Contemporary paradigm of cargo motor transport vehicles service

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Abstract. The results of the study of the organization of cargo vehicles operation by the transport processes mechanization in the environment, complicated by the climatic and industrial factors, are presented. The integrated technological process of using freight vehicles as a new modern paradigm of their operation during the life cycle is described.

1. Introduction
The problem of cargo motor transport vehicles (hereinafter – CMTV) maintenance should be considered as an important component of the strategy of creating a competitive national market and improving the marketability of the Russian automotive industry on the international market. In developed countries, the CMTV service has completely become an independent sphere of the economy.

Modern marketing and dealer services of automakers have formed their service concept, which provides for the services rendering in the maintenance of the CMTV for the entire duration of operation. This concept is supported by the orientation of large enterprises to increase the service sector, which stimulates the formation of their own internal grouped service points (for example, information technology structures that serve certain units), as well as the creation of subsidiaries or the purchase of the enterprises already providing the CMTV services. It does not change the basic marketing purposes, but reprioritizes general marketing decisions in the direction of the service, offered to the CMTV owners, or building an effective system of the CMTV service. This allows attracting more and more new customers and expanding the system of regular customers. The total set of services, provided during the CMTV operation, becomes a criterion for securing an order in those industries where competition in price, quality and reliability is no longer possible, where all enterprises use high-tech production methods. In general, the agreement on the service provision is now one of the most important conditions for the CMTV purchase and operation.

The need for the development and implementation of more economical modern methods and methods of CMTV operation, allowing obtaining high economic results of the operational enterprises, is becoming increasingly important. Undoubtedly, reducing the costs associated with the CMTV use contributes to the efficiency enhancement of any production, as well as the competitiveness of transport operations.

At the origins of the science of the machine service, there have been some prominent Soviet scientists: academician B.S. Svirschevsky, a honored worker of science and technology of the RSFSR,
doctor of Technical Sciences, Professor G.V. Vedenyapin, Professor N.Ya. Govorushchenko, N.S. Zhdanovsky, G.V. Kramarenko, P.T. Frolov, A.M. Scheinin. A significant contribution to the development of science was made by Professor V.I. Balovnev, V.A. Zorin, A.P. Kryvshin, E.M. Kudryavtsev, A.N. Maksimenko, A.K. Morozov, B.I. Filippov and others.

Through the joint efforts of these scientists and production specialists, the science of machine operation was formed, which became a powerful factor in ensuring the high-performance use of equipment for various purposes in the national economy.

Rational machines operation, allowing increasing productivity and efficiency, has become a system of machine service, implying a certain scheme of implementation of their life cycle (Figure 1). This approach can be considered the first paradigm of machine operation, which was formed in the 30s – 50s of the twentieth century.

Figure. 1. Scheme of the machine life cycle realization.

The paradigm (from the Greek \textit{paradeigma} – example) is a conceptual model of problem formulation and solution, predominating in the academic circles during a certain historical period, some clearly defined concept, style of thinking and methodology. It should be recognized that this is a special way of organizing scientific knowledge, which sets a particular vision of the world and, accordingly, examples and models of setting and solving research problems [1]. The paradigm shift is generally seen as a scientific revolution, which is now clearly visible in various fields of science, production and education. The science of machinery operating occupies a worthy place specified by its history, adequately responds to the many demands of production and human community, having powerful potential. The characteristic feature of the present time is globalization. It is the process of integration of mankind into a complex interconnected single planetary system, a qualitatively new level of human activity, based on the latest achievements of science and technology, the introduction and development of market economy.

In fact, currently, the CMTV operation is an integrated technological process (ITP CMTV), which includes technological processes of the CMTV use for their intended purpose, technological processes of CMTV technical operation (maintenance and repair processes, i.e. technical service), as well as technological management processes [4].

This approach makes it possible to form a system of freight vehicle operation for ITP CMTV. It should be noted that this system should include a CMTV producer, which plays the role of a CMTV supplier in the area of operation. At the same time, they need to participate in technological processes of maintenance service, carrying out so-called original service maintenance (OSMCMTV). The interactions between the CMTV manufacturer (PCMTV), operator (OCMTV), the operation control structure (SCOCMTV) in the sphere of the CMTV operation (SOMCMTV) are shown in Figure 2.

Thus, the scope of the CMTV operation is considered as a single flexible high-performance complex, ensuring the implementation of transport works and the provision of industrial infrastructure services to other participants of the integrated technological process of the CMTV. In modern conditions, the field of the CMTV operation should assume additional tasks, which, in comparison
with the traditional operation process, dictate new requirements for the development of the entire infrastructure, technical equipment and technology of all CMTV units and services [4].

![Diagram of the cooperation of the cargo motor transport vehicles operator (OCMTV), the cargo motor transport vehicles producer (PCMTV), the original service maintenance system of the cargo motor transport vehicles (OSMCMTV) and the operation control structure of the cargo motor transport vehicles (SCOCMTV) in the operation sphere of the cargo motor transport vehicles (SOCMTV).](image)

Figure. 2. Diagram of the cooperation of the cargo motor transport vehicles operator (OCMTV), the cargo motor transport vehicles producer (PCMTV), the original service maintenance system of the cargo motor transport vehicles (OSMCMTV) and the operation control structure of the cargo motor transport vehicles (SCOCMTV) in the operation sphere of the cargo motor transport vehicles (SOCMTV).

Any enterprise of the automotive industry, operating within the framework of the service concept, should use a systematic approach, first of all, to solve the problems of market competition. This involves the study of needs and demand; the analysis of the internal and external environment of the enterprise, the development of goods and programs of their production; pricing and marketing policy evaluating; rendering various kinds of services related to sales and consumption, including the organization of after-sales services and out-of-use goods utilization.

The observed steady trend of increasing demand for technical services is supported by the automotive industry enterprises, which have the value of products added by services. At the same time, the CMTV owners have the advantage of differentiated benefits owing to additional services. The activities primarily associated with science-intensive services take on greater importance. They include comprehensive services to the CMTV owners, consulting services, engineering and system integration services, project management organisation, special software of the CMTV owners, training and retraining of personnel, maintenance of installations, financial decisions and so on. The organization and expansion of knowledge-intensive service business is central to the strategic plans of many companies in the automotive industry [6]. The increasing complexity of the CMTV designs leads to a growth in the need for comprehensive solutions to technical problems, for example, in the supply of "turnkey", assistance in the management of systems and etc.

The purpose of this study is to improve the CMTV exploitation efficiency and safety and the competitiveness of the transport operations by optimizing the processes and costs associated with the use of modern CMTV for their intended purpose and technical service.

The scope of the CMTV operation cannot be considered in isolation from the environment in which they operate. Since the resource provision of the CMTV operation field is carried out from the
external environment, its functioning should be connected with it systematically. At the same time, the
direction of the CMTV operation is responsible for the external environment, performing transport
work for the customers – consumers of services of operating enterprises. The field of operation also
works for itself, performing the CMTV maintenance and repair.

For the analysis of the CMTV operation system effectiveness a process approach, in the terms of
which a complex organizational and technological system as a set of processes, structurally reflecting
the CMTV life cycle, can be seen as follows. "CMTV Design – CMTV Production – CMTV Operation
– CMTV Utilization" ("Des. CMTV – Prod. CMTV – OCMTV – UCMTV"). In this case, the concept of «operation of CMTV» includes the processes of their intended use and technical service processes
(including OSMCMTV) [5, 7, 8].

To describe the structure of the complex organizational and technological operation system of the
CMTV, cooperation and interaction of its constituent subsystems, a synergetic approach is applied. In
terms of the approach, the considered system is not local and between its elements there is an
interaction organized, which is perceived as the information transmission with an infinite velocity
(first of all, the quantum mechanical inequality by Jhon Bell reminds about this). The set of the
processes, accompanying its functioning, structurally reflects the CMTV life cycle [5, 8–11, 13–16].

With due regard to the process approach, the CMTV life cycle is divided into three levels:

1 – the level of the CMTV design and production (LDPCMTV).
2 – the level of the CMTV operation (LOCMTV).
3 – the level of the CMTV utilization (LUCMTV).

The CMTV operation technological processes are represented by the sequence: "Breaking in –
Intended Use – Original Service – Technical Service" ("BrInCMTV – IUCMTV – OSCMTV – TS
CMTV").

The scope of the CMTV operation, considered as a single flexible high-performance complex,
should ensure the implementation of transport operations on a commercial basis, as well as the
provision of commercial services of the technical service production infrastructure to other
participants in the production process of the CMTV operation.

The effectiveness of the CMTV use is a set of two concepts: the CMTV performance and the cost
of their purchase and operation.

The parameters ensuring maximum performance of the CMTV are called rational, and the
parameters that provide maximum efficiency are optimal.

Finding the best solution, that achieves the maximum productive capacity (maximum profit) or a
minimum cost of funds to guarantee the operation and operational reliability maintenance, is called
optimization of the CMTV use.

In practice, it is impossible to strive for maximum results and minimum costs at the same time. It is
necessary to get the most results, provided that the costs do not exceed certain values, or get the
minimum cost, provided that the results are not less than the specified ones.

The task of the CMTV use optimizing is extreme (finding the points of the greatest and least
values). Notably, it has the only most effective solution in this confluence of facts and circumstances.
As the most complete criterion of optimality (efficiency) of the CMTV use, it is accepted to apply the
criterion of specific reduced costs [5, 6].

The information support of the technological processes of the CMTV technical service is the most
important element of the unified operation technological process. The sources of information are the
results of statistical processing of data on the CMTV individual elements reliability and their
operational reliability in general. In addition, the information about the CMTV technical condition
should appear in the result of the data analysis obtained from the CMTV diagnosing on the service
companies fixed stations. The speed operation modes and levels of load impact on the CMTV should
be monitored by the diagnosis and registration equipment built into the CMTV construction design
[5, 6].

Formed as a result of the analysis of the production and technological system functioning (in a set
of processes), structurally reflecting the CMTV life cycle [5, 7], the system is transformed as follows:
"Performance Specification Development – CMTV Design – CMTV Production – CMTV Operation – CMTV Utilization" ("PSD – DCMTV – PCM TV – UCMTV "). In this case, the block of "Performance Specification Development" is introduced into the system, taking account of all requirements for the design and operation of the new CMTV. With the consideration of the activities of the structures, designing and producing machines and ensuring their implementation and delivery to the location of the user (operator), it is necessary to consider the above-mentioned production processes as the production-sales-maintenance-service system (PSMSS): "CMTV Manufacturer – CMTV Sales Dealer – CMTV Owner – CMTV Operator – CMTV Service Representative" ("MCMTV – SDCMTV – OwnCMTV – OCMTV – SRCMTV") [5, 7].

The CMTV life cycle levels should also be defined, introducing their notation conventions: 

- \( L_{PSDCMTV} \) – the level of performance specification development of the CMTV design;
- \( L_{DM1CMTV} \) – the design level of the CMTV;
- \( L_{DM2CMTV} \) – the production level of the CMTV;
- \( LO_{CMTV} \) – the operation level of the CMTV;
- \( LU_{CMTV} \) – the utilization level of the CMTV.

The technological processes of the CMTV operation are as follows: 

- \( Br\ln CMTV \) – the CMTV breaking in;
- \( In\ln CMTV \) – the intended use of the CMTV;
- \( OSMCMTV \) – the original service maintenance of the CMTV;
- \( TSCMTV \) – the CMTV technical service.

Natural-climatic and other factors characterizing the surrounding (external) environment have a significant impact on the CMTV technological processes. The level and characteristics of the operating conditions impact on the CMTV technical condition, causing its changes, are taken into account by the indicator "the cumulative value of the load impact on each CMTV", in which, according to the principle of the "blackbox", both the nature and the magnitudes of the specified cumulative value of the load impact are hidden. Modern built-in means of control of operating conditions and changes in the CMTV technical condition allow the monitoring mode to reveal the uncertainty of load effects and the CMTV technical state changes, which are concealed by the "blackbox". The theoretical justification and the examples of the practical use of these means are given in the dissertation of I.E. Berdnikov, written under the supervision of the author.

The theory of self-organization in complex, open, nonequilibrium and nonlinear systems of any nature is considered to be synergetic [8, 12]. Since the considered system of the CMTV operation consists of a large number of elements, it is complex and self-organizing. Besides, it is open, nonequilibrium and nonlinear. With an increase in non-equilibrium above a certain limit, it turns into an unstable state, in which there is a consistent behavior of the system elements and the transition of the system to a qualitatively new state with an ordered structure. Therefore, it can be attributed to the category of self-organizing synergetic systems, the way out of the instability of which is a jump due to the rapid restructuring of the system elements. However, the choice of one of the possible states of such a system is always random [5, 8–11].

In the process of the CMTV operation, the most common problem situations are associated with the development of sound management decisions (DSMD). This applies both to the problems of using the CMTV for their intended purposes (commercial operation), and the problems connected with the control and assessment of the CMTV technical state, constantly changing in the course of their operation due to stress effects. The changes in the technical condition should be compensated by preventive maintenance measures (PMM), and in cases of failures – by repairing (R).

To assess the effectiveness of the DSMD, the model, called "white box", is acceptable, in which the intangible component of the system – information is handled. In the process of the DSMD, the entities carry out operations only with information. To solve the problems, not only the resources of the company operating or servicing the CMTV can be used, but also the favorable conditions of the external environment as a specific resource for the development of the operational system.

The confluence of resources and problems allows for a variety of resource use cases to be considered for each problem. For example, a certain resource may be required to solve some problems, but predominantly the required synergetic effect is provided by a combination of resources. The gaps (contradictions) between the goals of the CMTV operation and their current technical condition allow to identify the problems, and the goals, in turn, are the quantitative indicators, which can be used to
evaluate the developed alternatives and make a grounded decision. The prerequisites for the new approaches search in the CMTV operation organization are created by the theory of technocratic discourse and awareness of the scale and importance of technical reality, determining literally all aspects of human life in the modern world.

It should be borne in mind, however, that the CMTV operation is a multi-faceted area of expertise, services and organizations, consisting in the task-specific and full employment of the CMTV potential, especially when it comes to commercializing these processes.

Since the scope of the CMTV operation should be considered as a single flexible high-performance complex, ensuring the implementation of transport works on a commercial basis and the provision of services of industrial infrastructure of technical service to other participants in the production process of the CMTV operation also on a commercial basis. The goals included in this activity and the methods of achieving them change depending on the level at which the work is carried out. However, at all levels, the purpose of the CMTV operation is:

1) to improve the service for the CMTV use and their parks for transport operations, taking into account their specific features in order to obtain an acceptable level of income;
2) to tighten control over the CMTV operation modes in the course of their functioning in order to obtain an acceptable level of income;
3) to technologically maintain and restore the CMTV performance;
4) to provide CMTV with the high quality maintenance materials;
5) to organize routes of cargoes handling;
6) to save, store the CMTV during the periods when they are not used for their intended purpose.

These areas of expertise and services simultaneously point to the causal factors that determine the CMTV operation effectiveness and are controllable.

In this case, it is necessary to remember the subjective factors affecting the CMTV use effectiveness. This may include the driver, managing the CMTV work, as an element of the system "Man – CMTV – Environment", the effectiveness of the implementation of the above tasks largely depends on his skills and experience.

Currently, in the period of the new scientific areas development, such as the control theory, reliability theory, technical diagnostics, probability theory and its section – Queuing theory and etc. – theoretical foundations of the CMTV operation are significantly enriched.

Thus, the CMTV operation should be an integrated technological process (ITP CMTV), which includes the technological processes of using the CMTV for their intended purpose, the management technological processes, as well as the technological processes of technical operation (maintenance and repairing) of the CMTV. All these processes in the market management mechanism, for the most part, are entrepreneurial, so the goal of most of them is to make a profit. In this regard, it should be recognized that the third synergetic paradigm of cargo vehicles operation has already been established.

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