System research on the preparation of sunflower seed cake using multimedia devices

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Abstract. The purpose of the study is to determine the direction of research of systemic studies in the protein feed preparation using contemporary multimedia devices. The analysis and synthesis of the compound feed production system are based on the principles of block-modular production, which consists in the separation of the basic structural subsystems from the technological system in the form of blocks, forming technological lines (modules) based on the type of processed raw material and (or) the type of its processing. The graph theory together with the system analysis allows describing the process of protein feed preparation from sunflower seeds in the form of cake by using multimedia devices allowing one to control the process of its production, that is, to obtain an accurate technology for protein feed preparation. Mathematical models based on system analysis make it possible to implement systems that consider the properties of technical means, depending on the stage of its preparation and the interrelationship between them.

1. Introduction

System analysis includes models and the decision-making technique. In general, the consistency in decision-making comprises several stages of identifying a problem situation, targeting, forming criteria for choosing solutions, developing decisions, agreement, choosing and implementing decisions, as well as evaluating the results. This sequence is used to create various complex systems, which include decision-making technique. The methods are not fixed on the design object, they focus on ways of organizing a group or individual search for solutions, which include methods (brainwork activation, for example, brainstorming, synectics; generation of options; choice, for example, the method of expert assessments) and models (selection of optimum alternatives and research of operations) [1].

The component of system analysis is a design technology that uses system analysis, focusing on a specific type of systems (computer-aided design technologies for technical systems for various purposes). Their distinctive feature is the presence of a regulatory design procedure, providing the implementation of certain stages, for each of which there are standardized methods and a standard set of documentation, or even at some stages the formation of various kinds of models is envisaged.

Any technology uses a systematic approach to design, which is based on a systematic decision-making sequence. Design methods are based on various methodologies of systems analysis and general decision-making procedures [3].

System analysis is considered in the random nature of machine impact in the production line on the material, the distribution functions and their variation from these influences are described by the logarithmically normal law. The stochastic nature of the effect of each machine on material particles during the technological process requires a certain approach to the implementation of the systemic
strategy principle for the preparation of compound feed, which is expressed in the fact that each subsequent operation should not worsen the quality of the work performed [2].

As is known, the system approach is a set of methods and tools, allowing studying the properties, function structure of objects, phenomena or processes in general, by presenting them as systems with all complex inter-element co-relations, the interaction of elements on the system and on the environment, as well as the system impact itself on its structural elements. A systematic approach in the study of a complex object, phenomenon or process is based on its holistic vision [2, 6–9].

The purpose of the study is to determine the direction of research of systemic studies in the protein feed preparation using contemporary multimedia devices.

2. Materials and methods

The analysis and synthesis of the compound feed production system are based on the principles of block-modular production, which consists in the separation of the basic structural subsystems from the technological system in the form of blocks, forming technological lines (modules) based on the type of processed raw material and (or) the type of its processing.

An enterprise for the compound feed production is considered as a complex technological system including functionally interconnected technical means affecting the raw material flows and intermediate material, and provides the release of finished biologically safe feed with specified quality characteristics. It is a continuous sequence of transport and technological process, forming a technological flow. The most important feature of the technological process flow is its integrity, and the integrity factor, connecting the system components, is the process stability in machines and devices for combined feed production.

The system analysis and synthesis of the compound feed production system is carried out on the basis of a functional and structural approach by building an operator model, which is a graphical representation of technological operations and the raw material flows, connecting them, i.e. the technological flow using the principle “input – output” [4].

The system analysis [2] of protein feed preparation is carried out by dividing the system into subsystems of different levels (technological lines) and elements (technical devices), which will allow outlining the research stages.

Let us compose an algorithm for the movement of a sunflower seed heap in the technology of protein feed obtaining, consisting of two technical means (a secondary cleaning machine and an extruder) according to RF patent No. 2636474, which is shown in Figure 1.
The algorithm is implemented in the technology of protein feed obtaining, for which RF Patent No. 2636474 was obtained.

Based on the flow chart and the operation scheme, we build a hierarchical structure of the protein feed production system in the line (Figure 2).

![Figure 2. Hierarchical structure of the protein feed production system](image)

Based on the scheme for the movement of a sunflower seed heap in the technology for sunflower cake preparation (Figure 1), in order to obtain it, a wide variety of algorithms for protein feed obtainment (RF patent No. 2688481) have been proposed using modern computer hardware (multimedia devices). This allows one to control the technological process and one of them is shown in Figure 3.

3. Research results
Based on the system analysis [5], we compose a mathematical model of the protein feed preparation. The properties of technical means in the protein feed preparation and their interrelationship between them are determined by the criterion of their isolation from a variety of technical means. Separating from a certain whole, the elements according to a certain criterion thereby determine the physic-mechanical properties of sunflower seeds associated with them in protein feed preparation in the form of cake together with micronutrients. In the form of an element, there are technical devices that are necessary and sufficient for the protein feed preparation in the form of cake: the technological process duration, the sunflower seeds and technical means cost, the further processing of the material in order to obtain the protein feed. At the first presentation, the graph edges are of a continuing character in obtaining material for feed, continuously operation lasting time, and the graph vertex is of a discrete nature: either an event has happened – yes, the purity of the obtained seed corresponds to more than 99% and to a certain temperature rate for feed cooling and further comparison with the database of zootechnical requirements for feed, or not.
Based on the presence of the properties of technical devices, which are necessary and sufficient for the protein feed preparation in the form of cake and their interrelationship between them, it is a system of the following type:

\[ S = A, R, Q_a, Q_r, \]  

(1)

where \( A, R \) – the technical means, depending on the stage of protein feed preparation and their interrelationship between them; \( Q_a, Q_r \) – the technical means properties and their interrelationship [5].

**Figure 3.** The scheme for protein feed obtainment (RF Patent No. 2688481)
The graph edges are directed to some elements, determining their order, and ultimately come to some key event, which is the target [5] in the high-quality protein feed preparation in the form of sunflower cake. The systematic nature of the activity is manifested in the fact that it is carried out according to a certain algorithm for the high-quality protein feed preparation in the form of sunflower cake for a farm animal. Consequently, the algorithm is an image of the future activity of obtaining high-quality protein feed in the form of sunflower cake, its model. Algorithmization of any kind of activity is an important way to increase its consistency.

The purpose is an image of the desired future. A model can represent a model of the state, at the implementation of which the activity is aimed:

\[ S = A, R, Q, Q_r, Z, \]  

(2)

where \( Z \) – the set and structure of targets.

If the graph edges are set as processes for converting sunflower seeds with a purity of 99% into a high-quality protein feed in the form of sunflower cake, and the properties of the edges are matched with technical means, and the vertexes are matched with targets, we return to the elementary definition of the activity of the entire system (Figure 4).

![Figure 4. The graphic representation of high-quality protein feed preparation](image)

Defining the system, at the same time the language means are selected, using which the system is commenced to be simulated (Figure 5) [5]:

\[ S = A, R, Q, Q_r, Z, L, \]  

(3)

where \( L \) – the language structure of the system description.
Figure 5. The system analysis of protein feed preparation using updated multimedia devices

At different stages of representing an object in the form of a system, in different specific situations, it is possible to use different definitions. Moreover, as the concepts of the system are refined and the transition to one or another structure of its description is made, the definition of the system not only can, but also must be refined.

Returning to the definition of activity and relying on the system-structural description of objects, the system can be defined as:

\[
S = Z, STR, TECH, COND,
\]

(4)

where 
- \(Z\) – the structure of targets;
- \(STR\) – the set of structures, carrying out the targets (\(STR_{pr}\) – the productional one, \(STR_{org}\) – organizational one, etc.)
- \(TECH\) – the set of technologies, carrying out the system (\(meth\) – the methods, means – the means production, \(alg\) – the algorithms, etc.);
- \(COND\) – the system existence conditions (external, internal factors, affecting its implementation and functioning) [5].

4. Conclusion
The graph theory together with the system analysis allows describing the process of protein feed preparation from sunflower seeds in the form of cake by using multimedia devices allowing one to control the process of its production, that is, to obtain an accurate technology for protein feed preparation.

Mathematical models based on system analysis make it possible to implement systems that consider the properties of technical means, depending on the stage of its preparation and the interrelationship between them.
References

[1] Sadovsky V N 1974 *Foundations of the general theory of systems* (Moscow: Nauka) pp 93-245

[2] Sadov V V 2018 *Substantiation of the structure and composition of technological lines for the production of animal feed in agricultural enterprises*, doctoral dissertation (Barnaul) 294 p

[3] Diyazitdinova A R and Kordonskaya I B 2017 *General theory of systems and system analysis* (Samara) 125 p

[4] Pakhomov V I, Braginets S V and Bakhchevnikov O N 2015 *Scientific and methodological conference “Innovative technologies in science and education-2015”* pp 338-343

[5] Laboratory of system analysis. Systems approach and systems analysis (St Petersburg) 53 p. Retrieved from: https://system-laboratory.ru/assets/systems_analysis.pdf.

[6] Ignatyev V V, Finaev V I, Kovalev A V, Spiridonov O B, Soloviev V V and Ignatyeva A S 2017 Systematic approach to selection of models for investigation into technical objects of automated systems *Int. J. of Civil Engineering and Technology* 8(10) 559-570

[7] Kotsis G 1997 A systematic approach for workload modeling for parallel processing systems *Parallel Computing* 22(13) 1771-1787

[8] White V J, Glanville J M, Lefebvre C and Sheldon T A 2001 A statistical approach to designing search filters to find systematic reviews: objectivity enhances accuracy *J. of Information Science* 27(6) 357-370

[9] Shang Z and Kokossis A 2005 A systematic approach to the synthesis and design of flexible site utility systems *Chemical Engineering Science* 60(16) 4431-4451