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PROCESS, SYSTEMIC AND DIALECTICAL ASPECTS INVENTIVENESS IN THE FOOD PRODUCTION INDUSTRY®

Procesowe, systemowe i dialektyczne aspekty wynalazczości w przemyśle produkcji żywności®

Invention is one of the most eminent manifestations of the creative process. The article analyzes this issue in an integrated approach: system-process-dialectical. This approach is logically justified by the nature of the process. The inventive process is not and cannot be unequivocally predictable because there is a special interaction of causal and consciousness processes in it. Invention, by its very nature, is also a dialectical process in which there is a constant confrontation of various opposing thoughts. For the inventive process itself, especially in the area of food production, two determinants related to a potential invention in the most direct way are important: the specificity of agricultural raw material and a set of creative rules. The article proposes an algorithmic method of inventive procedure that captures these determinants.

Key words: inventiveness, system approach, algorithmization of the invention, food industry.

Wynalazczość należy do jednego z najznakomitszych przejawów procesu twórczego. W artykule przeanalizowano to zagadnienie w zintegrowanym ujęciu: systemowo-procesowo -dialektycznym. Takie ujęcie jest logicznie uzasadnione charakterem procesu. Proces wynalazczy nie jest i nie może być jednoznacznie przewidywalny, ponieważ dochodzi w nim do szczególnego współdziałania procesów przyczynowych i świadomościowych. Wynalazczość ze swej natury jest także procesem dialektycznym, w którym dochodzi do nieustannej konfrontacji różnych przeciwstawnych myśli. Dla samego procesu wynalazczego, szczególnie w obszarze produkcji spożywczej, ważne są dwie determinanty związane z potencjalnym wynalazkiem w sposób najbardziej bezpośredni: specyfika surowca rolniczego i zespół zasad twórczych reguł, W artykule zaproponowano algorytmiczny sposób postępowania wynalazczego ujmujący te determinanty.

Słowa kluczowe: wynalazczość, ujęcie systemowe, algorytmizacja wynalazku, przemysł spożywczy.

INTRODUCTION

After nearly 2.5 thousand years, since the Greek philosopher Socrates uttered the sentence: *I know that I know nothing*, despite the experience from the practice of creating countless inventions and writing thousands of books on this subject, its validity is not questioned in relation to the act itself creativity of inventive and innovative nature. There is never too much knowledge about inventiveness and innovation. In Poland, the inventiveness indicators are highly unsatisfactory (according to the latest WIPO report on global intellectual property indicators, in 2018 Poland was 27th in the ranking of countries in terms of inventive activity; out of a total of 3,326. ml patents granted in the world, Poland was granted only 2906 of them). According to many authors, technical progress and globalization forces an increase in inventive activities and innovations also in the food production industry.

Dekker and Linnemann [4] presented their major directions in four broad areas of knowledge, giving them the meaning of generation:

- 1st generation – progress in food preservation and production of microbiologically safe food with a long shelf life,
- 2nd generation – a combination of nutritional value and taste requirements,
- 3rd generation – convenience in using the product and preparing food – development of the convenience food market,
- 4th generation – protection or improvement of consumer health – development of the functional food market.

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The Polish food industry is strongly associated with the international market and capital, which recognized that in Poland it is an industry with a future and that it is worth investing in their development [24]. The dynamics of socio-economic changes, contrary to what is commonly believed, is relatively slow, not up to the expectations [20]. Innovative culture is shaped by the education process, prevailing habits, patterns and the presence of innovative organizations operating in the neighborhood of traditional companies [1]. In the system, no part will work properly without proper cooperation. The above argument gives us a partial answer, why the same technologies and organizational and social solutions, tested in other countries, eg in Germany or the USA, allow to achieve high macroeconomic efficiency and are not effective in others [19].

Introducing the necessity to popularize innovation processes is connected with the need to introduce into their structure at least general knowledge about the first phase of this process, i.e. creating an invention. Such an approach may facilitate the construction of the organizational structure of innovative activities in the enterprise and the growth of inventiveness. The issue of knowledge in this field, adapted to the specificity of food production, is not adequately reflected in the manuals and publications in question.

In the development of new devices for food processing, the main role is played by the causal relationships between the properties of the raw material and the natural phenomena used in their creation (energy transfer, heat and mass exchange, and others). This industry, unlike other industries, processes a specific raw material or treats it to meet specific consumer needs (by eliminating some of its properties and enriching others) [21]. Hence, the role of the properties of this raw material is so important in the development of the construction of machines and apparatus used in this industry – as the authors indicated in the article [8], which started the presented cycle on inventiveness in 2013. Continuing these considerations in this article, in a way summarizing the presented issue, an integrated process, system and dialectical approach was used, which facilitates the understanding of the interdependence of processes occurring in the creation of the invention and provides the basis for its algorithmization.

THE ESSENCE OF INVENTION

The term "inventiveness" is derived from the term "invention", which is used to describe a new technical solution not obviously arising from the state of the art, for which (according to the regulations in force in a given country) a patent may be granted. Without inventiveness, there will be no innovation that is its derivative. Nowadays, in social perception, the key word is the concept of "innovation", which in terms of frequency of use has long dominated "inventiveness" and is treated as its synonym. However, it covers a much wider range of "novelties".

Inventiveness is the creative ability to use thought tools in a targeted support of the process of creating new solutions in all areas of the economy and social life, especially in the area of technology and technology [9, 17]. In solving inventive problems, creative thinking formulates needs (goals, functions) as well as ways of their implementation that relate to abstract beings, as well as structures for their application in the form of machines and apparatuses or their hybrid connections. The problem of understanding inventiveness results from the complexity of the problem. In the most general terms, all activities of the mind of an inventive nature constitute the process of creation in which the so-called "Creative element" – a concept introduced over 100 years ago by J. Schumpeter [16]. It is he who is inherent in all beings created by man, both abstract and material [23].

The authors analyzed the creative element as a determinant of the technical and civilization development of mankind in the article [7], published in the previous issue of this journal. The basis of this analysis was the finding by Przybysławski [15] that the two basic concepts of world development are:

a) development – as decreasing and increasing (cyclicality and repetition),
b) development – as the duality of what is one, into mutually exclusive opposites and their mutual relation (dialectical unity of opposites).

In fact, the image of the changes taking place depends mainly on the context of the analysis (in popular terms it is described by the saying: *the point of view depends on the point of sitting*). In terms of the first concept, it was made in the mentioned article [7], while here it will be presented in terms of the second concept. It is a synthesis of the topics included in the series of considerations and analyzes concerning thinking and inventive practice, resulting from the literature and author's experience in the field of food production. Among others, it is distinguished by the properties of the processed raw materials of plant and animal origin and the energy phenomena of nature used as the main factors determining its specificity in terms of universal knowledge about inventiveness.

Invention is a property belonging to a human being. No "thing" causes or creates another "thing." It is the result of a human idea and deed. Invention is the product of human thinking, the problem-solving process, and the eternal striving to improve the material world.

There is no mathematical formula for the invention that would ensure success for everyone, under any circumstances. In inventiveness, there is a special "interaction" of causal processes (relationship between events) and consciousness processes (relationship between thoughts), related to a large extent to the resources of knowledge. Scientific knowledge along with the ability to use it is the most common source of inventiveness [6, 13]. It is also worth emphasizing that inventions are usually not the result of knowledge from only one field, but several, and not all of them are of a strict or technical nature.

The process of inventive activity is associated with the need to solve specific problems occurring in the mental and material sphere. Invention, which is discussed here, is a correlate in the opposition: the sphere of the mind and the sphere of empiricism, goals and means, values and their material conditions. The determining factor, and thus limiting the course of the inventive process and, more broadly, the innovative process, can be each of the components of the initial situation shown in Fig. 1.

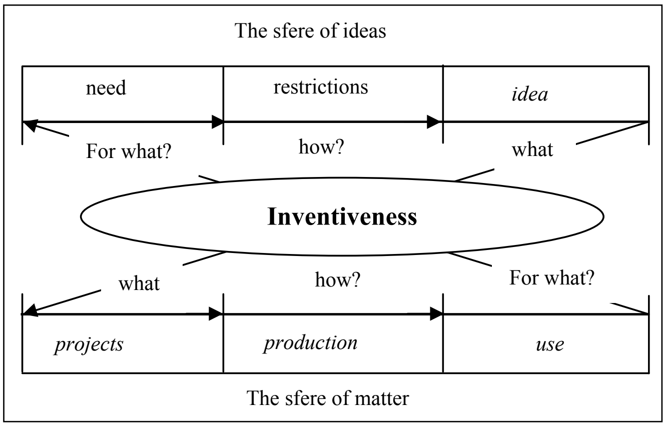

Fig. 1. Diagram of a systemic connection of the problems of inventiveness.
Rys. 1. Schemat systemowego powiązania problemów wynalazczości.
Source: Own study
Źródło: Opracowanie własne

You cannot free yourself from the action of both „external" and „internal" nature – that is, the subjective limitations of the creator, not you can also take a complete break with the environment in which you live [2]. It is a strategy of a higher level of human invention (the mere fact of asking a specific question is an expression of this level). It is a state in which a person acquires greater skills than the average of others, and in his imagination works that were not there before. It is she who, as if dozing in a human being, at least as a leaven of invention, demands implementation, disturbs, captivates, delights. The joy of creating, however, is not the joy of play, but the joy born of the difficulty of unveiling the new [5]. Achieving something essentially new requires an effort of the imagination, a willingness to take risks and overcome resistance to established routine and beliefs, which few can do [10]. This is possible when one can see in material reality something that is missing or something that can be obtained in a better way [17].

Thinking about inventiveness is therefore difficult, and it is even more difficult to follow the meanders of someone's creativity. It is easy to deviate, because many unspoken statements become dead ends. We don't really know how the brain works. As one of the most respected physicists of our times, Michio Kaku writes: *the two greatest mysteries of nature are the mind and the universe* [12].

THE PROCESS AND SYSTEM APPROACH OF INVENTION

Invention needs systemic support. For in order to find certain regularities in the process of creating an invention, we need the "macro-causal", ie systemic, level. Each system is a collection of properly arranged elements. The systems are different, but the approach to researching them and their properties is the same.

The themes of systemic thinking run through history and cultures in various ways, from the Chinese Book of Changes to the Mayan Calendar and from Buddhism to Kabbalah. Originally, however, this knowledge was not practical, but rather met intellectual requirements. In the mid-twentieth century, however, this knowledge began to take on a thoroughly practical aspect. Today, the "systemic approach" is treated as a cognitive, scientific and cultural phenomenon [22].

This approach allows for a significant simplification of the analysis of the socio-economic systems that interact with each other and with the environment. It is also a widely recognized methodology in social sciences, enabling both the use of the black box approximation, and then its gradual "whitening", until obtaining satisfactory descriptions of internal relations and structure [10]. The main feature of the systemic approach is universalism, i.e. the possibility of applying this approach to a wide range of issues. Thinking about the parts of the system produces quite different results if we see these parts as components of a whole, if we look at them holistically [2].

The applicability and the possibility of algorithmization increases as the domain area is specified [22]. For the inventive process itself, especially in the area of food production, two determinants related to a potential invention in the most direct way are important: the material and the set of rules of creative rules. They cannot be treated solely as passive, passive factors. Each material has its own properties and offers its own resistance, each creative rule is more or less obliging. The role of the material was discussed by the authors in the article [8], now a synthesis of thoughts concerning the "set of principles of creative rules" will be presented.

Narrowing (limiting) the concept of "inventiveness" only to the domain area, which is food processing and the range of generic transformations in the properties of agricultural raw materials and dynamic processes occurring in it, made it possible to use the systemic approach to present the algorithmic procedure for creating inventions. Analyzes in the field of food production engineering, using a system approach, are too varied and complex to be presented in such a short article; they were more widely presented by the authors in earlier studies published in this journal. Some of the ideas presented in more detail in the previous ones will therefore be synthesized below.

Inventive efficiency is not determined by a simple gathering of information concerning a specific problem, but by a thought process in which the brain "prepares" from this information the way for a creative idea [5]. In this approach, the algorithmization of creating inventive solutions in the food production industry can be interpreted as: setting out a path of inventive thinking determined by a system approach, and not the creation process itself, based on the use of knowledge about inventiveness and its other areas, adapted to the specificity of agricultural raw materials and the resulting specificity of processes their processing. For, as cognitive sciences claim, "the meaning of words cannot be included in definitions alone." Interpretation gives meaning.

Being creative is not just about looking for something new – anyone can do it, as novelty can be found in any random juxtaposition of things – but about making the novelty pop out of some well-established system [5].

Different people come up with ideas for new solutions at different times and in different places. However, there is no simple recipe: to whom? when? and where? it will happen. It is a derivative of: knowledge, skills and a relatively rare event (accident). While the third aspect is a "gift of fate", the first two are human-dependent and can be shaped in some way. We start with function (*what is* "it" and *what does it do*?) because function is at the heart of all difficult inventive problems. The diagram presented in Fig. 2 is illustrated the contextual connection of: information, knowledge and skills in the thought system ***Sm***, which leads to the integration of: a function, method and device into the system of implementation (cause-effect) ***Sr***, which is the basis for the algorithmization of the inventiveness triad.

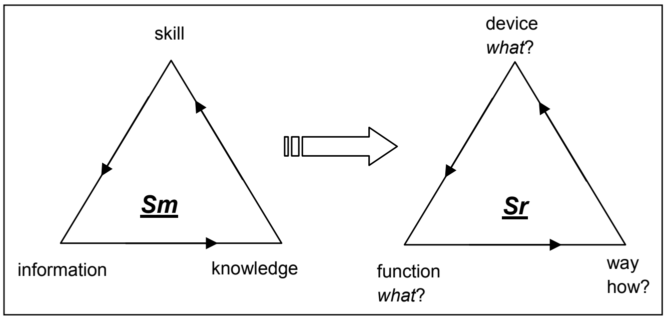

Fig. 2. Contextual integration of the *Sm* thought system and the *Sr* task execution system.
Rys. 2. Kontekstowa integracja systemu myślowego *Sm* i systemu realizacji zadania *Sr*.
Source: Own study
Źródło: Opracowanie własne

The triad of the *Sr* system, ordering inventive thinking, leads to answers to problem questions:

1) what? – resulting from the definition of the function,
2) how? – resulting from the adoption of the procedure. The way defines the essence any technology; includes: specific selection of elements and sequence of actions,
3) what? – resulting from a compelling question (invention) material structure of the working organ or reaction chamber.

Asking the wrong questions may result in setting the wrong course of action at the very beginning [5]. The most common question is how? in place of what? To get the right picture of what to do, you need to prioritize some things and ignore others temporarily. This is the essence of the algorithm procedure. The algorithm for this triad is shown in Fig. 3. These are some fixed points that will help to see the general outline of the procedure. This triad has a hierarchical organization. It maps the distribution of subsystems with specific properties and the ways of connecting these subsystems. Unlike other algorithmization procedures, this procedure is not linear and assumes the possibility of multiple iterations at each of its stages, resulting from the system feedback. Invention is the interaction of ideas with the possibilities of their application through multiple comparisons and improvements to successive versions of a product [11, 14]. This creates a multiple improvement cycle. The use of the "mechanism" of this cycle is one of the secrets of the inventive successes. The essence of this "mechanism" is described by essentialism (following the principle of "less, but better"). This principle can be established in the mind of the inventor or introduced in an artificial intelligence computer program. The starting point for the search for these interactions is the question: *why does not what can (or should) be*? It is the main problem. This question is fully answered by obtaining answers to all sub-questions of the inventive triad.

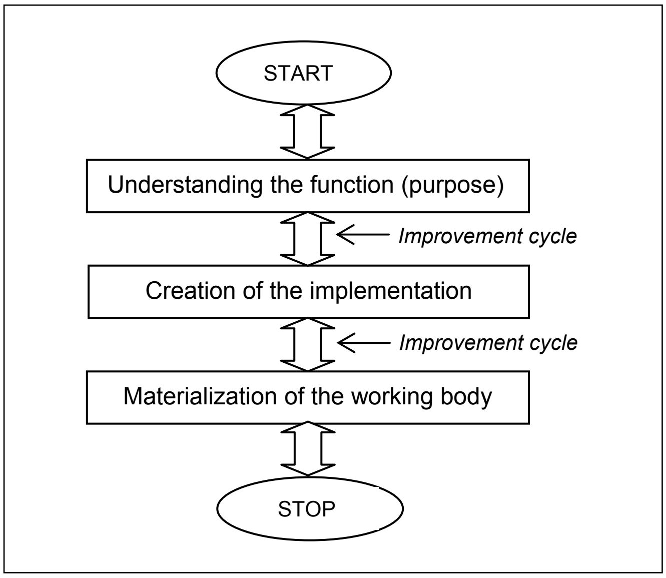

Fig. 3. Design work algorithm for an inventive task.
Rys. 3. Algorytm pracy projektowej dla zadania wynalazczego.
Source: Own study
Źródło: Opracowanie własne

The sub-questions describe the specific problems that are the basis for solving the main problem. The main problem is a kind of problem that cannot be solved with the knowledge available to the inventor. It is right to believe that „a well-formulated problem is half the solution." The description of this task, which is a problematic situation, must therefore include inefficiencies, imperfections and shortcomings in the analyzed area of technology. A problematic situation is an objectively existing (regardless of awareness of it) discrepancy between the existing state (what is it?) And the desired state (what should it be like?). Such a description should not be long and complicated, but should nevertheless go to the heart of the issues that need to be changed. From this description, a first-order constraint can be prepared, i.e. a problem that requires an inventive solution. When setting up an inventive problem one should be aware of (and also describe):

- what do we already know about it and what has already been written about it?
- what are the conclusions and what are the problems for further research?
- in which issues are there controversies, understatements, polemics?

In order to achieve the goal of a technological device fulfilling a given function, it is necessary to find answers (solutions) to the above-mentioned three steps of the inventive algorithm. To specify these steps, it requires (in total) the determination of nine of their constituent elements of systemic structures (located in two-way cause-effect relationships), using the processes of analysis, optimization, synthesis and inference. These subsystems (conceptually treated as autonomous systems) require the indication of their constituent elements, selected so that cause and effect relationships exist between them. Following the pattern of the procedural triad system (Fig. 2), they can be presented in the form of material and formal system structures, treated as its subsystems, created to find a solution to the problem contained in each of the questions that define them. The models of these subsystems are shown in Fig. 4.

A set of related actions resulting from the action function analysis (Fig. 4a). creates a subsystem of the goal. Invention is most often efficiently oriented (better, faster, more efficient...). After all, we find something for a specific purpose, in particular – to satisfy some or other needs existing at a given time and in a given society. Hence, the inherent (inseparable) property of this subsystem is pragmatism.

From this first set of interdependent elements, information is obtained that determines the function (what?), Which is an input element to the second subsystem (Fig. 4b), which gives the answer to the question how? It is a virtual or mental subsystem, where activities take place in human memory (*vir - Latin human*). These are the three basic thought operations: analysis, comparison and synthesis [14]. In search of an answer to the question of how? three settings should be integrated:

1) *physical*, every thing (as a rule) behaves according to the laws of physics,
2) *design*, the relationship between things results from reflection (design),
3) *intentional*, aimed at achieving the goal better (more efficiently).

Synthesis as a summarizing thought operation concerning the question of how? Creates an input, and at the same time a problem to be solved, in the material (executive) subsystem shown in Fig. 4c, for the question what?, in which the idea for the working organ of the machine or the reaction chamber of the apparatus appears. It is important to know the material, as well as the ability to use specific techniques that will enable its transformation. The scale of possible transformations is very extensive. In food production, they are referred to as "unit processes": from mechanical to thermal and biochemical processes. As a result of the integration of the answers obtained (to each of the sub-questions), a new device appears (a machine or apparatus, sometimes with the features of an invention). The answer to each of the functional questions is thus obtained in a systemic approach in an identical procedure, creating a kind of (verbal) algorithm of conduct, starting from the definition of the function, through the way of work, to the material structure of the working organs.

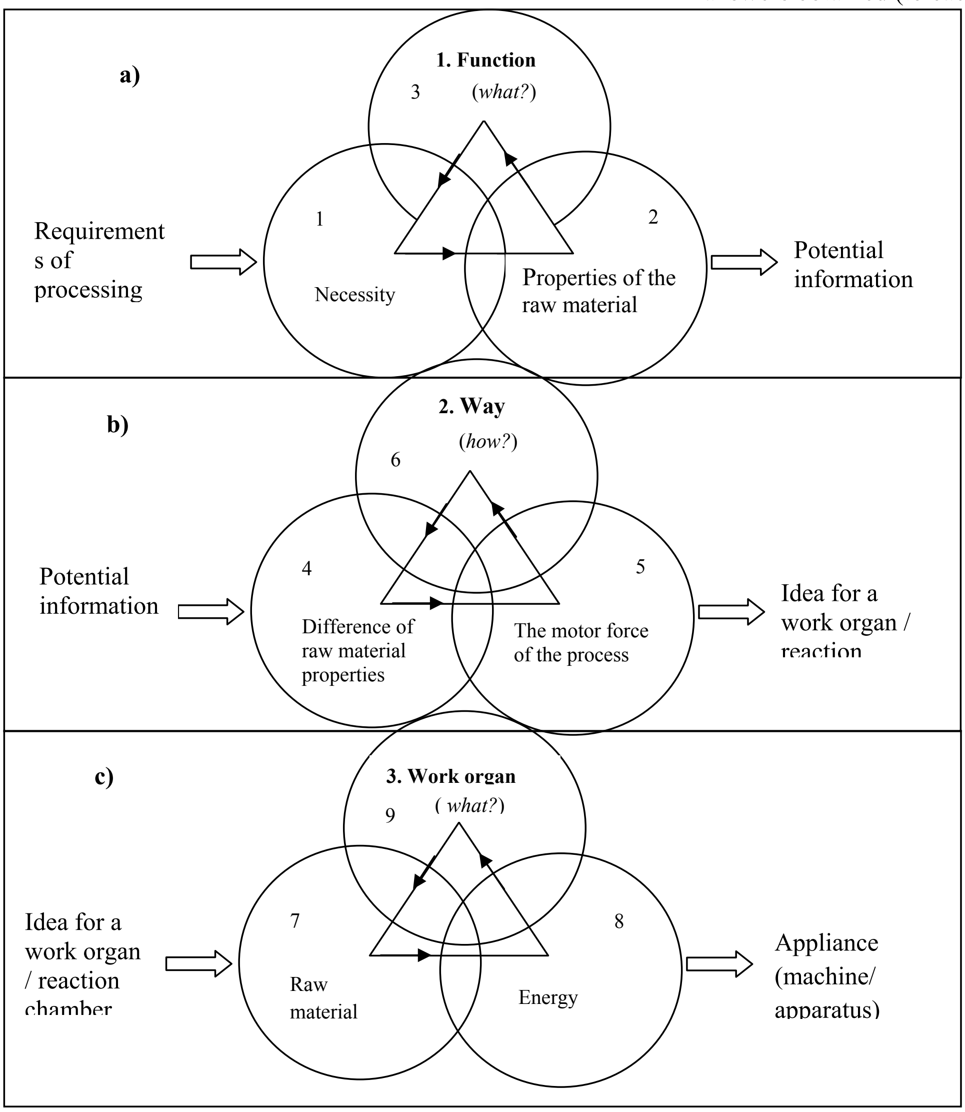

Fig. 4. Implementation subsystems of the inventive triad algorithm.
Rys. 4. Podsystemy realizacyjne algorytmu triady wynalazczości.
Source: Own study
Źródło: Opracowanie własne

The simpler the working organ is and the less it needs powering energy, the better. It is impossible (yet) to know what materials it will be made of, what physical principles will determine it, but it is known to what limit it is going. Their development begins with changes at the macro (part) level and then progresses to the micro (atoms) level. Descent to this level is one of the most important trends in the development of technology.

In every creative activity there can be not only a work-product, but also a work-process (eg the process of interpreting a musical work) [21]. The diagrams of the three component subsystems of the triad of inventiveness presented in Fig. 4 are just such a work-process. It is only against the background of the activities described by these schemes that the multifactoriality and complexity of creative thinking in the area of inventions becomes visible. It should also be emphasized here that even with rigorous observance of the presented "set of creative rules", it cannot be said that the invention is fully algorithmized. It is neither guaranteed by the raw material nor by these rules, but results from the discovery of a special necessity, a discovery that cannot be foreseen. But, as W. Stróżewski writes, "a happy discovery is a simple consequence of correct reasoning, in which the intermediate terms are sometimes skipped" [21]. This fact is a classic case of the dialectic of inventiveness.

INVENTION DIALECTIC

In the light of knowledge about mental processes, inventiveness has not two, but three faces. In addition to the synthesizing (systemic) and dynamic (process), there is also a third – dialectical. They must be taken into account because the creative process is essentially a dialectical process. During its duration, there is a constant confrontation of various dialectically opposing thoughts [21]. Creative thinking is characterized by "the ability to change the track, combine various threads, the ability to modify the starting material, break patterns and thought blocks, and the ability to act in a situation when we deal with insufficient funds" [14]. That is why the creative process is so exhausting. An illustration of such a triple approach can be seen in Fig. 5.

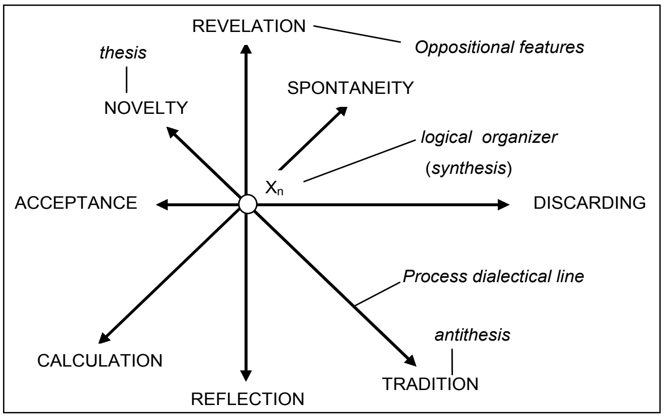

Fig. 5. System-process-dialectical model of creative thinking.
Rys. 5. Systemowo-procesowo-dialektyczny model twórczego myślenia wynalazcy.
Source: Own study
Źródło: Opracowanie własne

This drawing is a graphic illustration of the method of reasoning, which consists in moving from a given concept (thesis) to its opposite (antithesis) and combining them into a higher quality (synthesis). The Hegelian triad: thesis, antithesis and synthesis form a systemic structure that defines the pattern of thought processes. This type of structure is very beneficial for the processes that stimulate creative thinking.

Each activity related to the search for novelty depends on the cognitive processes running along various lines of dialectical opposition (the process nature is described by the arrows on these lines). They create a „tension" in the mind of the inventor from passing thoughts from one opposition to another. The mental life of an inventor is a constant change of narrative: from acceptance to rejection, from calculation to spontaneity, etc. It is a continuous process. The consensus between a thesis and an antithesis results from the creative synthesis of thought and can be described by some *logical organizer* x_n {X}, which abolishes the contradiction between dialectical oppositions. The unique organizer is functionally reflected in the form of an equally unique path of activity in the brain's neural network. As a result of this reflection, there may be novelty having the features of the invention.

Anyone who is inventive knows, however, that behind what is realized in an invention, there remains an ideal, non-exhaustible "rest", an insight into which this novelty opens and closes at the same time (dialectical unity). Each invention is therefore "a bit like" [5]. Therefore, completing one task somehow necessitates undertaking the next one (the dialectical law of improvement). When changes are introduced, the creator's dialectical coupling with his work continues. The creative process ends – when the contemplation of the work begins. The term "dialectic" in ancient Greece meant the art (skill) of proper reasoning when speaking or talking. In modern times, however, the term is used much more often in the philosophical sense prevailed by Heraclitus. Through this concept, he recognized "the variability of reality and the unity of opposites as the principle of the existence of the world" [3].

Why the authors support the analysis of the inventive process in dialectical terms, can be best explained by the encyclopaedic statement that: "dialectical reasoning concerns statements that arouse controversy and are also based on unverified hypotheses. Dialectics does not deal with problems that can be solved with logical inference peculiar to deductive sciences. Its principles are applied to argumentation in those areas that are devoid of formalization – when the rules of formal logic are not obvious or binding. The arguments analyzed by dialectics are not based on the inevitable cause-effect relationship, but on probability. This is the case with the inventive process.

With regard to creativity, this concept was thoroughly analyzed by W. Stróżewski in his book Dialektyka creative [21]. In this work, however, the author clearly stipulates that the subject of his deliberations is artistic creation, and thus other types of creativity, such as scientific or technical, are excluded from the sphere of direct interests. Hence, the authors made the effort to analyze this issue in relation to technical creativity, in which inventiveness plays a dominant role.

Dialectics is a process that permeates all reality. This means that reality is in its essence dynamic, changeable, transformations of one state into another take place in it. Therefore, when examining the inventive reality, this feature cannot be omitted from the description. The dialecticality of the creative process consists in the fact (as W. Stróżewski writes) in the fact that in each of its aspects that appear to the researcher, there are opposing moments or forces which only in their tensions show the essential features of this process. These tensions are different each time, have a different "intensity", a different "drama", but they always lead to something different, and at the same time new in its essential form [21]. Since it is difficult to analyze the course of human thinking or to consider the various stages of the formation of ideas, creativity is usually judged on the basis of its effect, i.e. output. Creative is considered not only an artistic product, but also any product that is new and valuable [14].

In assimilating inventive thinking, the basic question that an inventor asks himself is: how to do it differently to get a better effect? Hence, a dialectical indication for inventive activity may be the saying of Voltaire *better is the enemy of good*. The aim of this activity is to bring closer or reveal the *better*. One thing is to be sure that nothing that is not explained physically can play the "better" in any invention - there is no miracle *perpetual motion machine*.

The creator answers the question addressed to him by value. The choice of values adopted by him determines the choice of one of the possible ones, contained in the starting point, and thus the rejection and, in this sense, the negation of others. Each invention has its own (but not exhaustive) "value selection". The adopted values determine its originality. In the field of inventions, the value is primarily utility, resulting from pragmatism. An innovation (in a broader sense) can be a novelty that has value in other areas, e.g. aesthetics or organization.

According to Stróżewski, the necessity to assign a creative process to one of the values does not determine the fact that "a necessity related to a certain value may be rejected in favor of a necessity related to another value", for example the usefulness of, for example, a nuclear weapon may be rejected in favor of environmental protection.

In the dialectics of creativity, apart from the methodological perspective, we also have an axiological and sense-creating perspective. The point is "to know what it is, to know that it can be changed, and to know that there is something that can happen as a result of this change, and is now waiting to be realized. And then that something, even if it is good, can become better, and the better is in the field of view " [21].

It is also worth mentioning that if an inventor sees a specific value in the invention he shapes, it does not mean that the society and specialist knowledge will discover the same value, hence not all "novelties" reported to the patent office obtain their legal protection, e.g. in the form of a patent or utility model. The value of "novelty" therefore comes from the outside and is not subject to dialectical dynamics.

The dialectic of inventiveness can in fact be reduced to two main processes: separating anything and combining anything. An example, in relation to food production, can be the original invention of mechanization of separating fish from ice, using the difference in the density of these materials. The scientific thesis (there is a difference in density) and its dialectical antithesis gave an answer to the questions: what? and what?, and this (as a result of creative synthesis) led to the implications of the invention. The idea of the method of implementation arose in the human mind through a systemic approach: the properties of the raw material, the more precisely mentioned differences in density, buoyancy force (Archimedes' law) and needs (more efficient work), which are also a kind of elements of inventive thought. If this relationship had not resulted in the materialization of this thought (cause and effect process) regarding the method (question: how?) And the device (question: what?), Then the process of separating fish from ice would still be done by hand.

For the purposes specified in the subject of the article, the dialectic used is related to the procedure, so it can be defined as "techne dialectics" (art, skill). Systemically, two opposing methods can be distinguished:

a) inventive, intentional (planned) dialectic.
b) non-intentional (unplanned) inventive dialectic.

The authors provided in-depth descriptions of these methods in relation to the food production industry in their article from 2015 [18]. In the first case, it is used to describe rationally planned activities in the field of creating novelties with an inventive aspect. The flagship example of this type of behavior was the activity of the greatest inventor in human history, Thomas Alva Edison (1841-1931). The world's first "invention factory" organized by him, in Menlo Park, New Jersey, planned to create a small invention every 3 months, and a large one every 6 months (the output of this "factory" is over 1000 patents).

The inventive procedure used by T. Edison was based on the "trial and error" method. Nowadays, in such cases, the inventive algorithmization method is used, mainly based on the TRIZ theory, developed by H.S Altszuller [2]. This acronym, derived from the Russian words "Теория решения изобретательских задач", means „Innovative Problem Solving Theory". It is designed to overcome the mental inertia resulting from habit, education and existing paradigms of TRIZ to solve the problem with a creative solution, ie understanding the problem as a system and reaching its ideal solution (IFR) by resolving internal contradictions. Consequently, inventing inventions can be done analytically. The first TRIZ indication is „model the system and the problem and don't try to jump straight to the solution" [2]. The inventive procedure presented earlier (Fig. 4) illustrates this recommendation.

Non-intentional dialectics most often results from an unexpected event (the phenomenon of serendipity) and the mental enlightenment of people who are generally not inventive. This moment of illumination, a glimpse of intuition, appears in many statements by the inventors. Glare, or a sudden impulse of thought allowing one to become aware of something important, is called the „Eureka effect". It is a phenomenon related to the experience of the opening of a new reality, of a sudden understanding of the true (deeper) meaning of many issues. It alludes to the historical cry (heureka Greek – I found) uttered by Archimedes when he discovered the law of buoyancy during his experiments in the bathtub. The *serendipity* itself is not an invention, but an opportunity for its creation. Before it arises, however, there must be people who can understand practically. There are only two ways for them to arise: they must either evolve their own understanding, or be designed to be properly understood by those who have previously evolved [5].

An outstanding (for humanity) example of an invention derived from the phenomenon of serendipity (luck) may be the discovery of penicillin in 1928 by the Scottish physician A. Fleming. The phenomenon of serendipity was also the reason for the discovery of kevlar, one of the strongest materials in the world, by an American chemist of Polish origin - Stephanie Kwolek in the laboratories of DuPon in 1965, a microwave oven, X-ray radiation, Teflon, and thousands of other novelties, often (as shown above) features of the invention even on a global scale.

SUMMARY

The *sequence of concepts relating to inventiveness adopted in the title of the article* is logically justified. For anything to arise, including the rare abstract event of solving an inventive problem, a mental and material process is needed. The process of physical metabolism (processed agricultural raw materials) takes place under the influence of motor force, which is a manifestation of the flow of one or more of the 16 known types of energy.

When analyzing various methods of supporting inventiveness, it can be noticed that the inventiveness process has two faces: heuristic and algorithmic. However, we cannot divide into heuristic inventiveness and algorithmic inventiveness, because both of these aspects constantly interpenetrate and both are equally important.

Among the many concepts and procedures presented for supporting the ability to solve inventive problems, two aspects deserve special mention:

a) noticing the process and multi-stage nature of inventions as well as the source meaning and role of information (more broadly, knowledge from many fields), describing information about the material and energy properties of dynamic inventive processes,
b) acquiring the skills of systemic approach to these processes in their formal and material system structures, in which there are cause-and-effect relationships leading to the algorithmization of the invention.

Algorithmization, apart from general assumptions, defines the steps of individual design processes, which makes design work predictable at the level of the assumed partial effects. Moreover, thanks to clearly defined methodological frameworks, the possibility of creative chaos, i.e. the occurrence of an unstructured conceptual phase, is reduced. Considering the ability to algorithmize the procedure from the perspective of inventiveness makes it possible to sensitize to many aspects of the process itself, which, in another form, may be poorly emphasized. The undoubted feature of the algorithm is the ability to use the same mental creation to solve similar or synonymous tasks.

Ideas fully developed for new solutions to the ways of transforming matter and devices for their technical implementation appear relatively rarely. Complex intellectual structures of this type usually undergo a gradual and delayed process of improvement. The above statement applies to all areas, including the food production industry that is important for the development of the world. There is a view that the inventor's failure is a lack of answers to questions that he has not yet asked, which gives rise to great hopes of using the possibilities of artificial intelligence to support the processes of creating inventive solutions, already applicable in practice. Third-generation systems that combine machine learning with knowledge-based reasoning will be able to search millions of data and make conclusions in a specific context (a new, more advantageous solution). In the current state of technology development, the phenomenon of artificial intelligence creativity is more and more common.

Many pharmaceutical and IT companies already support the processes of creating new inventions and technologies with artificial intelligence. Soon computers will be inventions routinely, and it is only a matter of time before they are behind most innovations. Already in 2019, for the first time in the world, applications for patents were filed, the owner of which is to be the DABUS multi-neural network system created by Stephan Thaler from the University of Surrey (United Kingdom). The system can generate ideas and create inventions without human intervention. This example shows the practical possibility of algorithmizing the invention. If the future of technology really belongs to the inventions created by artificial intelligence (which is highly probable), then one must agree with the position that obtaining an appropriate patent by such a system will open a wide range of questions to which there are no clear answers.

PODSUMOWANIE

Przyjęta w tytule artykułu sekwencja pojęć odnoszących się do wynalazczości jest logicznie uzasadniona. Aby cokolwiek powstało, w tym rzadkie wydarzenie o charakterze abstrakcyjnym, jakim jest rozwiązanie problemu wynalazczego, potrzebny jest proces umysłowy i materialny. Proces fizycznych przemian materii (przetwarzanych surowców rolniczych) przebiega pod wpływem siły motorycznej, stanowiącej przejaw przepływu jednego lub więcej spośród 16-tu poznanych rodzajów energii.

Analizując różne metody wspomagania wynalazczości można zauważyć, że proces wynalazczości ma dwa oblicza: heurystyczne i algorytmiczne. Nie możemy jednak dokonać podziału na wynalazczość heurystyczną i wynalazczość algorytmiczną, gdyż oba te aspekty stale się przenikają i oba są jednakowo ważne.

Spośród wielu przedstawianych pojęć i procedur wspomagania umiejętności rozwiązywania problemów wynalazczych na szczególne wyróżnienie zasługują dwa aspekty:

a) dostrzeganie procesowego i wieloetapowego charakteru powstawania wynalazków oraz źródłowego znaczenia i roli informacji (szerzej wiedzy z wielu jej dziedzin), opisujących informacje o właściwościach materialnych i energetycznych składowych dynamicznych procesów wynalazczych,
b) nabycie umiejętności systemowego ujęcia tych procesów w ich formalnych i materialnych systemowych strukturach, w których występują związki przyczynowo-skutkowe prowadzące do algorytmizacji wynalazku.

Algorytmizacja, poza ogólnymi założeniami definiuje bowiem kroki postępowania poszczególnych procesów projektowych, przez co praca projektowa staje się przewidywalna na poziomie zakładanych efektów cząstkowych. Ponadto, dzięki jasno określonym ramom metodologicznym zredukowana jest możliwość twórczego chaosu, czyli występowania nieustrukturyzowanej fazy konceptualnej. Rozpatrywanie umiejętności algorytmizowania postępowania z perspektywy wynalazczości stwarza możliwość uwrażliwienia na wiele aspektów samego procesu, które w innej postaci mogą zostać słabo uwypuklone. Niewątpliwą cechą algorytmu jest możliwość wykorzystania tegoż samego tworu myślowego do rozwiązywania podobnych, względnie bliskoznacznych zadań.

Pomysły w pełni ukształtowane na nowe rozwiązania sposobów przekształcania materii i urządzeń do ich technicznych realizacji pojawiają się stosunkowo rzadko. Tego typu złożone konstrukcje intelektualne zwykle podlegają procesowi stopniowego i rozłożonego w czasie ulepszania. Powyższe twierdzenie dotyczy wszystkich dziedzin w tym, ważnego dla rozwoju świata, przemysłu produkcji żywności. Istnieje pogląd, według którego *porażka wynalazcy to brak odpowiedzi na pytania, których jeszcze nie zadał*, z którego wynikają wielkie nadzieje wykorzystywania możliwości sztucznej inteligencji, do wspomagania procesów tworzenia rozwiązań wynalazczych, znajdującej już zastosowanie w praktyce. Systemy trzeciej generacji łączące uczenie maszynowe z wnioskowaniem opartym o wiedzę, będą mogły przeszukiwać miliony danych i wnioskować w określonym kontekście (nowego, korzystniejszego rozwiązania). W aktualnym stanie rozwoju techniki zjawisko kreatywności sztucznej inteligencji jest coraz bardziej powszechne. Już obecnie wiele firm farmaceutycznych i informatycznych, wspomaga procesy tworzenia nowych wynalazków i technologii sztuczną inteligencją. Wkrótce komputery będą tworzyły wynalazki rutynowo i jest tylko kwestią czasu, zanim będą stały za większością innowacji. Ten czas już nadszedł. W 2019 r. po raz pierwszy na świecie złożono bowiem wnioski na patenty, których właścicielem ma być, stworzony przez Stephana Thalera z Uniwersytetu Surrey (Wielka Brytania), system wielu sieci neuronowych imieniem DABUS. **System może generować pomysły i tworzyć wynalazki bez ingerencji człowieka**. Przykład ten wskazuje na praktyczną możliwość algorytmizacji wynalazku. Jeżeli rzeczywiście przyszłość technologii należy do wynalazków wytworzonych przez sztuczną inteligencję (co jest wysoce prawdopodobne), to trzeba się zgodzić jednak ze stanowiskiem, że uzyskanie odpowiedniego patentu przez taki system otworzy szeroki wachlarz pytań, na które nie ma jednoznacznych odpowiedzi.

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