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THEORETICAL MODELS OF WORKING PARAMETERS' TECHNOLOGICAL SUPPORT FOR SHEET-FED SYSTEM DETAILS AND MECHANISMS

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В статті розглянуто теоретичні моделі технологічного забезпечення експлуатаційних властивостей деталей аркушепровідних систем офсетних друкарських машин. Моделі базуються та побудовані на основі математичних методів аналізу експлуатаційних властивостей деталей після проведення зміцнення за допомогою оздоблювально-зміцнюючої обробки та з використанням принципів симуляції нейронних мереж. Використання даних методів з поєднанням експериментальних даних дозволяє прогнозувати зміни параметрів якості друку до та після проведення комплексу технологічного забезпечення.

В статье рассмотрены теоретические модели технологического обеспечения эксплуатационных свойств деталей листопроводящих систем офсетных печатных машин. Модели построены и базируются на основании математических методов анализа эксплуатационных свойств деталей после проведения упрочнения с помощью отделочно-упрочняющей обработки и с использованием принципов симуляции нейронных сетей. Использование данных методов в совокупности с использованием экспериментальных данных позволяет прогнозировать смену параметров качества печати до и после проведения комплекса технологического обеспечения.

Introduction

Modern sheet-fed offset printing machines are a complex combination of mechanical, electronic and computer systems linked together. The accuracy and correctness of each of them depends not only the print quality but also the performance of wastage, generation, total working time, economical efficiency etc. The contribution of each system is not equal. There is a list of details and mechanisms which are most critical for final result of printing. When managing and improving the parameters of these parts the general print quality will be higher than in standard machine. According to different researches and scientific works, a sheet transferring system will take a leading place in this list [1, 2].

Another important influence factor is tear and wear of printing machine's parts. They directly affect the presence of defects in the print quality of the registration of colors, increasing of dot gain, changing dot sharpness and shape (especially when working with square dot and frequency-modulated type of screening).

Analysis of presented researches

There are different researches from EU and CIS countries which describe main questions of functioning of sheet-fed system in offset printing presses, and main of them offer results analysis the problems in presented system [3–5]. The main question which was analyzed describes construction of equipment and technical solutions of manufacturers to prevent any problems and improve the flexibility and efficiency of the system.

The mathematical apparatus for measuring an accuracy of register and quality of printing for different types of sheet-fed systems, some recommendations regarding usage of equipment are done in one of the researches [6]. In the same time, the factor of influence of gripper's working area and their construction to quality of transfer of different paper stocks; the influence of surface of transfer cylinders and tear, wear processes of whole system which is certainly changes results of printing.

Another part of researches is offered new methods of mechanical strengthening of details and parts of sheet-fed printing presses, but it is not covered constructional specifics — such as schemes of cylinders building, diameters of cylinders, system of sheet transfer and others [5].

Main tasks

Presented issue offers different theoretical models of working parameters' technological support for sheet-fed system details and mechanisms. Models based on the mathematical method of analysis of working parameters of details after strengthening with vibration roll burnishing and simulation of neuronal network. Usage of such methods in combination with experimental data allows making prognosis regarding a changing of printing quality during a print run before and after the technological support.

The main tasks of the present article are to analyze the influence of different factors from sheet-fed system to quality of printing and to offer a new methods and models to achieve a higher characteristics and productivity.

Results of present research

During the process of printing on modern high-speed sheet-fed printing presses with full color reproduction the average quantity of sheet transfers transactions could reach 24 times and even more, depending from building scheme of printing machine and type of sheet-fed system [3]. In the same time it is possible to

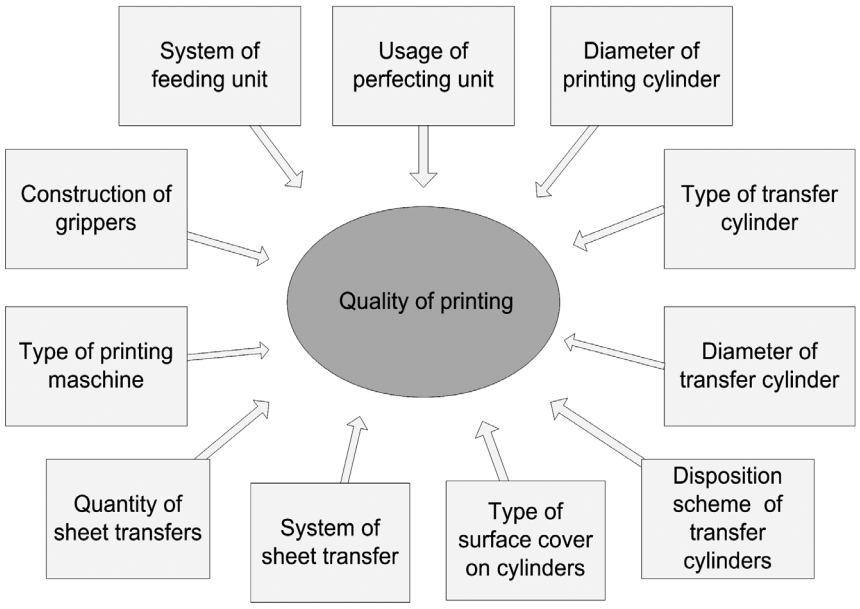
notice that the kinematics of sheet transfer is highly complicated: sheet has dynamical way-typed forces, tear and slipping typically appear, high level of distortion of the paper surface in variant of usage one-width (single-width) diameter cylinders.

The scheme of influence of sheet transfer system's construction specifics to quality of printing is developed during the research (see drawing. 1). The main factors of influence are:

— System of feeding unit;
— Usage of perfecting unit;
— Diameter of printing cylinder;
— Construction of grippers;
— Type of transfer cylinder;
— Diameter of transfer cylinder;
— Disposition scheme of transfer cylinders;
— Type of surface cover on cylinders;
— System of sheet transfer;
— Type of printing machine;
— Quantity of sheet transfers.

All of presented factors are critical, but there are some of them which can directly change basic quality parameters, such as register accuracy. During the research was made there were more than 80 models of printing presses of different formats analyzed. In general conditions it is possible to use such mathematical model to describe the influence of quantity of sheet transfers to register accuracy:

$$\sigma^2_{transf} = \sigma^2_{transf1} \times \sigma^n, \qquad (1)$$



Drawing 1. The diagram of constructional features influence of sheet-fed system for printing quality

where σ^2_{tran} — general dispersion during sheet transfer in printing press, σ^2_{tran} — dispersion for one sheet transfer between two nearest cylinders, n — quantity of sheet transfers.

It is possible to appoint that there is a direct connection between two parameters. Presented method allows with high accuracy make prognosis regarding quality of printing. It is critical to say that the lowest register accuracy typically reached between first and last printing units, highest — between first and second.

It is possible to make the same mathematical method for perfecting printing presses:

$$\delta^2_{av.} = \frac{\sum (\overline{x_i} - \overline{x})^2 \times n_i}{\sum n_i}, \quad (2)$$

where $\delta^2_{av.}$ — average dispersion during printing with perfecting printing units, x_i — average deviation between face and back sheet side, n_i — quantity of transfers during printing.

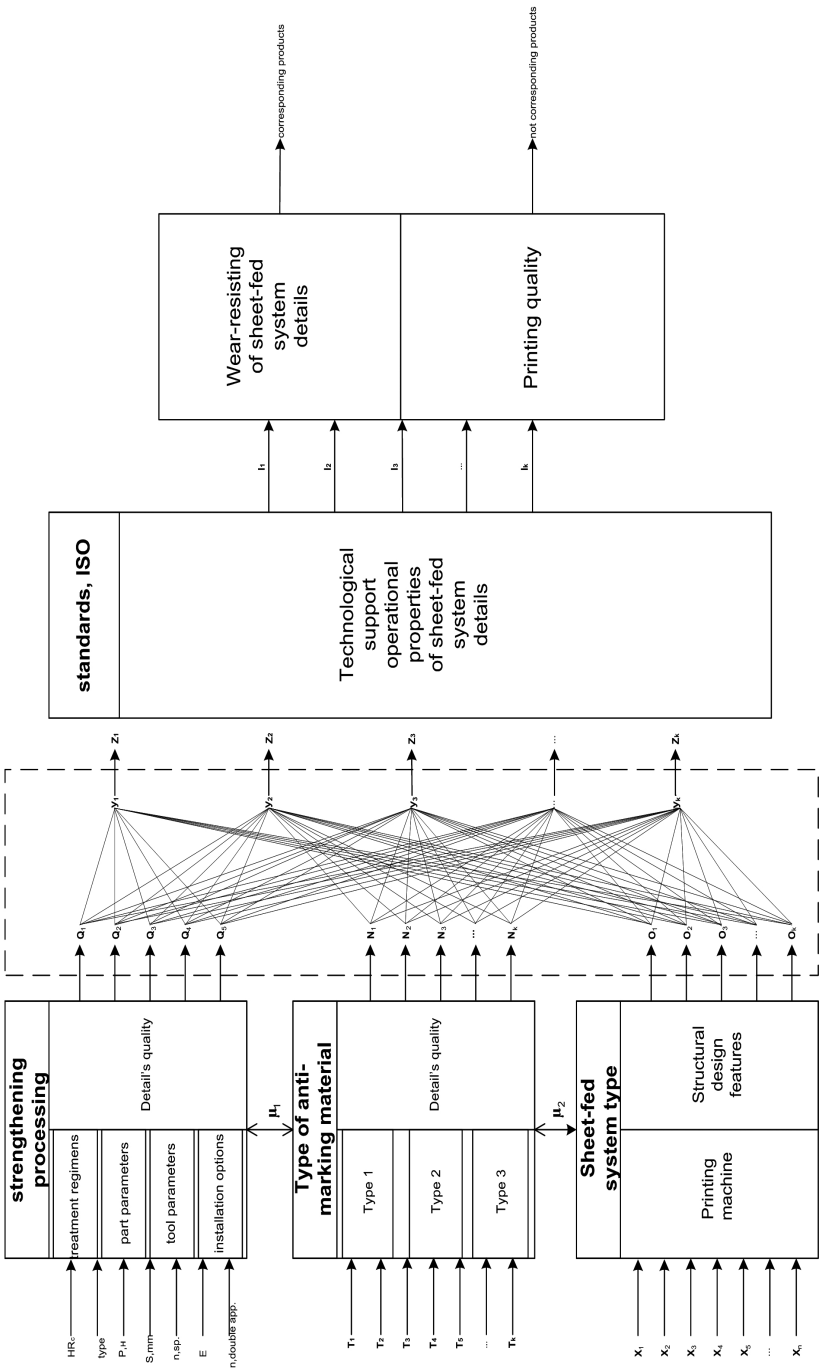
As a result, general accuracy of register can be described in such formula:

$$\sigma^2_{сум} = \overline{\sigma}^2_{пер} + \delta^2_{сум}. \quad (3)$$

Integration into this mathematical apparatus of the factors that caused kinematic features of the leaf passing through sheet-fed system is an important task that will create a comprehensive model of the impact of the type of sheet-fed system on the quality reproduction of printed products. One of the priorities is becoming well construction kinematic schemes for different types of APS with a view to a comprehensive analysis of the problem.

The logical schema (see drawing 2) describes the set of incoming factors that affect the mathematical parameters of the experiment. They, in turn, affect the print quality. Considering that the establishment of the mathematical apparatus in this case effectively applied neural network. Since the neural network is a special case of pattern recognition methods, discriminant analysis, clustering techniques, etc. From a mathematical point of view, the training of neural networks this multiparameter problem of nonlinear optimization. Neural networks are not programmed in the usual sense of the word, they are trained. Learning opportunity — one of the main advantages of neural networks over conventional algorithms. Technical training is to find the coefficients of the connections between neurons. During training, the neural network is able to identify complex relationships between inputs and outputs, as well as perform generalization. This means that in the case of successful learning network will be able to return the correct result based on the data, which were absent in the training set, as well as incomplete and/or partially corrupted data.

Neural network describes the influence of performance of certain nodes and components used in the print quality. After analyzing the incoming factors elements of



Drawing 2. Model of technological support operational properties of sheet-fed systems in offset machines

sheet-fed system applies complex technological support to set preferences that affect the quality parameters in accordance with the regulations. Next, the system checks the parameters of durability and quality, with the aid of which concludes on suitability of products.

Conclusions

In this article provides a deep analysis of the dependence on the print quality of operational properties sheet-fed systems offset printing machines. Just forecasting system developed print quality and to determine the quality of products, according to regulatory documents. The system analysis is based on the work of the self-learning neural network that enables to predict the quality of products before and after the application of a complex technological support.

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