

Management of technological competencies for the purpose of innovative development

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Abstract. To date, the choice of an enterprise development strategy that ensures the growth of its competitiveness depends on the timely transition to targeted competency management. This work is aimed at researching and developing approaches to managing unique technological competencies (UTC), which can be used by modern corporations of the machine-building complex. Key words: unique technological competencies (UTC), key competencies, competitive strategy, matrix of unique competencies, organic and inorganic competencies.

1 Introduction

Application of key characteristics of the product, its key elements, technological processes and competencies in the open innovations. One of the urgent tasks of the country's economic development is to ensure the innovative development of Russian enterprises. To solve this problem, especially in the field of high technologies, it is necessary to develop new economic approaches and mechanisms for innovative development, to choose the focus of the application of the main efforts in this activity - the main factor that ensures competitiveness and technological leadership. In modern economic scientific literature, it is substantiated that the unique technological (technical) competencies of scientific and technical teams of high-tech industrial enterprises, which form potential "points of growth" for the entire high-tech industry and the national economy as a whole, are such a main factor in innovative development [1].

2 Main part

Unique technological (technical) competence (UTC) is a set of knowledge, skills, and abilities of a team of scientists and specialists that allows them to create innovative technologies and products for various fields of application, while the technical characteristics of these products meet the criteria of global superiority (exceed the characteristics of the best world analogues) or global competitiveness (comparable to the characteristics of the best world analogues) [1].

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Currently, there is a growing interest in the topic of managing the UTC for the purposes of innovative development and competitiveness [1-5].

It should be noted that competencies reflect the ability of specialists to effectively achieve the desired result at all stages of the life cycle of a labor product: development, production, operation, repair, disposal. In the economy of enterprises, as a rule, the main stages of creating a product (or technology) are its development and production. At the product development stage, which includes design, construction, engineering, the technical appearance of the product itself, its key elements are formed, technical decisions are made, and technological production processes are developed. Therefore, the UTCs of the development stage are decisive, and the UTCs of the production stage are formed mainly during the training of the personnel of blue-collar professions in the relevant technologies. Such UTCs for the execution of technical processes, for all their importance and relevance (the popularity of WorldSkills competitions is growing in the world), are of a secondary nature. Performance competencies are of great importance in the fields of art, sports, handicrafts. At the same time, the creative stage of product development has the greatest impact on the innovative development of enterprises, when the characteristics of the product are laid down that determine its competitiveness.

Within the framework of this study, from the entire scope of possible UTCs [1], we will single out creative UTCs of the product or technology development stage, the inventive step, which are creative in nature and have the greatest impact on the creation of innovative products.

Under UTC development stage product or technology is understood as a set of knowledge, skills, and abilities of a team of specialists, which determines their ability to invent new devices, products, and technologies with characteristics unattainable for competitors, based on the management of specific physical (chemical, biological, social, etc.) processes that make up the principle of operation of these devices, products and technologies [3]. It does not matter whether intellectual property is registered in the form of patents and know-how. Given the transience of innovation processes, the speed of solving the set scientific and technical problems and developing technologies and products plays an important role. Successful solution of a new task forms a new UTC, and a similar task will be solved again by the team quickly and successfully. After a certain time, the competence ceases to be unique, because competitors are adopting a similar product or technology. Therefore, the number of UTCs is the number of new inventions, their growth per unit of time.

UTC reflects the distinctive ability (ability) of a team of specialists in a company to best perform specific actions in a particular technical area, which allows the company to create new competitive technologies and products and lead the market. As a rule, UTC arises on the basis of existing technological competencies in the process of solving new (non-standard) tasks and involves the use of an intelligent non-standard approach to solving such tasks. UTC can be transmitted through training.

The carriers of the UTC in the organization are the scientific and technical teams of specialists, the "UTC teams".

Technical (technological) advantages, as the basis of competitive advantages, can be achieved through the special skills of the team to develop and implement:

- 1) the design, use in the product of a specific key element(s), or links, arrangements of elements in the structure, providing superiority (and the ability of specialists to create such key elements), and / or

- 2) to create and apply technologies (specific actions) based on the possession of methods, methods of use and control of certain physical (chemical, etc.) processes.

Using a hierarchical approach to the description of the UTC, it becomes possible to show the entire causal chain of formation of a competitive technological advantage.

Note that the central concept is **key characteristic**, expressed quantitatively or qualitatively, which must be achieved, which is the criterion of technological leadership or competitiveness.

A key characteristic allows you to highlight and determine whether a particular technological competence is unique or ordinary. A key characteristic reflects the competitiveness of a product or technology. At the same time, with the help of a key characteristic, you can set the fundamental requirements for the development of a product and its elements.

In a more general case, when setting the task of creating an innovative product, a group of characteristics is required that can be conjugated (coordinated), when actions to achieve one characteristic simultaneously lead to the achievement of another (other) target characteristics, or otherwise, contradictory. The solution in the second case is achieved either by a compromise, or by setting and then solving an optimal control problem with an explicitly specified optimality criterion and constraints, or by TRIZ contradiction resolution methods.

In this paper, we introduce the following definitions: **Key characteristic** – a technical parameter of a product (system, key element) that determines the effectiveness of its intended use (functionality), including competitiveness or technical leadership.

A task (scientific and technical, technological) – formulated task to achieve a clearly defined goal, technical result (**key feature**).

If Goal - answers the question what, then the task - answers the question what to do? For example, «Create a Product».

The task is decomposed into subtasks.

Task Description Syntax: < action > < an object > < criterion >

Criterion – quantitatively (qualitatively) expressed key characteristic.

Problem – a task, a satisfactory method (method) for solving which is not defined. Contains a factor that hinders the achievement of the goal. Connected with

- technological barriers or
- contradictions.

A problem is a complex issue, a task requiring resolution, research. (Explanatory dictionary of Ozhegov)

Issue owner – the person responsible for solving the problem, endowed with the necessary powers (administrative, financial)

Request for a solution (innovation) – the formulated task (problem) transferred to the decision of the Contractor (internal or external).

Mathematically, the problem statement can be described as follows.

The technical quality of the Product, which is an integral part of its competitiveness, can be expressed as a vector (tuple)

$\vec{Q} = (\vec{K}, \vec{H})$, including:

$\vec{K}$ – vector of key characteristics of the Product and

$\vec{H}$ – vector of generic product specifications.

Matrix $\mathbf{K}$ [$\mathbf{N} \times \mathbf{M}$] competitive offers in the market can be compiled from a comparison $\mathbf{N}$ key features $\mathbf{M}$ competing Products.

Then the condition for the superiority of the Product will be the achievement of an extremum i -th key feature

$$L_i = \max_{j=1, N} k_{ij},$$

where L_i – outperforming competitors i -th key feature,

a k_{ij} - values i -th key characteristic of j -th product on the market. Achieving a certain level of a key characteristic, including its superior value, is a function of technological competencies

$k_i = f(\vec{C})$, where $\vec{C}$ – a vector of technological competencies of a team of product manufacturers, including both their unique technological competencies $\vec{U}$, as well as general scientific and general engineering competencies $\vec{R}$:

$$\vec{C} = (\vec{U} + \vec{R}).$$

Each t competence can be described as a function g_t :

$c_t = g_t(a_t, p_t, k_t)$, where

a_t – action,

p_t – an object,

k_t – key characteristic quantified.

Then the task of diversifying the UTC will be to search for an object $p_r \in P$, for which the condition **T** (technical and technological feasibility) and **E** (economic feasibility). P – is the set of relevant action application objects a_t .

The task of scouting (search for technologies and competencies) is mathematically reduced to finding such $a_r \in A$ (set of suitable actions) for which, with respect to a given p_0 required k_0 .

In the general case, an optimal control problem is formulated with an optimality criterion and constraints.

The process of developing a new innovative product is a sequence of the following stages, performed iteratively until the goal is achieved:

- Conceptual synthesis (shaping the appearance of the product - what is being developed, goals, purpose, principles of operation of the product / technology),
- Formation of technical requirements (main functions and characteristics),
- Functional, structural synthesis (architecture, basic elements and connections),
- Parametric synthesis (formation of quantitative requirements for elements, formation of partial technical task),
- Optimization (iterative redesign process to meet technical requirements, conflict resolution).

At the same time, the developer solves design, engineering and technological problems, meeting and overcoming the corresponding problems.

The solution of these problems is possible by attracting the necessary own and borrowed teaching staff, when inventive problems appear, TRIZ specialists can be involved.

This raises two important management challenges (fig. 1):

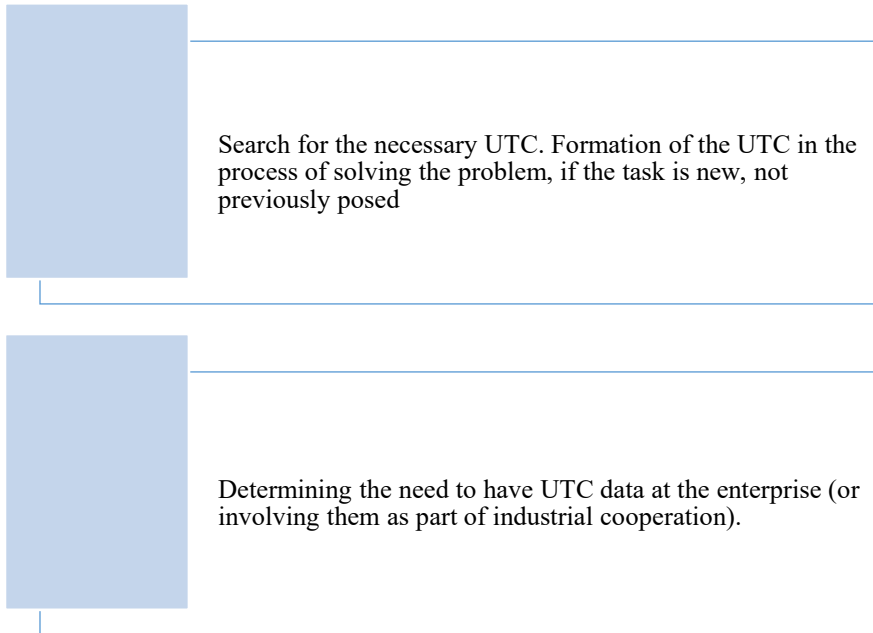


Fig. 1. Two management challenges.

It is clear that with the successful solution of a new scientific and technical problem, the corresponding UTC will be formed and can be further used as a competitive advantage for the company. At the same time, the formation of one's own UTC may require large time and material resources, and if there are available UTCs on the market, the feasibility of attracting third-party UTCs should be assessed, taking into account the available time and other restrictions for solving the problem, as well as future business prospects.

When creating an innovative product, as a rule, composite components of intersectoral application do not cause problems. Therefore, it is necessary to highlight non-standard elements and connections:

- Key elements (determining the leading characteristics of the Product),
- Critical elements (hard to reach, especially expensive, rare, i.e. having a small number of developers or suppliers, non-replaceable parts).

It is necessary to determine the elements for the development of one's own UTC and the elements ordered through cooperation. At the same time, it is recommended to develop key and critical elements within the enterprise, including mechanisms for attracting the necessary specialists and teams.

In any case, an adequate and correct statement and formulation of the task for external or internal performers will be required, which requires a certain amount of experience. For example, when transferring “cross-cutting” competencies from other areas of science and technology, it will be necessary to translate the terms of one subject area into the required one.

It should be noted that the root of breakthrough innovations is in the generation of market ideas. It is known that of the two known mechanisms for the formation of technological innovations Market Pull and Technology Push, the former accounts for 85% of successful businesses.

Jason Chen, CEO, President and Chairman of the Board of Directors of Acer Inc., in an interview with Business FM radio on April 11, 2019, said “the root of our innovation is that

we first determine the Market Direction, and then select necessary Technology, not vice versa!”

This suggests that the commercialization of UTC is mainly a source of improving innovations, while breakthrough innovations in solving market challenges. Deep analysis of market needs, vision of development trends are the basis of breakthrough innovation. The Schumpeterian entrepreneur combines resources, including the formation of the UTC of his own enterprises and attracting third-party UTC through requests for external innovations (competencies), is capable of revolutionary changes in the market and technologies will identify four types of innovation.

3 Conclusion

At the same time, the task of choosing the key characteristic of the consumer properties of the product, and its quantitative (in a particular case, qualitative) expression, as a criterion for a breakthrough innovation, remains. For example, the Tesla electric car has been changing the car market since 2009 by providing mileage on a single charge that is acceptable for everyday use (350 km). This key feature has been decomposed into system requirements and solved by in-house and affiliated UTCs

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