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PHYSICS AND MATHEMATICS

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COGNITIVE COMPUTER MODELING FOR BAKERY PRODUCTION'S TECHNOLOGICAL PROCESSES MODE OF BEHAVIOR

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Abstract. *An application of cognitive computer modeling for bakery production's technological processes methodology on obtaining a scenario forecast of their mode of behavior in uncertainty is considered in the article. Cognitive modeling method allows to provide impact factors analyze when bread cooking, to assess the strength of interoperating, to create provisional weighted graph of factors, to solve semi structured issues that arise, when managing such a complex organizational and technical system as a technological complex of bakery production. Using computer cognitive modeling, a support decision making is defined as the task of developing a strategy for transition from a current situation state to a target state based on subjective situation model as a cognitive map, which creates prerequisites to develop effective systems for bakery production process control scenario.*

Keywords: *computer cognitive modeling, impact factors, provisional weighted graph, forecast.*

Modern technological systems, organizational and technical (technological) systems, which include bakery production' processing facility are characterized by complex processes of intense dynamic interaction, energy, matter and information exchange. In such complex, nonlinear, multidimensional and multiply systems a phenomenon of intermittency occurs as an alternation of regular and chaotic behavior, which greatly complicates the decision-making process. To raise up control efficiency in such systems a modern control theory uses synergy and deterministic chaos methods, based on the idea of self-organization and dissipative spatial-temporal structures that allow taking adequate decisions in specific changing conditions. In synergistic control system constructing, it is necessary to predict and assess how the decision will affect the development of complex system. So, today scientists are on the lookout for a methodology that can evaluate a semi structured behavior control system adequately, based on objective laws of natural self-organization and personnel subjective understanding, representation in accordance with its experience and intuition about control system options and connections among them. It is proposed to use one of the most promising and suitable direction in the theory of managerial decision making as computer cognitive modeling.

Cognitive modeling is one of scientific method in cognitive science. Knowledge engineering (cognitive science) [lat. cognitio – gnosis, gr. logos - learning] - an interdisciplinary research area that integrates the theory of knowledge, cognitive psychology, neurophysiology, cognitive linguistics and artificial intelligence theory [1]. The science object of cognitive science [2] stands a hierarchically organized space of knowledge that contains the ordered subspaces, so that these insights are focused, allowing to use them relatively quickly while controlling. Cognitive modeling, in its turn, is seen by the authors, as a formalization of knowledge, decision making on the basis of visual knowledge, controlling at the intuitive knowledge level [3].

The basic idea of cognitive modeling for bakery production is to develop and refine a hypothesis on researched object functioning, which is regarded as semi structured system that consists of separate internal and external elements, subsystems that interact with each other, based on block diagram of causal relationships.

An analysis of bakery enterprise production situations within the scenario approach is conducted. The trends of bakery production biotechnological processes development by computer cognitive modeling are observed. During bakery production controlling it is necessary to provide decision-making process in situations where parameters, laws and patterns of development are described qualitative. Those are unique semi structured dynamic situations, where settings changing are accompanied by hard predictable changes in structure.

Computer modeling of biotechnological systems, which include bakery production, is based on the technology, methodology and algorithmic presentation on computer models developing regarding the computer' simulation model organization indicators; informational uncertainty and

results presentation; intellectual modeling development, including systems' and causal relationships' at micro and macro levels computer analysis evolution and forecast diagnosis; technological systems' main operation elements dynamic tracking that help to receive the optimal solutions in the mode of operational processes control.

Cognitive maps reflect only the fact of connections between factors. However, they do not reflect the power of connections and connection dynamics change of impact depending on situation change, when bread making. The issues can be solved by constructing cluster situation models. These models should include the following parameters:

- size and nature of connections between micro environmental factors, determined by experts;
- macro environmental factors on micro environmental factors connection degree, determined by experts;
- micro environmental factor impact size on corresponding situation cluster at every bread processing stage.

In summary, a typical clusters situations cognitive model for bakery process may be presented as a system of equations (1):

$$\begin{gathered} \pm \sum_{i,f,g-2}^{n} s_i w_f m_g = \pm \sum_{i,j-1}^{n} t_i e_j \\ \pm s_1 w_1 * m_1 \pm \textstyle\sum_{i,f,g-3}^{n} s_i w_f m_g = \pm \sum_{i,j-1}^{n} t_i e_j \\ \dots \\ \pm \sum_{i,f,g-1}^{n} s_i w_f m_g = \pm \sum_{i,j-1}^{n} t_i e_j \end{gathered} \quad (1)$$

where, w_f, f = 1 ... n - micro environmental factor;
e_j, j = 1 ... n - macro environmental factor;
s_i, i = 1 ... n –connections size between factors;
t_i, i = 1 ... n - macro environmental factors on micro environmental factors connection degree;
m_g, g = 1 ... n - micro environmental factor impact size on situation.

Defined noises Ғ, related to experts subjectivity and unreliability of their estimates, affect on cognitive modeling results reliability. To minimize these noises, (min → Ғ) while expert estimations, the requirements for qualifying experts features are taken into account:

- experience ≥ 3 years;
- higher education - bakery production managers and technology experts;
- individual expert assessment of work situations;
- interviews with experts during a shift and on shift basis;
- consideration the other related branches bakery production' employees views.

Constructed combined equation gives enough information to formulate scenarios for further development of typical control situations at the bakery production.

To describe the situation in structural terms a structural and functional decomposition is used: situation components are pointed out as a "Part-Whole" hierarchy, <D, Θ>, where D = $\{d_i\}$ – a set of situation elements - a whole and its component parts, Θ - "Part-Whole" relation on a set D, i = 1 ... n. To describe the situation in functional aspect main characteristics (hereinafter - signs) of all elements of the situation $F_i=\{f_{ij}\}$, j = 1 ... m are determined.

According to cognitive analysis of complex situations methods after collection and systematization the existing statistical and qualitative information it is needed to move on highlighting the main characteristic features of studied process and relationships, as well as factors determination, where situation subjects can affect practical. This allows constructing an issued cognitive (graph) model situation. So, it is needed to divide the process on such situational important areas: flour reception; dough process; dough processing; baking a product. To do this, it is needed to divide the process of beer production at situational critical zones, where main factors that describe an issue are highlightened. Then, determine the factors that affect situational target zones. While flour reception: flour grade, flour strength.

While dough process: process kneading time, dough viscosity, dough amount, dough temperature, water quantity, fermentation duration.

While dough processing: dough piece weight, form ability, proofing time, proofing moisture in the closet.

When baking: baking temperature, humidity in the oven area of moisture, baking term, crust color, sintering, finished product form.

Next step is to determine the direct connections among factors within the situational zones. Below, there are the examples of such connections.

1. Flour quality affects flour strength (the highest grade - the greater flour strength), with flour power increasing, the temperature of the dough during kneading increases; the duration of mixing reduces; the duration of dough proofing during processing increases; form ability while dough processing increases; dough amount increases; amount of water to be added into the dough during kneading increases.

2. Duration of mixing Connections form ability (the more time - form ability worse). With increasing the fermentation duration, the amount of dough increases. With dough temperature increasing: the fermentation duration accelerates (reduces); dough viscosity increases; proofing duration during dough processing reduces.

A software tool "Canva" was used to provide cognitive modeling. While factor naming a set of current, maximum, minimum and intermediate values were identified (fig. 1).

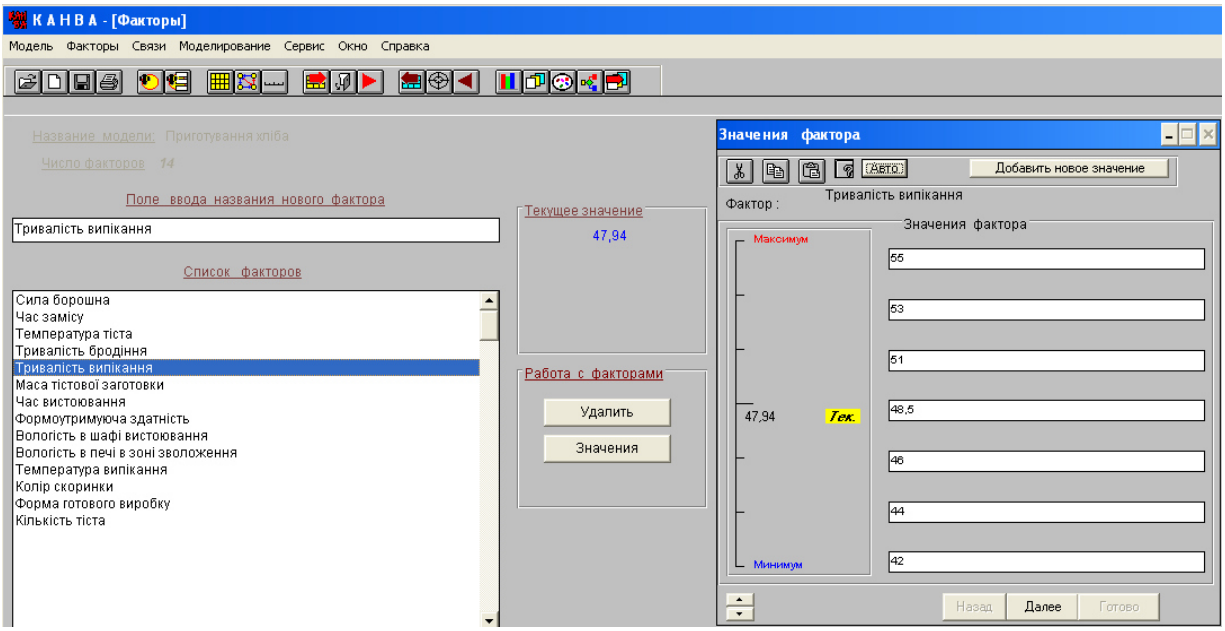

Fig. 1. Factors table windows and their values

If there is only one connection factor – a direct assessment applies on another factor. That is, the force of impact is indicated, how depending on this factor another factor changes. After constructing a weighted graph the power of factors connection on each other have to be mentioned. If there are several factor impacts, then pairwise assessment applies, it indicates not only the factor power connection, but which one is stronger than the other variable specified factor (fig. 2).

As a result of cognitive process computer modeling of bread making such results were obtained:

1. Automatically oriented weighted graph on connections between impacts is constructed;

2. A possibility of scenarios comparability depending on input factors values change at certain stages of bread making.

3. Constructing factors' change diagrams depending on the chosen scenario.

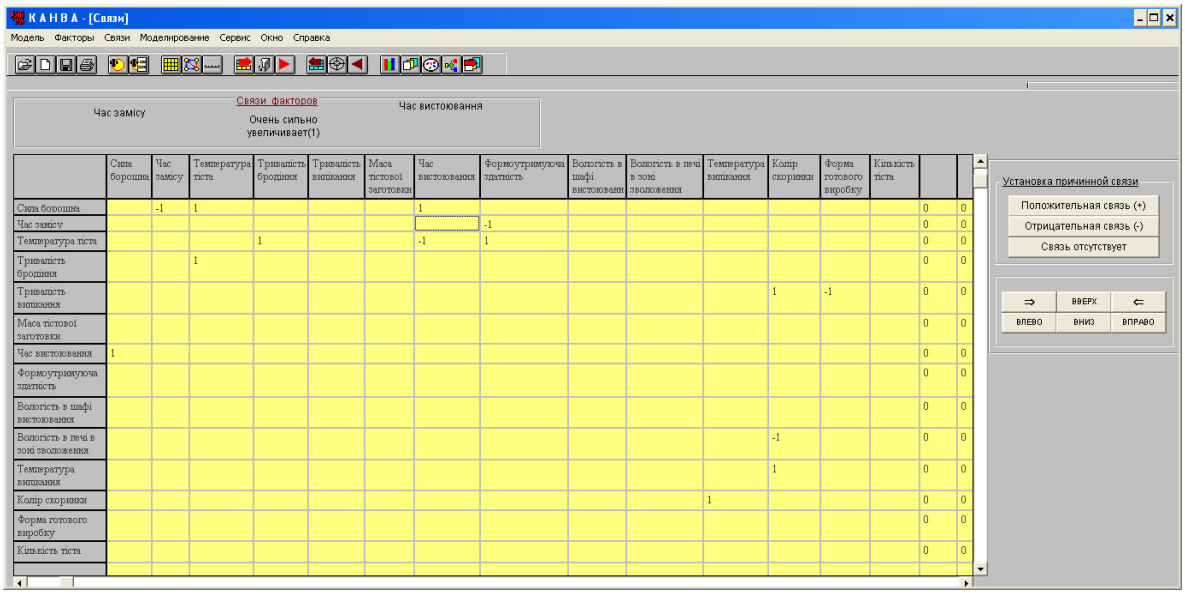

Fig. 2. Connection factors window on their relations

Based on data obtained while cognitive situation modeling and knowing what will happen under certain conditions, the expert has the ability to make the right decision about the impact on the process to receive a higher quality baking products. Cognitive modeling system can be used as part of a decision support system for the direct bakery control, or while predicting the course for bakery production technological processes.

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ОПЕРАТИВНЫЙ КОНТРОЛЬ СОДЕРЖАНИЯ ЖЕЛЕЗА В ПОРОШКОВЫХ ПРОБАХ С ИСПОЛЬЗОВАНИЕМ ГАММА-ИЗЛУЧЕНИЯ

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Abstract. *The article considers the factors influencing the accuracy of determining the benefit component when the Express method. Described what terms is the error of change, and cited influencing factors and theoretical justification of these variables. Describes the results of laboratory studies to determine the instrumental error and the accuracy impact of calibration factors to convert the measured values of the integral flux of gamma radiation in mineral content. The optimal number of measurements for the rapid analysis of samples, which ensures the required measurement accuracy for the technological process of extraction and preparation of ores. The results of the study classified all existing types of errors in the use of gamma radiation for rapid quality control of mineral raw materials.*

Keywords: *Express analysis, the content of iron, gamma radiation, measurement errors, powder samples, the accuracy of the measurement, the intensity of the gamma radiation.*

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