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Development of the Design Thinking Paradigm in the Context of the Transition to a New Technological Order

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ABSTRACTS

The subject of the article is the paradigm of design thinking as a method of scientific research and a method of project activity; the object of the work is design thinking in innovation activity; the purpose of the article is to increase the effectiveness of the practical use of design thinking in innovation activity; to achieve this goal, the following tasks are solved: studying the history of development and the essence of the design thinking method; research of design thinking as one of the ways of scientific research; description of design thinking as a method of innovative project activity; the research methods in this article are: historical and logical analysis, the theory of large systems, comparative analysis, heuristic methods; the method of design thinking; the scientific novelty of the article is associated with the formation of the paradigm of design thinking as one of the directions of modern theory of cognition and methodology of innovative project activity, including in the field of education.

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1. INTRODUCTION

The relevance of the article is determined by the need to find tools to improve the efficiency of innovative project activities in the context of the development of a new technological order. The hypothesis of the article is the assumption that the development of the design thinking paradigm and the active practical use of the design thinking methodology in innovative project activities can increase the economic efficiency of innovation activities, including in higher project education.

The purpose of the article is to increase the effectiveness of the practical use of design thinking in innovation. To achieve this goal, the following tasks are solved:

(i) Study of the history of development and the essence of the design thinking method.
(ii) Research of design thinking as one of the ways of scientific research.
(iii) Descriptions of design thinking as a method of innovative project activity.

2. METHODS

The object of the work is design thinking in innovation. The subject of the article is the paradigm of design thinking as a method of scientific research and a method of project innovation.

3. RESULTS AND DISCUSSION

The analysis of scientific publications on the topic of this article shows the following. In 2022, there is a transition to a new technological order (Vdovina, 2019). The new technological order is characterized by the intensification of innovation activity (Glushchenko, 2021a). A method of cognition called "design thinking" was proposed, which includes a set of methodological guidelines, the practical application of which in the process of implementing innovative projects creates the opportunity to: design innovative goods and services; raise the efficiency of innovative activities of the project team; to solve complex practical interdisciplinary tasks; to show latent needs of clients and others. For this reason, the methodology of design thinking is of interest to scientists from various fields of activity (Shilekhina, 2013; Panchenko, 2015). Innovators study cognitive processes within the framework of design thinking (Khomutsky, 2015). Design thinking is used to increase business profitability. Design thinking is recognized as an effective way of conducting innovative activities (Geyderikh, 2018). They believe that design thinking can be useful in the field of IT project management. In this regard, there is a growing interest in the methodology of design thinking itself and the peculiarities of its practical application (Zabbrova, 2018). During the crisis, design thinking is used in corporate finance and banking (Dmitrieva, 2018). Researchers note that design thinking is focused on human interests (Ogai, 2021). Diagnostics is considered an important element of design thinking. It is believed that the use of design thinking can increase the sustainability of society's development (Skvortsova, 2021). At the same time, during the formation of a new technological order, interest in new methods and techniques of cognition is growing (Bondareko *et al*., 2018). For the successful development of a new technological order, it is necessary to increase the efficiency of innovation activity (Glushchenko & Glushchenko, 2015). At the beginning of the 21st century, research on control systems is developing.

At the same time, no studies have been identified in this study that would establish a connection between design thinking and the general theory of scientific research (Glushchenko & Glushcenko, 2015). At the same time, there are several points:

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(i) A developed paradigm of design thinking.
(ii) Knowledge about the features of using design thinking in the field of mechanical engineering

These can reduce the effectiveness of design thinking. It is necessary to link the methodology of design thinking with the stages of designing mechanical engineering products (research, preliminary design, preliminary design, technical design, and prototype stage). At the same time, it is important to study the features of the stages of design thinking in the industry. The lack of understanding of such features of design thinking may constrain the application of this methodology in real economy and project education. All this further confirms the relevance of the topic of this article.

The paradigm of design thinking is called the systemic unification of several points: philosophy, ideology, and policy of innovation activity within the framework of the methodology of design thinking. The formation of a paradigm of design thinking is designed to harmonize the ratio of elements of design thinking to increase the practical effectiveness of this method of implementing innovative projects.

This study calls the philosophy of design thinking the wisest general view of design thinking as a method of implementing innovative activities in the real economy and project higher education. The philosophy of design thinking is designed to describe the methodology of design thinking as a single process, considering the features of the stages of design thinking and the goals of applying this method in innovation. The practical significance of the philosophy of design thinking lies in the description of the principles of this methodology for the implementation of innovative projects in the real economy and project higher education.

The following principles of design thinking can be formulated:

(i) Product approach, which means the constant focus of the team to create a competitive product (product and/or service) on the market;
(ii) Harmonization of customer needs, technology capabilities, and business interests;
(iii) Integration of methods of scientific, pre-scientific, and artistic cognition;
(iv) The focus of the methodology of design thinking is on the formation of a method for turning the needs of consumers into a solvent market demand;
(v) Active use in an innovative project of observations, experiments, and rapid changes;
(vi) Effective communication with all stakeholders of the project;
(vii) Cooperation, discipline, self-control, self-development of the project team, and more.

The principles of design thinking can be considered as the values of the organizational culture of innovation activity using the methodology of design thinking. The organizational culture of the process of practical use of the design thinking method will be referred to as a set of such elements:

(i) Beliefs, beliefs of the project team regarding the behavior of participants in the design thinking process;
(ii) Norms and stereotypes of the behavior of team members in the process of innovation using the design thinking method;
(iii) Ways of the project team's response to emerging problems and opportunities;
(iv) Project team values and more considerations.

The cultural values of the project team include everything that will be useful in the process of achieving the goals of an innovative project.

This study calls the ideology of design thinking: firstly, the main idea of this method (systematic integration of customer needs, technology capabilities, and business interests in the interests of creating a competitive product); secondly, a way of distributing power in the process of innovation based on design thinking aimed at harmonizing relations between

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stakeholders of an innovation project within the framework of design thinking methodologies.

The policy of design thinking is a set of coordinated measures aimed at achieving the goals of the project when using the methodology of design thinking in this project.

In turn, the policy of design thinking can be divided into strategy and tactics of design thinking. The formation of a paradigm of design thinking harmonizes the process of implementing an innovative project using the methodology of design thinking.

In this article, by design thinking in innovative projects and project education, this study understands the controlled process of cognition and designing reality, which includes the following stages:

(i) Collection, presentation, and assimilation of information in the process of empathy;
(ii) Abstraction in the knowledge of the conditions and goals of the project at the focus stage;
(iii) Generation of hypotheses, ideas, and project goals (at the stage of idea creation),
(iv) Integration of ideas into a holistic design object (a project as a set of actions or a project object);
(v) Prototyping as the formation of a working model of a project and/or its object;
(vi) Testing the prototype to confirm the fact that the project goals have been achieved and to identify the fact that the project goals have not been achieved.

The goal of the project is the ideal result of an innovative project in the future. The definition of the project goal is reflected in the search and selection of the goal of the innovation project. The formulated project goal allows you to define criteria for evaluating the effectiveness of the project. Then, following the criterion, it is possible to establish the fact that the planned result of an innovative or educational project has been achieved in the project. At the same time, simultaneously with the above-mentioned stages, design thinking in project activities can include:

(i) Description of the desired state of the project in the future – definition of project goals (setting goals);
(ii) Marketing of research methods, which includes: the possibility of synthesis and/or selection of a specific set of tools; description of ways and methods to achieve the goal of an educational project with resources available to the team, including time;
(iii) Management of design thinking in the project, which implies the presence of a certain sphere, a list of opportunities, and methods of maintaining balance in the triangle of "people - goals – resources" in the process of implementing an innovative or educational project.

When using design thinking, industry-specific features of innovation activity in the real economy should be considered. It is necessary to adapt the methodology of design thinking to the specifics of innovations in a particular branch of the economy. For example, this study is talking about the need to establish the relationship between the stages of design thinking (empathy, focus, ideation, integration, prototyping, testing (Shilekhina, 2013).and the stages of real project implementation traditionally for Russian engineering. A real project in mechanical engineering goes through the following stages: research, preliminary design, preliminary design, technical design, and prototype stage. Adaptation of the methodology of design thinking to the peculiarities of innovative activity in mechanical engineering can be considered one of the urgent tasks of epistemology in the context of the development of a new technological order.

In the process of adapting design thinking to the branches of the real economy, design thinking can be recognized as one of the new directions of cognition and project activity of organizations at the same time. When studying design thinking, it is recommended to

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consider that the problems of epistemology, agnosticism, and scepticism are given a large place in philosophy [20, pp. 44-51]. In project higher education, the philosophical approach of the project team to the problem is important, and the psychophysical features of the project team can manifest themselves in the research process and affect the results of the project.

Design thinking can be recognized as one of the new directions in epistemology. As you know, epistemology - the theory of cognition is usually called a methodology related to the following: the study, development, and modernization of forms, human relations to reality; cognition processes aimed at obtaining new data, skills, and abilities.

At the same time, cognition is a process of obtaining and accumulating knowledge conditioned primarily by socio-historical practice, which includes the constant deepening, expansion, and improvement of the processes of human cognition of reality. Design thinking is a process of interaction between an object and a subject (researcher) of the real world, because of which new knowledge about real-world objects, human needs, and business processes arises. Knowledge, acquisition within the framework of design thinking, can be called an objective reality is given in a person's mind. This study using the method of design thinking in activity reflects and perfectly reproduces the objective needs of society, the natural connections of the real world, and the scientific and technological capabilities of society. As you know, knowledge means several points:

(i) Abilities, skills, the ability to do something.
(ii) Any information that can influence action, decision, or behavior;
(iii) The form of the attitude to reality, aimed at acquiring new information, skills, and practical skills.

The knowledge gained as a result of applying the methodology of design thinking can be viewed from several points of view. There are possible such points of view on the knowledge obtained through design thinking: knowledge as a result of removing the uncertainty of the project results; knowledge as a proven project practice result of project implementation based on knowledge of reality; knowledge as an adequate reflection of the information in the minds of project participants. It is known that knowledge is the opposite of ignorance. Ignorance is the uncertainty associated with the lack of reliable information about something.

The advantage of design thinking as a method of cognition can be considered its integrative nature. The method of design thinking systematically combines (aggregates) and applies in practice all types and forms of knowledge, namely the following forms of knowledge:

(i) Everyday knowledge (for example, knowledge of the needs of a person or society as a whole). This type of knowledge consists in fixing in the mind of the innovator the information obtained in practice during the study of people's lifestyles; applied business processes; research of the process of social production; study of professional social institutions; analysis of the relations of members of society, social groups, society as a whole;
(ii) Pre-scientific knowledge. This type of knowledge reflects information stored in the brain of an engineer or on various physical media (stone, rocks, papyri, paper, or in electronic form). This knowledge characterizes: the state of things inherent in the situation; the totality of conditions and circumstances;
(iii) Artistic knowledge. Such knowledge reflects reality and its development with its inherent distorting effect of the subjective features of consciousness characteristic of the object, the inherent desire of a person to change reality;
(iv) Scientific knowledge. This type of knowledge describes objective reality. This reality was obtained by the object in the process of observations and experiments. Scientific

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knowledge (as well as other types of knowledge) in their totality are used in design thinking to achieve high project efficiency.

The integration of various types of knowledge in design thinking allows you to increase the amount of available knowledge. As you know, an increase in knowledge is possible: firstly, as a result of random actions (trial and error); secondly, within the framework of a methodologically sound process of cognition, for example, in this case, within the framework of the design thinking method.

At its core, the method of design thinking is a multivariate method of cognition in innovation. This multivariance of cognition reduces the risks of cognition and increases the likelihood of achieving the desired result in the project. The risk of cognition is associated with uncertainty in the knowledge of the object of management (or innovation activity) by the subject of this activity. The fact that cognition within the framework of design thinking has a multivariate character reduces the risk associated with errors in the process of cognition.

As you know, in epistemology it is customary to distinguish two types of scientific knowledge, namely empirical and theoretical types of scientific knowledge. At the same time, in the historical aspect, there are such points of view on the key role of a particular method in the process of cognition:

(i) Sensualists claim that sensory methods are the main ones in cognition (in design thinking empathy can be called a sensory method of cognition);
(ii) Rationalists consider thinking to be the main method of cognition (in design thinking, thinking itself as a method of cognition is used at the stages of integration, prototyping, and testing);
(iii) Empiricists believe that specially planned experiments are a key method of cognition (in design thinking, the method of experimental research is used at the prototype testing stage). Based on this, design thinking can be recognized as a method of complex cognition of reality.

This study can say that in design thinking, the empirical and theoretical levels of the cognition process are closely integrated. The process of cognition in design thinking is a continuous and systematic combination of such elements: observations, experience, and theory.

Empirical knowledge is widely represented in design thinking, which is obtained directly from experience, through direct observations. It is characteristic that in design thinking, methods of extracting empirical knowledge can be passive (empathy, focusing) or active (testing).

Observation at the stages of empathy and concentration in design thinking is, in fact, a passive way of obtaining empirical knowledge. Observation consists of contemplation and registration of the facts of innovative project activity to achieve a certain result in the project. Because of this, design thinking (as a research method) is characterized by the property of adapting the research process to the interests of the project of the process of obtaining and perceiving knowledge relevant to the project.

At the same time, an experiment in design thinking is an active way to extract empirical knowledge. The experiment can be used in such cases:

(i) as when defining project goals;
(ii) planning experiments;
(iii) organizing experiments;
(iv) conducting experiments;
(v) recording information and indicators;
(vi) when processing and using information from experiments in the project in practice.

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It should be borne in mind that a certain sequence of experiments may be required to solve the tasks of an innovative project. A group of experiments united by a single goal and plan, a plan for organizing experiments is called an experimental program or a test program in an innovative project.

In the methodology of design thinking, the process of theoretical cognition encompasses the reflection of directly unobservable connections and phenomena. Theoretical knowledge can: use subconscious information and analogy, as well as can anticipate experimental data. This anticipation is reflected in the synthesis of hypotheses that must be verified in experiments. From the standpoint of completeness and comprehensiveness of the description of the project object, concrete and abstract knowledge can be distinguished. It is known that knowledge has a concrete character if it comprehensively covers the project objectives (the property of the consistency of specific knowledge). At the same time, knowledge is abstract if this knowledge reflects certain characteristics of an entire group of projects or objects, regardless of their other properties. Focusing on design thinking is a distraction (abstraction). Abstraction (distraction) is considered the main method of reflection in the process of innovation activity, and project implementation. Abstraction consists in highlighting the structural elements, characteristics, and properties of a particular project or object that are essential in each project. At the same time, in the process of focusing, the selected characteristic of the design object, the property of the object (or project) can be studied in isolation from the project itself or the object that acts as the carrier of this characteristic or property.

Therefore, abstraction in the process of focusing can allow you to discover properties and/or connections in a project or object that is hidden and inaccessible to empirical knowledge. Abstraction at the stage of focusing can be considered one of the main methodological methods of cognition of the essence of a project or a design object in design thinking. At the same time, abstraction may include a mental decomposition of the project, and the project object - dividing them into parts, properties, and relationships.

In design thinking, the law of the development of theoretical knowledge can be recognized as the movement of the process of cognition from the sensually concrete (the stage of empathy in design thinking) through the abstract (the stage of focus in design thinking) to the concrete (the stage of ideation in design thinking) knowledge. At the same time, truth always acts as a theoretical system of knowledge. The truth is aimed at reflecting the project (or its object) in its integrity and the variety of possible situations. For truth to be objective, it must have the following properties: truth must be concrete; the truth must be in development; the truth must be enriched with new elements during the project; new elements of truth must describe new properties, connections of the project and/or its object in a constantly changing environment (external environment). Within the framework of the methodology of design thinking, such methodological techniques as analysis and synthesis play an important role in the process of moving toward the truth.

Scientific research within the framework of the methodology of design thinking is one of the areas of cognitive activity. Such cognition includes the process of forming new scientific knowledge. For this reason, scientific knowledge within the framework of design thinking has the following properties: objectivity, completeness, reliability, accuracy, scientific validity, and reproducibility.

In the process of scientific research, two interrelated levels of cognition of reality are distinguished. The empirical level is considered the first (lower). This level of knowledge consists in registering new facts of science and describing empirical patterns of development based on their analysis and generalization. At the second, higher (theoretical) level of the

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cognition process, the patterns common to a specific subject area of activity are described. Such a description of patterns helps to explain previously identified facts, and empirical patterns and predict facts and events in the future.

At the same time, (as already noted) design thinking can be considered as a way of integrating various types of scientific research within the framework of an innovative project or project in higher education. As part of the method of design thinking as a way of implementing innovative or educational projects, the keys main scientific research are:

(i) Problem detection (empathy);
(ii) Synthesis of goals and their decomposition into project tasks (focus);
(iii) Description of tasks, based on the results of a preliminary analysis of the received information, conditions, and known methods for solving problems of this class, and then the nomination of initial hypotheses (ideation);
(iv) At the stage of integration of design thinking can be carried out: theoretical analysis of hypotheses, organization, and planning of observations, measurements, and experiments;
(v) At the prototyping stage, a working model of the project object is created;
(vi) At the prototype testing stage

Then, at the prototype testing stage, the following can be carried out:

(i) Experiments and observations;
(ii) Generalization of information and analysis of the results obtained;
(iii) Verification of the initial hypotheses using the results obtained in experiments (including the use of mathematical-statistical methods);
(iv) Completion of the prototype.

In design thinking, all forms of research (scientific research, everyday form, art form) are initially oriented. This orientation of design thinking allows us to talk about the property of customization of all forms of research in this method. Therefore, research in the way of design thinking will be initially customized to the goals of an innovative or educational project. The meaning of customization of research and education is described in (Glushchenko, 2021c).

At the same time, the reason for such customization (initial orientation of research) in design thinking are the following factors: the goals of an innovative or educational project; previous innovative project experience; subconscious informalized information accumulated in the brain (implicit knowledge), and others. Taking into account the degree of study of the project problem, such customization (preliminary orientation) of the study can find its expression, in particular, in the development of the project idea. Such ideas (ideation stage) of the project may include hypotheses, concepts, methods, and algorithms of project research.

The hypothesis is an a priori, intuitive assumption on such issues: possible tasks of the project; properties, structure, parameters of materials; economic efficiency of the project or process, and more. The hypothesis is formulated at the beginning of the study of little-studied problems of an educational project. The information base of the hypothesis is the whole of explicit and implicit knowledge. In the process of design thinking and project execution, the hypothesis is either confirmed or rejected.

Putting forward a hypothesis in an educational project allows you to reduce the cost of funds and/ or time to achieve the desired project result or establish the fact that it is impossible to achieve the goals of the project. In design thinking, the main practical purpose of the hypothesis is to focus efforts on the most productive, promising areas of project activity, to minimize losses during the implementation of the project.

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In a project activity, a hypothesis can be the basis of an idea (the ideation stage). As you know, the concept of "hypothesis" in Greek means "assumption". A hypothesis can act as a scientific assumption or an assumption. The true meaning of the hypothesis at the time of its nomination is uncertain. Implicit knowledge (intuition) is the main information source of hypotheses. Intuition refers to the ability to comprehend the truth through direct discretion (without justification using evidence). The basic components of intuition include implicit knowledge (subconscious information) as well as the predictive abilities of the project participant in the field of generating hypotheses and/or project ideas adequate to such information.

In the course of innovative project activity within the framework of the design thinking method, two types of hypotheses can be distinguished: 1. a hypothesis can be a method of developing integrated (scientific, everyday, artistic) knowledge, which includes the nomination and subsequent experimental verification of the assumption that makes up this hypothesis; 2. a hypothesis can be considered as a structural element of the scientific basis of an innovative or educational project.

When investigating the role of hypotheses in design thinking, it is recommended to consider the following. The development of the hypothesis synthesis method is associated with the early stages of the formation of ancient mathematics. With this approach, hypotheses are put forward and deduced from them using analytical deduction of consequences to verify the truth of the initial assumption.

In the methodology of cognition of the 21st century, the method of hypotheses is used in an explicit or implicit, latent (hidden) form. In the implicit form of hypothesis research, they are used as part of other methods of scientific cognition (thought experiments, inductive and constructive methods).

Within the framework of the methodology of design thinking, a scientific hypothesis is usually put forward in the context of the project goals, if necessary to solve the problems of the project, in the interests of explaining new experimental data or eliminating contradictions between the idea of the project and the results of experiments using a prototype.

When using the method of design thinking, the replacement of one hypothesis in an innovative project with another, more corresponding to the observed facts, does not mean the fact of recognizing the absolute falsity of the replaced hypothesis or the uselessness of the replaced hypothesis in the process of design thinking. Refutation of the project hypothesis is also considered the result of design thinking, and sometimes a stage in the implementation of an educational project. When using the methodology of design thinking, the nomination of a new hypothesis reflects both the positive aspects and the shortcomings of the previous design hypothesis. A new project hypothesis is confirmed only when this hypothesis eliminates the shortcomings of the previous hypothesis.

As components (elements) of the design thinking process, hypotheses must meet the requirements of verifiability. To do this, hypotheses must have the properties of confirmation (verifiability) and the property of refutation (falsifiability) of the hypothesis.

As an element of the methodology of design thinking, hypotheses can be put forward on such issues:

(i) the nature and content of customer needs;
(ii) problems of the philosophy and ideology of the business process;
(iii) when synthesizing the appearance of the project object;
(iv) when determining the content of the project stages;
(v) when evaluating the characteristics of the external environment of the project;
(vi) when evaluating the values of the parameters of the internal environment of the project;

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(vii) studying the limitations of the project and another.

At the stage of focusing or prototyping in design thinking, it may be methodologically sound and practically effective to evaluate hypotheses. Such an assessment of competing hypotheses may have a probabilistic and/or comparative character against the background of already reliably established events and facts.

Within the framework of design thinking, it should be taken into account that the hypothesis has a predictive property. Therefore, the hypothesis can be considered as the result of heuristic forecasting of the project object and/or the content of the innovation project.

During the implementation of innovative and/or educational projects using the method of design thinking, hypotheses of the following orientation can be formed:

(i) hypotheses that are aimed at shaping the appearance of the object of an innovative or educational project;
(ii) hypotheses on the content of the project stages;
(iii) hypotheses related to the assessment of the effectiveness of the project;
(iv) hypotheses related to the evaluation of the time duration of the implementation of the innovation project;
(v) hypotheses on the problem of estimating total project costs;
(vi) hypotheses for determining the sources of project risks, etc.

After the synthesis of hypotheses, it is advisable to investigate them in the course of historical and logical analysis, evaluation of the feasibility of hypotheses, the possibility of constructing scenarios based on these hypotheses, and others.

If in the course of such an analysis a certain hypothesis is confirmed as true, then such a hypothesis turns into reliable knowledge. Otherwise, the hypothesis in question is rejected.

Synthesis of hypotheses of an innovative project is one of the most difficult and poorly formalized elements of the method of design thinking, innovation, or educational project.

For the concept of an innovative or educational project, this study agrees to call a set of hypotheses united by a single idea and included in the scenario for the implementation of this project.

The concepts of innovative projects are formed in the process of performing exploratory preliminary design studies (advance projects), which include a significant number of insufficiently structured problems. Such a project concept may include a set of hypotheses, the order, and the stages of their research. The concept of an innovative or educational project gets its development in the project implementation scenario, the project implementation algorithm.

At the same time, the project implementation scenario is a logical sequence of project procedures that together make it possible to achieve the goals of the educational project.

The algorithm of project implementation is understood as a well-defined, rigid sequence of project activities, collectively aimed at achieving the goals (results) of the project. The project implementation algorithm can be compiled for projects that contain well-structured problems.

Let's agree to call any real action of the project team, which is aimed at obtaining an intermediate, local result in the course of project activity, a design technique in design thinking.

The procedure for the implementation of the stage of the project activity will be called a certain set of design techniques aimed at solving the tasks of a specific stage of the project.

The methodology of an educational project can be defined as a set of techniques for the implementation of this project.

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In general, the materials of this article allow us to conclude that design thinking can be simultaneously considered a comprehensive method of researching real problems and a methodology for implementing educational projects. Design thinking acts as a methodology that organically combines pre-scientific (every day) research methods, scientific methods of problem research, and artistic (design) methods of problem research. It is the systematic combination of all these methods of problem research that leads to an increase in the effectiveness of design thinking as a methodology of innovation and higher project education. The methodology of higher project education is described in (Glushchenko, 2021b).

As you know, the idea of the design thinking method was born in the company IDEO and it belongs to the CEO of this company Tim Brown. The author of this idea claims that the methods and strategies of design thinking can be used in any kind of commercial activity. Within this method, innovations are born from practice. After going through the process of design thinking, the idea is transformed into new opportunities for various types of business. Design thinking is considered a process that is based on the active use of intuition and the practical experience of specialists to explore the needs of people and turn them into a living demand for business products. IDEO's methodology is successfully used primarily (but not only) in the creative industries of the economy. At the same time, it is premature to talk about the widespread use of this methodology in traditional industries and education. The following can be mentioned as the reasons for the slow penetration of design thinking into the traditional branches of the economy and education of the design thinking method: in 2022, the design methodology exists in the form of a set of practical techniques and recommendations; there is no detailed theory of the design thinking method; there are no methods of adapting design thinking to the specifics of traditional sectors of the economy; the methodology of design thinking is weak it is covered in industry scientific literature and scientific articles; the organizational culture of design thinking is still poorly developed and more.

At the same time, at the beginning of the 21st century, in the process of forming a new technological order, the tasks of increasing the level of safety and comfort of human life processes and activities in the economy and society are relevant. Improving the comfort and safety of people's lives appears as a general direction for the formation and development of a new technological way of life (Glushchenko, 2021a). To solve these problems, it is necessary to increase the level of customer-oriented research and development (R&D) in mechanical engineering. At the same time (as already noted), the growth of the level of customer-oriented research and development can be ensured by applying the methodology of design thinking. Therefore, in this section, this study discusses the possibility of adapting the methodology of design thinking to the needs of improving development work in mechanical engineering.

The adaptation function of organizational culture is responsible for adapting the methodology of design thinking to the specifics of traditional economic sectors. As is known, organizational culture (in this case, the method of design thinking) performs two functions: the function of internal coordination of activities; the function of external adaptation of activities. Therefore, first of all, when assessing the prospects, it is possible to establish the existence of a correspondence between the values of the organizational culture of the methodology of design thinking and the real (and not declared) values of a particular branch of the economy. The coincidence of the values of design thinking and the studied industry will accelerate the introduction of this method in this industry. And, conversely, the mismatch of values of organizational cultures can lead to the rejection of the method of design thinking in

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the industry. At the same time, it is also necessary to take into account the influence of inertia on mental and professional processes in economic sectors.

In this article, by design thinking in research and development in mechanical engineering, this study understands the controlled process of cognition and design of mechanical engineering products with the application of the basics of the methodology of design thinking.

At the same time, in all sectors of the economy, the methodology of design thinking should be adapted to specific industry features: structure and content of the "technological pyramid of the industry"; features of the stages of the life cycle of mechanical engineering products; features of the design process of new products (goods and services).

When considering the specifics of the application of design thinking at various levels of the industry technological pyramid, the following can be said. At the highest level of this pyramid (the level of conceptual developments), the object of the practical application of design thinking becomes a conceptual approach to the design of such a mechanical engineering product. At the second level of this pyramid, the object of using the methodology of design thinking is the development of technologies. At the third level of the technological pyramid, the object of application of design thinking is samples of equipment that allow the technology to be implemented (which is obtained at the second level of the pyramid). At the fourth level of the technological pyramid, the object of design thinking becomes the production process and/or business process. At the fifth level of the technological pyramid, design thinking is focused on the processes of service and training in the use of products.

Next, this study explains the features of the process of adapting the methodology of design thinking to the specifics of the stages of the engineering product design process. Based on the methodology of design thinking, the process of designing a mechanical engineering product includes the following stages in terms of its content and specifics:

(i) Collection and assimilation of information about a mechanical engineering product and the conditions of its use as part of the empathy stage;
(ii) Abstractions in the process of cognition at the stage of focusing;
(iii) Generation of hypotheses, and ideas, the definition of the goals of an innovative project at the stage of ideation in design thinking,
(iv) Integration of a set of hypotheses and ideas into an innovative project as a set of activities, or a project object (at the stage of integration in design thinking);
(v) Prototyping as the creation of a working model of an innovation project object and/or an innovation project process;
(vi) Testing of the prototype to confirm the fact of achieving the goals of the innovation project or to detect the fact of not achieving the goals of the project.

At the same time, the existence of a project goal is manifested in the choice of a project goal, which allows you to determine the criteria for evaluating the effectiveness of the project. In turn, the existence of a project evaluation criterion makes it possible to establish the fact that the planned result of this project has been achieved in an innovative project.

The research and development work of mechanical engineering organizations organically combines research, design, and design work in the interest of creating mechanical engineering products. The whole complex of works included in the design of a mechanical engineering product covers the following sequence of stages: research (preliminary design), preliminary design, technical design, and prototype stage (Glushchenko, 2021c). At the research and development stage (preliminary design), the following is determined:

(i) the main purpose of the engineering product;
(ii) conditions for the practical use of a machine-building product;

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(iii) synthesizing the appearance of the product (determine the main characteristics of the product and its structural elements);
(iv) conduct modelling (prototyping) of the most significant, fundamental design and design solutions;
(v) conducting a technical and economic analysis of the innovative design project, and even more.

At this stage of results and development, design thinking can be considered as a way of research and a method of achieving the goals of this stage of an innovative project in mechanical engineering.

At the stage of preliminary design in mechanical engineering, the following works are performed: the operating conditions of the machine-building product are specified; the functions performed by the machine-building product are confirmed, models of the entire product and its blocks are created; prototypes of blocks are created and tested. At this stage, the method of design thinking can be used at a lower hierarchical level, namely for the development of existing mechanical engineering products.

At the stage of the technical design of machine-building products, the following is performed: (i) the creation of a complete set of design documentation; (ii) testing of product blocks; (iii) testing of the entire machine-building product in laboratory conditions. At this stage, the methodology of design thinking can be used to perform all types of design work.

At the prototype stage, prototypes of mechanical engineering products are manufactured. Such prototypes can be specialized and designed to carry out certain types of tests (for example, testing of a product for strength, etc.). Then these prototypes of a machine-building product are tested in real, natural (field, full-scale) operating conditions, the use of this product. At this stage of OCD, the design thinking method can be used in determining the conditions and tasks of testing, developing test programs, and analyzing test results, as well as product modification following the results of tests, etc.

Summarizing everything that has been said in this article, this study can recognize that design thinking can be considered in the following aspects: as one of the new directions of theory and practice of cognition; one of the promising areas of innovative design activities of engineering organizations; one of the promising areas in the field of higher education in mechanical engineering and others.

4. CONCLUSION

The article discusses the methodological foundations of design thinking as a general theory of the method of implementing innovative and educational projects in the real sector of the economy. The paper describes the paradigm of design thinking and its elements. The article examines the content of the stages of design thinking (empathy, focus, idea formation, integration, prototyping, testing) from the point of view of their real content and their connection with the methodology of science. The article shows that the effectiveness of design thinking as a methodology for the implementation of educational projects can be determined by the integration of everyday, scientific and artistic methods of cognition of the surrounding reality within the framework of this methodology of innovation activity. The article shows that within the framework of design thinking, its scientific and methodological basis is organically complemented by an everyday and artistic method of cognition and solving problems of innovative projects. Therefore, the organic solution of project tasks using various methods (household, scientific, artistic) creates the basis for the emergence of a synergetic effect in innovative project activities. In the context of the transition to a new technological

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order and the increasing complexity of innovative projects, design thinking can be considered a popular and effective method of project activity in the real economy and education.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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