

**STUDIES TO EVALUATE THE EFFECTIVENESS OF
INNOVATIVE SOLUTIONS IMPLEMENTING THE
TEACHING OF THE DISCIPLINES CYCLE AT THE
DEPARTMENT OF "SERVICE OF CARS AND
TECHNOLOGICAL MACHINES"**

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Abstract: *The results of the research having been conducted since 2012 at the Department of Automobiles and Technological Machines at the Industrial University of Tyumen (IUT) in assessing the effectiveness of innovative solutions in the field of specialists' training in the organization and technology of service in the direction 23.03.03 – Operation of transport technological machines and complexes are presented. Much work in this vector was carried out by a group of specialists implementing the teaching of a disciplines cycle, forming competences related to the restoration of the technical conditions of rolling stock – the repair of vehicles.*

Keywords: education, personnel training, efficiency of training, car repair, methods of efficiency evaluation, training content.

A sufficient number of scientific works and studies dealing with various aspects of effectiveness, competitiveness and, directly, the effectiveness of the educational service, the educational institution and the system of higher professional education in general, have been devoted to the issues of the effectiveness of higher education earlier and at the present time. Each scientific school determines its approach to this issue. Thus, the theory of human capital treats the higher education as an investment in the potential market value of an individual as a labor market agent, which evaluates both the economic effectiveness of the funds invested in education, and social effects having the character of external effects (externalities)¹. From the same perspective, the theory of human capital examines the effectiveness of higher professional education from the point of view of the state, the society and the employer².

Modern research in the field of management of higher professional educational institutions is increasingly considering by universities as agents

¹ E.M. Akhmetshin, V.L. Vasilev, A.S. Puryaev, R.R. Sharipov, T.N. Bochkareva, "Exchange of property rights and control as a condition of the innovation process effectiveness at collaboration between university and enterprise", in *Academy of Strategic Management Journal*, 2017, vol. 16, Special issue 1, p. 1-9.

² Baldridge national quality program, *Education criteria for performance excellence*, National Institute of Standards and Technology, Gaithersburg, 2000.

of the market environment, and the effectiveness of their activities from the perspective of strategic management as a comparison of available opportunities and the results achieved to the strategic goals set^{3,4}. At the same time, the strategic goals of the higher educational institution are usually localized in the direction of fulfilling the state tasks for the personnel training and the direction of increasing their own competitiveness⁵. In the papers of the authors dealing with the problems of interaction between the system of vocational education and the labor market, the main attention is paid to the effectiveness of the activity of higher educational institutions in terms of quantitative and qualitative conformity of graduates' turn-out to the needs of regional labor markets⁶.

The effectiveness of the activity of a higher educational institution of vocational education should be considered from several positions, namely:

- from the point of view of the state as a customer and guarantor of meeting the social needs (macro-efficiency);
- from the point of view of the individual as a consumer of educational services (individual investment efficiency);
- from the point of view of the regional labor market and the specific employer – the consumer of the university product (market efficiency); from the point of view of the activity of the university as an economic subject.

Thus, the purpose of these studies can be formulated as follows: improving the training of bachelors by means of developing of recommendations for the formation of relevant methodological support of technical disciplines taught at the Industrial University of Tyumen.

Analysis of the issue status

When sending cars to overhaul, the decision is made on the basis of an analysis of their actual technical condition. Trucks are subjected to

³ M.N. Lukiyanova, I.A. Zayarnaya, M.A. Kadyrov, “Introduction of the "3-p" model in the concept of strategic management of municipal entities”, in *Public Policy and Administration*, 2018, vol. 17, no. 4, p. 586-599.

⁴ G. Isatayeva, S. Arzymbetova, G. Daiyrbekova, N. Shegenbayev, A. Baibatshayeva, “Pedagogical management as the theory and practice of management of educational process: Case study of Kazakhstan”, in *Astra Salvensis*, 2018, vol. 6, no. 12, p. 309-322.

⁵ A.S. Dosbenbetova, K.K. Kiyassova, S.Z. Arzymbetova, L.P. Abisheva, G.A. Zhapbarova, “Basic principles of the maintenance of economic education of school students”, in *Astra Salvensis*, 2018, vol. 6, no. 12, p. 353-361.

⁶ G.K. Selevko, *Modern educational technologies*, Prosveshchenije, Moscow, 2009.

major repairs when it is necessary to overhaul the ring-bridge structure and cabin, as well as at least three other major units in any combination. Cars and buses are sent for overhaul if major repairs are required. Units come in overhaul if their basic parts require repair, and also if their work capacity cannot be restored by routine repairs^{7,8,9}.

In the framework of these studies, a survey was conducted among the practitioners with a rank not lower than the head of the workshop of the repair enterprise or the service and current maintenance area of the enterprise operating the rolling stock of transport-technological machines¹⁰¹¹.

The reasons for insufficiently effective training of specialists for repair services of enterprises can be summarized in the following list:

1. Insufficient knowledge of normative and technical documentation for the transport equipment repair.
2. Difficulties in calculating the need for aggregates of transport equipment in repair
3. Lack of clear knowledge of methods for statistical control of quality of the repaired products.
4. Insufficient orientation in the methods of formation the technological processes for repairing of automatic telephone stations and maintenance stations for oil and gas refinery.
5. Lack of practical work skills: with means of detecting the hidden defects in parts (defectoscopy); with diagnostic equipment when repairing units according to technical condition, etc.

⁷ V.V. Poptsov, V.N. Krasovsky, V.A. Korchagin, "Development of modern technological process for vehicle parts in condition of centralized repair", in *Biosciences Biotechnology Research Asia*, 2015, vol. 12, no. 2, p. 1857-1866.

⁸ V.N. Krasovsky, "Estimation of efficiency of information technology support processes for maintenance and repair of special offshore oil and gas production", in *Proc. of the Intern. Scient. and Techn. Conf. "Interstrojmeh-2005"*, May 15-16, Tyumen, 2005, p. 8-14.

⁹ V.N. Krasovsky, "Methodical provision of improved design polimarshrutnyh technologies of centralized repair special offshore oil and gas production. the problem of the exploitation of transport systems", in *Proc. of All-Russian Sci.-Pract. Conf.*, March 5-6, Tyumen, 2008, p. 12-17.

¹⁰ E. Akhmetshin, E. Danchikov, T. Polyanskaya, N. Plaskova, N. Prodanova, S. Zhiltsov, "Analysis of innovation activity of enterprises in modern business environment", in *Journal of Advanced Research in Law and Economics*, 2018, vol. 8, no. 8, p. 2311-2323.

¹¹ I.S. Volegzhanina, S.V. Chusovlyanova, E.S. Bykadorova, J.V. Pakhomova, "Ontology-based virtual learning environment for academic knowledge co-management (by an example of transport universities)", in *Astra Salvensis*, 2018, vol. 6, p. 787-796.

At the same time, the overall assessment of the preparation for practical activities of graduates of the specialty Cars and Vehicle Fleet was no more than 62-70 %. At different times, the following disciplines could be classified among the disciplines directly related to the repair cycle or its sections.

1. Fundamentals of production technology and car repair (or transport and transport-technological machines and equipment).
2. Fundamentals of the organization of repair production.
3. Post-delivery maintenance of vehicles.
4. Organization of repair of car components by the manufacturers.
5. Fundamentals of reliability theory and technical diagnostics.
6. Technology and organization of the restoration of parts and assembly units at road transport enterprises.
7. Car diagnosis.
8. Basics of the workflow management in the road transport.
9. Documentation support for management at the enterprises of transport and transport-technological machines and equipment.
10. Technology and organization of assembly units recovery when service support.
11. Theoretical basis for diagnosing the technical condition of vehicles.

Table 1 gives an example of data systematization on the composition of the repair cycle disciplines and their planned load. Taking into account the ratio of the contents of the disciplines "Fundamentals of reliability theory and technical diagnostics", "Car diagnosis" and "Basics of the workflow management in the road transport" to the repair cycle by only 30-40%, the final load for these disciplines is chosen within 33% of the declared. New work programs introduced since 2016 and the updated composition of the cycle of repair disciplines provides for students in the direction 23.03.03 Operation of transport-technological machines and complexes studying the following subjects.

1. Technology and organization of recovery of assembly units when service support.
2. Technology, maintenance and repair of special oilfield equipment.
3. Documentary support of management on the road transport.

Table 1: Contents of the discipline "Fundamentals of production technology and car repair"

General content of the training material,	Amount of hours		
	Specialist	Bachelor	Bachelor

hours/semester	(until 2016)	(until 2016)	(since 2016)
Lectures	34	18	---
Laboratory works	34	18	---
Practical lessons	---	---	---
Students' independent work	61	36	---
Total	125	72	---
	Final events, term		
Graded test (Examination)	---	---	---
Graded test	7	5	---
Course paper	7	---	---

Method for assessing the effectiveness of the disciplines cycle

Analysis of literature sources^{12,13,14,15,16} revealed the complete absence of any formalized methodologies for assessing the effectiveness of disciplines taught in higher educational institutions (Table 2). This allows us to propose the following empirical expression for achieving the goal set in this paper:

$$\mathcal{E}_o = P (\delta_s + \delta_b) [(K_{\Sigma}^{room} + K_{\Sigma}^{ext}) + (k_g\delta_g + k_e\delta_e + k_{sp}\delta_{sp})] \quad (1)$$

where K_{Σ}^{room} is the cumulative classroom load in the discipline, hours; K_{Σ}^{ext} the total extracurricular load in the discipline, hours; k_g, k_e, k_{sp} is the amount of hours allocated, respectively, for conducting graded tests, examinations and the presentation of course paper on the discipline; P is the conditional share of the ratio of discipline to the repair cycle (from 0.00 to 1.00). The analysis of real situations when conducting classes on

¹² A.A. Kolesnikov, *Total quality management*, "LETT", Saint Petersburg, 2001.

¹³ V.G. Navodnov, *Integrated assessment of higher educational institutions. Students manual. Researcher-inform*, The Center of the State Accreditation, Moscow, 2011.

¹⁴ T.E. Rychun, *Higher educational institution as effective entity of the national economy (Multidimensional view)*, FGOUVPO "RGUTIS", Moscow, 2010.

¹⁵ N.A. Selezneva, *Quality of higher education as an object of systematic study*, Research Center of Problems of Quality Training, Moscow, 2004.

¹⁶ V.S. Sobolev, "Concept, model and performance criteria for quality management system of higher vocational education. University governance: practice and analysis", in *FGOUVPO*, 2014, vol. 31, no. 2, p. 102-110.

specific disciplines makes it possible to introduce into the formula (1) the following integer variables:

$\delta_s = 1$ in the presence of discipline among specialists and 0 in the contrary case;

$\delta_b = 1$ in the presence of discipline in bachelors and 0 in the contrary case;

$\delta_g = 1$ if there is a graded test on the discipline and 0 in the contrary case;

$\delta_e = 1$ if there is an examination in the discipline and 0 in the contrary case;

$\delta_p = 1$ if there is a course paper (project) in the discipline and 0 in the contrary case.

Table 2: Contents of the discipline "Technology and organization of recovery of assembly units when service support"

General content of the training material, hours/semester	Amount of hours		
	Specialist (until 2016)	Bachelor (until 2016)	Bachelor (since 2016)
Lectures	---	---	36
Laboratory works	---	---	---
Practical lessons	---	---	18
Students' independent work	---	---	90
Total	---	---	144
	Final events, term		
Graded test (Examination)	---	---	4
Graded test	---	---	---

Table 3: Values of model parameters (2) for disciplines included in the repair cycle

Name of the discipline	Parameter Values						
	P	$K_{\Sigma^{ayd}}$	$K_{\Sigma^{umc}}$	k_{s_3}	k_{s_2}	k_{sp}	k_{RN}
Period until 2001							
Fundamentals of production technology and car repair	1.00	125	14	7	7	7	...
Period from 2001 to 2010							

Fundamentals of production technology and car repair	1.00	125	14	7	7	7	...
Period from 2010 to 2016							
Fundamentals of production technology and car repair	1.00	72	5	5	...	...	...
Period since 2016 (enrolled students in the specialty Cars and Vehicle Fleet (Bachelor training)-15)							
Technology and organization of the restoration of parts and assembly units at road transport enterprises.	...	...	...	...	...	...	...
Car diagnosis	...	...	...	...	...	...	...
Documentation support for management at the enterprises of transport and transport-technological machines and equipment	0.20	108	7	7	0	0	...
Technology and organization of assembly units recovery when service support	1.00	144	4	0	4	0	...

During the period under study, working curricula changed three times: until 2001, from 2001 to 2010, from 2010 to 2016 and since 2016, so the final expression of the objective function can be presented in the following form:

$$\Theta_{\Sigma}^o = \square_{i=1}^N \Theta_o \delta_p \quad (2)$$

where N is the composition of the disciplines included in the repair cycle; $\delta_p = 1$ in the presence of discipline in the cycle for the considered period of time, 0 in the contrary case. Discipline in the cycle for the considered period of time, 0 in the contrary case. The values of the parameters and variables of model (2) are given in Tables 3 and 4.

Table 4: Values of model variables (2) for disciplines included in the repair cycle

Name of the discipline	Values of variables					
	δ_c	$\delta_{\bar{c}}$	δ_s	$\delta_{\bar{s}}$	δ_{kp}	$\delta_{\bar{t}}$
Period until 2001						

Fundamentals of production technology and car repair	1	0	1	1	1	1
Period from 2001 to 2010						
Fundamentals of production technology and car repair	1	1	1	1	1	1
Period from 2010 to 2016						
Fundamentals of production technology and car repair	1	1	1	0	0	1
Period since 2016 (enrolled students in the specialty Cars and Vehicle Fleet (Bachelor training)-15)						
Fundamentals of production technology and car repair	0	0	0	0	0	0

The results of calculating the parameters of the effectiveness of the quantitative and qualitative composition of the disciplines of the repair cycle for the periods of their teaching, as well as their final values, are presented in Table 5. The final results of calculating the efficiency parameter for individual disciplines and for generalized efficiency parameters for the study periods under consideration are given in Table 5. In order to save space in the paper, tables 3 to 5 are presented in a fragmented manner, which can cause some difficulties in estimating the amount of work to collect and process empirical data for calculating the efficiency parameters and forming the objective function.

Table 5: Final values of calculations of efficiency parameters

Name of the discipline	Parameter Values
Period until 2001	
Fundamentals of production technology and car repair	160.00
TOTAL	200.80
Period from 2001 to 2010	
Fundamentals of production technology and car repair	160.00
Fundamentals of the organization of repair production	150.00
Post-delivery maintenance of vehicles	59.00
TOTAL	...
Period from 2010 to 2016	
Fundamentals of production technology and car repair	0.00
Fundamentals of the organization of repair production	0.00

Post-delivery maintenance of vehicles	572.00
TOTAL	428.20
Period from 2016 (enrolled students in the specialty Cars and Vehicle Fleet (Bachelor training)-15)	
Fundamentals of production technology and car repair	0.00
Documentation support for management at the enterprises of transport and transport-technological machines and equipment	24.40
Technology and organization of assembly units recovery when service support	152.00
Technology, maintenance and repair of special oilfield equipment.	132.00
TOTAL	308.40

For clarity, the calculated values of the generalized efficiency parameter of the repair disciplines cycle studied are presented graphically in Figure 1.



Figure 1: Final values of calculations of efficiency parameters

Thus, the results of studies on the assessment of the dynamics of changes in the qualitative and quantitative composition of the cycle of disciplines forming the competences related to the restoring of the technical condition of the rolling stock – the repair of vehicles, allow us to make a reasonable conclusion about the systematic reduction. To achieve the research goal, we have developed a number of recommendations allowing us to make concrete steps for the future planning of specific activities:

- provide the existing laboratory practice for information support for all technological operations; study and introduce in the educational process the use at the enterprises of free access to electronic catalogs for all sites of the repaired rolling stock;
- develop and publish an engineering workshop on the formation of technological routes for the repair of vehicles, due to the planned nature of their formation;
- provide the educational process for all the necessary tools to perform repair operations; substantiate the need to purchase the modern diagnostic equipment for assessing the technical condition of electronic and mechanical vehicle systems;
- introduce materials on the automated accounting system of all types of work performed at the car repair shop for each unit of the rolling stock in the discipline "Documentary support for management in the road transport";
- to form a branch of the department Service of cars and technological machines in the real repair or operational enterprise "Tyumengortrans", taking into account the practical orientation of the personnel training, with the transfer there of a certain volume of training sessions of the repair cycle in the direction of 23.03.03 Operation of transport-technological machines and complexes.