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DEVELOPMENT OF AN INFORMATION SUPPORT METHODOLOGY FOR QUALITY ASSESSMENT OF THE PREPRESS PROCESS

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A methodology for improving the information support of the prepress system by introducing new information blocks to prevent errors and predict the final result before the start of prepress operations is presented. Conceptual provisions for assessing the quality of the prepress process have been developed. These conceptual provisions have become the basis for solving the problem of systemic and random errors at the planning stage, created conditions for a significant reduction in prepress time. This parameterized form allows a formal description of operations, the determination of relevant quality indicators based on the formed parameters, and the development of databases and knowledge of the information support system for the anticipatory quality control of prepress.

Classification of factors that affect the quality of the prepress process was carried out. As a result, it is possible to exclude from further consideration the factors that are not important for assessing the prepress quality. The proposed factors form the basis of the knowledge base of the information system for assessing the quality of the prepress process.

The method of "anticipatory" quality control was developed. This method provides the detection of "bottlenecks" in each technological operation of the prepress process, as a result of which random and system errors can be avoided. The resulting indicators of the proposed method are the probability of an error, the probability of error-free execution of the technological operation, the cost of controlling the technological operation, and the cost of eliminating the error.

The information support method for the quality assessment of the prepress process is proposed. Implementation of the developed information support methodology for assessing the quality of the prepress process in the form of an information system for assessing the prepress quality was carried out. This information system allows automating the method of "anticipatory" quality control proposed in this study. Thus, on the example of the technological operation of color correction and color separation by the "CMYK color model" parameter based on the use of the expert knowledge base subsystem, the probability of an error is 1, and the cost of eliminating the error is $ 6

Keywords: information support of prepress quality assessment, prepress errors, color correction, "anticipatory" quality control

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1. Introduction

One of the most significant factors for the successful development of an enterprise in any industry represented in the market of goods and services is the ability to compete. A high level of competitiveness is achieved by providing consumers with quality products. The quality of manufactured products is one of the key factors in the formation of demand, which allows enterprises to organize their place in the market among many competitors. The degree of product quality and cost determine the level of profitability of the enterprise.

There are many ways to improve quality, such as the purchase of expensive equipment, retraining of personnel, reorganization of the enterprise structure, and optimization of production processes. As a result, it is important to design and implement a quality control system based on an information system at enterprises of various industries, as well as to develop a quality control method that will ensure error-free execution of the process.

Such a system becomes an integral part of the production process in ensuring quality control. The introduction of a quality control information system significantly reduces the costs of enterprises associated with the occurrence of defects and helps to deal with the difficulties that become an obstacle to production: from the purchase of materials to the delivery of products to customers. Its task is to check carefully selected data, detect deviations of parameters from the planned values, find the cause of the deviation, troubleshoot the problem, and check the compliance of the planned data (standard or norm). The areas of use of the quality control information system have no borders, and the printing industry is no exception. Enterprises engaged in the manufacture of printed products have many technological processes.

The most important stage of production is prepress. This stage includes acceptance and verification of original layout files, trapping, color separation, and output of photo forms on printing plates using Computer to Plate (CTP) systems. Often at this stage, there is a large number of errors in the performance of technological operations. Therefore, the use of a quality control information system and the method of anticipatory control is necessary to avoid and prevent errors at the stage of planning a technological operation.

For a printing company, the use of such a system will have significant monetary costs. However, this allows identifying possible areas of errors and predicting the final result before the start of the operation. It is also possible to reduce the time for repeated control and increase the competitiveness of the enterprise.

These aspects determine the relevance of the problem of information support for quality assessment of the prepress process.

Usually, quality assessment of the prepress process is based on the use of instrumental means (spectrophotometers, densitometers) and appropriate information systems for the automation of prepress processes. But at the same time, errors often appear, usually of subjective nature, such as layout errors, inaccurate combination of raster structures in the process of rasterization, trapping errors, and errors of designers in the preparation of the original printing layout. Ignoring such seemingly insignificant errors leads to a considerable deterioration in product quality. There is an urgent need to control the occurrence of errors at certain stages of prepress. Because the approach based on neglecting design, rasterization, color separation, layout, and trapping errors complicates the mechanism for assessing the quality of the prepress process. When trying to go beyond these limitations for operational quality control of prepress, objective difficulties arise. These difficulties are associated with the lack of automated tools that allow optimizing the process of information support for assessing the quality of the prepress process, in particular, to improve the efficiency and quality of image compression.

These difficulties should be overcome by developing a methodology of information support for assessing the quality of the prepress process. The essence of information support in this sense is to assess the quality of prepress at the planning stage using the appropriate information system. The central link of this methodology is the method of "anticipatory" quality control based on the assumption that random and systemic errors may occur in the production process.

The creation of this methodology will provide an effective toolkit for improving the information support of publishing and printing. In addition, the development of an information support methodology for assessing the quality of the prepress process will create conditions for improving the competitiveness of printing houses and obtaining certain effects from implementation in production. In particular, this can increase the number of customers of printing products as a result of improving the prepress quality.

2. Literature review and problem statement

The practical need for the prompt creation of high-quality printing products causes the corresponding scientific interest in the problems of information support for assessing the quality of the prepress process. Thus, in the work [1], a methodology for assessing the quality of digital printing is proposed. It also outlines the main components that should be included in the relevant information system for assessing the quality of digital printing. But this work does not take into account the specifics of prepress.

The study [2] proposes a prepress algorithm for printing on fabrics. The basis for this study was a project-oriented approach. However, the study does not provide opportunities to consider the full range of parameters of prepress operations.

The study [3] is devoted to the justification of the choice of equipment for printing on fabrics. The specifics of information support for this process, including some prepress parameters, are considered. However, the work does not contain a description of the most significant factors that affect the quality of the prepress process.

The work [4] presents a systematic review and discussion of the final illustration of the prepress design of printing products. A description of the procedure for improving the quality of the graphic design of products is given. But the work does not focus on information support for assessing the quality of the prepress process as a whole.

The analysis of the use of modern prepress automation tools and examples of automated processing for individual prepress tasks is proposed in [5]. At the same time, consideration of the problem of information support of the prepress process is quite narrow in terms of the issues examined and is intended mainly to improve the quality of individual automation tools.

The study [6] presents a methodology for packaging quality control using an integrated production flow system in prepress. Particular attention in this work is focused on creating accurate prints with computer-processed data. However, the paper lacks an algorithm for assessing the quality of printing products at the planning stage using an appropriate information system.

In [7], a description of the prepress process for offset printing technology without isopropyl alcohol in a moistening solution is proposed. This technology solves the problem of prompt creation of high-quality printing products. However, the issue of determining the conceptual provisions of quality assessment of the prepress process remains open in the study.

The work [8] proposes the development of a methodology for designing a publishing and printing web portal, which provides effective tools for information support for prepress processes. However, the work does not contain a description of the basic procedures for prepress quality assessment.

The scientific work [9] considers possible "bottlenecks" of prepress. However, this study does not take into account the need to prevent system errors for improving the quality of the prepress process.

The description and analysis of adaptive image processing algorithms for printing are given in [10]. But the study does not contain recommendations for the optimal selection of parameters of the prepress process based on the information system.

The method of automated balancing of vector illustration and its software implementation to create a high-quality printing publication is proposed in [11]. However, this scientific work does not consider the design of a conceptual database model and the creation of an information system for assessing the quality of the prepress process.

Thus, the analysis of scientific research on the problems of improving the prepress quality indicates the absence of a holistic scientifically based information support methodology for assessing the quality of the prepress process in the works under consideration.

3. The aim and objectives of the study

The aim of the work is to develop an information support methodology for assessing the quality of the prepress process. This will make it possible to improve the information support of the prepress system by introducing new information blocks to prevent errors and predict the final result before the start of prepress operations.

To achieve the aim, the following objectives were set:

– to develop conceptual provisions of quality assessment of the prepress process;

– to classify the factors that affect the quality of the prepress process;

– to develop a method of "anticipatory" quality control;

– to implement the developed information support method for assessing the quality of the prepress process.

4. Materials and methods

The object of research is the prepress process.

The subject of research is methods and means of quality assessment of the prepress process.

In the course of the study, the following hypotheses were formulated:

– hypothesis 1: the use of an information system for the prepress process will allow controlling the occurrence of errors at certain stages of prepress and the quality of the process;

– hypothesis 2: using an information system, it is possible to identify areas of errors and predict the final result before the start of the operation;

– hypothesis 3: printing enterprises that produce printed products can improve their quality by incorporating an information system into the technological process. This information system should perform the functions of preventing prepress errors and predicting the final result before the start of prepress operations;

– hypothesis 4: the quality of the prepress process can be improved if the process is evaluated at the planning stage using an appropriate information system.

An applied problem identified on this topic is the occurrence of errors when performing prepress operations.

The scientific problem is the lack of methods and means to prevent prepress errors and predict the final result before the start of prepress operations.

The following research methods were chosen:

– generalization – for the formation of conceptual provisions for assessing the quality of the prepress process;

– classification – to identify and justify the main factors that affect the quality of the prepress process;

– deduction – for parameterization of prepress operations;

– analysis and synthesis – to design a conceptual database model and create an information system for assessing the quality of the prepress process.

The information system for prepress quality assessment was developed using Microsoft Access (USA).

5. Results of research on the development of an information support method for quality assessment of the prepress process

5. 1. Development of conceptual provisions of quality assessment of the prepress process

When developing the method and means for assessing the quality of the prepress process, it is necessary to take into account the specifics of the prepress stage: the presence of consistently interrelated technological operations, each of which may contain an error. Errors can be random and systemic, but mostly systemic. Control of each technological operation of the prepress stage and error checking are carried out only after the execution of the stage as a whole.

Thus, a contradiction arises. The need to ensure a given level of quality of printing products requires the introduction of additional elements of the quality control system. On the other hand, the complication of the quality control system will increase financial costs and time of the technological process, and as a result, the order.

Overcoming this contradiction and prepress optimization are possible based on the use of conceptual provisions of quality assessment of the prepress process.

To form a list of conceptual provisions for assessing the prepress quality, experts in the publishing and printing field were involved. Such experts were specialists-technologists of the enterprises Globus Book Factory LLC, Unisoft PE, Astron+ LLC and Balance-print LLC. Based on the survey of experts, the following list of conceptual provisions for assessing the quality of the prepress process was formed.

Provision 1. The prepress process contains both systemic and random errors. Therefore, it is necessary to use the method and means of controlling the prepress process that will result in the production of quality products and increase the level of competitiveness. Regarding the elimination of systemic and random errors, we are talking about errors in color separation, color correction, trapping, layout, imposition, PS file writing, and rasterization. To determine the indicators that should be improved, it is necessary to develop a parameterized form of description of each prepress operation. This parameterized form will allow a formal description of operations, determination of relevant quality indicators based on the formed parameters, and development of databases and knowledge of the information system to support the anticipatory quality control of prepress. Automation of anticipatory quality control of the prepress process should be carried out for any type of printing product. To ensure such irrelevance to specific types of printing products, a table with order characteristics should be created in the database of the information system of prepress quality control.

Provision 2. Improvement of the process quality is possible by preventing system errors. The implementation of this provision will make it possible to prevent system errors at the stage of planning prepress operations, which will ensure the correct and effective execution of the production process as a whole.

Provision 3. Detection of system errors should be carried out based on the information system. In the process of error detection, the information system will highlight the most problematic areas of the prepress and production processes.

Provision 4. Reduction of the prepress time is possible with the optimal selection of parameters of technological operations based on the information system. On the example of trapping, we are talking about such parameters as stroke width, percentage of the trapping zone of vertical and horizontal lines, accuracy of object contour calculation, etc. For the optimal determination and selection of such parameters of prepress operations, a parameterized form of description of each technological operation should be created. As a result of the optimal selection of parameters, the decision of the information system will be explained to the user at a qualitative level based on the use of the knowledge base.

Provision 5. Visual representation of the possible result before performing the operation will reduce the rate of errors.

Each of the prepress operations has a corresponding set of parameters, which are determined by the relevant requirements for the final type of printing products and require certain verification and control. Let's consider the parameters of the main prepress operations.

To describe the parameters and determine the quality indicators of prepress operations, it is advisable to use the Backus-Naur form. The main technological operations of parameterization are color separation, color correction, trapping, layout, imposition, PS file writing, and rasterization. To automate the quality control process, it is more expedient to use a parameterized form. The parameterized form makes it possible to determine the main quality indicators of prepress to be improved in the context of this study. As an example of such a parameterized form, the following form for making a book edition can be given:

1) color separation and color correction:

<image>::= <color model><tone correction><color correction><dot gain><angle of reticle grating>;

<color model>::=<CMYK>|<Grayscale>|<Bitmap>|<Duotone>;

<tone correction>::=<lightness>|<midtones>|<shadow>;

<color correction>::=<white balance>|<color model channel values>;

<dot gain>::=<17 %>|<20 %>|<50 %>;

<angle of reticle grating>::=<300>|<450>|<900>;

<printed area>::=<ink amount>|<printing method>|<paper type>;

2) trapping:

<image>::= <screen width, pt><background color>;

<screen width, pt>::=<0.55–2.20>|<0.36–1.44>|<0.27–1.08>|<0.18–0.72>;

<background color>::=<internal trapping><external trapping>;

<internal trapping>::=<object colors>;

<external trapping>::=<neutral optical color density>;

3) layout:

<page parameter>::=<paragraph parameters><type page size>

<page size><binding position>;

<paragraph parameter>::=<character parameters><indents><paragraph>

<formatting method>;

<character parameter>::=<font><case><width>;

<font>::=<type><size><face>;

<type>::=<TimesNewRoman>|<Arial>|<.>;

<face>::=<normal>|<italic>|<.>;

<case>::=<uppercase>|<lowercase>;

<indent>::=<left>|<right>|<before>|<after>;

<paragraph>::=<indent from the first line>|<indent of the first line>;

<formatting method>::=<left margin>|<right margin>|<center>|<width>;

4) imposition:

<imposition>::=<imposition type><type page format><number of lines in the notebook><orientation and location of each line><fold number><print sheet size><mo><gathering><binding type>;

<imposition type>::=<portrait>|<sheetwise>;

<orientation and location of each line>::=<head down>|<head up>;

<fold number>::=<1>|<2>|<3>|<4>;

<type page format>::=<line length>|<line height>|<field sizes>;

<number of lines in the notebook>::=<2>|<4>|<8>;

<print sheet size>::=<width>|<length>;

<mo>::=<1/8>|<1/16>|<1/32>|<1/64>;

<gathering>::=<flat>|<saddle>;

5) PS file writing:

<PS file>::=<designed layout><font set><service information>.

<layout>::=<text>|<illustrations>;

<font set>::=<type>;

<service information>::=<cut marks>|<fold marks>|<lead crosses>;

6) rasterization:

<raster image>::=<color model><lineature><dot shape>;

<color model>::=<CMYK>|<Grayscale>|<Bitmap>|<Duotone>;

<lineature>::=<65lpi>|<100lpi>|<133lpi>|<150lpi>|<200lpi>;

<dot shape>::=<round>|<square>|<elliptical>.

Implementation and development to improve the presented parameterized model will attract specialists in the field of information technology and programming.

5. 2. Classification of factors affecting the quality of the prepress process

To assess and control the quality, it is necessary to determine in-production and non-production factors that must be taken into account. In general, these factors include:

1) engineering (technical) factors that determine the design parameters of the manufactured product:

– state of technical documentation;

2) production (technological) factors that determine:

– level and state of production tooling;

– condition of test equipment and quality of measuring and control equipment;

3) social factors that characterize:

– qualification of employees involved in the production process;

– selection, location, and movement of personnel;

– relationships in the team;

– living conditions;

– organization of rest during non-working hours;

5) organizational factors that characterize:

– state of technological discipline;

– compliance with the principles and methods of scientific organization of work;

– depth of product market research;

– quality management policy;

– organization of information support;

– organization of catering and recreation at the enterprise;

6) economic factors that characterize:

– relationship between product quality, cost, and price;

– forms of remuneration and amount of wages;

– organization and conduct of economic accounting;

– procedure of crediting and financing for quality improvement;

– system of moral and material incentives for making quality products.

Having analyzed the general classification of in-production and non-production factors, it should be noted that to reflect the specifics of the prepress process, it is necessary to clarify the classification. In-production factors include those that are related to the ability of the enterprise to produce products of proper quality, that is, depending on the activities of the enterprise itself. The following groups of factors are distinguished: technical, production, supporting, subjective-personal, and organizational.

Technical factors have the most significant impact on product quality, so the introduction of new technology, the use of new materials, and the accuracy of production planning are the material basis for the production of competitive products. Due to production factors, the company has the opportunity to track the latest technological innovations, applying them in the production cycle to improve quality. Supporting factors are necessary for the order to be executed on time with minimal costs, if all the needed tools are available. It is also necessary to take into account the subjective-personal factors that determine the quality of order execution by production staff. Organizational factors are associated with improving production and labor organization, increasing production discipline, and responsibility for product quality. Such classification of factors for the quality of the prepress process can be presented as follows:

1) technical factors that determine:

– state of technical documentation (technological, post-operational, route maps);

– level of the publication project;

2) production factors that determine:

– level and state of production tooling;

– availability of appropriate equipment for technological operations;

– availability of measuring and control means;

3) supporting factors that determine:

– availability of appropriate software;

– availability of text and illustration materials;

4) subjective and personal factors that determine:

– level of organization of management and planning of the prepress process as a whole, and individual operations;

– qualification level of employees;

5) organizational factors that characterize:

– compliance with the principles and methods of scientific organization of work;

– depth of product market research;

– quality management policy;

– organization of information support.

The given classification of in-production and non-production factors can be incorporated into the knowledge base of the information system being developed, with indicators that characterize them, on the basis of which the quality of prepress stages will be assessed.

5. 3. Development of the method of "anticipatory" quality control

The method of "anticipatory" quality control is based on the idea that systematic errors can be eliminated thereby ensuring high-quality technological operations at the planning stage.

The method of "anticipatory" quality control assumes that random and system errors can occur in the production process. By identifying bottlenecks in each technological operation of the prepress process, it is possible to avoid the occurrence of random and system errors. The method of "anticipatory" quality control provides efficient data processing and is designed for ongoing quality control in the production process.

The method is based on obtaining information by calculation and includes five stages:

1) parameterization of technological operations (an example of using such parameterization is presented in subsection 5.1 of the paper);

2) determining the degree of significance of parameters in terms of prepress control;

3) calculation of the probability of an error in the parameter value, in the context of the technological process;

4) calculation of the error probability for technological processes in general;

5) calculation of expected losses.

The first stage is the parameterization of technological operations. The prepress process consists of several technological operations, which in turn have certain parameters to be controlled.

The presented parameterization will allow you to quickly navigate which technological operation a particular parameter belongs to, as well as what its value may be.

The second stage is to determine the degree of significance of the parameters in terms of prepress control. At this stage, the expert assessment is taken into account, that is, based on the analysis regarding at which stage errors occur more often, the degree of the need to control the parameters of this operation is determined. Such determination of the degree of significance of the parameters of technological operations will make it possible to reduce the time for additional control and immediately pay attention to problem areas.

The third stage is the calculation of the probability of an error in the parameter value in the context of the technological process. That is, based on the possible number of errors in the parameter value of a particular technological operation and the number of operations performed, the probability of an error can be calculated. The formula for calculating the error probability is as follows:

$$P_{Eij} = \frac{m_{Eij}}{n_j}, \quad (1)$$

where P_{Eij} – the probability of an error in the i-th parameter of the j-th technological operation;

m_{Eij} – the number of errors when performing the j-th technological operation in the i-th parameter;

n_j – the number of executions of the j-th technological operation.

The probability of errors in the j-th technological operation is calculated by the formula:

$$P_{Ej} = 1 - \prod_{i=1}^{k}\left(1 - P_{Eij}\right), \quad (2)$$

where P_{Ej} – the probability of an error in the *j*-th technological operation;

P_{Eij} – the probability of an error in the *i*-th parameter of the *j*-th technological operation;

k – the number of parameters.

The probability of error-free execution of a technological operation is calculated by the formula:

$$P_E = 1 - \prod_{j=1}^{l} \left(1 - P_{Ej}\right), \tag{3}$$

where P_E – the probability of error-free execution of the technological operation;

P_{Ej} – the probability of an error in the *j*-th technological operation.

The fourth stage is the calculation of error probability in general for technological processes. The calculation formula is as follows:

$$P_{Ej} = \sum_{j=1}^{M} \left(1 - \prod_{i=1}^{k} \left(1 - P_{Eij}\right)\right). \tag{4}$$

The fifth stage is the calculation of expected losses. The cost of controlling the technological operation and the cost of eliminating (correcting) the error are calculated.

The cost of control is calculated by the formula:

$$Z_c = t_c * C, \tag{5}$$

where t_c – the time of the technological operation;

C – man/hour cost.

The cost of eliminating errors in the *j*-th technological operation:

$$Z = Z_{R_j} * P_{E_j}, \tag{6}$$

where Z_{Rj} – the cost of eliminating the error set by the expert;

P_{Ej} – the probability of an error in the *j*-th technological operation.

5. 4. Implementation of the developed information support methodology for quality assessment of the prepress process

The information support method of the quality assessment of the prepress process taking into account the need for "anticipatory" control is proposed:

– stage 1 – parameterization of prepress operations. The purpose of this parameterization is a formal description of technological operations for further use in the information system;

– stage 2 – determination of in-production and non-production factors that must be taken into account in the quality assessment of the prepress process;

– stage 3 – "anticipatory" quality control of prepress operations based on the corresponding method. The need to use this method is due to the fact that it allows eliminating systematic errors thereby ensuring high-quality technological operations at the planning stage;

– stage 4 – designing a conceptual database model and creating an information system for assessing the quality of the prepress process.

To design the database of the information system, Microsoft Access, the Microsoft Office package, was chosen. The database was designed in several stages:

1) study and analysis of the problem area;

2) database formation;

3) definition of the essence and its attributes;

4) creation of tables.

Below is the list of created tables.

The "Type of product" table, Designer mode, is shown in Fig. 1.

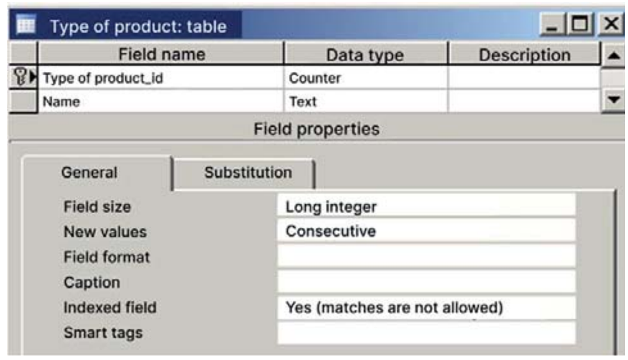


Fig. 1. "Type of product" table, Designer mode (developed in Microsoft Access)

The "Type of product" table is used to store information about the product type, where the "Name" attribute is the name of the product type. The "Type of product" table, Table mode, is shown in Fig. 2.

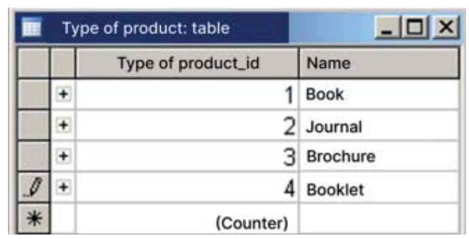


Fig. 2. "Type of product" table, Table mode (developed in Microsoft Access)

The "Order" table, Designer mode, is shown in Fig. 3.

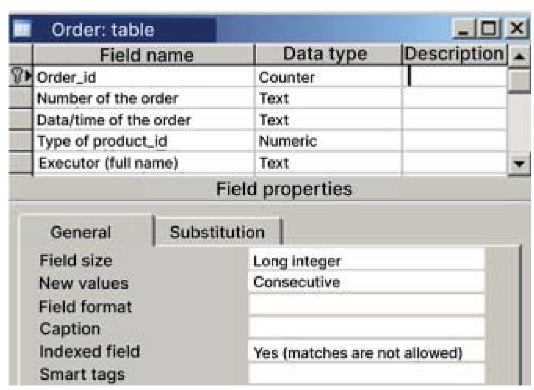


Fig. 3. "Order" table, Designer mode (developed in Microsoft Access)

The "Order" table is used to store information about the order, where the "Number" attribute is the order number, the "Date/Time" attribute is the date and time of the order, the "Executor (full name)" attribute is the last name, first name, and patronymic of the order executor. The "Order" table, Table mode, is shown in Fig. 4.

Order: table

Order_id	Number of the order	Date/time of the order	Type of product_id	Executor (full name)
1			1	
2			1	
3			1	
4			1	

Fig. 4. "Order" table, Table mode (developed in Microsoft Access)

During the pre-diploma practice, various types of errors that occur in the prepress were identified. On the basis of the obtained data on errors, the "Errors" table was created. The "Errors" table, Designer mode, is shown in Fig. 5.

Errors: table

Field name	Data type	Description
Error_id	Counter	
Characteristics of the order_id	Numeric	
Reason	Text	
Cost of elimination (UAH)	Monetary	

Field properties

General | Substitution

Field size	Long integer
New values	Consecutive
Field format	
Caption	
Indexed field	Yes (matches are not allowed)
Smart tags	

Fig. 5. "Errors" table, Designer mode (developed in Microsoft Access)

The "Errors" table is used to store information about errors during the operation, where the "Cause" attribute is the cause of the error, the "Cost of elimination (UAH)" attribute is the cost of eliminating the error. The "Errors" table, Table mode, is shown in Fig. 6.

The "Parameters" table, Designer mode, is shown in Fig. 7.

The "Parameters" table is used to store information about the parameters of the operation, where the "Type of parameter" attribute is the name of the parameter of the technological operation, the "Cost of control (UAH)" attribute is the cost of parameter control. The "Parameters" table, Table mode, is shown in Fig. 8.

The "Technological operation" table, Designer mode, is shown in Fig. 9.

The "Technological operation" table is used to store information about the technological operation, where the "Name" attribute is the name of the technological operation. The "Technological operation" table, Table mode, is shown in Fig. 10.

Errors: table

Error_id	Character. order_id	Character. order_id	Cost of elimination (UAH)
1	1	1.the angle of inclination of the raster grating is greater than required	
2	2	2. RGB color model is set, not CMYK	

Fig. 6. "Errors" table, Table mode (developed in Microsoft Access)

Parameters: table

Field name	Data type	Description
Parameters_id	Counter	
Technological order_id	Numeric	
Type of parameter	Text	
Cost of control (UAH)	Monetary	

Field properties

General | Substitution

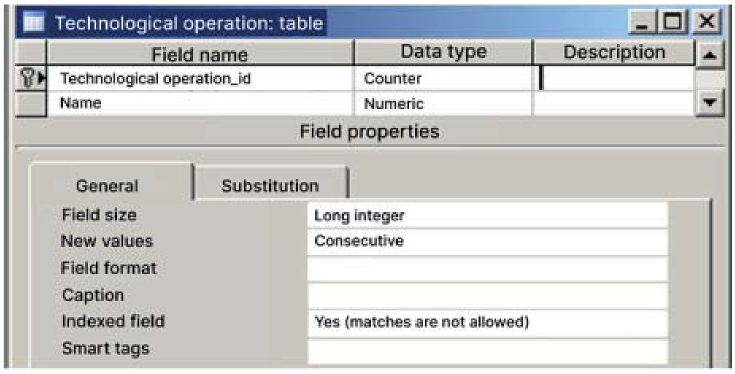
Field size	Long integer
New values	Consecutive
Field format	
Caption	
Indexed field	Yes (matches are not allowed)
Smart tags	

Fig. 7. "Parameters" table, Designer mode (developed in Microsoft Access)

Parameters: table

Field name	Technological operation_id	Type of parameter	Cost of control (UAH)
1	1	1.1.1 % dot gain	
2	2	2.2.1 color model	
3	3	3.3.1 screen width (pt)	
4	4	4.4.1 paragraph parameters	
5	5	5.5.1 type page format	
6	6	6.6.1 service information	
7	7	7.7.1 lineature	

Fig. 8. "Parameters" table, Table mode (developed in Microsoft Access)



Technological operation: table

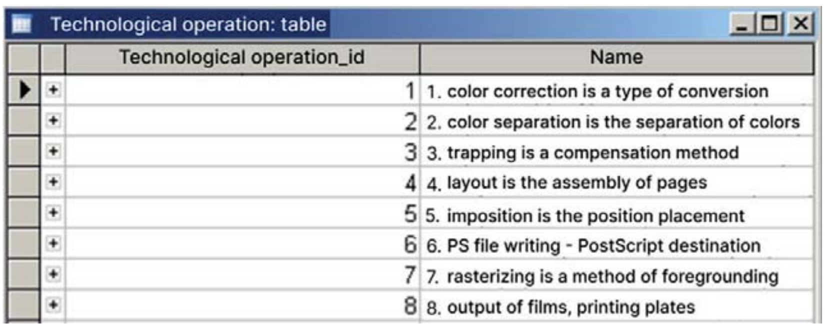
Field name	Data type	Description
Technological operation_id	Counter	
Name	Numeric	

Field properties

General | Substitution

Field size	Long integer
New values	Consecutive
Field format	
Caption	
Indexed field	Yes (matches are not allowed)
Smart tags	

Fig. 9. "Technological operation" table, Designer mode (developed in Microsoft Access)



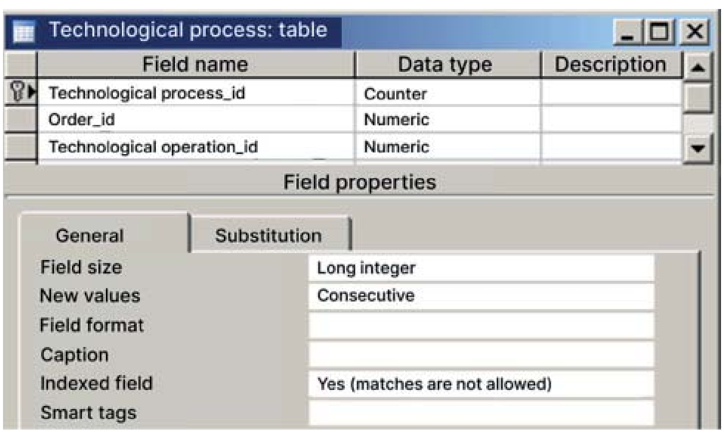
Technological operation: table

Technological operation_id	Name
1	1. color correction is a type of conversion
2	2. color separation is the separation of colors
3	3. trapping is a compensation method
4	4. layout is the assembly of pages
5	5. imposition is the position placement
6	6. PS file writing - PostScript destination
7	7. rasterizing is a method of foregrounding
8	8. output of films, printing plates

Fig. 10. "Technological operation" table, Table mode (developed in Microsoft Access)

The "Technological process" table, Designer mode, is shown in Fig. 11.

The "Technological process" table is intermediate. It connects two tables, "Order" and "Technological operation". The "Technological process" table, Table mode, is shown in Fig. 12.



Technological process: table

Field name	Data type	Description
Technological process_id	Counter	
Order_id	Numeric	
Technological operation_id	Numeric	

Field properties

General | Substitution

Field size	Long integer
New values	Consecutive
Field format	
Caption	
Indexed field	Yes (matches are not allowed)
Smart tags	

Fig. 11. "Technological process" table, Designer mode (developed in Microsoft Access)

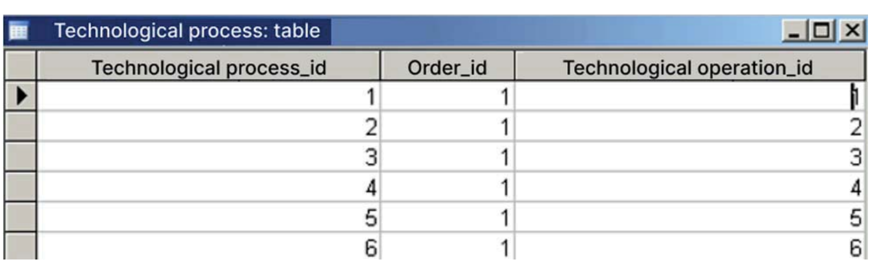
The "Characteristics of the order" table, Designer mode, is shown in Fig. 13.

The "Characteristics of the order" table is used to store information about the characteristics of the order, where the "Value" attribute is the value of the technological operation parameter. The "Characteristics of the order" table, Table mode, is shown in Fig. 14.

Microsoft Access was chosen as the software for interface development and, based on the formulated requirements, the interface of the information system was developed, which contains the following components:

1) "Screensaver" window (Fig. 15);
2) "Enter order data" window (Fig. 16);
3) "Select technological operation" window (Fig. 17);
4) "About the system" window (Fig. 18);
5) "View the result" window (Fig. 19).

The designed information system will allow storing data on errors in the prepress process and on places of error occurrence. Also, the designed information system makes it possible to issue recommendations for eliminating errors and provides maximum control at the planning stage.



Technological process: table

Technological process_id	Order_id	Technological operation_id
1	1	1
2	1	2
3	1	3
4	1	4
5	1	5
6	1	6

Fig. 12. "Technological process" table, Table mode (developed in Microsoft Access)

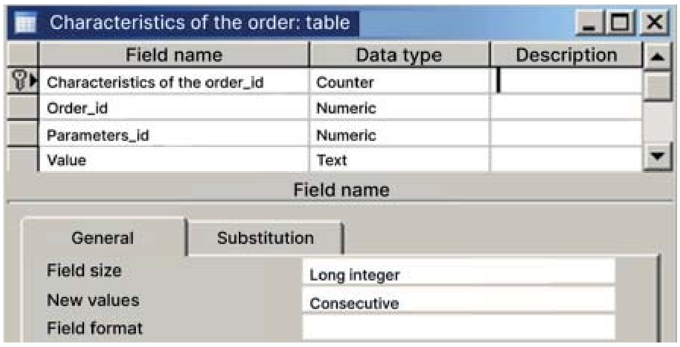


Fig. 13. "Characteristics of the order" table, Designer mode (developed in Microsoft Access)

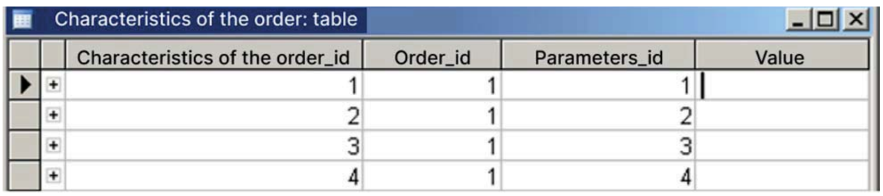


Fig. 14. "Characteristics of the order" table, Table mode (developed in Microsoft Access)

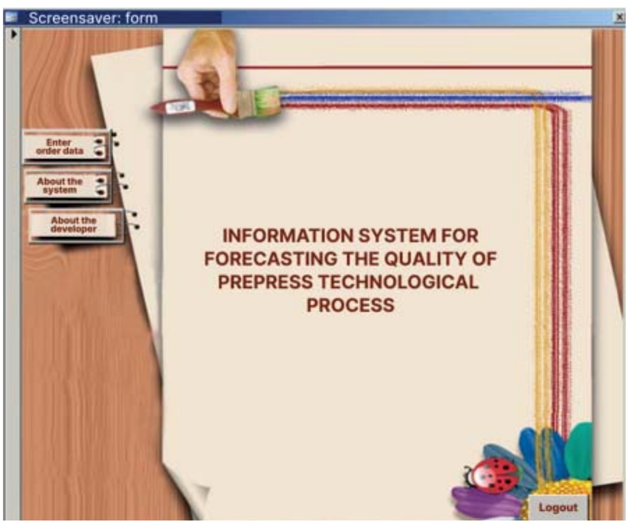


Fig. 15. "Screensaver" window (developed in Microsoft Access)

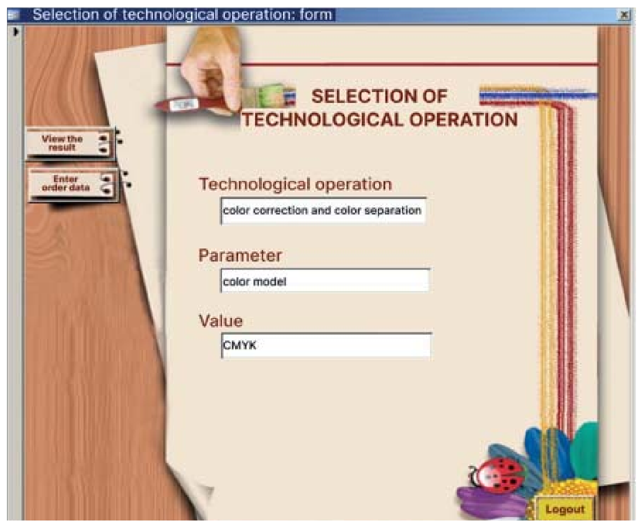


Fig. 17. "Select technological operation" window (developed in Microsoft Access)

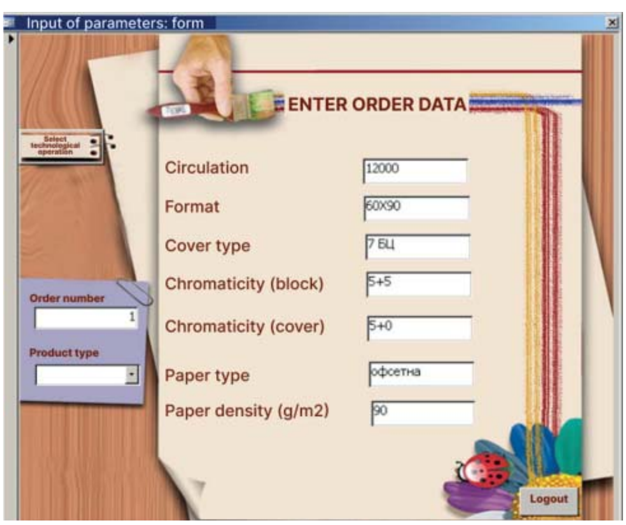


Fig. 16. "Enter order data" window (developed in Microsoft Access)

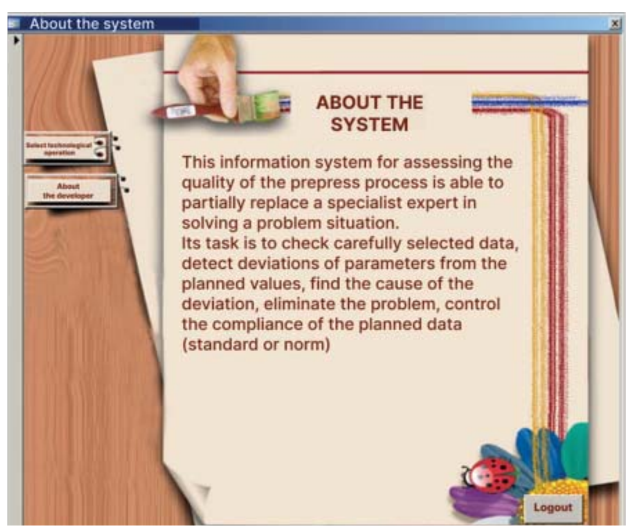


Fig. 18. "About the system" window (developed in Microsoft Access)

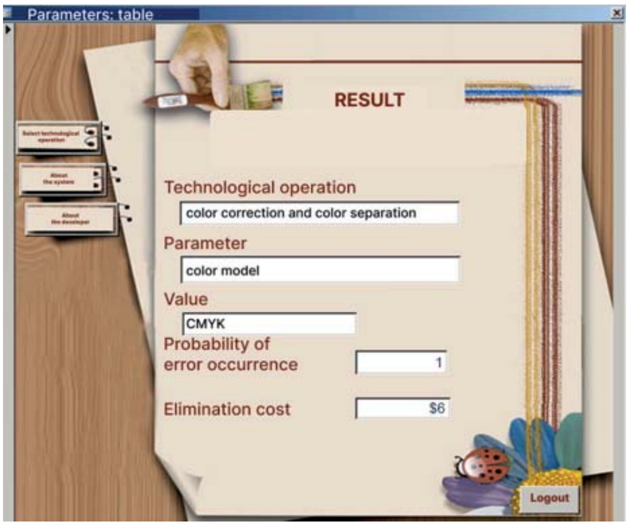


Fig. 19. "View the result" window (developed in Microsoft Access)

6. Discussion of the results of the development of the information support methodology for quality assessment of the prepress process

Within the framework of this study, the information support methodology for assessing the quality of the prepress process was developed. In the process of creating the methodology, the key factors that affect the quality of the prepress process were taken into account, as well as systematic errors in the performance of each technological operation. The proposed methodology is a continuation of the authors' research on the development of the information support method for publishing and printing. Possible areas of the practical application of the proposed methodology are:

– management of prepress processes;

– quality assessment of the prepress process;

– information support of publishing and printing.

The developed methodology closes the problematic part of information support for quality assessment of the prepress process in terms of controlling the occurrence of errors at certain prepress stages. This is achieved due to the method of "anticipatory" quality control developed by the authors and is explained by the corresponding results of the designed information system.

Based on the results of the development, the following conclusions can be made about the possible practical application of the information support methodology for assessing the quality of the prepress process:

1. The method of anticipatory quality control should be used for such stages of the prepress process as color correction, color separation, trapping, layout, imposition, PS file writing, rasterization, output of films, and printing plates. The corresponding calculations should be carried out using formulas (1)–(6).

2. To organize the system of the "anticipatory" quality control method, it is advisable to use the information system. Order data is entered in the form shown in Fig. 16. The designed information system has the following advantages: availability, reduced cost and danger, permanence, the possibility to obtain expert knowledge from many sources, reliability, explanation, quick response, complete and correct answer.

3. The initial loading of information into the database of the designed information system (Fig. 1–3) initiates a fairly narrow range of errors. Basically, these are the problems with the inconsistency of data during loading and native errors of loaders, that is, what was not tracked in the test data. During the period of information accumulation, you may encounter the fact that the database management system (DBMS) will not withstand the flow of information. To reach the system's design capacity, various kinds of errors should be corrected.

The obtained results of the study on developing the information support method for assessing the quality of the prepress process are adequate within the prepress operations of printing enterprises.

The developed information system allows automating the implementation of the proposed "anticipatory" quality control method. Thus, on the example of the technological operation of color correction and color separation by the "CMYK color model" parameter based on the use of the expert knowledge base subsystem, the probability of an error is 1, the cost of eliminating the error is $ 6 (Fig. 19).

The advantages of the proposed information support method for quality assessment of the prepress process are as follows:

– the opinions of leading specialists of printing enterprises regarding the formation of a list of conceptual provisions for assessing the prepress quality are taken into account;

– the idea that systematic errors can be eliminated thereby ensuring high quality of technological operations at the planning stage is laid as a basis for creating the method of "anticipatory" control;

– a parameterized form of description of technological operations, which allows designing various options for automation systems is created.

The disadvantages of the created information support methodology for assessing the quality of the prepress process include the fact that it does not take into account risk and uncertainty that may arise in the decision-making process.

In the process of using the proposed results, the following subjective limitations may be imposed:

– to automate all the parameters of prepress operations described in the created methodology, it is assumed to use specialized software for the content management system;

– the list of factors that affect the quality of the prepress process may vary depending on the specific conditions of each technological operation.

Further areas of research may include:

– evaluation of the efficiency of the prepress process;

– development of a risk management methodology for the prepress process;

– development of a decision support methodology for improving the prepress quality.

In the process of implementing these research areas, the following difficulties may arise:

– when evaluating the effectiveness of the prepress process, it may be difficult to determine a generalized effectiveness indicator and quantify its components;

– in the process of developing a risk management methodology for the prepress process, one may face the problem of selecting acceptable risks;

– in the development of a decision support methodology for improving the prepress quality, it may be difficult to identify factors to overcome uncertainty.

7. Conclusions

1. Conceptual provisions of quality assessment of the prepress process were developed. These conceptual provisions outlined a range of the main directions and parameters in relation to which systemic and random prepress errors should be eliminated. The use of these conceptual provisions in the development of methods and tools for assessing the quality of the prepress process will solve the problem of systemic and random errors at the planning stage. As a result, it is possible to significantly reduce the time of prepress, and, consequently, the entire production process.

2. Classification of factors that affect the quality of the prepress process was carried out. This made it possible to exclude from further consideration the factors that are not important for assessing the prepress quality. The proposed factors form the basis of the knowledge base of the information system for assessing the quality of the prepress process.

3. The method of "anticipatory" quality control was developed. This method makes it possible to identify "bottlenecks" in the performance of each technological operation of the prepress process, as a result of which random and system errors can be avoided. The resulting indicators of the proposed method are the probability of an error, the probability of error-free execution of the technological operation, the cost of controlling the technological operation, and the cost of eliminating the error.

4. The implementation of the developed information support methodology for quality assessment of the prepress process was carried out. The specifics of parameter selection are determined by the relevant data of the database and knowledge base of the designed information system, which are selected by the expert in the process of using it. The practical result of this methodology is the developed information system for assessing the prepress quality. This information system allows automating the method of "anticipatory" quality control proposed in the paper. In the example of the technological operation of color correction and color separation by the "CMYK color model" parameter, the probability of an error is 1, the cost of error correction is $ 6.

Conflict of interest

The authors declare that they have no conflicts of interest in relation to this study, including financial, personal, authorship, or other that could affect the study and its results presented in this paper.

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Data availability

Manuscript has no associated data.

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