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**DEVELOPMENT OF METHODS TO COMMERCIALIZE UNIQUE
TECHNOLOGICAL COMPETENCIES AT HIGH-TECHNOLOGY
ENTERPRISES**

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Abstract

One of the most important condition for increasing the competitiveness of business is the formation, retention, and development of key competences of the organization, which reflect the competitive advantage. Oultined problem is especially urgent for high-tech industries, which are the most sensitive to all kinds of changes and innovations. The solution is also needed in the process of creation of an IT system of competence management for the need of a certain enterprised or firm. The similar question also arises in the process of development of independent cloud system which can be used by many corporate clients of different size and type.

The ways of applying the company's technological competences to form a business model, the proper form of competence description and analysis are considered in the paper. The following from is recommended to use in IT solutions for competence databases or for the educational program design or evaluation. The examples of formal description and classification are given. The ultimate goal of the paper is to outline the methodology for identifying, describing, and searching for directions to commercialize the unique technological competencies of high-technology enterprises to diversify their activity and provide stable development. The methodology was used and tested on the real cases of Russian machine building enterprises.

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1. Introduction

Nowadays, the main objective of enterprises, along with maximizing profits, is to maintain sustainable development and ensure successful survival under the conditions of drastic changes in the market. Competitiveness issues have always been fundamental and remain so. However, the mechanisms for achieving competitive advantages by enterprises have significantly changed. According to the reputable American scientist J. Barney, "the only constant of the business activity is... permanent changes" (Barney, 1991, p. 99). The goal of this paper is to improve one of the mechanisms for forming sustainable competitive advantages of technology enterprises in the modern conditions – the methods for identifying, describing and commercializing the unique technological competencies of the teams at high-technology enterprises.

It was not possible to find a complete and ready-to-use methodology for identifying, describing and commercializing unique technological competencies in Russian and foreign scientific and methodological literature. First of all, this is related to the fact that the concept of unique technological competencies has been for the first time formulated comparatively recently as an object of scientific research and the main aspect of the formation of innovations and competitive advantages of enterprises (Chemezov, Volobuev, Koptev, Yu.N., & Kashirin, 2017). The unique technological competence of the team and the personnel is the ensemble of knowledge, skills, abilities of the scientists and specialists, which allows them to create innovative technologies and products for various applications, the technical characteristics of which meet the criteria of global excellence (exceed the characteristics of the best world analogues) or global competitiveness (comparable with the characteristics of the best world analogues). Unique technological competencies are the distinctive ability (characteristics) of specialists in the enterprise to perform specific actions in the best way and in a certain technical field, which allows the company to create new competitive technologies and products and to be a leader in the market. As a rule, unique technological competencies emerge based on existing technological competencies in the process of solving new (non-standard) problems. Moreover, it involves the use of an intellectual non-template approach to solve such problems. Unique technological competencies can be communicated through training.

Previously, the key competencies of the company were considered as a similar resource and the object of research (Chemezov, Volobuev, Koptev, Yu.N., & Kashirin, 2017; Varlamova, 2005; Markova, 2014), which in its turn are based on the competence or the qualification of specialists in one or another field (Andreeva & Chaika, 2006; Milner, 2003). At the same time, highlighting key competencies as a factor in the formation of competitive advantages of the enterprise, some researchers approach the issue of its identification, however, failing to identify and clearly describe the task due to the lack of satisfactory definition of the key competencies: "It is inaccessible to the direct perception of researchers and practitioners, it is not clearly understandable and poorly controlled ... Such properties cannot be determined" (Markova, 2014, p. 30). Cognitive scientists went much further in building intellectual expert systems, concerning questions of experts' knowledge determination (Milner, 2003, Podlipskii, 2010, Muromtsev, 2005). To identify and describe the specialists' technical and technological knowledge, a linguistic and mathematical apparatus was developed – the predicate calculus of the first order (Mendelson, 1976), and a number of breakthrough developments of the existing expert systems was

carried out (Muromtsev, 2005). However, the proposed methodological approaches are aimed at describing specific knowledge in a given subject area, but not at identifying competencies as an integral ability (skill) to perform specific actions in a certain technical field. Taking into account the unconditional usefulness and applicability, cognitive methods of extracting knowledge from experts within the framework of the task posed have a number of shortcomings. The structure of the description of technological competences, as well as the approaches to determining their uniqueness and searching for alternative directions for their application in different markets have not been developed in these methods.

2. Problem Statement

The paper deals with the problem of the increasing the efficiency of high-tech competence management.

3. Research Questions

The search of a language, models, and tools to describe unique technology competences for a high-tech corporation.

4. Purpose of the Study

Development of the methodology for identifying, describing, and searching for directions to commercialize the unique technological competencies of high-technology enterprises to diversify their activity and provide stable development.

5. Research Methods

The "meta-model", developed within the framework of neurolinguistic programming (NLP), is related to methods of providing strict and unambiguous definitions while describing processes and systems (Grinder & Bendler, 2015).

In addition, the form of describing the specialists' competencies (as members of scientific, technical and project teams) is applied, for example, in the requirements of the Federal State Educational Standard of Higher Education (List of competencies n.d).

The approaches developed within the framework of modern theory of inventive problem solving – "the technique of inverse functionally oriented information search" and the "algorithm for expanding the areas of technical systems' application" are considered to be the most advanced. However, these approaches are characterized by a number of shortcomings:

- One of the characteristics of this method is its subjectivity (dependence on the expert's opinions).
- The concept of leading areas is not defined. In case the expert defines the leading areas, the success of the procedure is determined by the expert's qualification and versatility.
- The search is not algorithmized; the search has an undefined degree of completeness.

These scientific and methodological developments in various scientific disciplines served as prerequisites and a basis for developing practical methodology for identifying, describing and searching

for new directions to commercialize unique technological competencies, which can be applied for diversification of high-technology enterprises' activity.

The diversification of Russian high-technology enterprises' activities is the most important task of the country's economic development, and the successful solution of this problem will unleash significant economic potential, increase the competitiveness of enterprises and allow reaching the leading positions in world markets in some areas (Chursin, 2012; Vlasov, Yu., & Chursin, 2016). To solve the problem of diversifying the activities of several machine manufacturing enterprises in the period of 2016-2017, the work was carried out to identify, describe and search for new directions to commercialize the unique technological competencies of the scientific and technical staff of these enterprises.

While executing this work, the methodical approach described below was tested.

The purpose of the work in respect of identifying, describing and searching for options to commercialize unique technological competencies (hereinafter – UTC) is to diversify the activities of enterprises and increase their economic stability by creating new market proposals (products and services), primarily in civilian markets. It is economically rational for these products and services to be characterized by high added value, which is possible in case the market offers are based on the resources, which the competitors do not possess. In our case, these resources are the unique technological competencies of organizations.

The carriers of the unique technological competencies at the enterprise are scientific and technical specialists, hereinafter referred to as the "UTC team".

The technical (technological) advantages, as a basis of competitive advantages, can be gained due to:

- 1) the use of a special key element (elements), which provide superiority (and the ability of specialists to create such key elements) in the composition of the product and/or
- 2) special abilities of the team to perform specific actions (knowledge of technologies, methods and means of controlling certain physical processes).

Accordingly, there are two types of unique technological competencies:

The first type is based on the ability to develop and produce products and their key elements; we will call such unique technological competencies a product, while the unique technological competencies, mentioned in the second option, will be a process (methodological).

A logically justified description of each technological (both unique and non-unique) competence explains "how, in what way, how technically (technologically)" the problem is solved (the result is achieved and the necessary function is performed).

The technological competence, which is the basis of the top-level competence (the development and production of the leading product), in its turn, relies on a lower level competence or its ensemble. At each level, there are both the application of the key elements and products (and the competence to create it) and the competencies, which reflect the method of solving the problem (i.e. the methods for both a product and a process).

Moreover, the problem can be solved by various methods (ways) based on different physical principles. For example, the information from the touch screen can be extracted by using resistive, surface-capacitive, projection-capacitive, IR, optical, strain-gauge, induction and piezoelectric methods.

The description of these cause-and-effect relationships can be visualized in the form of information trees (graphs), the nodes of which are the competencies of the lower levels, providing the higher-level competencies. If an unrivaled technical result of the product or process is achieved, one should speak of a unique technological competence, which can be the total of the unique or non-unique technological competencies. From the point of view of effective commercialization, only unique technological competencies are of interest; therefore, when compiling the information tree description, it is expedient to reach the levels, where the uniqueness of competencies starts to fade and generally accepted engineering competencies take place.

In the information tree, reflecting the cause-and-effect relationships, the description of unique technological competencies of one and another type is somewhat different (Figure 1).

The description of each UTC includes a functional and evidentiary part.

The functional part describes the function provided by the UTC – what the Product should do or what the Team does; the Team itself is capable of providing some special function, or "automatizing" it by giving this function to the Product: for example, the team ensures an aircraft landing, or builds systems, which can perform such functions.

The description is made in the following form: (subject), (what does it do?), (object).

Moreover, for the product UTC, the subject is the Product itself and its function (purpose) is described. The competence of the team is the ability to develop and produce similar Products. As far as the methodical (process) UTC are concerned, the subject of special skills is the UTC team.

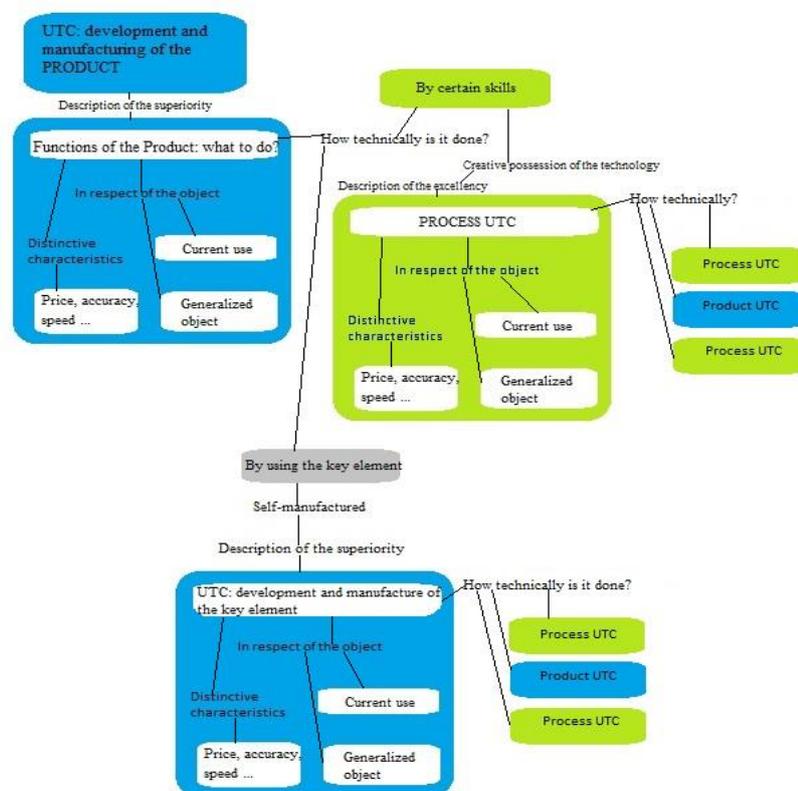


Figure 01. Structure of UTC relations at various levels, reflecting cause-effect relationships. Product and methodical (process) UTC are shown.

In order to search for new areas of application, a generalization of the OBJECT concept with subsequent definition of other object types, in relation to which the team also acquires a special ability (capability or possibility), is introduced into the UTC description.

6. Findings

In the **evidentiary part of the UTC description**, quantitative characteristics are shown, which reflect the superiority over the world analogues.

The work is carried out in the following stages:

Stage 1 – Identification and description of the UTC;

Stage 2 – Search for possible options for new application and commercialization of the UTC;

Stage 3 – Making a presentation, commercial proposals and preparation for UTC promotion.

6.1. Stage 1 – Identification and description of the UTC.

The result of the first stage is a *formalized description of the identified UTC of the enterprise of the current and generalized application.*

The UTC identification in an enterprise should begin with the selection of advanced (leading) products (technologies) of the enterprise, which have proven their technological advantages in the market. The ability to develop and produce advanced products is the first identified UTC at an enterprise.

The process of identifying own unique technological competencies is presented in the form of a step-by-step algorithm:

1. The definition of an advanced product, which has major superiority over competitors' analogs and exceeds them at least by one of the tactical and technical characteristics (consumer properties), proved to be important for the Customer.
2. The determination of the distinctive characteristics (competitive advantages) of the leading product, confirming its uniqueness by specific numerical values in comparison with the closest world analogues.
3. The determination of the key element (elements) of the leading product by means of its decomposition. The determination of the technical superiority of the product, its functions, as well as in relation to which object it operates, which distinctive characteristics (competitive advantages) it possesses.
4. The formulation of unique technological competencies, such as the ability to develop and produce a leading product and its key elements. (Strictly speaking, the competencies determine all stages of the life cycle of the product – to develop, produce, use, repair and discard. Within the framework of the work, we are interested in the following stages of creating a product – "develop" and "produce"). In these recommendations, such unique technological competencies are defined as the product UTC.

The unique technological competencies are reflected not only in the ability to produce unique products, but also in the special skills of the team to do something (methods, means and processes).

The UTC description format can be represented as follows:

(what they are able to do), (with respect to which object), (quantitative evidence of the uniqueness = technical result) and (by which it is achieved, the principle of action)

- The form of the detailed description of the product UTC (for example, the advanced electric vehicle Tesla Model S P100D) is given below:

Product = electric vehicle Tesla Model S P100D

The function of the Product (premium passenger car) is presented in Table 1.

Table 01. Function of the Product (premium passenger car) =

What does it do?	In respect of which OBJECT of the current use:	Generalization of the definition of the OBJECT and new directions of the application:
- comfortable means of transfer - convenience and prestige = a prestigious accessory with unsurpassed characteristics	wealthy motorists	Passengers: - Owners of the means of transport, - Taxi passengers, - VIP

The main rival =

2009 year:

GM/EV1 (130 km/hour/150 km), VW/CityStromer (100 km/hour/90 km), Peugeot/Electrique (96 km/hour/80 km)?

2017 year:

Lucid Air

Distinctive characteristics:

- *mileage between the recharges* = over 540 km,

- *acceleration up to 100 km/hour* = 2.5 sec,

- *technical servicing* = not provided,

- *software update via the Internet* = Yes,

- *dynamic change of settings (for example, clearance of the suspenders, based on GPS coordinates)* = Yes,

- *autopilot option* = Yes

Main goal of the development =

Provide comfortable operation of an electric vehicle for a city resident = without recharging for acceptable daily mileage,

over 350 km (technical result)

How is it achieved? (technically):

(below you may find the references to the UTC descriptions, providing this competence):

1. Key element = Battery pack (AB)

2. Key element = Autopilot

3. Key element = Solar cell

4. Key Element = Asynchronous (induction type) three-phase AC motor

5. Key element = Control systems (equipment + software) for electronic onboard vehicle systems

Further, these product and process UTC are similarly described.

For example,

Key element = Battery pack (AB)

The function of the element presented in Table 2.

Table 02. Function of the element=

What does it do?	In respect of which OBJECT of the current use:	Generalization of the definition of the OBJECT and new directions of the application:
Provide energy	power units (engines) and other on-board equipment of the electric cars	energy consumer, - household (Tesla Powerwall)? - current supply sources for portable devices

Main competitor =

power sources of energy (power)

Distinctive characteristics:

- capacity = 102.4 kWh,

- weight = 540 kg,

- volume = 2.10×0.15×1.50 m³,

- (specific capacity) = 0.19 kWh/kg, 216 kWh/m³,

Group of 74 cells' pairs × Module 6 group × Battery 16 modules = 7104 cells

Main goal of the development =

Ensure high specific capacity (technical result),

the possibility of the use on board an electric vehicle (safety and usability) at an acceptable cost

How is it achieved? (technically):

1. Key element = Li-Ion cell
2. Quick charge AB
3. Provision of AB explosion prevention, electrical and fire safety

An example of the process UTC description:

Provision of AB explosion prevention, electrical and fire safety

UTC = Provision of AB explosion prevention, electrical and fire safety

Function and skills of the team (solved scientific and technical problem) are presented in Table 3.

Table 03. Function and the skills of the team? (solved scientific and technical problem) =

What does it do?	In respect of which OBJECT of the current use:	Generalization of the definition of the OBJECT and new directions of the application:
provision of AB explosion prevention, electrical and fire safety	battery pack (AB)	powerful accumulators of concentrated energy (electric accumulator, etc.)

Distinctive characteristics:

Extremely low inflammation statistics

Main goal of the development =

Ensure the absence of inflammation in all operating modes

How is it achieved? (technically):

1. Key element = original AB circuit diagram
2. AB cooling

Key element = self-control, protection from the overcharging and overload

There is a difference in the descriptions of the product and process UTC:

the subject of the product UTC is the Product (Key element), while the subject of the process UTC is the UTC team.

It should be highlighted that the phrase, containing "what does it do?" and "generalization of the definition of the OBJECT" is a generalized formulation of the UTC, which is subject to commercialization.

It is recommended to further describe the UTC parametrically, i.e. to apply not only a direct-action verb that denotes a UTC function (or a verbal noun), but also a change in the parameter. For example, it should not be "heat up", but "increase the temperature".

- If the UTC is identified, during the process of defining, the following can be considered:
 - a set of operations and techniques, which the technological process is composed of;
 - a sequence of operations in time;
 - modes of conducting operations and actions;
 - materials and substances involved in the technological process;
 - devices and gadgets for carrying out individual operations.
6. To give the definition of the scientific and technical problem (problems), which was solved while elaborating a product or a key element for the first time or independently, by using the original method. In case the problem is solved successfully, the team has formed a unique methodical technological (process) competence, which can be commercialized separately from the others.
 7. To build an "information tree", which reflects the hierarchical interrelationships of the technological competences.
 - The UTC of each level relies on one or several more general, basic UTC, in total ensuring the achievement of the required technical result. A more general UTC level can be defined by searching for an answer to the questions: "How is it technically done? What ensured the achievement of the technical result? What is the physical principle of action?" In turn, the reverse information link "from the general to the specific" means "for which purpose? It is done to achieve which parameters (characteristics and properties)?"

- Among the levels of the competence tree, there can be both product and process competencies. It is not rational to reflect non-unique competencies in the information tree, as further search for the opportunities for their overtaking commercialization has no basis.

6.2. Stage 2. Search for possible options for new application and commercialization of the UTC

The result of the second stage is a formalized description of the teams' UTC of an enterprise, concerning new areas of application, which can be the basis of a commercial proposal or a business idea.

The search for possible options for a new application of product and process UTC is carried out for each identified competence separately. To do this, we must primarily use the "generalization principle", and then "the principle from general to the specific", which allows us to find new UTC applications, without losing the existing uniqueness.

7. Definition of generalized class of objects, to which each identified UTC can be applied.
8. Identification of new specific UTC applications.

Example (company "Honda"):

In the 1950s, the company "Honda" produced motor bicycles, which became very popular not only in Japan, but also abroad. The key element providing global competitiveness to the motor bicycles was a high-quality petrol engine, to which the product UTC corresponded in terms of the development and production. Serious competition in the world market forced the company to look for new ways to promote its products in the market. Using the "generalization principle" in practice, "Honda" switched from motor bicycles to a common class – "moving objects" and applied its motors (a key element) in boats, small-scale machines and lawn mowers. Then, having entered a new level of generalization – "fixed objects", "Honda" began to use motors in generators, water pumps, mini power stations and other industrial equipment.

6.3. Stage 3. Formation of presentation, commercial proposals and preparation for the UTC promotion

The result of the 3rd stage is:

UTC presentation containing a description of the UTC and the commercial proposals for potential customers (business ideas) in the form of competencies (abilities) reflecting the special skills to develop and produce certain products and solve certain scientific and technical problems of third-party customers in an original way, as well as the **UTC commercialization plan**.

Traditionally, within the framework of the strategic marketing, the development and introduction of new product (product or service) into the market is composed of the following stages:

1. Generating and collecting business ideas
2. Assessment and selection of ideas (from the point of view of technological and economical rationality)
3. Elaborating the concept of new product:
 - Assessing the advantages for the customer
 - Technical parameters of the product

- Characteristics of the target market
 - Consumer perception of competitive products
 - Competitiveness level of the product
4. Economic analysis
 - Investments, prime cost, expected profit, cash flows, payback period
 5. Elaborating the product and the marketing plan
 6. Market testing (trial marketing)
 - Customer Development
 7. Placing a new product to the market
 - Evaluation of the expected demand and implementation of the marketing plan
- Schematically, the content of this process is depicted in Figure 2.

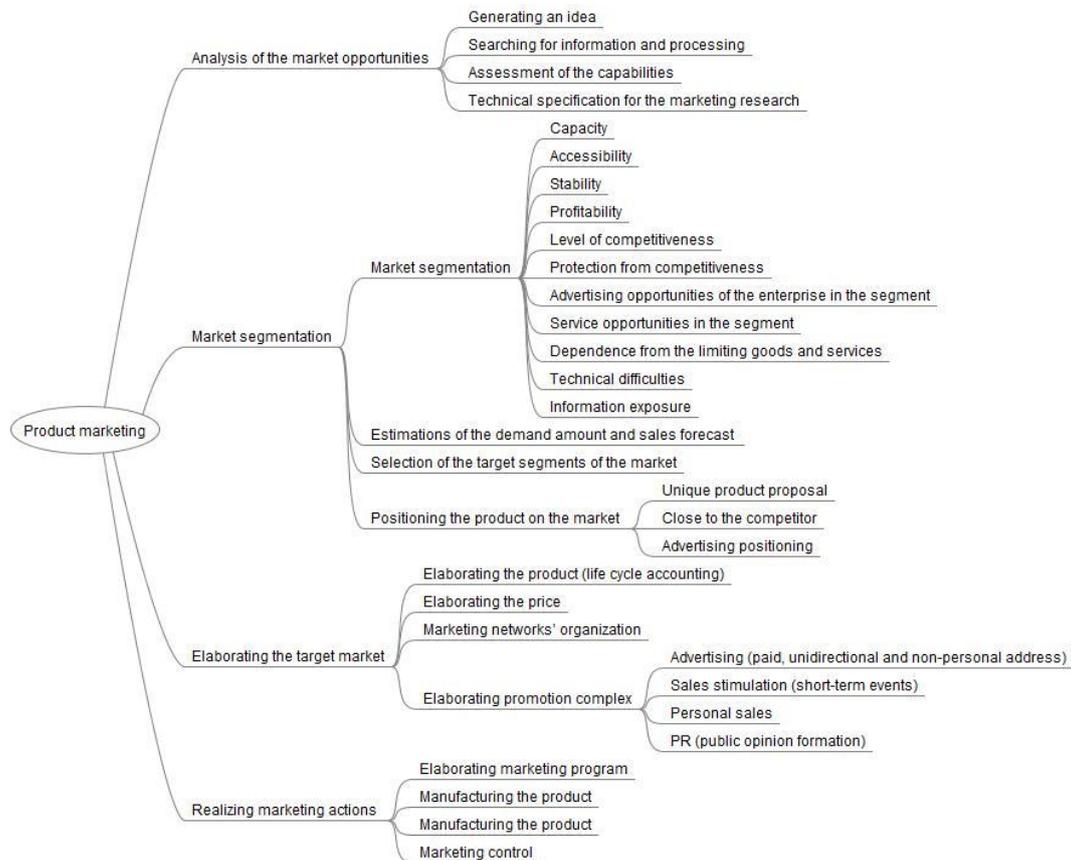


Figure 02. Marketing scheme of a new product.

This stage of work contains the preparation of commercial proposals for potential consumers, based on UTC, as well as preparation of the presentation.

The commercial offers are made according to the following algorithm:

1. Define the competence of the organization to develop and produce certain products and solve scientific and technical problems (including third-party customers' problems) in an original way, i.e. their own unique technical (technological) competencies in respect of different markets.

2. Offer services to potential customers to solve scientific and technical problems in accordance with the UTC on a contractual basis.
3. Clarify the suggestions on the results of the feedback, received from potential consumers.

It should be noted that the amount of the UTC requests will increase along with the growth of production cooperation, and especially with the boost of developers' innovative activity of all levels – from the final products to the selection of all levels.

After verifying the commercial proposal (business idea) and identifying potential customers, it is vital to proceed to the development of the business plan, its approval by the management of the enterprise and then to the next stages of creating a new product, including its development, trials under market conditions, commercial implementation and its market entry. For these purposes, it is possible to use the techniques, which are described in detail in the literature on marketing products.

7. Conclusion

We have elaborated a methodology for identifying, describing, and searching for directions to commercialize the unique technological competencies of high-technology enterprises to diversify their activity and provide stable development.

While searching for possible option of the new application of the product and process UTC, it is considered rational to use: "the generalization principle", "the principle from the general to the specific", creative thinking of the carriers of the competency, "brainstorming", classifiers, requests in the search engines and other ways, enabling to define the image of a new product or a service and the possible areas of its application.

During the UTC commercializing, it is recommended to primarily define the possible offers of services for the market, based on the UTC, and immediately start searching for the consumers (customers and clients) in the market. This will help to gain information at an early stage regarding the availability of competencies, receive feedback and contacts with the interested people (potential consumers), start the negotiations with them to make an offer and define the ways for commercialization (Blank, 2017). Practically, the cooperation may start from fulfilling commissioned work and grow into other forms of cooperation or business, as well as other commercialization options.

For Russian high-technology enterprises, the UTC commercialization may be the source of additional income by increasing the amount of specialized innovative products, as well as by means of expanding the diversification of activity, entering a new market, which in its turn will lead to the increase in the stable development of these enterprises.

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