority of operators in the learning process quickly and successfully acquired the necessary knowledge and skills, but in the real stress situations they lost the ability to use them. This fact can’t be explained by problems in education [6...8] and because it is the basis for the emergence of problems – the need to assess the stress resistance of the operators. Of course, this problem is not new, but today has a number of tasks: taking into account the action of stress factors of environmental and human activity; forecasting of negative scenarios of functioning of man as the management unit in stressful situations; search of effective methods and means of selecting people who are stress resistant; search for effective methods of determining the “cost” of human adaptation to the activity under stress.

Based on the above, today necessary the aimed steps in human resource management. To successfully achieve this goal we need a systematic study of the state of stress of the human-operator as multicriteria task without solution of which significantly increased the risks and unpredictability of behavior of complex dynamic systems controlled by man in conditions of stress.

Research stress as condition. The problem of stress can be viewed from different perspectives. With biological position as a system of adaptive acts; in physiological perspective – as mechanisms of regulation of different functional systems; in the psychological aspect – the impact on various aspects of psychic activity: perception, memory, attention, mental operations, etc.; in the social aspect – human behavior in a team, impact the atmosphere of the team on the change its functional state; the medical aspect – as the disruption of normal function of various organs and systems [2].

Despite the variety of approaches to the study of stress, none of them give a complete picture of it. This is due primarily to the fact that these approaches make it possible to evaluate only a few signs of stress in man, but does not associate them together. As a result, obtained data have differentiated nature, which reduces their value. However, this problem was solved through the use of psycho-physiological approach to the study of stress, because it makes the complexity of the information received about the human condition, which allows the simultaneous evaluation of both physiological and psychological changes in the body when factors of different intensity, duration nature and origin [7, 8] exposed at him. Today, this approach is the most informative and promising.

The effects of the action of stress factors. Stress factors are such environmental conditions (both negative and positive) that inappropriate of congenital and acquired properties of the human body. All stress factors affecting a person, usually measured at the intensity (power) of impact, the nature of origin, novelty and specificity of action on the body (the mechanisms that applied to form an appropriate response). Each of these indicators represents a set of characteristics of stress factor and requires research and evaluation. However, the biggest difficulty in assessing the stress factor is above all that almost impossible to draw a clear line between normal and stress factors, because the same factors at the same time for some people may be conventional, but for others – stress. The difference determines not only the specifics of irritant as personality reactions of the human body. Raising or lowering ambient temperature, hunger or thirst, emotional stress or immobilization, etc. – all these raise a number of changes in the body that combined by the concept of “stress reaction”, but each person is

individual and it is often difficult to forecast. Today attention of researchers most concentrated on the study of individual man reactions on the impact of stress factors.

The stress resistance. Note that while the problem of scrutiny of stress as state, existence of many approaches, methods and tools for evaluating the stress, applied task of evaluating of man resistance to stress and determining its "cost" remains unsolved.

The above indicates that the problem of stress resistance arose because of distribution of occupations related to the activities in extreme conditions, which causes increased stress of the physiological systems of the human body and its mind and has a negative impact on the results of its operations. The efficiency and reliability of activity in stressful conditions determine the ability to resist the negative effects of stress, called resistance to stress. Strict requirements to stress resistance this is feature of operator work, which is characterized by high accuracy and speed of action, responsibility and "cost" mistakes and taken decisions. Therefore important is the search for solutions of the problem of evaluating of stress resistance and its "cost" for the human operator. It is obvious that noninvasive intervention should be preferred with registering of the most technically available indicators.

Many studies show that reactions to stress can cause long-term negative effects on human health. Specifically, conducted research of stress effects on the cardiovascular system, studied the relationship with arterial hypertension, and impaired coronary circulation, risk of heart failure (S. Sauter, J. Hurrell, L. Murphy, L. Levi, etc.).

L.S. Fainzilberg and *M.V. Ragulskaya* show the correlation of parameters of the cardiovascular system and biologically active points of human skin with heliogeophysical factors. Also, *M.V. Ragulskaya* [9] considered the influence of environmentally unfriendly anthropogenic factors of modern metropolis to its citizens, and features of the human body to adapt to such complex effects that estimate by the parameters of the cardiovascular system and biologically active points of the skin.

Note, that the "cost" of adaptation to stress factors of environmental and activity is high, because it is achieved through the use of functional resources of the body and stress regulatory mechanisms. Most clearly it's expressed in people who are at high psycho-emotional or informational load (for example, operators of complicated technical complex, pilots, drivers, dispatchers, managers, doctors, etc.). For them, even small increase of stress rate of regulatory mechanisms in reply to influence of stress factors of activities or environment leads to disturbance of homeostasis; and it is reflected in the change of dynamic parameters of biologically active points of the skin and the cardiovascular system.

Therefore for different scientific and practical areas (ergonomics, personnel management, etc.) to improve manageability (safety, security) of ergatic dynamic systems the problem of detection state of operator stress and evaluating its "cost" for the organism is actual.

The aim of this research is to develop methods for monitoring, forecasting and evaluation of stress states of the human operator to improve manageability of the ergatic dynamic systems.

Materials and Methods. We conducted series of experiments to study the dynamics of the functional state of students and cadets in stressful conditions. The experiment consisted of two stages.

In the first stage the object of study were 100 students aged 18…20 of National Aerospace University "Kharkiv Aviation Institute", in the second – 50 cadets aged 18…20 of Kharkiv National University of Air Force n.a. Ivan Kozhedub. During the work we studied the effect of stress conditions of the learning process (during exams) and personal factors (alcohol consumption, smoking, presence of disease, lack of exercise, level of anxiety, activity and efficiency factors) on the dynamics of the functional state of students.

For the study we used the methods of psychophysiological diagnostics.

When choosing the human organism parameters, which satisfy the criteria of consistency, integrity, inclusiveness and hierarchy, we used the most integrated information system of human organism – the skin [7, 10]. Selected measurement points – biosensors – located in the most accessible parts of the human skin – feet, hands, tip of the nose and lips. Measured the following electrophysical parameters of representative biologically active points and "stress points" (*VG*25, *VG*26, *GI*4) – capacitance *C* (pF) and resistance *R* (MOhm) in the variable field.

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For more complete information about the functional state of the experimental subject the physiological characteristics of his body determined by two tests – Lüscher color test and Spielberger test. With Lüscher eight color test we obtained the following quantitative characteristics of psychophysiological state of the experimental subject – activity factor (*AF*) and performance factor (*PF*). With Spielberger test we obtained such a psychophysiological indicator as the level of personal anxiety (*PA*). Also, experimental subjects were asked to answer a questionnaire concerning basic habits and lifestyle.

To obtain adequate results the experiments carried out under the same conditions – before the beginning of exam. In addition, the students are divided into two groups according to the degree of susceptibility to stress, which is assessed by a combination of personal factors such as physical inactivity, presence of bad habits, irregular diet, disease. Conventionally groups are named "prone to stress states" and "not prone to stress states". The cadets into groups not divided. This is because from the beginning in the group selected cadets, which have almost the same personality characteristics as students from "not prone to stress states" group.

Results and Discussion. To assess the degree of influence of stress conditions on the dynamics of the functional state of the students we determined the number of correlations between the measured parameters. Calculating Spearman's rank correlation coefficient allowed to determine the presence of significantly more statistically significant relationships in the group "prone to stress states" in comparison with the group "not prone to stress states" (Tables 1, 2). Based on data of tables for groups we built "correlation graphs of functional state" shown in Fig. 1.

Table 1

Correlation between psychophysiological indicators of functional state of experimental subjects in the "prone to stress states" group

	C	PA	AF	PF	R_{GI4}	C_{GI4}	R_{VG25}	C_{VG25}	R_{VG26}	C_{VG26}
R	–0.632			–0.339	0.765	–0.599	0.312	–0.419	0.537	–0.418
C					–0.469	0.673	–0.471	0.511	–0.443	0.39
PA			0.461	0.756						
AF				–0.451						
PF										
R_{GI4}						–0.551	0.484	–0.458	0.538	0.422
C_{GI4}							–0.412	0.519	–0.441	0.492
R_{VG25}								–0.563	0.335	–0.4
C_{VG25}									–0.52	0.762
R_{VG26}										–0.528

Fig. 1. The correlation graphs of functional state for "prone to stress states" (a) and "not prone to stress states" (b) groups

It should be noted that both the representative points and "stress points" have high activity and with increasing impact of stress factors on humans significantly change their electrophysical performance [10]. In this regard, in the first stage of the experiment the following results are obtained:

– with increasing of stress load in both experimental groups observed growth correlation between measurable indicators "stress points", as shown in Fig. 1 (connections between "stress points" shown by the dotted line). However, growth correlation in "prone to stress states" group are more significant than in "not prone to stress states" group;

– correlation between capacitance C and resistance R of representative biologically active points of the skin in the tested groups has an inverse trend compared with the "stress points" (more significant in "not prone to stress states" group), which is explained by a rapid decrease in balance organism as a system in "prone to stress states" group under the influence of stress factors.

The second stage of the experiment for students of "not prone to stress states" group and cadets we studied the dynamics of correlations between the measured parameters. Correlation analysis showed the presence of a large number of statistically significant relationships in the cadets group (Table 3) compared with the students group (Table 2). Based on received experimental data we built "correlation graphs of functional state" shown in Fig. 2.

Table 2

Correlation between psychophysiological indicators of functional state of experimental subjects in the "not prone to stress states" group

	C	PA	AF	PF	R_{GI4}	C_{GI4}	R_{VG25}	C_{VG25}	R_{VG26}	C_{VG26}
R	0.719				0.647	–0.475				
C					–0.53	0.695				
PA				–0.72						
AF										
PF										
R_{GI4}						0.622			0.318	
C_{GI4}							–0.35	0.353		0.362
R_{VG25}								0.436	0.433	
C_{VG25}										
R_{VG26}										–0.335

Fig. 2. The correlation graphs of functional state for cadets (a) and students (b) groups

The correlation graphs of functional state in Fig. 2 show that stress factors have a greater impact on a group of cadets (number of statistically significant relationships between the "stress points" in this group higher) than on students. Based on this we can conclude that learning in Ivan Kozhedub Kharkiv University of Air Force more stressful compared with National Aerospace University "Kharkiv Aviation Institute". This fact can be explained by the higher risk of the profession pilot. Therefore, to the cadets are placing higher demands during training.

Thus, the design method of "correlation graphs of functional state" allows to identify and evaluate stress in humans. However, in addition, the method can be used to assess "cost" of adaptation to stressful operating conditions. This requires analysis of the correlation between parameters of representative biologically active points of human skin, because their parameters give information about the condition of the body as a whole.

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Evaluation of correlations between parameters of representative points in tested groups (Tables 1, 2, 3) showed the presence of statistically significant relationships in "not prone to stress states" group in comparison with the other two. This result indicates the maximum balance of functional state in this tested group in stressful conditions.

Table 3

Correlation between psychophysiological indicators of functional state of experimental subjects in the cadets group

	C	PA	AF	PF	R_{GI4}	C_{GI4}	R_{VG25}	C_{VG25}	R_{VG26}	C_{VG26}
R	–0.544			–0.465	0.595	–0.823			0.47	–0.593
C		–0.444								
PA				0.999						
AF										
PF						0.5				0.489
R_{GI4}						–0.705	0.514	–0.684	0.595	–0.647
C_{GI4}								0.498	–0.5	0.664
R_{VG25}								–0.805	0.744	–0.544
C_{VG25}									–0.716	0.652
R_{VG26}										–0.873

The least statistically significant connection of parameters of representative points in "cadets" group, which indicates significant cost for the organism to maintain optimal of functional state in terms of stress. Thus, the "cost" of adaptation to the effects of stress factors for cadets is higher than for students, but also the cadets stress resistance is higher, as evidenced by the correlation relationship of level of personal anxiety and performance factor. Cadets have this relationship the highest, followed by "not prone to stress states" group, and the last – "prone to stress states" group. In other words, in more difficult situation, the cadets have higher efficiency than students. Consequently, cadets have higher levels of stress resistance compared with students.

In summary, we can conclude that cadets more stress resistant in stressful situations than students, but even "cost" higher and this result is achieved through significant costs of functional resources of the organism.

Conclusions. Thus, on the basis of the experiment and statistical analysis of the results can make such conclusions:

– The proposed design method of "correlation graphs of functional state" allows to identify stress in humans and determine which is the main reason for its occurrence. Knowledge of objective reasons for the deterioration of operator will improve human safety during the activity, and, consequently, its stress resistance;

– The proposed method can be used to determine the "cost" of human adaptation to stressful operating conditions. It is necessary to assess "*costs of the organism* vs. *worker's skills/characteristics/quality*" balance;

– It was shown that the number and nature of the correlations between psychophysiological parameters of human organism along with data on the most typical stressful factors and lifestyle provide an opportunity to assess not only the current state of the workers, but also to carry out its monitoring and, therefore, to predict the development of stress state, and fluctuation of stress resistance level.

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