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ERGONOMIC REQUIREMENTS FOR INTERIORS AND WORKPLACES OF TRANSPORT OPERATORS

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Abstract. The article is devoted to the identification and project implementation of ergonomics requirements in the architectural design of the interiors of traffic control rooms and other premises in which monitoring, analysis and management of objects in motion is carried out. Based on the achievements of systems engineering, engineering psychology, biomechanics, occupational hygiene, occupational physiology, and technical aesthetics, the specifics of design systems have been established. Ergonomic requirements are considered in relation to the specifics of the work of traffic operators, which have purely professional and general forms of embodiment: from the locomotive cabin to the cockpit of a marine vessel, from the air traffic control room to the traffic control point, etc. Modern innovations in the traffic system and the latest requirements for its coordination are considered. The results of empirical research and experiments, the features of modern equipment and combined forms of monitoring, the specifics of the environment of the point of regulation and monitoring of traffic and external connections, etc., are taken into account. On the basis of taking into account the anthropometric requirements for the equipment, design tasks regarding the organization of the motion control panel have been established. Recommendations are provided to prevent overload and loss of attention at the workplace. Prospects for further research on the problem are outlined.

Keywords: ergonomic system, ergonomic requirements, traffic, ergodesign of the working city, professional requirements for the operator's working city, ergonomic standards, control panel

Introduction. The problems of organization and control of traffic in the urban environment and beyond are gaining new relevance due to changes in the typology of vehicles, the appearance in the traffic system of vehicles without drivers and individual electric vehicles with increased maneuverability, etc. Complicated combinations of traffic by air, water and by land transport return. In addition, due to new technologies and production capabilities, speeds are significantly increased, means of orientation and traffic regulation are changing, and traffic is increasing and becoming more complicated. Additional logistics schemes and mixed forms of traffic require new forms of management and regulation. The movement takes place in various weather conditions and in dark periods of the day, in wartime conditions, etc. In these circumstances, the work of dispatchers and other regulators and traffic participants acquires additional loads. The use of ergodesign tools for workplaces, taking into account the requirements of ergonomics for the design of interior spaces for specialists in this field, can significantly reduce negative factors and reduce overload, contribute to increasing work capacity and efficiency of professional activity.

Analysis of recent research and publications. Various aspects of the ergonomics of the «man-machine» and «man-machine-environment» systems are studied in the works of V.N. Samsonkin. (theoretical foundations of human factor control in man-machine systems on railway transport), V.E. Abrakitova (workplace ergonomics), V.G. Brusentsova [1,2,3]. Physiology and psychology of work, psychological and psychophysiological aspects of increasing the reliability of the management of moving objects are comprehensively reflected in the works of Ya.V. Krushelnytska, L.S. Nersesyan, O.Yu. Burova, O.V. Shevyakova, Yu.L. Trofimova and others [4,14,15]. Ergonomics of information technologies, ergonomics of interior equipment, ergonomics of the working city is described theoretically and in regulatory documents (V.F. Runge, J. Panero, O.Yu. Burov etc.) [5,6]. Acquisition of biophysics, biotechnology, biomechanics (V.A. Tymagniuk, E.N. Zhivotova, E.G. Aznakaev, T.A. Yehorova, G.I. Mykhasev, B.E. Lamash, etc.) [9,16,17]. Modern acquisitions of medium- and mini-ergonomics emphasize that the shape and functional dimensions of the subject environment and volume-spatial structures are inextricably linked to the dimensions and proportions of the human body. Ergonomic requirements for the formation of the properties of «man – tool», «man – machine», «man - machine – environment» systems are established at the stage of its design. In these systems, a person - an operator or a group of operators interacts with technical devices in the process of managing and processing information; in this case, architectural and design decisions are based on the acquisition of systems engineering and engineering psychology. Both vectors of design activity: substantiation of restrictions and generation of new dimensions and combinations of elements according to the requirements of aesthetics, require joint design. But the scientific base for this has not yet been developed, and the theory and practice of the formation of ergonomic complexes as a whole, which synthesizes the interaction of elements taking into account integral emotional and qualitative indicators, is looking for its own researchers. This makes the research problem relevant.

Statement of the objective. We can solve research tasks in the area of the problem outlined above by: determining the typology of equipment elements; definition of the type of architectural environment as an environment with additional requirements and activity specificity; research of equipment for environmental formations of this type; formation of complexes of environments and systems. Based on ergonomic standards and the percentile method, we establish the basic requirements for the equipment of the designed interiors; the analysis of the practice of activity in the traffic control and management system allows making corrections based on empirical experience and improving the modern operational qualities of such equipment.

Subject of research. Ergonomic requirements and tasks of ergodesign of premises and workplaces of transport operators. On the basis of taking into account the features and forms of modern traffic management, establish the problem area and project tasks of ergonomic design of interiors and workplaces for operators.

Task. 1. Investigate the requirements of ergonomics for the organization of the workplace with increased attention; 2. Take into account the ergonomic requirements for the formation of the properties of «man – tool», «man – machine», «man - machine – environment» systems at the stage of their design.

Main material and results. The operator's workplace is a part of the space in the Human-Machine System (HMS), equipped with information display, control bodies and auxiliary equipment and is intended for the activities of the HMS operator [1]. The organization of the workplace in accordance with anthropometric characteristics involves the fulfillment of ergonomic requirements for the placement of technical means in the workplace, to the light and color characteristics of displays, to the letter-digital information of the displays, the keyboard of the remote of the display, the necessary sanitary and hygienic working conditions [2,3,4]. If you identify and classify harmful and dangerous factors, indicators of hazards of human disorder in the workplace take into account the mechanic of human body and balance of position of body as a basis for minimizing energy costs, examining methods of prevention to the ergodesign jobs and premises.

Dynamic and static anthropometric characteristics are given in the works of V.E. Abrakitov, I.O. Tkachenko and others [1,2], and help to determine the volume of working movements, reach

and inspection areas. They calculate the spatial organization of the workplace and set the workplace parameters.

The National University «Odessa Maritime Academy» conducted full studies of hygienic and ergonomic working conditions in the steering of the speed vessel [7], the state of both physical and psychological comfort was investigated. Professional studies have revealed the specifics of employees' overloads associated with the processing of large amounts of various information in a shortage of time, increased nervous and emotional tension. There is a relative hypodynamics, which is caused by the limited space of the cabin. Factors that complicate the condition and well-being in the work process: monotony of the environment, uniformity of information, increased noise and vibration levels, gas pollution, etc. Psychophysiological studies have provided data that after eight hours of such work there are such manifestations of fatigue as: decrease in functional activity of the central nervous system, visual analyzers, performance, attention, vegetative-vascular support of the activity of the body regardless of the degree of involvement in the processes.

On the basis of empirical research, requirements for the organization of the employee's workplace in specific conditions of movement management were formulated, namely:

- the workplace should be located in a sufficient work space, which allows all the necessary production operations, movements and movement, to ensure descriptive capacity during the period of working time;
- the control panel and workplace should include measures for the prevention and reduction of fatigue and nerve overload of the operator, static muscle fatigue. Prevent erroneous actions;
- the design of the remote and organization of the workplace should ensure speed, safety, simplicity of control, the ability to work in different positions of the body;
- the means of displaying information, the equipment should be a single complex with the workplace;

The characteristic dimensions of the control panels taking into account the reach and comfort zones are shown in Fig. 1, 2. The scheme of M. Schmidt was formed to control the locomotive, should ensure safety, functionality, reduction of physical and mental load. In addition, the load and organs of vision, hearing, and others are taken into account.

The design of the equipment is based on the choice of priority channel perception of information (visual, audial, tactile) in each case when solving a specific professional problem [8,10].

A characteristic feature of the modern traffic operator is that it can use both direct supervision of the situation and data that come to it with various communication channels. All the higher percentage of activity with information models of real objects, with aggregate information about the status and functioning of the management object and the environment. An essential feature of human activity with the information model is the need to compare data from different structures, appliances, monitors, scoreboards, etc.

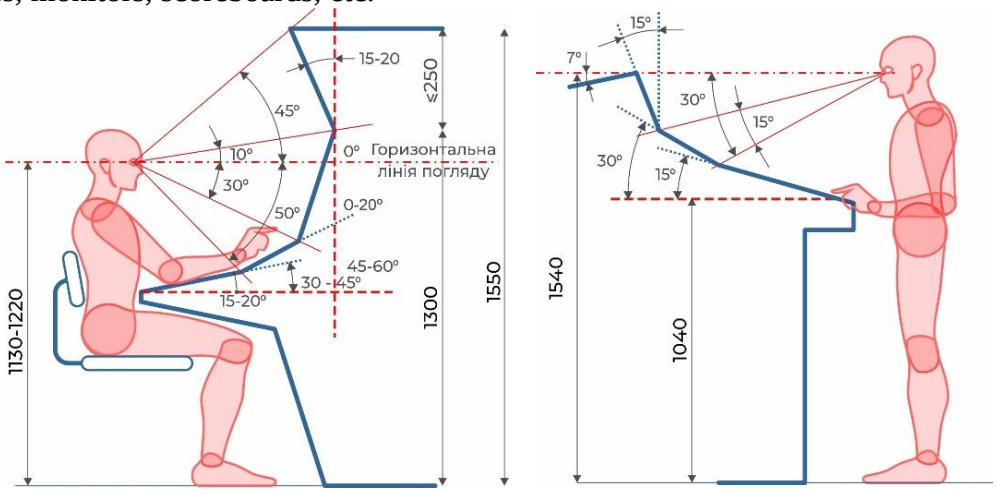

Fig. 1. The dimensions of the control panels and the reach zones of work in different positions the operator

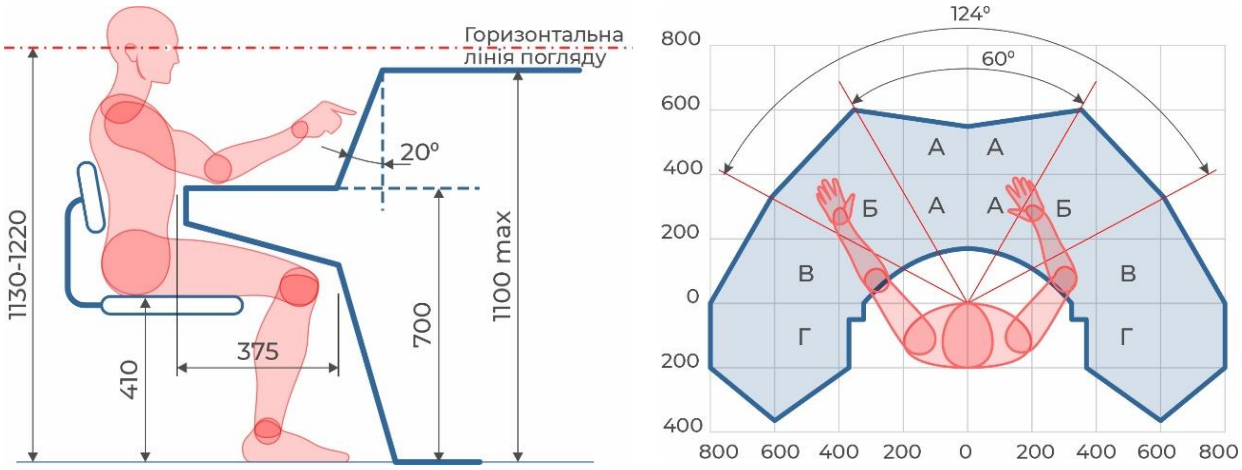

Fig. 2. The characteristic dimensions of the control panels and the reach zones of work in different positions of the body of the operator

If you put the process into stages, we can distinguish:

- the stage of perception of information (separation of the object of perception, establishment of certain features in it, familiarization with them and recognition of the object;
- the stage of detection of links between the individual properties of the object of perception and formation of their own system of standards for further assessment of the situation.
- the stage of consolidation of features, a combination in structures that in the future play the role of uniform operational units of perception.

Fig. 3, 4 shows examples of interior organization of transport systems in spaces isolated from the environment.

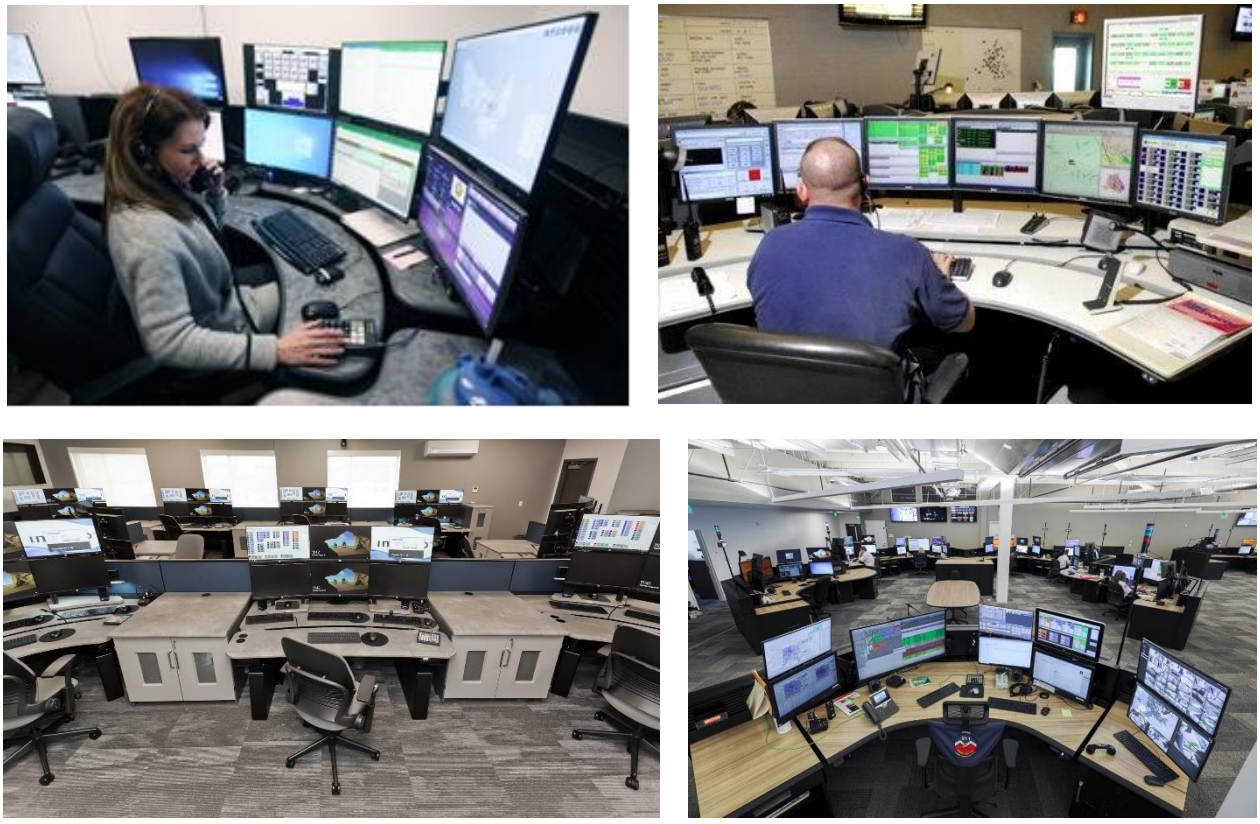

Fig. 3. Information comes from the appliances, the workplace is surrounded by technical management and monitoring

Fig. 4. Information comes from the appliances, the workplace is surrounded by technical management and monitoring

Figures 5, 6 show the modern look of the control panel and the location of individual workplaces in the space of the control hall.

Fig. 5. Modern control panels and arrangement of a complex of individual workplaces

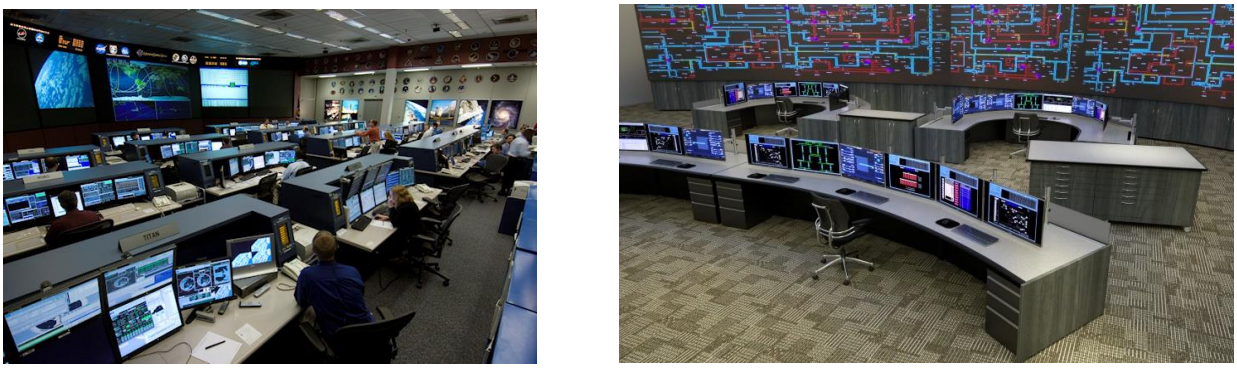

Fig. 6. The interiors of the control hall with the location of individual workplaces

Taking into account the latest ergonomic requirements for the organization of interiors and workplaces of operators of various traffic, project tasks for the form and placement of premises and equipment for operators in the mobile and stationary object of management:

- ensuring an increase in room volume and work space;
- preventing injury, promoting free movement without any obstacles;
- exclusion of negative side information, reflection of light signals and information from the control panels;
- preventing complications associated with a decrease in visibility and recognition;
- preventing visual overload from excess brightness and contrast;
- taking into account changes and additional elements, space for operators - doublers;
- taking into account the features of the process in the placement of appliances, other means of displaying information, in the size of the panels, the angles of placement of the appliances depending on the frequency of use, etc.;

- additional attention to emergency signals and means of their location on the remote.

Figure 7 demonstrates common approaches to the implementation of ergonomic and aesthetic requirements in the premises for operators, with external traffic field direct monitoring options.

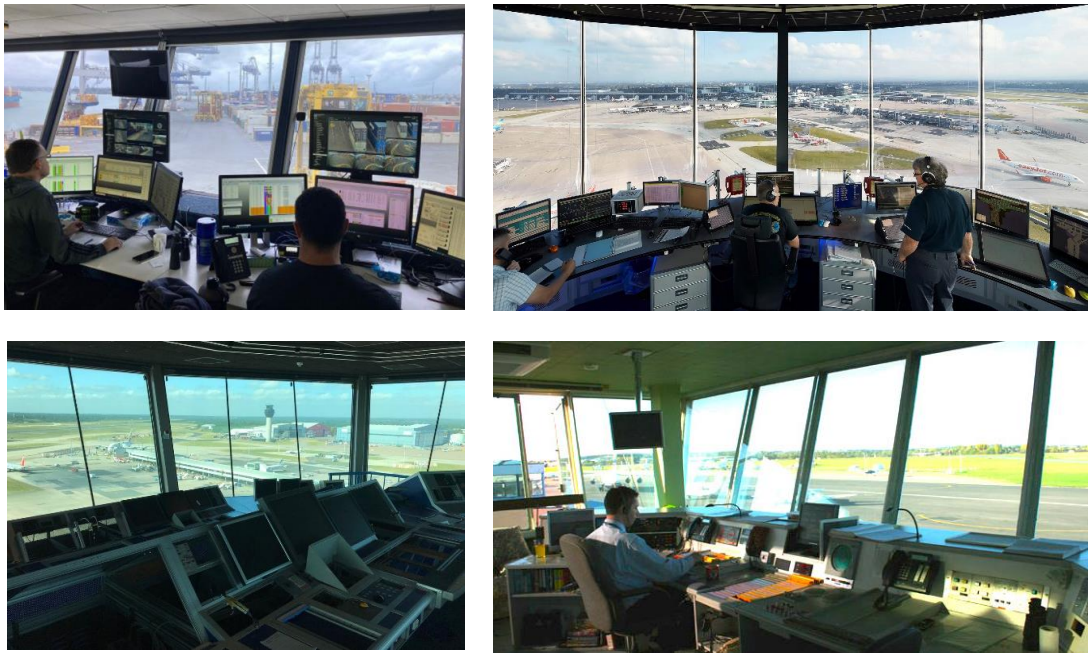

Figure 7. The interiors of modern traffic management rooms with a combined monitoring form

Analysis of empirical data and their comparison with theoretical guidelines push us to generate instructions to improve the workplace and seating of the operator. Attention is paid to the choice of working posture, the size of the working chair, footrests, armrests are determined. A prerequisite that provides the optimal working posture of the operator is the ability to straighten the back and legs. The back of the chair should not be rigidly fixed to the seat, but be able to fix at an angle that changes at the request of the operator. The possibility of changing the seat position height should be provided; the chair should also have a vibration resistance. The dimensions of the seat and back of the working chair according to the anthropometric data of the operator are determined [11-16].

Attention is paid to the creation of color comfort in the interior, the color of moving parts, in brighter tones compared to the fixed ones, indicates the need to use materials with matte or semi-matt coatings on panels of the remote control to eliminate visual fatigue, etc.

Conclusions and prospects for further research. The study of ergonomic requirements for the organization of workplaces of traffic operators and interiors for the management and monitoring of traffic, comparison of these requirements with empirical research, made it possible to set design tasks for organizing interiors of this type: ensuring volume and workplace increase; preventing injury, promoting free movement without any obstacles; exclusion of negative extraneous information, reflection of light signals and information from the control panels; prevention of complications related to decreased visibility and recognition; preventing visual overload from excessive brightness and contrast; taking into account changes and additional elements, space for operators - doublers; taking into account the features of the process in the placement of appliances, other means of displaying information, in the size of the remotes, the corners of placement of the devices depending on the frequency of use, etc.; additional attention of emergency signals and means of their location on the remote [17-21]. In further research, let us look at examples of solving these problems in student works.

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ЕРГОНОМІЧНІ ВИМОГИ ДО ІНТЕР'ЄРІВ ТА РОБОЧИХ МІСЦЬ ОПЕРАТОРІВ ТРАНСПОРТНИХ ПОТОКІВ

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Анотація. Статтю присвячено виявленню та проектному втіленню вимог ергономіки в архітектурному дизайні інтер'єрів диспетчерських транспортного руху та інших приміщень, в яких здійснюється моніторинг, аналіз та управління об'єктами в русі. Спираючись на досягнення системотехніці, інженерної психології, біомеханіки, гігієни праці, фізіології праці, технічної естетиці, встановлено специфіку систем проектування. Ергономічні вимоги розглянуті стосовно особливостей роботи операторів руху, які мають сугубо професійні та загальні форми втілення: від кабіни локомотиву до рубки морського плавзасобу, від авіадиспетчерської до пункту керування автомобільним рухом тощо.

Вивчення ергономічних вимог до організації робочих місць операторів дорожнього руху та інтер'єрів для управління та моніторингу дорожнього руху, порівняння цих вимог з емпіричними дослідженнями дозволило поставити проектні завдання щодо організації інтер'єрів такого типу: забезпечення об'єму та збільшення робочого місця; попередження травматизму, сприяння вільному пересуванню без будь-яких перешкод; виключення негативної сторонньої інформації, відображення світлових сигналів та інформації з пультів керування; профілактика ускладнень, пов'язаних зі зниженням видимості та розпізнавання. Розглянуті сучасні інновації в системі руху та новітні вимоги до його координації. Враховано результати емпіричних досліджень та експериментів, особливості сучасного обладнання та комбінованих форм моніторингу, специфіка оточення пункту регулювання та моніторингу руху та зовнішніх зв'язків тощо.

Приділено увагу створенню колірного комфорту в інтер'єрі, забарвлення рухомих частин, більш яскравих тонів порівняно з нерухомими, вказує на необхідність використання матеріалів з матовими або напівматовими покриттями на панелях пульта для усунення візуального ефекту. втома та ін.

На основі урахування антропометричних вимог до обладнання, встановлені проектні завдання щодо організації пульту керування рухом. Надані рекомендації щодо запобігання перевантаженням та втраті уваги на робочому місці. Окреслені перспективи подальших досліджень з проблеми.

Ключові слова: ергономічна система, ергономічні вимоги, транспортний рух, ергодизайн робочого міста, професійні вимоги до робочого міста оператора, ергономічні стандарти, пульт управління.