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AUTOMATION OF PREPRESS PROCESSES FOR PRINTING PRODUCTS

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This paper analyzes the current state of prepress automation in the printing industry and the tools available for this purpose. It examines the theoretical foundations for implementing Deterministic AI and automated workflow management systems, using Xerox FreeFlow and AccurioPro Flux case studies. The paper presents the results of developing a set of actions for the Adobe Photoshop graphics editor aimed at batch image processing, control, and automatic reduction of the Total Area Coverage (TAC) without using external profiles. The methodology for creating an integrated web system for booking prepress consultations based on the Wix platform using the low-code automation tools Zapier and GetResponse is described. The effectiveness of combining technological automation of layout preparation with the automation of marketing communications and CRM processes is substantiated. The findings confirm that these solutions significantly reduce manual operations, minimize production errors, and increase the overall productivity of small and medium-sized enterprises (SMEs) in the printing sector.

Keywords: *automation, prepress processes, marketing, Photoshop actions, Total Area Coverage (TAC), Deterministic AI, CRM, Zapier, GetResponse.*

Statement of the problem. In modern printing, prepress preparation remains the most labor-intensive stage, where, according to statistical data, 60% to 80% of production defects originate. The primary issues stem from incorrect file preparation by customers – including low image resolution, the use of composite black, and exceeding Total Area Coverage (TAC) limits – all of which necessitate significant time for manual verification and layout correction. The implementation of automation tools is critical for enhancing the competitiveness of printing houses by reducing lead times and stabilizing product quality. Modern solutions such as AccurioPro Flux Ultimate, Xerox FreeFlow, Enfocus Switch, and Esko Automation Engine demonstrate the potential for comprehensive automation, encompassing order receipt, layout processing, quality control, and print queue management. However, despite significant progress, most enterprises still rely on a combination of manual and partially automated operations due to high implementation costs, integration complexity, and the need for specialized staff training. This gap between available technology and practical application necessitates further research into optimized, accessible automation workflows.

Analysis of recent research and publications. Leading industry players such as Esko [1], Enfocus, Kodak, and Heidelberg [2] are actively addressing the issues of workflow automation. Recent studies emphasize the significance of a systemic approach

to managing print production. Simultaneously, the application of artificial intelligence for defect detection and automated layout correction is being pioneered by Xerox through its Deterministic AI concept [3-4]. Furthermore, the search for accessible low-code solutions to automate customer interactions and baseline prepress processing for SMEs (small and medium-sized enterprises) remains a highly relevant area of inquiry.

The Purpose of the article. The aim of this study is to analyze, develop, and implement automation tools designed to optimize prepress preparation processes and enhance the efficiency of customer interactions within the printing services sector.

Main research material. In the field of printing automation, three primary areas are distinguished: integrated automated workflows, Adobe-based automation tools, and specialized preflight systems.

Automated workflow systems, such as Enfocus Switch, Esko Automation Engine, Kodak Prinergy, and Heidelberg Prinect, are designed to create fully autonomous production environments. These platforms automate between 50% and 90% of routine operations, ranging from automated file sorting and color profile verification to seamless integration with CRM/ERP systems.

Adobe applications (Photoshop, Illustrator, InDesign) offer robust built-in automation capabilities, including Actions, JavaScript-based scripts (ExtendScript), automated panels, and batch processing via presets. Furthermore, specialized preflight systems, such as Enfocus PitStop Pro, Callas pdfToolbox, and FlightCheck, provide comprehensive verification and correction of PDF files. These tools ensure strict compliance with international printing standards and minimize prepress errors before the job reaches the printing stage [5-6].

The current stage of development in the printing industry is characterized by the rapid adoption of automated and intelligent technologies, which are significantly transforming traditional approaches to production organization. An analysis of the state of automation in printing confirms the relevance of this trend and aligns with the research findings conducted by Xerox [4].

The challenges facing the modern printing industry include an increasing volume of short-run jobs, reduced turnaround times, excessive manual labor, and a significant skilled labor shortage. According to Xerox surveys, a substantial number of printing houses still rely on manual prepress workflows. This reliance inevitably leads to common production errors, such as:

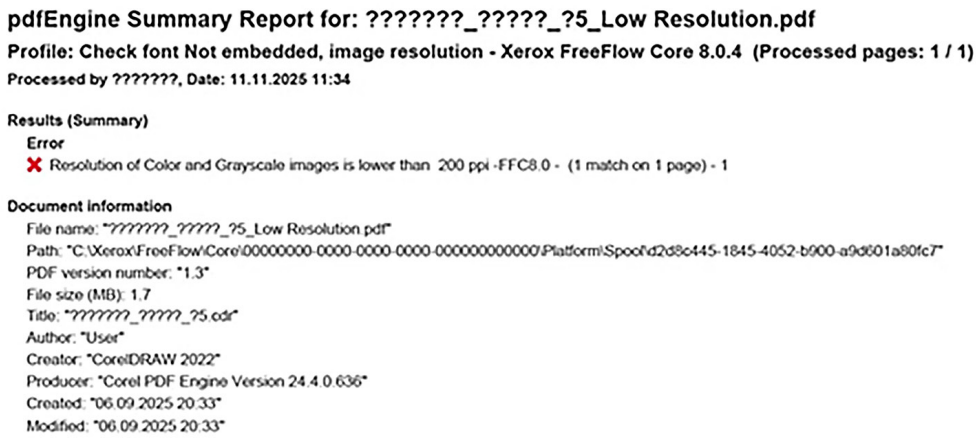
- Inappropriately large file sizes;
- Files provided in RGB color space without required bleed;
- Manual merging of similar tasks and imposition errors;
- Issues with page and section numbering;
- Manual nesting (layout) of small-format jobs on the press sheet;
- Order rejection due to staff overcapacity.

The effectiveness of automation is ultimately determined by the capacity to maintain production volumes while significantly reducing labor intensity and operational costs.

The integration of artificial intelligence into printing systems minimizes the need for operator intervention: it is sufficient to place the prepared file into a designated hot folder, and the system independently generates the imposition layout, adds trim marks,

and sends the job to the press. In the event of technical discrepancies – for instance, if the incorrect paper type is loaded – the built-in preflight module automatically halts the process and triggers an error notification, thereby preventing waste and reducing material costs.

A typical example occurs when files are created using simplified online design tools, such as Canva. In these cases, black text or elements are often rendered as composite black (rich black, consisting of all CMYK components), which can lead to registration issues or insufficient saturation on the final print. Intelligent preflight systems detect such issues, as well as low image resolution (e.g., 200 ppi, see Fig. 1), and highlight the problematic areas for correction before the printing stage, as illustrated in Fig. 2.


pdfEngine Summary Report for: ???????_?????_?5_Low Resolution.pdf

Profile: Check font Not embedded, image resolution - Xerox FreeFlow Core 8.0.4 (Processed pages: 1 / 1)

Processed by ???????, Date: 11.11.2025 11:34

Results (Summary)

Error

✖ Resolution of Color and Grayscale images is lower than 200 ppi -FFC8.0 - (1 match on 1 page) - 1

Document information

File name: "???????_?????_?5_Low Resolution.pdf"
Path: "C:\Xerox\FreeFlow\Core\00000000-0000-0000-0000-000000000000\Platform\Spool\d2d8c445-1845-4052-b900-a9d601a80fc7"
PDF version number: "1.3"
File size (MB): 1.7
Title: "???????_?????_?5.cdr"
Author: "User"
Creator: "CorelDRAW 2022"
Producer: "Corel PDF Engine Version 24.4.0.636"
Created: "06.09.2025 20:33"
Modified: "06.09.2025 20:33"

Fig. 1. Preflight report indicating the nature of the error: low image resolution [4]

When modernizing production, companies face a critical dilemma: whether to invest solely in hardware or to opt for solutions featuring integrated automation. Partial automation, which involves the use of isolated software products, typically yields a modest efficiency increase of approximately 6%. In contrast, integrated automation provides comprehensive control over the entire technological workflow and is capable of increasing operational efficiency by an average of 43% [4].

Xerox offers printing enterprises a specialized technical and process AI audit designed to identify «bottlenecks» and high-frequency repetitive operations within the production cycle. Based on the findings of this audit, automated scenarios are developed to optimize routine tasks, thereby enhancing the stability and throughput of the print shop. Once developed, these scenarios undergo rigorous testing, refinement, and integration into the production environment, followed by continuous technical support and staff training.

According to Xerox, a wide range of tasks can be automated using AI, including file conversion, prepress preparation, imposition, optimization, page resizing, numbering, verification, job assembly, scheduling, image quality enhancement, color management, watermark and barcode generation, job distribution, print load balancing, document merging, as well as page insertion and deletion.

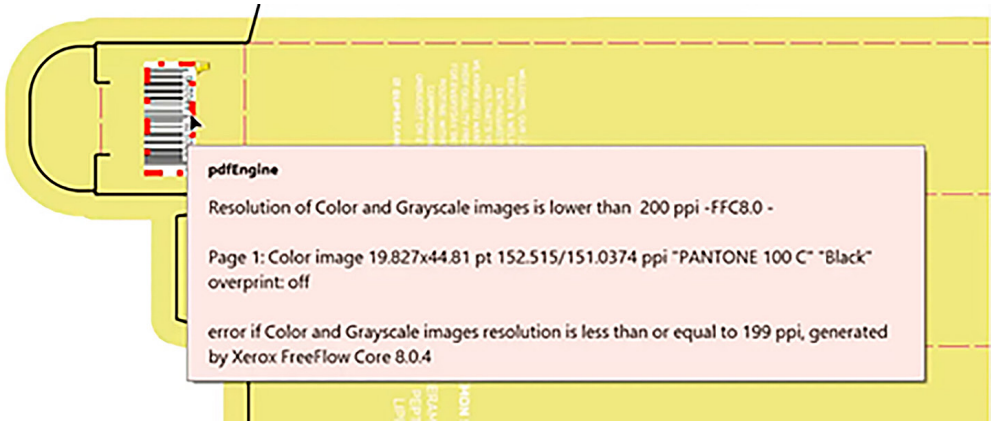


Fig. 2. Visual identification of a problematic element within the layout [4]

Deterministic AI (deterministic artificial intelligence) refers to a class of algorithms where the execution outcome is strictly defined by a predefined set of rules, and the sequence of actions is entirely predictable. Unlike stochastic or neural network models, which may produce varying results under identical conditions, deterministic AI consistently returns the same output for a given set of input data. This makes the deterministic model ideal for the printing industry, where precision, compliance with international standards, consistency, and the total absence of errors are paramount.

The diagram in Fig. 3 illustrates an automated workflow for print job processing. The cycle commences with the Basic Preflight stage, where initial file verification is conducted, focusing on format compatibility, image resolution, font embedding, and color profile integrity. This is followed by the Book Covers and Blocks stage, where the system automatically generates book blocks, covers, and signatures, ensuring the document is correctly structured for subsequent production.

During the Number Pages stage, AI-driven tools perform automated pagination while preserving the logical sequence. The workflow then proceeds to the Duplicate Job phase, enabling parallel production to accelerate the process and balance the workload across multiple print engines. Subsequent finishing operations–including CS Gathered Signatures, Flip Left, Inline Plow Fold, and Accordion Fold – define the signature gathering and folding methodologies, dynamically selected based on the specific parameters of the document. The final stages comprise Print, where individual sections are outputted, and CF Cut Mark, which applies registration marks for high-precision trimming. The defining advantage of this architecture is its capacity for multi-stream parallel processing, which significantly reduces total turnaround time.

Automation within graphic editors represents the foundational level of optimization. This study introduces a proprietary set of Adobe Photoshop Actions designed to automate the generation of layouts with proper bleeds and the rigorous control of technical parameters.

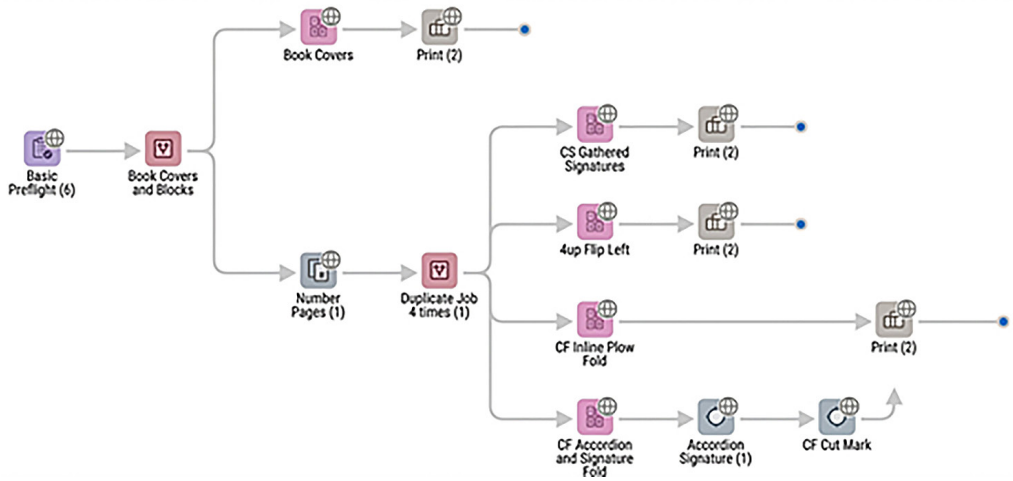


Fig. 3. Xerox workflow architecture for prepress process automation [4]

A pivotal contribution of this research is the development of a methodology for controlling Total Area Coverage (TAC). To achieve this, a «detector action» was implemented to visually isolate areas exceeding established industry standards (e.g., 300% for ISO Coated v2 or 240% for uncoated offset paper). For TAC correction, an algorithm was developed utilizing Smart Objects and Layer Styles (Blending Options). This approach allows for a selective reduction of ink limits in deep shadows while preserving critical detail in highlights and mid-tones, all without necessitating a global color space conversion. This technique significantly minimizes the degradation of visual integrity compared to conventional ICC-based reprofiling.

The methodology is centered on the strategic application of Curves adjustment layers. For a 300% limit, the threshold is calculated by dividing the total limit by the four CMYK channels (300 / 4 = 75%). Areas appearing on the «white canvas» indicator signify compliance with the 300% limit. For substrates with lower ink requirements, such as newsprint or offset paper, a 240% limit is applied, resulting in a 60% threshold (240 / 4 = 60%). By setting the threshold to 60%, the action reveals specific regions that exceed the TAC limit. This diagnostic method provides a rapid and precise visual assessment of ink-heavy areas requiring correction.

To implement this, a Channel Mixer adjustment layer was created with the total value of C+M+Y+K set to 100%. Typically, a CMYK image has a theoretical maximum of 400% (100% per channel); however, by assigning 25% to each channel, we generated a reference image with a normalized 100% ink limit. Using the Info Palette, we verified the reduction: for instance, a point with an original TAC of 287% was scaled down to 72% in the reference layer. To perform a targeted check for a 240% TAC limit, an Input value of 60 was set on the Curves adjustment layer (240 / 4 = 60). Consequently, only the areas exceeding the 240% threshold remain visible (Fig. 4b).

To enhance the visual detection of these over-limit areas, an additional Curves layer was applied to maximize shadow contrast (Fig. 4c). The developed Action automatically

visualizes these problematic regions and subsequently reduces the total ink volume to the specified level without relying on external ICC profiles. The core of this methodology lies in selective color component compensation, which does not interfere with the Luminosity channel. Specifically, the midtones and highlights are preserved from the original source, while only the deep shadows are sampled from a Smart Object layer re-separated under a lower ink limit profile. This is achieved through the Layer Style (Blend If) functionality, ensuring that the image's fine detail and visual integrity remain intact. Residual deviations within 2-3% are considered technologically acceptable and do not degrade print quality.

а)

б)

в)

Fig. 4. Application example of the developed TAC control methodology: a) original [7], b) areas exceeding 240% TAC, c) enhanced visualization of over-limit areas for further processing

The methodology focused on retaining only the color information by utilizing a Clipping Mask in Color blending mode, thereby preserving the original luminosity (brightness) component. Since ink limit exceedances are inherently localized in the shadows rather than midtones or highlights, we selectively reduced the black ink density in these regions without affecting the color channels or lighter tonal ranges.

To achieve this, we masked the highlights and midtones using the Blend If (Current Layer) settings within the Layer Style dialog. By setting the shadow-to-midtone slider to 50 and splitting it with an offset of +40, we ensured a smooth tonal transition. This splitting technique is crucial for preventing banding (posterization) artifacts, which are frequently encountered in CMYK color spaces during aggressive tonal adjustments.

The second stage of the project involved the development of the Prepress Consultation Hub, an automated ecosystem illustrated in Fig. 5. A landing page was built on the Wix platform to capture consultation requests. To eliminate manual lead processing, we implemented a multi-stage automation workflow via Zapier [8]. The scenario is triggered by a form submission: data is instantly routed to GetResponse [9], which dispatches an

automated double opt-in email. Upon selecting «Confirm Booking,» the user is redirected to a personalized thank-you page and receives a calendar confirmation. Once confirmed, the contact data is automatically synchronized with Google Sheets, which functions as a streamlined CRM system for real-time lead management.

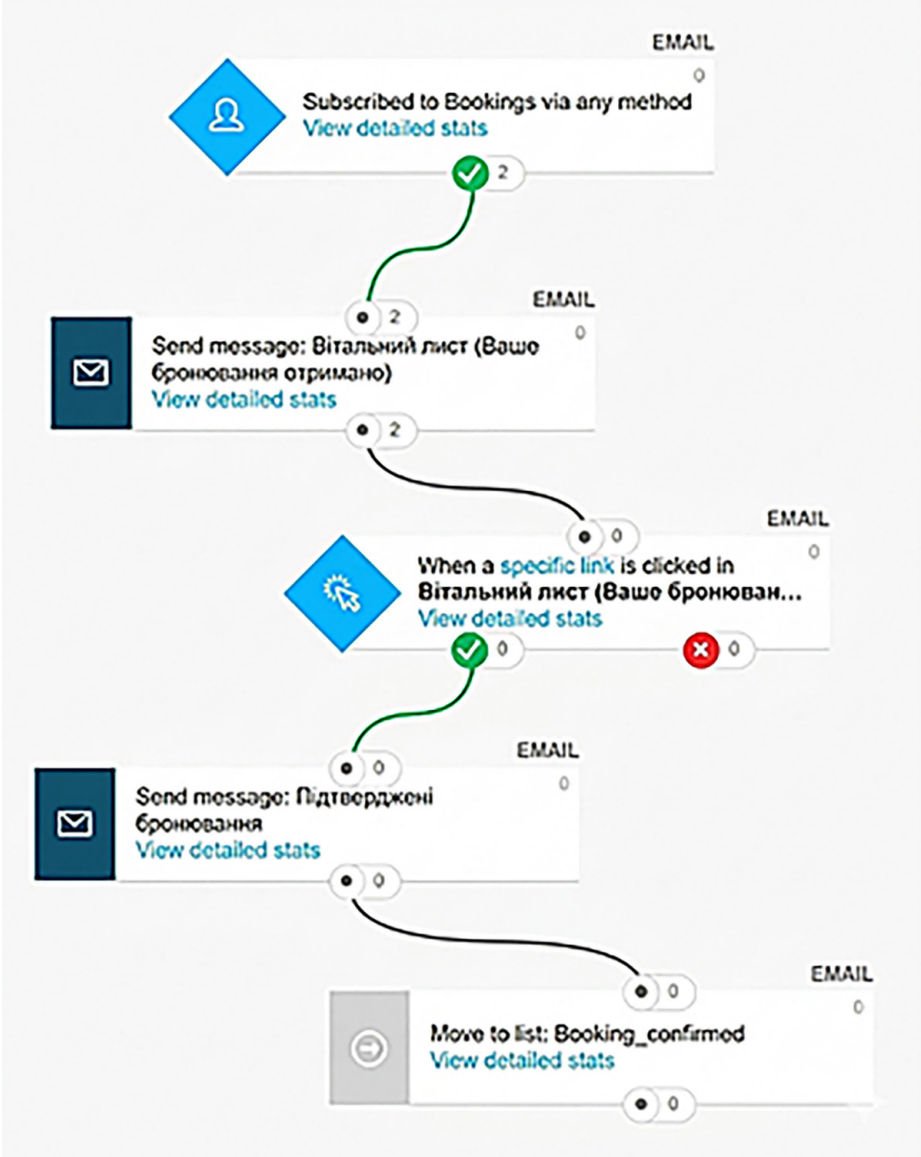


Fig. 5. Developed workflow architecture for customer interaction automation

System testing confirmed the seamless transfer of data and the real-time generation of a customer database without manual intervention. The automation successfully eliminated redundant communication steps, ensuring high data integrity.

Conclusions. The implementation of deterministic algorithms and specialized automation tools significantly optimizes the prepress workflow. The developed suite of Adobe Photoshop Actions provides a rapid and precise solution for correcting common technical errors, specifically the regulation of Total Area Coverage (TAC/TIL) limits. Simultaneously, the integration of Wix, Zapier, and GetResponse creates a robust, end-to-end cycle for managing client requests. These proposed solutions are highly scalable and can be readily adopted by printing enterprises to enhance operational responsiveness, minimize human error, and mitigate production risks.

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АВТОМАТИЗАЦІЯ ПРОЦЕСІВ ПІДГОТОВКИ ПОЛІГРАФІЧНОЇ ПРОДУКЦІЇ ДО ДРУКУ

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У статті проаналізовано сучасний стан та інструменти автоматизації додрукарських процесів у поліграфії, що є критичноважливим у контексті зростання вимог до швидкості та якості виготовлення друкованої продукції. Розглянуто теоретичні засади впровадження детермінованого штучного інтелекту (Deterministic AI) як надійної альтернативи стохастичним моделям, що забезпечує стабільність результатів та чітку відповідність технологічним стандартам. Проведено аналіз автоматизованих систем управління робочим потоком (workflow management systems) наприкладі промислових рішень Xerox Free Flowта Accurio Pro Flux, які дозволяють мінімізувати вплив людського фактора на етапі підготовки макетів. У роботі представлено результати розроблення авторського комплексу екшинів для графічного редактора Adobe Photoshop, спрямованих на пакетну обробку зображень, технічний контроль та автоматичнее зниження суммарного ліміту фарби (TAC) без використання зовнішніх ICC- або Device Link-профілів. Запропонована методика базується на використанні коректувальних шарів, смарт-об'єктів та налаштувань діалогового вікна Layer Style (Blend If), що дозволяє проводити селективну корекцію ділянок із перевищенням фарбового ліміту. Такий підхід забезпечує збереження деталізації в глибоких тінях та візуальної цілісності зображення, незачіпаючи нейтральні півтони та світлі

ділянки макета, що є суттєвою перевагою над стандартними методами перепрофілювання.

Описано методику створення інтегрованої вебсистеми для бронювання додрукарських консультацій на базі платформі Wixi з використанням low-code інструментів автоматизації Zapier та GetResponse. Детально розкрито архітектуру взаємодії цих сервісів: від моменту заповнення форми клієнтом на сайті до автоматичного надсилання тригерних листів-підтверджень та миттєвої синхронізації даних у Google Sheets, що виконує роль базової CRM-системи. Це дозволяє організувати ефективне управління вхідними запитами (lead management) без залучення адміністративного персоналу.

Обґрунтовано ефективність поєднання технологічної автоматизації підготовки макетів (Preflight) із автоматизацією маркетингових комунікацій та CRM-процесів. Отримані результати підтверджують можливість значного скорочення частки ручних операцій, мінімізації виробничих помилок та підвищення загальної продуктивності малих та середніх поліграфічних підприємств. Впровадження запропонованих рішень сприяє стабілізації технологічного процессу та зниженню собівартості продукції за рахунок зменшення відсотка браку та оптимізації робочого часу фахівців.

Ключові слова: *автоматизація, додрукарськіпроцеси, маркетинг, екшини Photoshop, сумарне покриття фарби (TAC), Deterministic AI, CRM, Zapier, GetResponse.*

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