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THE APPROACH TO TRAINING LOGGING MACHINERY OPERATORS

Dmitrii Chernykh[1], Lyudmila Steshina[1], Igor Petukhov[1]*, Yuri Andrianov[1], Dimiter Velev[2]

[1] Volga State University of Technology, Yoshkar-Ola, Russian Federation
[2] University of National and World Economy, Sofia, Bulgaria
** PetukhovIV@volgatech.net*

The article considers the problem of increasing productivity in harvesting, algorithm for the formation of individual educational trajectories for training operators of logging machines is proposed and the detailed experimental results on practical implementation of developed algorithm are given. The experimental results are checked, verified and efficiency of developed algorithm is proved via various criteria.

Keywords: operator, logging machines, individual educational trajectories

1 INTRODUCTION

At present, there is a wide variety of automated systems which is operated by a human-operator who plays an integral role in its steering. Range of applications of control systems is rather wide and starts with the simple car driving and finishes with steering military aircrafts and regulating work processes in nuclear power stations. The processes of human-interaction with complex technological machines permeate the sphere of logging operations, as well.

The authors [1, 2] made the connection between the experience of an operator of logging machines and his ability to perform all technological stages of all operator functions competently and successfully. Ovaskainen [3] divided the factors influencing the productivity of logging machines into three groups: external environment, technical condition of machines and individual psychophysiological characteristics of a human-operator. Kariniemi [4] proved that such an engineering-technical solution as a harvester had been working at its maximum since the 1960s. Since it is impossible to change the external environment quickly during the harvesting process, there is a challenge to increase the productivity not by improving technical means but by enhancing competence of operators.

Steshina L. et. al. [5] remark that the operators` functions are not only immediate steering a logging machine but also decision-making on the choice of the best technical trajectory both of the machine itself and of its working parts.

One of the main challenges to achieve the goals for performance improvement of harvesting is development of methods for professional staff recruitment and effective operators` training. Before training prospective operators, it is advisable to conduct a pre-selection of harvesting operators using psychophysiological tests [6].

Increasing requirements for the human-operator performance have resulted in the emergence and development of fundamentally new forms and technologies for staff training. The research of Ovaskainen [3] shows that working process with the simulator generally corresponds to the technological processes while working on real physical equipment. Moreover, other groups of the authors [7, 8] stated that virtual reality technologies were used for the most effective acquisition of practical experience of the operators of human-machine systems in the learning process.

Therefore, the relevance of the issue under discussion is due to the need of the amendment of the training process of logging machinery operators.

The objective of this study is to increase the productivity of logging machinery operators by reducing non-productive time through the use of individual educational trajectories in the process of vocational training.

2 THEORY AND EXPERIMENTAL

For the design of individual educational trajectory of students of basic professional degree program of vocational training in employees` professions of the specialization of logging machinery operators, first of all, it is necessary to define a general list of professionally important qualities (both general and specific), as well as a list of psychophysiological characteristics of a person required for performance of professional activities for each such program. The content of these lists is defined in terms of qualification levels and in accordance with the professional standards (if any) for a specific worker`s occupation by current labour market demands.

Based on the certain lists of professionally important and psychophysiological characteristics, the basic educational program for a specific occupation is compiled on a modular principle, in which the correspondences are established between the outcomes of mastering disciplines, qualities, knowledge, skills and competencies necessary for professional activity. It should be noted that such a basic educational program can be both a professional training and a professional retraining program and development program, at the same time; designated minimum workload defines its attribution to a specific type.

Algorithm for development of individual educational trajectory of logging machinery operators is given in Fig. 1 and works as follows.

First, it is defined if a student has any worker`s profession or a position of an employee. In their absence, the type of educational program being mastered is defined as vocational training, admissions test is conducted for the availability and level of development of psychophysiological characteristics.

If a trainee has a certificate of an employee or a position of an employee, it is necessary to define whether the existing profession coincides with the one being mastered. In case of coincidence, the type of the educational program being mastered is defined as development program, testing for the availability and level of development of professionally important qualities, admissions test for the presence and level of development of psychophysiological characteristics, testing of available knowledge and skills, as well as testing for compliance with the existing grade are carried out.

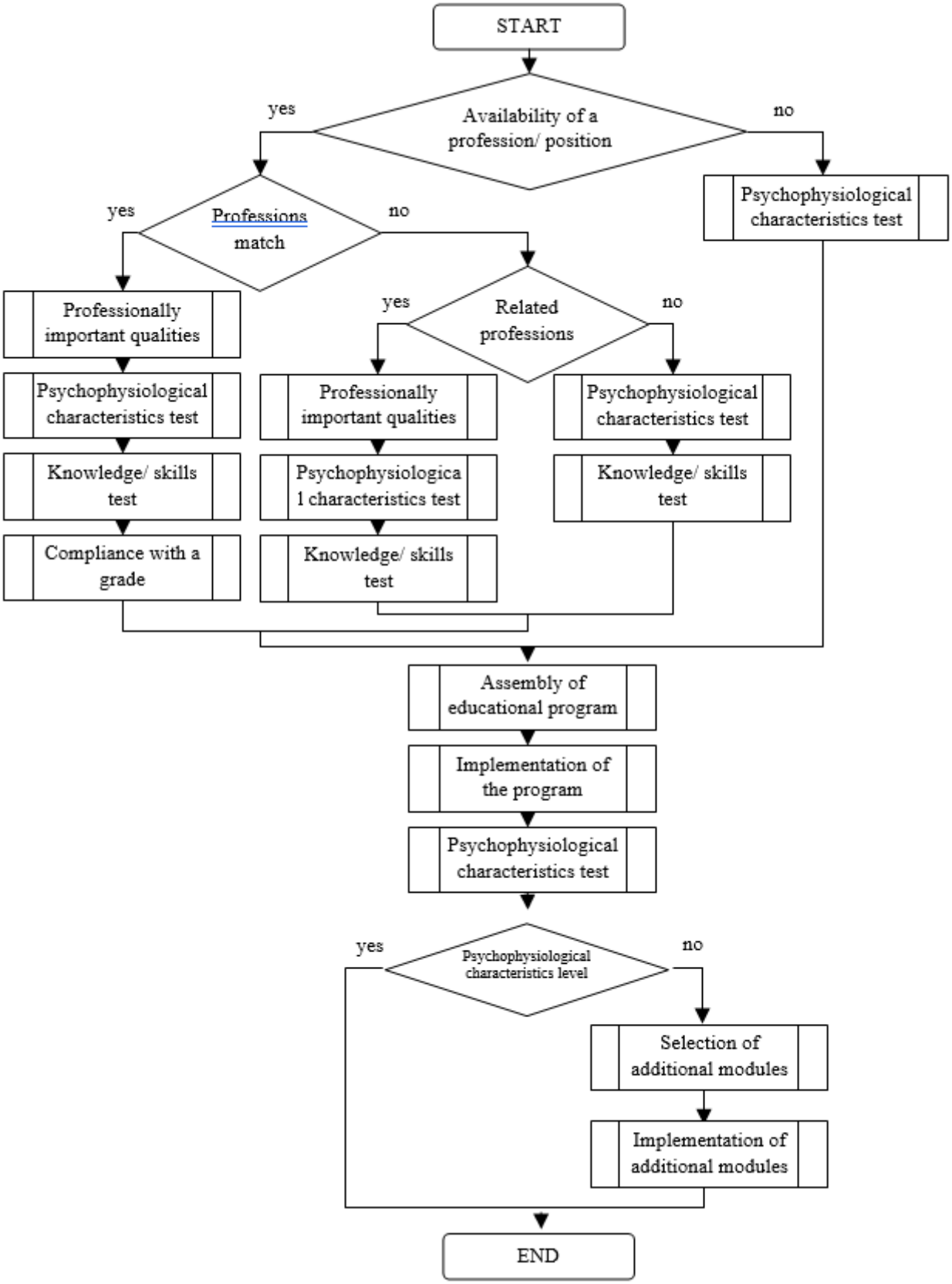


Figure 1. Algorithm for the Formation of individual educational trajectory (Complied by the authors)

If the existing profession of a student does not coincide with the one being mastered, then the type of educational program being mastered is defined as a professional retraining program and it is necessary to define whether the existing profession is related (from one subgroup of professions). If the professions are not related, then an admissions test is conducted for the availability and level of development of psychophysiological characteristics, testing existing knowledge and skills. If the professions are related, an additional test is conducted for the availability and level of development of professionally important qualities.

After identification of the type of educational program and admission checks there is an assembly of educational program modules based on the results obtained. The educational program is then implemented directly.

After completing the development of the educational program, a student does a final test for the level of development of psychophysiological qualities. In the event that the level of development is insufficient according to the results of testing, the selection and implementation of additional modules of the educational program are carried out.

3 EXPERIMENTAL SECTION

The outstanding interest in the diagnosis of psychophysiological parameters of a person is the study of the interaction of visual perception and motor activity, since in modern technical systems the operator plays a key role and must have developed visual-motor skills, especially in cases where there is a risk of dangerous situations.

To assess the skills of managing a logging machine using the developed methods, a study was conducted with the participants of 36 persons aged 19 to 48 years.

The group of experimental subjects was divided into two subgroups of 18 people:

"control" - trainees who have received vocational training in profession "Skidder driver (operator)", in non-graded educational program;

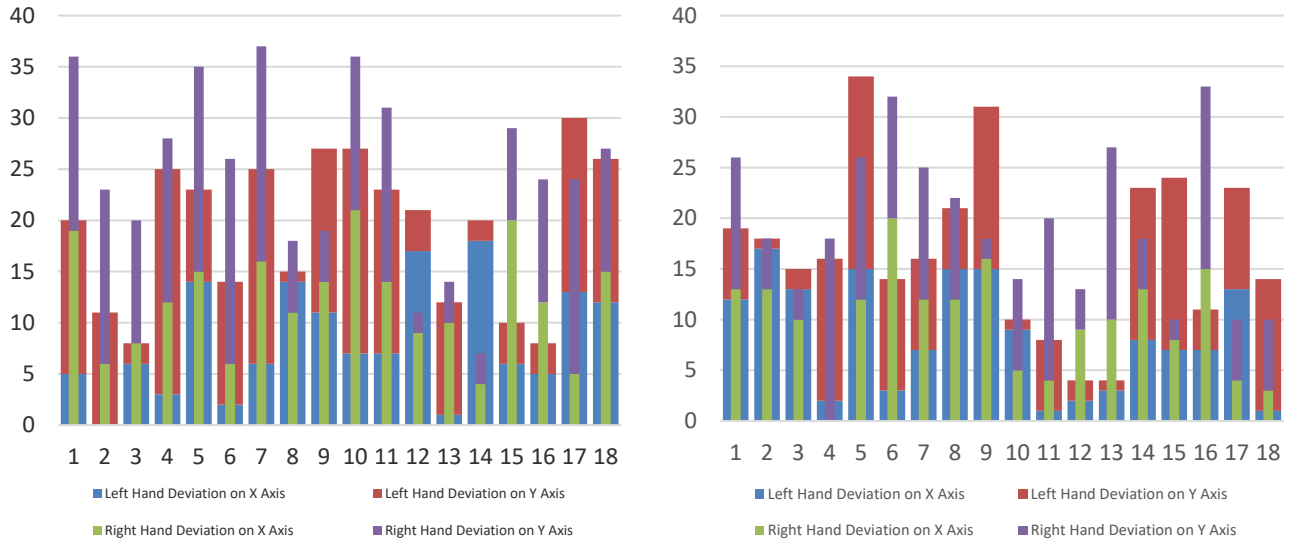
"experimental" - trainees who have received vocational training in profession "Skidder driver (operator)", in educational programs formed on the basis of development of individual educational trajectories.

4 RESULTS

The results of the study of visual-motor tracking to assess the ability to control manipulators of the "joystick" type (test 1) in time are shown in Tab. 1. The results of test 1 on the accuracy of implementation are shown in Fig. 2. The results of test 1 on the accuracy of implementation by age groups under 35 and over 35 years old are shown in Fig. 3.

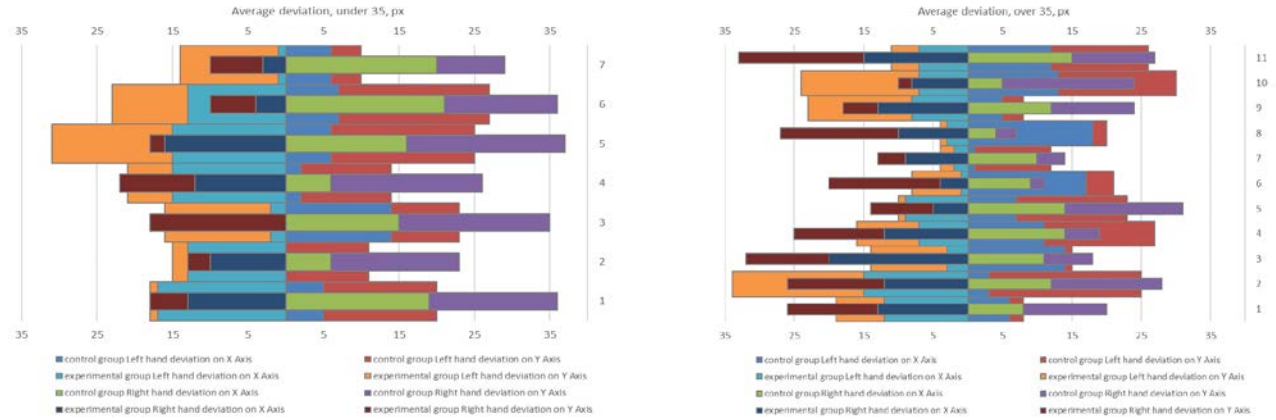
Table 1. Distribution of the results of visual-motor tracking study

Measurement Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
in a control group, average, sec	11	9	12	8	7	6	14	12	9	9	9	10	10	5	12	11	11	8
trainee's age in a control group – under 35 (u) / over 35 (o)	u	u	o	o	u	u	u	o	o	u	o	o	o	o	u	o	o	o
Experienced (e) / non-experienced (ne) in a control group	e	ne	ne	ne	e	ne	e	e	e	e	ne	ne	ne	e	e	e	ne	ne
in an experimental group, average, sec	8	5	5	9	12	11	6	8	5	9	14	7	8	9	11	13	12	9
trainee's age in a control group – under 35 (u) / over 35 (o)	o	u	u	u	o	o	o	u	u	o	o	o	o	o	o	o	u	u
Experienced (e) / non-experienced (ne) in a experimental group	e	e	ne	ne	ne	e	e	ne	e	ne	e	e	ne	ne	ne	ne	e	e



a) b)

Figure 2. Column charts of the distribution of measurement results: a - a number of results of control group, px.; b - a number of results of experimental group, px.



a) b)

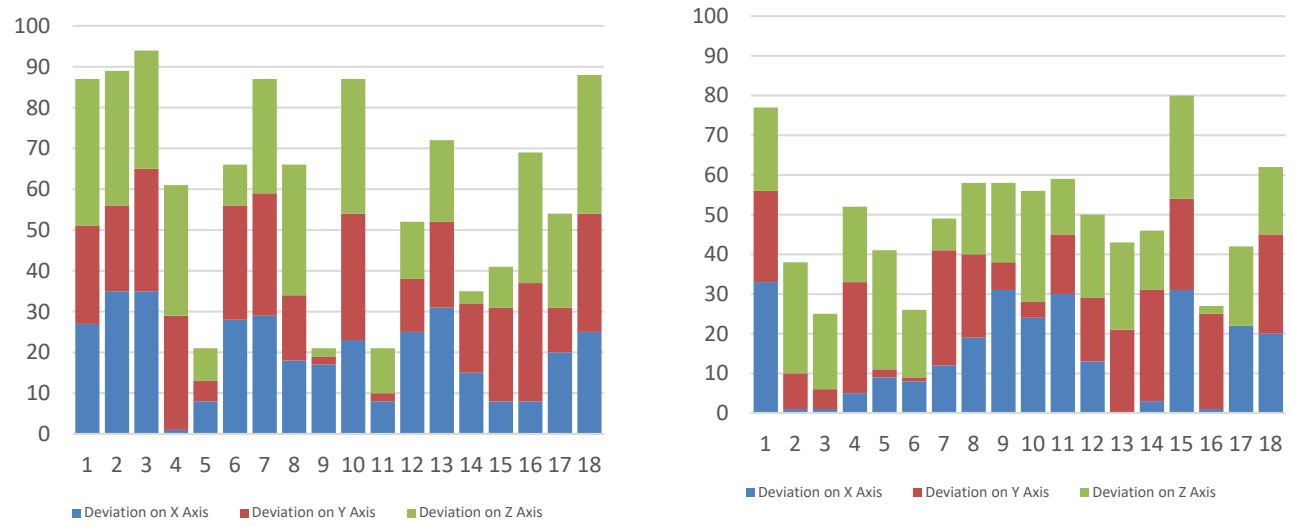
Figure 3. Linear charts of the distribution of measurement results: a - a number of results of trainee under 35, px.; b - a number of results of trainee over 35, px.

The results of the study of three-dimensional management to assess the ability to control manipulators of the "joystick" type (test 2) in time are shown in Tab. 2. The results of test 2 on the accuracy of implementation are shown in Fig. 4. The results of test 2 on the accuracy of implementation by age groups under 35 and over 35 years old are shown in Fig. 5.

Table 2. Distribution of the results of three-dimensional management

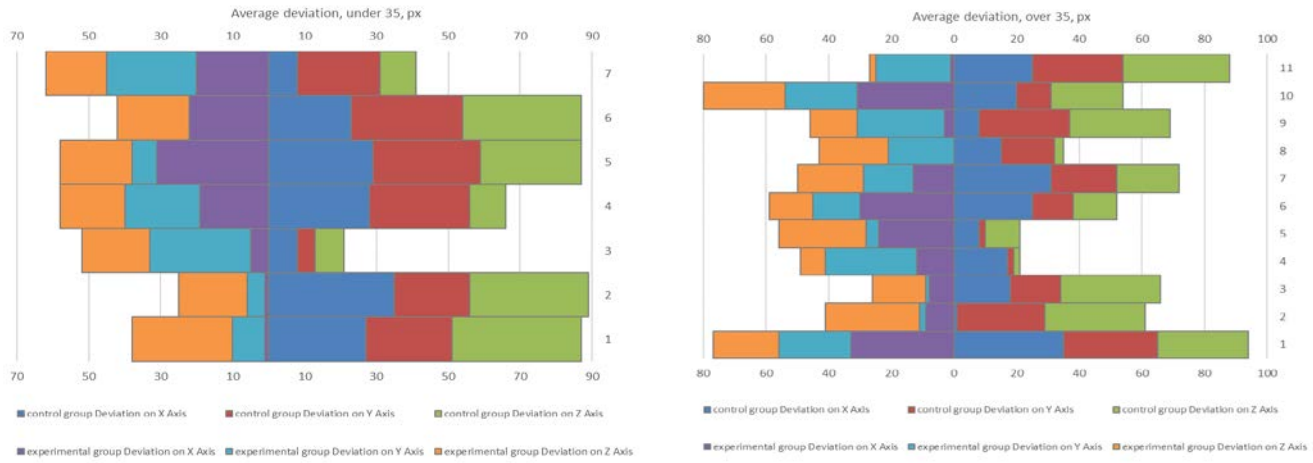
Measurement Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
in a control group, average, sec	6	18	10	16	18	29	21	11	23	17	23	28	13	8	13	22	14	17
trainee's age in a control group – under 35 (u) / over 35 (o)	u	u	o	o	u	u	u	o	o	u	o	o	o	o	u	o	o	o
Experienced (e) / non-experienced (ne) in a control group	e	ne	ne	ne	e	ne	e	e	e	e	ne	ne	ne	e	e	e	ne	ne

Measurement Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
in an experimental group, average, sec	18	15	19	19	10	16	10	21	12	7	22	17	19	12	8	9	21	23
trainee's age in a control group – under 35 (u) / over 35 (o)	o	u	u	u	o	o	o	u	u	o	o	o	o	o	o	o	u	u
Experienced (e) / non-experienced (ne) in a experimental group	e	e	ne	ne	ne	e	e	ne	e	ne	e	e	ne	ne	ne	ne	e	e



a) b)

Figure 4. Column charts of the distribution of measurement results: a - a number of results of control group, px.; b - a number of results of experimental group, px.



a) b)

Figure 5. Linear charts of the distribution of measurement results: a - a number of results of trainee under 35, px.; b - a number of results of trainee over 35, px.

5 DISCUSSION

According to Shapiro-Wilk test, the data obtained in tests 1 and 2 were checked for compliance with the normal law of distribution. The developed methods have a positive effect on increasing productivity of the transport and technological process of mechanized logging that was proved by Student's t-test.

Considering results of tests 1 and 2 by age showed no significant difference between trainees under 35 and over 35 years old.

6 CONCLUSIONS

In the present paper, algorithm for individual educational trajectory of logging machinery operators has been developed, which is based on psychophysiological special characteristics and initial level of proficiency of the necessary skills for work performance.

According to the results of experimental studies, it is proved that the developed methods have a positive effect on increasing productivity of the transport and technological process of mechanized logging.

7 ACKNOWLEDGMENTS

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