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D. Yu. Panov and D. A. Oshanin

Man in Automatic Control Systems

At the meeting of a technical council of an American company the project of a complex automatic system was being analyzed. Although the constructor was able to carry out all the requirements of the customer by means of scores of very intelligent machines the systems still lacked reliability. In completing his report the instructor said:

"You see, gentlemen, that our system can operate in accordance with technical conditions only if we are able to create another 15-20 apparatuses. The design of these apparatuses is not yet known (the Americans call such apparatuses "black boxes". Author). It is clear only that they must carry out approximately the following functions: to restore the ability of the system to work with failure of any of its elements; to operate dependably itself; to find at least approximately correct solutions in unforeseen cases ... I have thrown in the specifications of these "black boxes". In complexity and cost they exceed the cost of the entire system. In connection with this I find myself in a difficult situation and I would be glad if any one of you will give me a good idea."

After a brief silence a young engineer got up.

"It seems to me, boss," he said, "that I can propose 'a black box', which would satisfy your requirements."

"How much would it weigh?"

"About 80 kilograms."

"Very good! And what would its dissipated power be?"

"Approximately 600 watts".

"Excellent! How much time would be necessary for your 'black box' to begin to operate in the system?"

"I think that it would be completely ready after five-six months."

"But this is phenomenal! What is this magic 'black box'?!"

"This box is a man, boss".

Several years ago in the American press statements could be found to the effect that automation would be able to eliminate man completely from production processes and would, by the same token, make it possible to "solve" social problems associated with the working class. In 1953, the Wall Street Journal wrote, for example, in this connection: "The aim of automation of enterprises lies in completely eliminating the workers". The organ of big business, Fortune, clarified this: "People are too difficult and capricious elements ... throw them out of your plants completely and you will feel fine".

Naturally, life has caused even the most reactionary American businessman to refrain from the idea of such prospects, and in this connection the example which we have presented above is quite typical. Now, it is clear to everyone that automation of production processes does not always and does not necessarily lead to the elimination of people from them. Furthermore, even in the modern control systems which are the most complicated technically man continues to be the most important organizing and the most reliable factor.

It goes without saying that without the application of automation facilities man becomes perfectly powerless in control systems. Left on his own, he cannot cover the necessary volume of data about the processes being controlled, cannot make the calculations in time which would provide for correct solution of the complex production problems confronting him, nor can he react to signals coming in from without at the required rate of speed and with the required accuracy. Man, to the highest degree, is subject to the influence of various subjective factors and states, such as fear, lack of confidence, boredom, irritability, fatigue, which have a harmful influence on the nature of his actions and not uncommonly paralyze him and put him out of commission completely at the most decisive and important moment.

By virtue of these characteristic features man frequently delays in his decisions, vacillates, makes a multitude of errors which considerably reduce the quality of his work, interfering with its rhythm and causing accidents, etc. A machine does not know of such weaknesses. It does not "become afraid" and it does not "become confused" in the presence of danger; it does not "become tired" in the human sense of this word. It can develop the tremendous strength and speed, "remember" and process an incomparably greater quantity of information than man: for its capacity is tens and even hundreds of thousands of operations a second, whereby this is far from being the limit.

Thereby, the machine carries out not only "machine-like", elementary actions which are repetitive and mechanically unchanging. Actually, it can be entrusted with any job as long as it can be described by an "algorithm", that is, by a clear and definite system of rules. Under this condition the machine is ready to carry out even complex "mental work"; it will do logical operations, solve operational problems, count ... and do all this magnificently -- frequently much better and faster than man, the operator with average qualifications.

In contrast with these indisputable advantages of machines over man is, however, the main and unavoidable shortcoming in their work: they do what and only what man instructs them to do. According to the rules which man has worked out for them they carry out their operations highly productively and frequently without fail. They react adequately and precisely to the entire ensemble of phenomena which a man who has programmed their work has been able to foresee and take into consideration correctly. However, all that has to happen is for a situation to arise which for some reason cannot be provided for by the program and the most perfect machine will suddenly be helpless. In the results which it gives out there will be hopeless confusion. The best that it is capable of doing under such circumstances is to stop the system, stop the process. Only man can restore to normal the disordered operation of an automatic apparatus with program control. This is why the inclusion of "human factors" in the automatic control system who watch over the course of events and who are able to make the necessary decisions in a responsible way when various unforeseen circumstances arise protects the systems against the possibility of going out of commission and, by the same token, considerably increases their total efficiency.

Recently, in the special literature much attention has been given to the so-called "self-organizing" and " learning" systems. However, to date such machines and systems have always carried out actions which had been determined, by and large, beforehand. They independently select various numerical values of parameters determining the course of the process which are most advantageous under the given conditions, but so far none of the machines can imitate, even to a remote degree, the association processes in the human brain, chiefly, probably, because we do not know how they occur to date; knowledge of the results is inadequate for clarification of the nature of these processes and the nature of thinking generally.

The role of man in modern control systems, however, is certainly far from being exhausted by his intervention in unforeseen and emergency situations. Being himself the most reliable factor in such systems man regularly carries out a number of important functions in them, including those which cannot at all be modelled technically.

Man has a well-developed ability to make very fine analysis and synthesis of phenomena, thanks to which he can always be well informed about changes occurring in his environment. He distinguishes precisely between stimuli coming in a continuous stream into his nerve centers, selecting those of them which for any reason are important to him at a given moment. As a rule, he has no difficulties in distinguishing signals against the background of fortuitous noise or interference, whereas the creation of machines which would possess such properties requires very complex and costly apparatuses. The system of congenital as well as conditioned nerve connections created as the result of individual experience and learning and constituting the physiological basis of behavior, makes it possible for man to react to signals expediently. His reactions to those which are of particular importance for him, for example, those associated with the appearance of a danger to his life or health, are frequently of the nature of excellently developed and impeccably operating automatisms.

True, the natural communication channels in man generally possess less speed of action than the corresponding machine channels. However, man makes up for his weakness in this way by the application of highly efficient methods of receiving and processing information characteristic of him alone.

By possessing excellent qualities of generalisation and imagination he frequently does not experience the need for a painstaking processing of the entire mass of information arriving concerning a process being controlled. From the complex stream of information he culls only some separate data while he is on the move, and this data can play the part of starting points for the work of the imagination, and by means of them the essential features of the process can at least be represented adequately, if not the entire process.

An analysis of the "fixation points" during reading shows, for example, that in running over some text with his glance, a man does not perceive successively and separately the entire ensemble of symbols, that is, letters making up this text. Now and again, his glance runs forward, as though striving to cover the text as a whole from the start; his glance stops only on each fourth-sixth letter during his reading and this is enough to enable the reader to realize the meaning of the words (Fig 1). It is well known also that in perceiving letters visually, a man directs attention chiefly to their upper halves only. Fig 2 illustrates the fact that there is no particular difficulty in understanding text when it is read in this way.

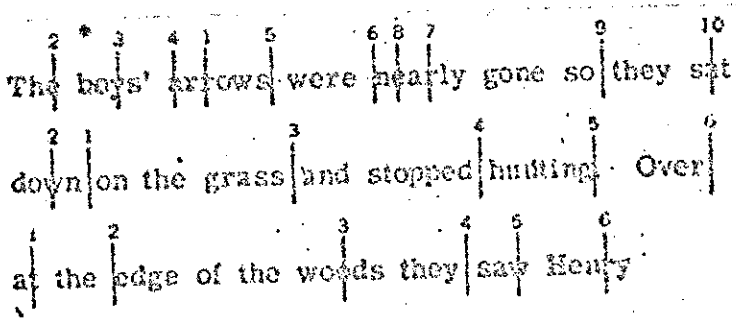


Fig 1

A

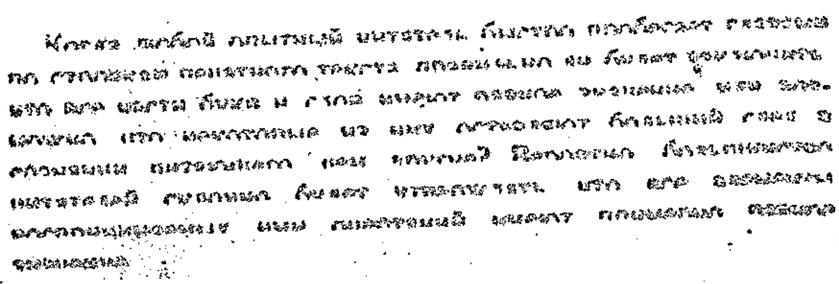


Fig 2

Because of the work of his imagination a man sees solid bodies arranged in three-dimensional space in several lines depicted on a drawing.

Only man can, by using his ability to generalize, collect an unlimited quantity of various data into an intelligent, logically organized whole. This makes it possible for him, for example, to combine information coming in simultaneously from a multitude of the most varied sources for the purpose of future utilization. The use of gener al concepts mastered previously and preserved in memory concerning the rules and regulations of phenomena increases by many times the ef ficiency of information processing by man, at the same time complete ly changing the nature of this process.

Hardly any one will doubt that this entire uniqueness of man, which markedly distinguishes his work from the work of any of the computers which he has constructed, is brought about by the char- acteristics of arrangement and development of higher nerve centers in man and chiefly in the cerebral cortex. It is sufficient to bring to mind, for example, that a modern computer contains tens of thousands of active elements, while in the human brain the number of these ele- ments (neurons) is estimated at the tremendous figure of 10^{10}. The en ergy dissipated by the neurons amounts to about 10^{-9} watt, whereas the vacuum tube dissipates energy of the order of one-0.1 watt, and the transistor dissipates tenths to hundredths of a watt. On the other hand neurons work with much less speed than the artificial active elements of computers (approximately 10^{4}-10^{5} times less).

Comparing these data, one of the very great mathematician of our day and one of the creators of cybernetics, John von Neumann (Leningrad, 8) concludes that the brain is basically a parallel apparatu in contrast to machines, which are series apparatuses in the sense tha they must carry out the necessary operations one after the other. Neumann notes specially the distinctive system of data transmission in neurons which assures the exceptionally high degree of reliability of the brain, which, true enough, is at a lower speed of operation. Be- cause of the unusually small dimensions of neurons and the relative simplicity of the physicochemical processes occurring in them the brain is an apparatus with a very high degree of reserve. Information comes to the brain over thousands and millions of parallel channels. This also creates a high degree of reliability of work and a very unique system for processing the data, in which an integration and synthesis of them occurs, a kind of mixture which gives results essentially dif- ferent from a simple sum of information received over various routes. Emphasizing the inimitable distinctiveness of the operation of the hu- man brain, Neumann concludes that "the language of the brain is not the language of mathematics" (Leningrad, 8).

Another great American scientist, Dr. Vannevar Busch, the creator of the great "differential analyzer" and one of the initiator of the investigations which led Dr. Wiener to the formulation of the main principles of cybernetics, said in his report to one of the com- mittees of the United States Congress: "The human mind is a wonder- ful mechanism. Machines can prevail over it in accuracy of memory and work as well as in speed but they can in no way compete with its unusual complexity and flexibility. In my opinion, they never will be able to compete, at least within limits of our lifetime".

Surely, this does not mean that scientists will not try to discover laws underlying the functioning of living organisms and living matter generally and give them a mathematical formulation, at least an approximate one. However, the unusual difficulties of this problem which we even now can imagine with inadequate clarity, should not be forgotten. One of the very great contemporary theoretical physicists, R. Payerls, believes, for example, that "... it cannot be said that the laws of physics of inanimate matter can completely explain the living organism" (Leningrad, 10). It goes without saying that we are dealing with the author's belief in some kind of "vital force" rather than simply with the fact that there are unknown laws which control living matter.

To be sure, the considerations which we have presented are of a schematic and superficial character. What is known so far, generally, about the work of the brain is exceedingly little. However, it is clear that ignorance of the functional characteristics of the brain, ignorance of the uniqueness of human mental activity and control systems is an essential obstacle to efficient work organization of these systems, to preservation and utilisation of human powers and maximum increase in reliability and productivity of his labor.

While man and machine work differently, while man, sometimes becoming a bottleneck in control systems at the same time possesses, as we have seen, a number of most valuable qualities making it possible for him in certain situations to leave even the most perfect machines far behind him, it is clear that it is necessary to learn how optimally to combine the technical factor and the human factor in control systems with precise consideration of the relative weaknesses and relative advantages of each of these two factors over the other.

For the purpose of realizing this task a detailed study is needed of the psychophysiological functions of the working man, and in a number of cases also the performance of special experimental research.

Everyone knows, for example, that under normal conditions it is inadmissible to demand exceptional efforts from man and that the preservation of his energy is the most elementary and most important condition for proper work organization. However, the difficulty in work is not always evident. There are quite a few operations in existence which give rise to an exceptional expenditure of nervous energy, which, despite this, can appear "easy". We have here certain operations associated with risk and responsibility for work entrusted and for this reason requiring a high degree of emotional strain. It is sufficient to present the example of personnel on duty at central control panels of electric power stations who sit for long hours anticipating always possible emergencies, apparently "doing nothing" and, despite this, becoming very much fatigued.

Investigations made under the direction of one of the authors at the Laboratory of Labor Psychology of the Institute of Psychology of the Academy of Pedagogical Sciences revealed the specific functional changes in the nervous systems of workers during the accomplishment of continuously repetitive operations of the assembly-line type which, although they were not complicated and did not require physical or mental effort, were monotonous and boring (Leningrad, 1).

Problems of signalling are of exceptional importance for the comfort, safety and work output of the operator. In working, a man should receive all the necessary information in a timely way; otherwise, he will make errors, produce faults and cause waste. The main difficulty in work in apparatuses of high voltages lies, for example, specifically in their "signalling" inadequacy. Not being able to perceive with his senses the difference between being and not being under lines with voltage, the operator does not realize the danger which threatens him, does not behave properly with respect to it, and does not take the necessary protective measures in time (Leningrad, 5).

On the other hand, the signalling should be economical. The "capacity" of the operator as a link in the communication is limited: per unit time he can receive and process only a strictly defined quantity of information. For this reason, his attention should not be overloaded; the volume of information given to him should be in correlation with the time spent for processing it.

The selection of the type of signal stimulus should also depend on the rate of work, particularly where the decisive part can be played by very short time intervals. The situation is that the reaction time of a person to various types of stimuli is different (Leningrad, 11). It varies as follows:

Stimulus	Time, milliseconds
Visual	150-225
Auditory	120-182
Tactile	117-182
Temperature	150-240
Pain	400-1000

In selecting a type of signal stimulus preference should be given to those sensory channels which from their very nature are in best agreement with the material used for transmission, avoiding excessive coding, coefficients, conversions, and others. While the visual analyzer best perceives its own type of content material, preventive signals of various kinds can very successfully be introduced through the systems of auditory or tactile analyzers. The utilization of other channels is advisable in the case of overloading of the main channels as well as for signalling of a special character.

The nature of the signal stimuli should also correspond to the rate of work being done. Thus, for example, numerical signals are apparently poorly suited to work at a very fast tempo. Under these conditions it is much more efficient to use signals in the form of figures and colors and, particularly, the so-called "signal instructions", which directly emphasize the direction of movement and others to the person who is to react to these instructions (Leningrad, 9).

From what has been stated it follows that the problem of optimum coordination of the human and machine factors in control systems should be solved chiefly technically. Planners, designers and constructors should be acquainted with the main rules and regulations of labor psychology, and with the aid of the appropriate specialists should take them strictly into consideration in the creation of machines. Indeed, if the problem consisted only of the planning and designing of the actual electromechanical and electronic apparatuses of the control system, the selection of variables for such apparatuses would be entirely in their hands. They would be free to determine at what speeds various elements of the system operate, what power should be used or dissipated in them, what volume of information will pass through them. However, the problem also lies in correctly connecting a man to the automated control system. This should not be done without taking into consideration the characteristics of man and the technical parameters possible for his activity which, in turn, are determined by the physical and mental nature of man and, therefore, when man is introduced into the system these factors can no longer be essentially changed.

The main trend in the work of planners and designers of control systems striving correctly to connect a man into them, is determined, evidently, by the specific nature of these systems.

Thus, as applied to work with a radar indicator the relative brightness of the echo and of the background, the lighting of the premises in which the electron-beam tube is located, the color of the auxiliary lighting, the shape and size of sound signals, the angle of inclination of the screen assume particular importance. In constructing the instrument board of an airplane problems of arrangement of the instruments, grouping of them, distinctness of the designations on them, and others arise.

A number of experimental psychological investigations has shown the importance of various characteristics of dials utilized in control systems. Thus, for example, work with different shapes of dials gives the following percentage of errors under otherwise equal conditions (Leningrad, 18):

Shape of the Scale	Errors, Percent
Vertical linear	35.5
Horizontal, linear	27.5
Semicircular	16.6
Round	10.9
Window	0.5

Of no less importance is the correct solution of the problem of the so-called "legibility" of the dials, which is associated with the nature of their ciphering, with the distance between the divisions, with the form of print, and others.

From Fig 3 it is seen what influence is exerted on the percentage of errors by the distances between divisions of one of the types of dials (Leningrad, 12).

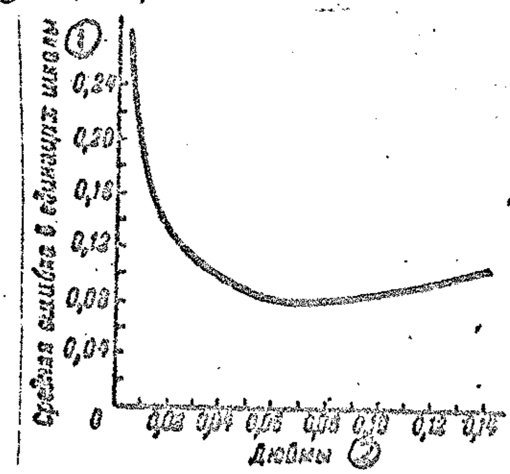


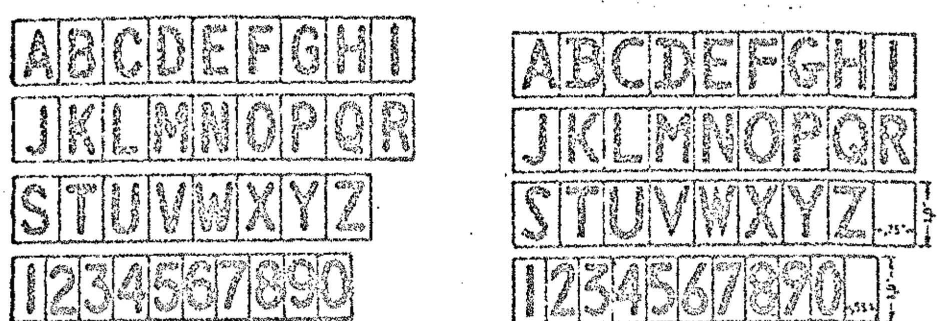
Fig 3

1. Average error in units on the dial; 2. Inch.

Mackworth (Leningrad, 16) made an experimental study of the percentage of errors made in the reading of print of the two types shown in Fig 4 at different distances. The results of these experiments are shown in the following table:

Шрифт (1)	Расстояние, м (2)	
	7,5	9
(3) Старый (рис. 4, а)	5,2%	12,5%
(4) Новый (рис. 4, б)	1,9%	5,3%

1. Print; 2. Distance, meters; 3. Old; 4. New (Fig 4, b).



а) б)

Fig 4

With the simultaneous utilization of a group of instruments the positions of the arrows indicating the normal courses of the processes acquire special importance. This is explained by the fact that in the majority of cases it is not so much the reading from different dials which is important for the operator as the possibility of immediately noting a movement of any of the arrows beyond established limits. Study of the influence of the position of indicators on the counting time showed that if the indicators of all the instruments are normally in the same position (for example, all of them point to "nine o'clock"), a board of 45 instruments is checked over in less than one second; if the indicators normally are in different positions the time for a reading is prolonged by nine-10 times.

Aside from these characteristics of instruments, the efficiency of the operator's actions depends to no less a degree on the proper solution of a number of problems associated with the characteristics and arrangements of the control organs, that is, with the direct motor "output" of man into the system.

Here, for the sake of example, we have several elementary requirements which should be made for the construction and arrangement of the control organs:

1. The number of control organs and actions with them should not exceed a minimum which is determined by the structure and purpose of the systems.

2. Control organs should be easily identifiable and distinguishable by means of certain external characteristics, for example, such as shape, size, location, color, and others. Errors in the identification of control organs have frequently become the causes of accidents. Thus, in the American Air Force during the Second World War errors in the identification of two levers on one of the fighter planes were alone responsible for 400 accidents in 22 months. As a result American psychologists worked out a set of handles for the levers which were readily identifiable by their shapes (Fig 5).

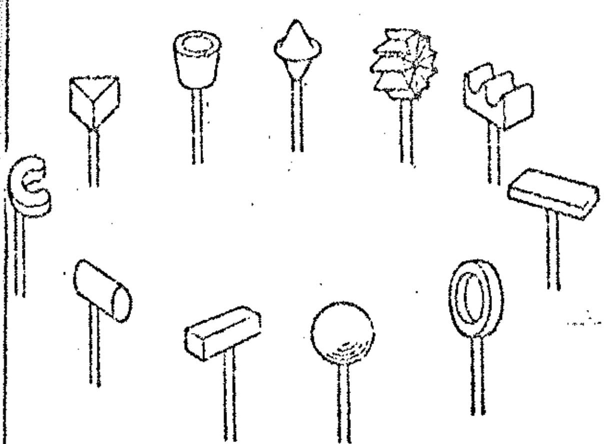


Fig. 5

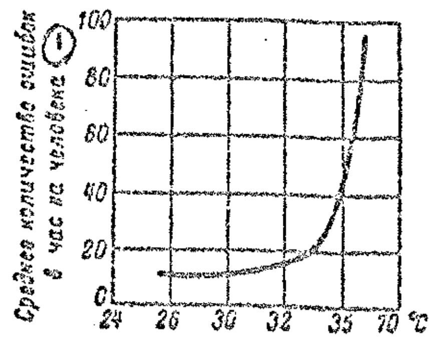


Fig 6

1. Average number of errors per hour per man.

3. It is desirable that the shape of the control organs be of semantic significance, that is, resemble their function so that, for example, the lever for extending the landing gear of the airplane be made in the shape of a wheel; the lever for controlling the wing flaps, in the shape of a wing, etc.

4. The control organs should be constructed and arranged in such a way that the necessary effect can be accomplished in a single way. If, incidentally, there are no special factors, one should avoid alternative methods for carrying out the operations.

5. Optimal effectiveness should be assured for utilization of the control organs for certain purposes with consideration of their size, shape, proportions, movements, and pressure sensations produced.

6. The direction of the movements and greater or lesser

muscular contraction necessary for manipulation should be in accordance with the nature and force of the effect being produced.

7. The system of control organs should be organized so that their combined utilization provide not only for the accomplishment of the task but also for convenience of manipulation with consideration of the logic of the sequence of motor actions of the operator -- the relative significance of the elements, frequency and sequence of working with them, their role in critical situations, as well as a number of other factors, such as, for example, functional asymmetry of the upper extremities (the presence of a stronger right hand and a weaker left hand), and others.

A decisive influence on work efficiency of the operator is exerted by the characteristics of the environment in which he is located, particularly the place of work itself. Such factors as the temperature, humidity, and lighting deserve a great deal of attention in this connection.

In Fig 6 the number of errors is shown, for example, which are made by operators on radio transmitters at different temperatures.

As far as lighting problems are concerned, here the knowledge and application of the laws of psychology can be particularly useful. Thus, for example, work at the screen of an electron-beam tube requires lighting of the control instruments and at the same time is associated with the need for darkening. The laws of dark adaptation of the eye assist in eliminating this contradictory situation. They show the expediency of using red light at a wavelength of over 0.62 micron in this case; this does not interfere with dark adaptation and, at the same time, makes it possible to watch the instrument readings well.

Finally, it is impossible to organize the work of the operator optimally in control systems without considering the tremendous influence of his individual characteristics on the course and results of this work.

For specifically the individual characteristics -- the so-called "personal" or "subjective" factor -- underlie the majority of accidents. In aviation for example, the percentage of accidents caused by this factor is equal, according to some data (Leningrad, 6) to 40-65 percent, whereby the proportion of the basic factors, that is, the congenital anatomical-physiological characteristics, amounts to 70-80 per cent, whereas the proportion of characteristics associated with the flier's personal experience does not exceed eight-14 percent.

The influence of individual characteristics is expressed, naturally, not only in the number of accidents and emergency situations which arise. Individual characteristics on which the operator's work success depends can be divided arbitrarily into three groups.

In the first group are included the anatomical and psycho-physiological factors, among which in one of the leading places are the congenital properties of the nervous system -- the strength, mobility and equilibrium of the nervous processes -- as well as certain congenital characteristics of the analyzers, for example, visual acuity and auditory acuity, autonomic nervous system excitability, and others.

In the second group are the psychomotor and intellectual characteristics: on the one hand, the fineness of motor coordination and dexterity, kinesthetic sensation, muscular strength and, on the other hand, the rapidity of generalization, accuracy of analysis, capacity of predicting and extrapolating data, the power of imagination with regard to technical subjects, and others.

In the third group are the characterological and personality qualities, such as industriousness, purposefulness, love of one's occupation, the feeling of duty and responsibility for work entrusted, attitude toward work.

For the purpose of proper consideration and utilization of individual characteristics of the operator the following are necessary:

1) the possession of a detailed knowledge of the psycho-physiological and social structures of these characteristics and an understanding of their significance for occupational activity; 2) the possession of methods of diagnosing the characteristics precise enough so that the diagnosis made can underlie the prognosis with relation to the influence of the given operator's individual aptitudes on the results of his work.

Unfortunately, the scientific reliability of our actual data on the structure of the individual characteristics as well as the diagnostic value of the corresponding methods at the present time are generally in inverse proportion to the complexity of the phenomena being studied. Thus, for example, with respect to the higher moral qualities so far we have very imperfect methods of investigation at our disposal and only purely descriptive materials, which are not of any considerable scientific value. The situation is entirely different, let us say, with the typological characteristics of the nervous system, about which we know incomparably more. Here, we also possess adequately fine methods which, true enough, still lack the necessary portability for large-scale application.

In the study of typological differences naturally the question arises which work methods and techniques are optimal for persons who possess various characteristics and, therefore, in which direction it is necessary to individualize the process of occupational training of these persons. Very interesting in this connection are data obtained at the chair of psychology of Kazan' University; they show how the typological characteristics have an influence on the individual style of progressive workers how, for example, the "poorly mobile" workers, in I. P. Pavlov's sense [referring to typological characteristics of the nervous system] spontaneously compensate for the inertia of their nervous processes by working at a uniformly high rate of speed to avoid emergency accelerations which are difficult for them, with intensification of orientating activity, and an increase in the proportion of preventive operations (Leningrad, 7).

Another important problem which arises in connection with the study of the typological characteristics of the nervous system is the problem of the types of occupational activity in which persons who possess various typological characteristics have greater chances of success. The works of the Laboratory of Psychophysiology of the Institute of Psychology of the Academy of Pedagogical Sciences show, for example, that frequently the capacity of concentrating attention in the presence of the action of extraneous stimuli, so necessary for the operator in control systems, is essentially a function of the strength of the nervous system. The mobility of the nervous processes apparently underlies the mental qualities, usually called "imaginativeness", liveliness and flexibility of thinking, which are no less important for the operator; self-possession, cold-bloodedness, restraint, etc. also depend on the equilibrium of nervous processes.

The problem touched on here leads us right up against problems of occupational orientation and occupational selection. We shall not delve into a criticism of the well-known weaknesses of psychotechnical methods of selection by means of so-called "testological tests". However, we should state very definitely that the inadequacy of various methods sometimes used in the Soviet Union and still popular abroad should not constitute the basis for an attitude of neglect toward the problem of occupational selection generally. Such an attitude is particularly intolerable in those cases where we deal with operators in control systems whose work is frequently associated with great risk and even with danger to the lives of the operators themselves and other people.

The main conclusion from everything which we have stated boils down to the following: automatic control systems should be planned and designed in such a way that human functional possibilities are taken into account as far as possible in them; for only under this condition can it operate well. Correct consideration of the functional possibilities of man in control systems requires, in turn, performance of research work on a large scale in the fields of those sciences which study the functions of man in work and chiefly his highest intellectual functions specifically, which submit most poorly to technical modelling. Evidently, we are speaking about labor psychology.

The tremendous scale of foreign work in this field is seen at least from the fact that the American journal Psychological Abstracts has been annotating 450-800 complete studies on problems of industrial psychology alone every year for the last 10 years. A bibliography of work on labor psychology published recently, made up at the order of the United States Navy, contains 376 references for the year 1955 alone. Naturally, none of the multitude of secret works has been included here.

Various large capitalistic industrial enterprises are giving very considerable attention to research work in the field of labor psychology. Thus, for example, the well-known American computing machine company, "International Business Machines Corporation" (IBM) includes in its "psychological group" specialists who have academic degrees in psychology for the purpose of carrying on individual and group studies, including purely theoretical studies, on psychophysics, on problems of visual and auditory perception, problems of learning, on communications theory, on information theory, psychometrics, on problem-solving processing, and others.

In the Soviet Union, work in the field of labor psychology and physiology is being conducted by a number of scientific research institutions of Moscow, Leningrad, Kiev, Tbilisi, Kazan' and other cities. This work acquires special meaning for Soviet citizens. The directors of the Party constantly indicate that man remains in first place at any level of mechanization or automation of production, and responsibility for the appropriate utilization of new technical equipment should be laid on him. Investigation of human functions in labor has a direct bearing on the creation of the technical basis of communism.

In addition, while under capitalism the study of the so-called "human factors" in control systems is regarded only as a new, more perfect means of exploiting people -- by means of increasing labor output, improving the quality of work, creating a favorable "psychological climate", and others -- in the Soviet Union the situation is entirely different. In the socialistic government providing optimum working conditions for man is not only -- and not so much -- a means of increasing work output as a goal.

This is why work on the study of human psychophysiological functions in automatic control systems needs to be encouraged and developed in every way.

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