

**117. *Kobernik M.V., National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine.***  
**SMART SYSTEM TECHNOLOGY OF DESIGNING OF LOGISTIC SCHEMES OF SUGAR BEET  
HARVESTING**

The problem of creating a flexible logistics technology for harvesting and transporting root crops during their harvest will be considered as a complex system, a complex object to be studied. The result of solving this problem will be the creation of a comprehensive document of information and recommendation (consulting) nature, which would contain certain mandatory sections and their content in relation to the flexible choice of a set of technical means with optimal economic performance, parameter groups, etc. depending on specific natural, economic, legislative and other numerous conditions during the harvest of cereals.

Since there is no sufficient information base for the content of such a document at the beginning of such a comprehensive study, in our opinion, the solution of this system problem should be performed from the standpoint of inductive approach to modeling complex systems, which has proven itself in solving many complex uncertain problems.

One of the effective tools of this approach to the creation of this type of document is the inductive technology of system information-analytical research, which applies the main principles of the theory of inductive modeling of complex systems. It will be recalled that the result  $R^*(I_b^*)$  of complex inductive technologies of system information-analytical research is a specific document  $D\{R^*(I_b^*)\}$ , which reflects the results of system subject analysis of a complex object (process, phenomenon or problem in general), which is based on the optimal information base  $I_b^*$  constructed in the research process. Requirement has an information-recommendatory (consulting) nature, endowed with a certain official status and level of access.  $D\{R^*(I_b^*)\}$  means a document prepared and executed in accordance with the requirements, based on a set of optimal research results  $\{R^*(I_b^*)\}$ , which may still have a certain sketch character. This is the only difference between the results  $R^*(I_b^*)$  and the resulting document  $D\{R^*(I_b^*)\}$ .

Here are the main stages that must be passed in accordance with the inductive technology of system information and analytical research to create a meaningful document.

Stage I. Formation of the top-level expert commission and construction of the primary information base, selection of analytical groups  $A$  and  $B$  to perform system-analytical research and synthesis of the optimal information base  $I_b^*$ , which should generate results  $R^*(I_b^*) \in \{R^*(I_b^*)\}$ .

Stage II. Creating a matrix of reference (target) result:

$$E = E\{R^0(I_b^0)\} = (e_{ij}) = \begin{pmatrix} e_{11} & \cdots & e_{1n} \\ \vdots & \ddots & \vdots \\ e_{m1} & \cdots & e_{mn} \end{pmatrix}, \quad 1)$$

in which the  $i$ -th line,  $i = 1, 2, \dots, m$ , reflects one of the indisputable types of requirements for the target result of the study from the standpoint of the expert commission, and the  $j$ -th column,  $j = 1, 2, \dots, n$ , possible gradations of estimates of the  $i$ -th element. The line in our case is one of the necessary sections of the future document, and the elements of the line are the formalized values of expert assessments (requirements) to its subdivisions. The elements  $(e_{ij})$  of the matrix  $E\{R^0(I_b^0)\}$  are formalized according to a certain algorithm based on the assessments of top-level experts. For example, this may be the median on the set of expert tolerances (conclusions) regarding such an element  $(e_{ij})$ .

It is important to note that the matrix  $E\{R^0(I_b^0)\}$  concerns only the form of the future result and the importance of reflecting in it the most important positions and their parts. In addition, in contrast to the known analytical technologies such as the Delphi method, the key point is that members of the top-level expert commission who agreed with the generalized estimates of matrix  $E\{R^0(I_b^0)\}$  tolerances  $(e_{ij})$  cannot change their conclusions about the shape of future results throughout the project. That  $(e_{ij})$  is, there are constant estimates. The semantic content of all these positions is performed by analytical groups and tested by experts from the top-level expert commission at each step of the next stage III.

Stage III. Execution of information-analytical project by iterative procedure.

Step 1 of stage III. Groups  $A$  and  $B$  synthesize analytical results  $R_k(I_b^1)^{(A,B)}$ ,  $k = 1, 2, \dots, K$ , which include only the initial information base  $I_b^1$ , and for each such result, experts make estimates, ie build matrices that are formalized on the same principle as for the matrix  $E\{R^0(I_b^0)\}$ .

$$W_k^{(A,B)} = (w_{ij}) = \begin{pmatrix} w_{11} & \cdots & w_{1n} \\ \vdots & \ddots & \vdots \\ w_{m1} & \cdots & w_{mn} \end{pmatrix}, \quad 2)$$

That is, the matrix  $W^A$  – reflects the formalized  $k$ -th result  $R_k(I_b^s)$ , achieved by the analytical group  $A$  in the  $s$ -th step of the study ( $s = 1, 2, \dots, S$ ) and, accordingly  $W^B$  – reflects the formalized  $k$ -th result  $R_k(I_b^s)$  achieved by the analytical group  $B$  in the same  $s$ -th step of the study.

Each synthesized result is evaluated according to the criteria of systemic correlation:

$$CR_{corel} = \sqrt{\sum_{i=1}^m \sum_{j=1}^n (\delta_{ij}^2)_{W^A W^B}}, \quad 3)$$

and systemic relevance:

$$CR_{rel} = \sqrt{\sum_{i=1}^m \sum_{j=1}^n (\delta_{ij}^2)}_{W(A \wedge B)_E}, \quad (4)$$

where  $\delta_{ij}^2$  – the elements of the matrices

$$\Delta_{(*)}^2 = \begin{pmatrix} \delta_{11}^2 & \cdots & \delta_{1n}^2 \\ \vdots & \ddots & \vdots \\ \delta_{m1}^2 & \cdots & \delta_{mn}^2 \end{pmatrix}, \quad (5)$$

and are equal to the squares of the differences of the corresponding elements of the pairs of matrices  $W\{R_k(I_b^S)\}^{(A \wedge B)}$  and  $E\{R^0(I_b^0)\}$  and  $W\{R_k(\delta_{ij}^2)\}^A$ ,  $W\{R_k(I_b^S)\}^B$ , respectively, and all these matrices have dimensions  $n \times m$ . The sign \* means to which pairs of matrices, and therefore to which criterion, the object belongs  $\delta_{ij}^2$  (relevance or correlation).

Therefore, these system criteria require minimal differences both between the achieved two groups of results (2) and between such results and the reference. Then the information monitoring system is activated, an additional target portion  $I_b^+$  of monitoring information is formed, which should complement the already existing ensemble  $I_b^s$ ,  $s = 1, 2, \dots, S$ , in order to improve the results  $R_k(I_b^s)$ , bringing them closer to the reference  $R^0(I_b^0)$ .

Step 2 of stage III, ..., S. Analytical results  $R_k(I_b^s)$ ,  $k = 1, 2, \dots, K$ ,  $s = 1, 2, \dots, S$  are synthesized, which are based on the results of previous steps and information  $I_b^+$  of purposeful information monitoring. Again, each synthesized result is evaluated by criteria of systemic correlation (3) and systemic relevance (4).

Criteria (3) and (4) should theoretically have minima, which indicate the cessation of the inductive procedure for the synthesis of the optimal result  $R^*(I_b^*)$  (or a certain limited set of such results  $\{R^*(I_b^*)\}$ ). The last step of the procedure of inductive technologies of system information-analytical research is one in which:

- the result is obtained, which is objectively the best according to the system criteria (3) and (4) and satisfies the customer;
- the result is obtained, which can still be improved, but it already satisfies the customer;
- exhausted research resources (time and money, for example).

Stage IV. Formation of the optimal result  $R^*(I_b^*)$  and the corresponding consulting document  $D\{R^*(I_b^*)\}$ . Both analytical groups should already work here under the control of the project manager.

Stage V. Protection of the document  $D\{R^*(I_b^*)\}$  and its transfer to the customer. Obviously, the described technology does not require complex, long-term and costly field experiments to achieve the result (although in the general case it is not denied). In addition, it is also obvious that such an approach should be used to solve complex problems, to implement intelligent projects of high complexity. The problem undoubtedly belongs to this class of problems. Thus, comparing the above, a consulting document that would contain simple and at the same time sufficient for decision-making procedures (schemes) for the synthesis of flexible logistics technologies for harvesting and transporting grain to granaries and optimally adapted to specific natural production, economic, technical and other conditions during the collection period, it is advisable to create, based on the described inductive technology of system information and analytical research. The concept of developing such a document for the synthesis of logistics technologies for harvesting and transporting grain involves the following stages.

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**МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ**  
**ЖИТОМИРСЬКИЙ АГРОТЕХНІЧНИЙ ФАХОВИЙ КОЛЕДЖ**



## **ЗБІРНИК ТЕЗ**

*XI Міжнародної науково-практичної конференції*  
**«Перспективи і тенденції розвитку конструкцій  
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Збірник тез доповідей XI Міжнародної науково-практичної конференції «Перспективи і тенденції розвитку конструкцій та технічного сервісу сільськогосподарських машин і знарядь. PTDSTSAMT-2025» з нагоди 30-річчя започаткування підготовки ОС «Бакалавр» за спеціальністю «Агроінженерія». 11 квітня 2025 року. МОН України. Житомирський агротехнічний фаховий коледж. Житомир. 2025. 333 с. <https://doi.org/10.64165/proceeding-ptdstsamt.2025>.

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В збірнику представлені тези доповідей науково-педагогічних працівників, наукових співробітників, аспірантів та студентів Житомирського агротехнічного фахового коледжу, провідних вітчизняних і закордонних закладів вищої освіти та наукових установ, в яких розглядаються завершені етапи розробок.

The collection presents abstracts of reports by scientific and pedagogical workers, researchers, postgraduates and students of the Zhytomyr Agrotechnical Professional College, leading domestic and foreign higher educational institutions and scientific institutions, which consider the completed stages of development.

*Передрук або інше відтворення в будь-якій формі в цілому або частково матеріалів, опублікованих у цьому віданні, дозволено лише за посиланням на джерело і дотриманням вимог законодавства*