Food technologies and their environmental impact

S Antipov 1, I Khozyaev 2, V Panfilov 3, D Rudoy 2, and S Shakhov 1,4

1 Voronezh State University of Engineering Technologies, Revolution avenue, 19, Voronezh, 394036, Russia
2 Don State Technical University, Gagarin sq., 1, Rostov-on-Don, 344003, Russia
3 Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Timiryazevskaya Str. 49, Moscow 127550, Russia

E-mail: 4 s_shahov@mail.ru

Abstract. Humanity has long been striving to realize the deserted technologies for obtaining food. For its implementation, it is necessary to detail the technology as a way of organizing natural processes that are aimed at creating artificial objects, in particular, food. To implement a deserted method of food production, it is necessary to use technology. Technology in the article is considered as a man-made material that is used to expand the capabilities in food production. We consider technical means of food technologies as integral material systems that function and develop in the environment. The purpose of the work is to study and develop trends in the engineering strategy for the development of food technology, taking into account the possibilities and advantages of adaptive control of a technological system with a wide range of variability in the properties of controlled objects, including in conditions of information uncertainty. We have analyzed the dialectics of the development of food technologies. On its basis, an engineering strategy for the development of food technology techniques has been developed. Identified technical and technological trends that provide for the development of mechatronics, the creation of new equipment, as well as lines that implement new machine technologies. The task is to consciously activate the process of creating a new food production technique using the laws of dialectics.

1. Introduction

Today the number of technological operations involving human hands in the food and processing industries of the Russian agro-industrial complex exceeds 50%. There are over 70% of such operations in industries related to fish and seafood processing. Humanity has long dreamed of deserted technologies for obtaining food, and this problem in our country has only worsened due to the social upheavals of the late XX - early XXI centuries.

In this difficult time, the only correct path can only be the path illuminated by the laws of nature. That is why we define the development of technique and technology as a dialectical inevitability. Our research is based on the works of famous scientists in the field of philosophy of science and technology: R.F. Abdveyeva, B.I. Kozlova, G.N. Alekseyeva, V.G. Gorokhova, G.A. Davydova, L.F. Ilyicheva, N.I. Lapin, V.M. Rozina, V.I. Svidersky, V.S. Tyukhtin, G.I. Shemenev and others.

Technology is a way of organizing natural processes that are aimed at creating artificial objects, in particular, human food.
Technique – multifaceted object. There are many definitions of it, each of which fixes attention on one or more of its aspects. We will consider technology as a human-made material used by him to expand his functionality in the manufacture of food.

Technical means of food technology are integral material systems that function and develop in the environment.

We strive to show that the rapid development of food technology in the agro-industrial complex of such a state as Russia is a dialectical inevitability. Currently, the modification of old food technology techniques and the creation of new technology are in deep stagnation as a result of social transformations in the state. However, any integral system after a period of rest and inhibition must necessarily enter a period of effective functioning and development. This is the essence of the regularities of the vital activity of systems of different nature: natural, artificial, social [1].

We have made an attempt to outline the patterns and mechanism of the development process itself, as such, as well as in application to food technology and designs of machines, apparatus and bioreactors [2].

Thus, the purpose of the work is the research and development of trends in the engineering strategy for the development of food technology, taking into account the possibilities and advantages of adaptive control of a technological system with a wide range of variability of the properties of controlled objects, including conditions of information uncertainty [3, 4].

2 The development of technique and technology at the stages of various social formations

In technique and technology of ancient world, from the very beginning of mankind to the Middle Ages, stages of evolutionary and revolutionary development of tools, technical means and scientific knowledge are clearly traced. Their periodicity, duration and enrichment at each turn of a kind of historical spiral are closely related to the corresponding system of production relations that arise at a certain stage of development of the productive forces.

During the period of the primitive communal system, the evolutionary development of technical means prevailed, which after long periods of time was interrupted by technical revolutions, such as, for example, the invention of the wheel or the appearance of metal tools.

The one-sided revolutionary development of technology showed its unviability in a slave-owning society and, in the end, became one of the reasons for the change in the system and the arrival of feudalism.

The feudal system was the complete opposite of the slave system. The main productive force in it were not slaves, but serfs and artisans, who had their own economy, their own property and therefore were vitally interested in increasing labor productivity and improving technology to increase it. This ensured, albeit a slow, but progressive and steady evolutionary development of technology - improved smelting of iron and processing of steel, improved weapons of knights, etc. But at the same time, there was practically no revolutionary approach to the design of technical means, since the dominant religious philosophy of the feudal Middle Ages limited free thought even in the scientific and technical sphere. During this period, over 30 thousand people were burned at the stake of the Inquisition, including Giordano Bruno.

By the middle of the XX century the continuing alternation of evolutionary and revolutionary development of technical means of material production, and science as a form of spiritual production, brought close to the scientific and technological revolution.

Sharp increase in requirements for technology, for its functionality and characteristics - performance, speed, reliability, led in the second half of the XX century to a radical revolutionary renewal of the park of technical means, to the emergence of new technological processes, ways of organizing technical activities. One of the most striking manifestations of this trend is the creation and use of so-called large technical systems - complex, as a rule, multifunctional, hierarchically organized technical devices, consisting of many hundreds of thousands of elements. The increasing complexity of the design, principles of operation, manufacturing technology and methods of ensuring functioning...
- all this became a kind of payment for new properties and characteristics of technical means, for an increase in the technical efficiency and functionality of new technology.

The main goal of the food and processing industry development is the formation of a sustainable and efficient production of food products, which would guarantee the satisfaction of the country's population's needs for high-quality domestic food at a level that ensures its normal life. Thus, we are talking about ensuring one of the conditions for the country's food security - physical accessibility for the population of the required amount of basic food products of the corresponding range.

3 The development of technique and technology as a dialectical inevitability

The dialectical-materialist philosophical doctrine of development deals not only with the methods of cognizing development, but also develops its own relatively independent knowledge of development. What is the specificity of such knowledge, what are its essential features?

First of all, the philosophical approach to development is not just an extremely general and abstract approach to it, which boils down to fixing the features common to all development processes. It inevitably includes a worldview orientation formed by the initial principles that set the way of seeing the problem of development, its general theoretical interpretation.

The idea of the universality of development reflects the dialectical unity of the integrity of the world process and its "openness" in the sense of fundamental incompleteness. The world is perceived not only as having already become, but also as eternally becoming, inexhaustible in its possibilities. The openness of development confirms the universality of the laws of dialectics, which consists not only in the fact that they are applicable to all processes of development, but also in the fact that by the action they create the possibilities of the endless emergence and deployment of new processes of development. Due to the spontaneous self-contradictory nature of material systems, mutual transitions of quantitative and qualitative changes, cycles of denial of negation with a return supposedly to the old and the synthesis of the new, development processes are continuously produced in an inexhaustible variety of their forms, integrating into a single, inextinguishable and inevitable process.

Let us emphasize that the growth of philosophical part of scientific and technical knowledge is increasingly serving as a necessary condition for scientific and technological progress. At the same time, the most important channel for the mutually enriching connection of philosophy with the sciences of a special profile is the dialectical study of specific laws of the cognitive and creative activity of scientists and engineers - the creators of new technology, in particular for food technologies.

3.1 Technique and technology: accelerating development dialectics

The essence of the strategy for accelerating the development of technique and technology covers a complex set of problems of the dialectics of evolution and revolution, negation as a moment of connection with the retention of the positive. In this strategy, the laws of the unity and struggle of opposites, the transition of quantity into quality, the negation of negation are tied into a single knot. This strategy is revolutionary in nature.

This is the dialectic of acceleration. It would be an oversimplification, however, to think of acceleration as an unambiguously predetermined, continuously progressive process. In the history of technology, there are often cases of regression or stagnant "cycle of motion" instead of the expected progress. To prevent such opportunities from becoming a reality, the scientific and engineering community will, in particular, deeply master the dialectical principle of self-development, cultivate a philosophical understanding of the problems of the development of food technology.

3.2 Engineering sciences: dialectical development process

The development of technology and technology for food production is directly related to the development of technical sciences. There is no coincidence that in recent decades it has been an increased interest in the methodological problems of applied sciences, the elucidation of the its origin sources. Therefore, consideration of the main stages in the development of technical sciences
undoubtedly makes it possible to more clearly draw the prospect of technical solutions to technological problems of food production.

Note that under the influence of transformations in technology and various sectors of the economy, which have superimposed on social systems in society, the organizational structure of the system of research, design and engineering institutions in Russia, as well as technical sciences in the general system, is currently changing.

In addition, the modern period is characterized by the fact that as the complexity of technical systems that carry complex social functions, technical sciences are moving closer to social sciences. Therefore, the emergence of a section of social and technical knowledge, which is aimed at optimizing the functioning of technical devices and systems from the point of view of technical and economic, engineering and psychological, technical and aesthetic, ergonomic, environmental and other social characteristics, is a dialectical stage in the development of technical sciences.

3.3 Engineering activity: dialectical development process. Change of technological structures
Comparing modern engineering activity with its state, for example, in the second half of the XIXth century, then striking differences will become visible. The point is not in the qualitative and quantitative complication of engineering objects. The very structure of engineering activity and the tasks that are solved by it have changed. Design, based on one or two scientific disciplines, was replaced by engineering developments, including, along with design, design, pilot production, experimental or mass production of a product (machine, apparatus or device) and its implementation in technology (for example, food products).

Thus, engineering activity forms a closed cycle in which the types of this activity included in it mutually support each other in the process of achieving a single goal - the creation of an engineering object.

Analyzing the engineering activity process development from ancient times to the present, we can conclude that this process is experiencing a dialectical acceleration. We have made an attempt to philosophically understand the state and prospects of food production and food machine-building in our country in connection with the reforms that Russia is going through in the late XX and early XXI centuries. An objective look at the transformation processes in the food and processing industries of the agro-industrial complex makes it possible to assess this transition period as a forerunner of the rapid development of technology and technology.

Currently, six technological orders have been identified. The technological structure is a set of related industries that have a single technical level and develop synchronously. The change in the dominant technological structures in the economy is predetermined not only by the course of scientific and technological progress, but also by the inertia of society's thinking: new technologies appear much earlier than their mass development. At the moment when the technological capabilities of the existing technological order are exhausted, the economy plunges into depression and a crisis arises, the way out of which is associated with a bunch of new technologies, which at this time attracts business, and as the new technological order matures, the economy enters a stable mode again growth that lasts 20 - 25 years.

3.4 The innovation process in the economy. Innovative activity
The emergence of inventions and scientific discoveries is to a decisive extent determined by the creative abilities of people with the appropriate qualifications. Therefore, a sufficient number of highly qualified specialists already guarantees an extensive flow of new scientific and technical ideas.

Innovation activity is a process aimed at the development and implementation of the results of completed research and development or other scientific and technological achievements in the form of a new or improved product sold on the market, a new or improved technological process used in practice, as well as related additional research and development.

The basis of the innovation process is innovation activity related to the transformation of ideas, research and development results into a new or improved product introduced to the market or
production. It involves the implementation of a whole range of scientific, technological, organizational, financial, commercial activities aimed at the creation and implementation of innovation. The following types of innovative activity are distinguished: preparation and organization of production, its development, marketing and advertising of new products, acquisition of tangible and intangible technologies, patents, licenses, trademarks, know-how; industrial design [5].

The creation of a national system of support for innovation and technological development on the basis of a large-scale technological renewal of production using advanced scientific and technical developments will ensure the transition of the economy to an innovative path of development, create the necessary conditions for the full implementation of the competitive advantages of Russian food producers to ensure the country's food security [2, 5]. Innovation is the living water of development.

Thus, the process of creating and disseminating innovations is called the innovation process - the process of transforming scientific knowledge into innovation, that is, such a sequential chain of events during which an innovation matures from an idea to a specific product, technology or service [6, 7]. The innovative process, using the process approach as a tool for its activities, allows simplifying multi-level hierarchical organizational structures, to increase the flexibility and adaptability of enterprises to the changing conditions of the competitive environment.

4 Engineering strategy for the food technique and technology development

The technology and equipment development process in the branches of the agro-industrial complex is continuous. Based on modern knowledge about the nutritional value and technological properties of raw agricultural raw materials, scientifically grounded recipes and a range of products are being developed, taking into account their purpose. This, in turn, leads to the creation of advanced technologies and designs of machines, apparatus and bioreactors operating as part of technological lines [2, 8].

As a rule, the creation of new technology and techniques is implemented within the framework of priority fundamental and applied scientific research in the food and processing industries of the agro-industrial complex of Russia, which in turn corresponds to the list approved by the President of the Russian Federation (No Pr-843 dated May 21, 2006) by the priority areas for the development of science, technology and technology:

- living systems;
- industry of nanosystems and materials;
- information and telecommunication system;
- rational use of natural resources;
- energy and energy saving,
and also with a list of approved by the President of the Russian Federation (No Pr-842 dated May 21, 2006) by critical technologies:

- biocatalytic, biosynthetic and biosensor technologies;
- nanotechnology and nanomaterials;
- bioengineering technologies;
- technologies for processing and utilization of technogenic formations and waste;
- software technology;
- technologies for the production of fuel and energy from organic raw materials;
- distributed computing technologies and systems;
- technologies for creating biocompatible materials;
- technologies for creating and processing crystalline materials;
- technologies for creating polymers and elastomers;
- technologies for creating membranes and catalytic systems;
- technologies for creating energy-saving systems for transportation, distribution and consumption of heat and electricity;
- technologies for environmentally friendly resource-saving production and processing of agricultural raw materials and food.
The engineering strategy for the development of food technology technology is associated with the development of adaptive control systems [9, 10].

Adaptive control is the process of changing the functional parameters of a technological system based on current information (both at the input and at the output) in order to achieve certain results. It is used both to control a nonlinear system and a system with variable parameters. Such systems include machines, apparatus and bioreactors used in the food industry. Adaptive control makes it possible to make automatic changes in the process of processing operating modes and, by optimizing them, create the possibility of manufacturing high-quality products with the protection of food equipment from such operating overloads that can cause their breakdown or accelerated wear, especially in conditions when the initial (a priori) information about the object insufficiently or the characteristic of an object in the course of the system's functioning changes in an unforeseen manner within wide limits.

4.1 Mechatronics
New direction of scientific and technological progress, focused on the creation and operation of qualitatively new automated systems with intelligent (microprocessor) control, is called mechatronics [11, 12].

In the food industry, at all stages of production, transportation, storage and sale, it is of particular importance to control temperature, pressure and many other parameters of the production process of perishable products without human intervention. Therefore, mechatronics is a progressive direction in the development of science and technology in the food industry, focused on the creation and operation of automatic and automated machines and systems with computer (microprocessor) control of their movement.

In the production of food technology, industrial robots are used at the stage of packaging finished products for the formation and disbandment of packages, as well as for packing bottles into boxes. In addition, robots can additionally deal with the processing of the bottle layer (for example, installing or removing spacers between the layers, etc.) and pallets. At the same time, industrial robots are able to work in conditions with high temperature and humidity, vibration, noise, and polluted air. Their use increases the efficiency of energy consumption, productivity and quality of products [13-15].

Additive technologies as applied to the food industry are developing in two directions: the creation of food equipment and food products.

The main types of additive manufacturing technologies include:
- extrusion - extrusion of molten material;
- photopolymerization - polymer curing by UV or laser radiation;
- printing by sintering and melting materials;
- lamination - gluing layers of material with subsequent cutting.

4.2 System of processes of agricultural raw materials deep processing
At present, the issue of technological re-equipment of all branches of domestic production is becoming increasingly important. The agricultural sector is one of the strategic ones for Russia, but many sectors of the agro-industrial complex require technological renewal, and it is necessary to start with breakthrough technologies. Deep processing of agricultural raw materials can be an innovative way that will contribute to the development of the agro-industrial complex of Russia, simultaneously involving a number of related industries in production: food industry and industrial biotechnology, bioenergy, mechanical engineering, etc.

The structural diagram of food production by deep processing of raw materials can be represented as follows (Fig. 1): raw materials → semi-finished products → finished products → bioproducts that are obtained using modern biotechnology, i.e. the integration of natural and engineering sciences, which makes it possible to fully realize the possibilities of living organisms for the production of food, medicines, solving problems in the field of energy and environmental protection.
One of the main competitive advantages of enterprises in the deep processing of grain (Fig. 2) is the ability to regulate the volume of products at various stages, which allows you to adapt the process to current market requirements and increase economic efficiency.

A technology has been developed for the complete (waste-free) processing of oilseeds into oil, biofuel (fuel pellets, biodiesel), cake, and fat-vitamin additives (Fig. 3).

At the same time, it is proposed to carry out processing of raw materials directly at the place of harvest, using the developed mobile processing plants for oilseeds.

Bioproducts obtained from the processing of oilseeds are biofuels - a relatively new type of environmentally friendly fuel. Biofuels can be used in conventional internal combustion engines without changing their design. After the production of biofuel, cake remains, which is used as animal feed and the glycerin phase, which, when purified, turns into pure glycerin, which is used to obtain a
As promising early ripening sources of nutrients of animal origin for deep (three-stage) processing, it is advisable to use fish from inland waters, which is the basis of aquaculture (Fig. 4), as well as rabbit products.

The advantages of the approach are: development of new technological solutions for the use of fish tissues in food systems in the production of traditional, analog, imitating and functional products; rational processing and use of secondary fish processing products as sources of connective tissue proteins (skin, fins, scales, heads, entrails); organization of deep processing of fish in inland water bodies with the allocation of sources of food, feed and technical purposes, which will serve as a real

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**Figure 3.** Block diagram of oilseeds deep processing

**Figure 4.** Block diagram of food production by deep processing of inland water bodies’ fish
way to eliminate the deficit of complete proteins, essential macro- and micronutrients; harmonization of a basket of fish products on the market by reducing the cost of finished products. [17-19]

It is necessary to accelerate the creation of a new generation of technology systems and systems of machines for agricultural production and processing and food industries in Russia, if we want to dramatically increase food production in the country, guarantee its safety, quality and competitiveness.

4.3 Technical and technological trends
The world market of mechanical engineering for the food and processing industry is characterized by the following technical and technological trends:
- automation of work and reducing the influence of the human factor;
- reduction in the use of energy resources;
- increasing the depth of processing of raw materials and switching to waste-free production;
- increase in the production capacity of equipment;
- increasing compactness and modularity;
- development of a remote service system;
- increasing the level of environmental friendliness of equipment.

The current state of domestic mechanical engineering for the food and processing industry is characterized by:
- low level of automation in production and a high proportion of manual labor;
- long terms of development and updating of design and technological documentation.

Areas for further technical and technological development of the Russian engineering industry for the food and processing industry are:
- increasing the production of new types of products in close cooperation with consumers;
- increased automation of production processes;
- introduction of resource-saving (primarily energy-saving) technologies;
- increasing the share of modern production equipment (numerical control machines, laser cutting, welding robots);
- introduction and use in production of specialized engineering software;
- expansion of the product line of Russian equipment and development of the production of high-performance equipment;
- transfer of foreign technologies;
- increasing productivity, reliability and durability, increasing energy efficiency and environmental friendliness of manufactured equipment;
- increasing the consumer attractiveness of products by improving the appearance and organoleptic properties;
- improving the quality of service.

Thus, we live in a digital age in which technical technology trends continue to evolve every day. In the future, a huge number of technical innovations and further developments are expected that will make the work of people easier and more convenient. These new technologies and trends are aimed at creating new and improving existing methods of production.

5. Conclusion
In modern conditions, for the effective functioning of food industry enterprises, it is necessary to develop an innovative development strategy. Therefore, the further development of food enterprises is impossible without the implementation of artificial intelligence systems based on the synergistic combination of precision mechanics units with electronic, electrical and computer components that ensure the design and production of qualitatively new modules, systems, machines and systems with intelligent control of their functional movements based on the use of concepts adaptive control, mechatronics, robotics and additive technologies.

Technical and technological trends include the development of mechatronics, the creation of new equipment, as well as lines implementing new machine technologies. Scientific and innovative
projects should be free from stereotypes of thinking in relation to the technologies themselves and
designs of machines, apparatus and bioreactors. They should be aimed at creating hundreds of new
designs of machines, apparatus and bioreactors to operate in dozens of new technological lines. The
task is to consciously activate the process of creating a new food production technique using the laws
of dialectics.

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