University of Pardubice

Faculty of Chemical Technology

Current possibilities and use of prepress automation

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ZADÁNÍ DIPLOMOVÉ PRÁCE
(projektu, uměleckého díla, uměleckého výkonu)

Jméno a příjmení:	**Bc. Petr Roudný**
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Téma práce:	**Současné možnosti a využití automatizace předtiskové přípravy**
Zadávající katedra:	**Katedra polygrafie a fotofyziky**

Zásady pro vypracování

1. Zpracujte přehled dostupných produktů pro automatizaci předtiskové přípravy a shrnutí dosavadních poznatků o možnostech a přínosech jejich využití na základě odborné literatury.
2. Proveďte průzkum stávajícího využití automatizace předtiskové přípravy v ČR.
3. Porovnejte rychlost a kvalitu operací v předtiskové přípravě při využití různých stupňů a typů automatizace.
4. Na základě získaných dat a zkušeností jednotlivá řešení analyzujte a vyhodnoťte.

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Rozsah grafických prací:
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Seznam doporučené literatury:

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Petr Roudný

Diplomová práce vznikla za podpory projektu Modernizace praktické výuky a zkvalitnění praktických dovedností v technicky zaměřených studijních programech, reg. číslo CZ.02.2.67/0.0/0.0/16_016/0002458 operačního programu Výzkum, vývoj a vzdělávání. Tento projekt je spolufinancován Evropskou unií.

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Annotation

The diploma thesis is focused on the prepress and possibilities of its automation. The thesis describes the technological concepts and individual phases that can be encountered in prepress, which is followed by a detailed overview of available software products for its automation.

The thesis also includes a survey of problematic areas, the use of software tools and the current use of prepress automation in the Czech Republic. The survey is followed by a comparison of different levels and types of automation in selected software solutions for selected problems in prepress. Based on this, analysis and evaluation are made of what are the positives and negatives, as well as overall benefits of software used.

Keywords: prepress, automation, metadata, hot folder, action, PDF, software

Anotace

Diplomová práce je zaměřena na předtiskovou přípravu a na možnosti její automatizace. V práci jsou popsány technologické pojmy a jednotlivé fáze, se kterými se lze setkat v předtiskové přípravě, na což navazuje podrobný přehled dostupných softwarových produktů pro její automatizaci.

Součástí diplomové práce je také průzkum týkající se problematických částí, softwarového vybavení a stávajícího využití automatizace předtiskové přípravy v České republice. Na průzkum navazuje porovnání různých stupňů a typů automatizace ve vybraných softwarových řešeních u vybraných problémů v předtiskové přípravě. Na základě toho je provedena analýza a vyhodnocení, jaká jsou u použitých softwarů pozitiva a negativa i jejich celkový přínos.

Klíčová slova: předtisková příprava, automatizace, metadata, sledovaná složka, akce, PDF, software

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List of abbreviations

AG – German term for a public limited company
API – Application Programming Interface
APPE – Adobe PDF Print Engine
ASP – Active Server Pages
BPC – Black Point Compensation
CAD – computer-aided design
CAD – Canadian Dollar
Cal – Calibrated
CID – Character Identifier
CIE – Commission Internationale de l'Eclairage
CLI – command-line interface
CMYK – Cyan, Magenta, Yellow, Key or blacK
CPSI – Configurable PostScript Interpreter
CSV – Comma Separated Values
CTP – computer-to-plate
CZK – Czech Republic Koruna
DTP – Desktop Publishing
ECI – Color Initiative group
EPS – Encapsulated PostScript
ERP – Enterprise Resource Planning
EUR – Euro
EXIF – Exchangeable Image File
FIFO – First In, First Out or Fly-In Fly-Out
FTP – File Transfer Protocol
GATF – The Graphics Arts Technical Foundation
GmbH – German term for "company with limited liability."
GBP – United Kingdom Pound Sterling
GCR – Gray Component Replacement
GWG – Ghent Workgroup
HKS – Hostmann-Steinberg Druckfarben, Kast + Ehinger Druckfarben, and H. Schmincke & Co.
HTML – Hypertext Markup Language
HTTP – Hypertext Transfer Protocol
HTTPS – HyperText Transfer Protocol Secure
ICC – International Color Consortium
IPTC – International Press Telecommunications Council
ISO – International Organization for Standardization
JDF – Job Definition Format
JMF – Job Messaging Format
JPEG – Joint Photographic Experts Group
LAN – Local Area Network
MAM – Media Asset Management
MAXML – Multi-Channel Access eXtensible Markup Language
MHz – Megahertz
MIME – Multipurpose Internet Mail Extensions
MIS – Management Information System
OCGs – Optional Content Groups
PCS – Profile Connection Space

PDF – Portable Document Format
PHP – Hypertext Preprocessor
PJTF – Portable Job Ticket Format
PNG – Portable Network Graphics
PPF – Print Production Format
PPI – Pixel Per Inch
PPML – Personalized Print Markup Language
PRO – Professional
QA – Quality assurance
RAM – random-access memory
RIP – Raster Image Processor
RGB – Red, Green, Blue
SaaS – Software as a Service
SDK – Software Development Kit
SQL – Structured Query Language
SRA – Supplementary Raw Format A
SSL – Secure Sockets Layer
SWOP – Specifications for Web Offset Publications
TAC – Total Area Coverage
TDA – Total Dot Area
TIFF – Tagged Image File Format
TLS – Transport Layer Security
TVS – ToneValue Sum
TXT – Text
UCR – Under Color Removal
USD – United States Dollar
VCR – Variable Content Replacement
VIPP – Variable-Data Intelligent PostScript Printware
VPS – Variable Print Specification
VT – variable data and transactional printing
VDP – Variable Data Printing
W2P – web-to-print
XJDF – Exchange Job Definition Format
XML – eXtensible Markup Language
XMP – Extensible Metadata Platform
XSLT – Extensible Stylesheet Language Transformations

Introduction

This diploma thesis is focused on prepress and possibilities of its automation using various software solutions available. These include software applications as well as workflow systems, which can mutually communicate.

Due to the rapid digitalization in this field, it is advisable to track the software and automation options in prepress if a company wants to compete with others on the market. Since the related investment is not insignificant in most cases, it is advisable to consider which steps of prepress need to be covered in a given workflow first and how it is possible to automate the selected steps. Individual applications and modules of workflow systems can be combined in various ways so that a company can cover the necessary part of its workflow. It is also important to stress that automation does not mean only buying software that can process metadata, hot folders, or actions. Effective automation involves mapping all the pitfalls in prepress and then deploying the appropriate tools to cover a particular part of the workflow. Then, it can help companies eliminate problems in prepress, increase the speed and quality of job processing, and increase the processing volume.

The thesis provides the necessary background and explains the technical terms related to prepress and its automation. The individual phases that can be encountered in prepress and the possibility of their automation are also discussed. These include preflight by a customer or graphic designer, color management, data transfer, preflight and normalization by a company, imposition, raster image processing, planning, scheduling, and subsequent monitoring in production.

The experimental part includes a survey concerns problematic areas and the use of software tools and automation in prepress among printing plants in the Czech Republic. Missing data for processing steps (varnishing, cutting, embossing, etc.), problems with bleed and problems with printer marks (crop marks, registration marks, color bars, etc.), are chosen as model situations that are solved in different levels and types of automation. In particular, example solutions in Adobe Acrobat, pdfToolbox, Enfocus PitStop, Xerox FreeFlow Core, and Esko Automation Engine are demonstrated. The content of the thesis as a whole should help companies to gain insight and make their decisions, whether and under which conditions it is worth investing in prepress automation.

1 Digital prepress

Modern technologies have completely changed the way how jobs are prepared and processed in prepress. This Chapter brings an overview of the main concepts relevant to digital prepress.

1.1 Graphic content creation

The graphic content is usually a combination of raster, vector and text elements, with the last defined using fonts. The fundamental description of image and text processing is explained in [1]. A raster image is made up of pixels located in a regular rectangular matrix, and each pixel is assigned specific parameters. The quality of a raster file is affected by its resolution. A vector image is made up of a certain quantity of objects whose shape and location are described by mathematical expression or equations for geometric objects. Vector images can be usually transformed without a negative impact on their quality. In terms of fonts, vector font formats are usually used in prepress, the most common are Type 1[1], TrueType[2], and OpenType[3] fonts. For fonts with more characters, CID[4] (Character Identifier) codes are used to assign a specific number to a character (using a character map), which are called CID fonts. Character identifier fonts can be derived from Type 1 and TrueType fonts. OpenType itself uses 16-bit[5] encoding and allows to embed only a subset of a font with used characters in a file.

1.2 Color reproduction

1.2.1 Bit and color depth

Bit depth defines the number of distinguishable luminance levels per color channel [1]. The line copy is processed at a single bit depth [2]. The sum of the bit depths of all the color channels is called color depth [1]. Higher bit depth indicates more values over the tone range [2]. Increased bit depth also enables a more precise conversion between RGB (Red, Green, Blue) and CMYK (Cyan, Magenta, Yellow, Key or blacK) color spaces (or between any color profiles in general) and more accurate color corrections [2]. On the other hand, the higher the color depth is, the more storage space the image needs, and it reduces processing speed [1]. For this

[1]The worldwide standard for digital type fonts, developed by Adobe Systems for use in PostScript printers [3].

[2]Standard for digital type fonts, developed by Apple Computer and licensed to Microsoft Corporation [3].

[3]The newest standard for digital type fonts, developed by Adobe and Microsoft [3]. It has some advantages over previous font formats, such as small caps, ligatures, using the Unicode standard, and the font is only a single file [3].

[4]Codes used for fonts with a higher number of characters (typically used for Chinese, Japanese, or Korean languages) [4].

[5]The smallest basic unit of measurement used to measure computer data in the digital environment. One bit contains a single value either 0 or 1 [5].

reason, it is advisable to reduce the bit depth just before output on the output device (typically to 8 bits per channel) [2]. Common masters are processed at an 8-bit depth [2], e.g. JPEG[1] (Joint Photographic Experts Group) is an 8-bit format [6]. Common bit depths are also 10, 12, 14, and 16 bits per channel [2], e.g. TIFF[2] (Tagged Image File Format) can carry 16-bit information [6].

1.2.2 Print color separations

When color images are reproduced, the artwork is usually separated into four CMYK separations (or optionally into spot colors or other colors), one separation for each color [1]. When the separations are subsequently printed with the given inks and with accurate registration, the colors are combined to create a copy of the original artwork [7]. The color registration means the accurate positioning of the printing elements (most often with four CMYK process inks) during multiple passes of printed material through a printing machine [1]. In conventional printing, color separations are used to produce printing forms in the last step before printing [1]. Nowadays, it is common to perform separations in the raster image processor [7], where mathematical algorithms are used for separations producing [1].

1.2.3 Black generation

Automatic color conversion using UCR (Under Color Removal) replaces chromatic CMY colors in neutral dark tones constituted by overprint with a corresponding proportion of black, while for GCR (Gray Component Replacement), the replacement concerns entire image, not just dark tones [1]. Both methods are illustrated in Fig. 1. Optimized black generation helps printing companies to save costs, while preserving the same visual output [8]. To create a profile for CMYK to CMYK conversion that can use UCR or GCR, it is required to use the DeviceLink profile [9], which is a special kind of ICC profile that converts a color space of an input device directly into a color space of an output device [10]. Unlike ordinary source or destination ICC profiles, DeviceLink profiles only define the conversion from a source color space to a destination color space [10].

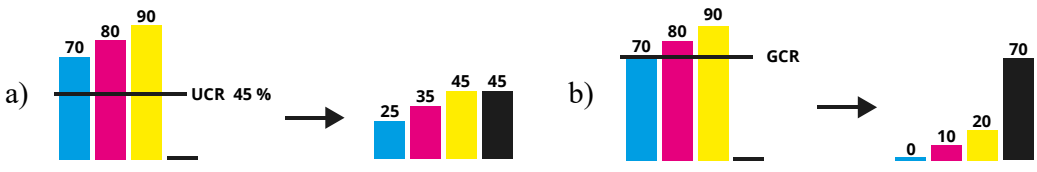


Fig. 1: Example of a) 45 % UCR replacement, where is a partial replacement of overprint gray composed from CMY with achromatic black, b) GCR replacement, where is a complete replacement of overprint gray composed from CMY colors with achromatic black color (adapted from [11])

[1]Commonly used method of lossy compression for storing raster graphics images [12].

[2]File format commonly used for storing raster graphics images using lossless or lossy compression [12].

1.2.4 Tone value sum

Another important factor is the tone value sum (TVS) formerly known as the total dot area (TDA) or total area coverage (TAC), which are deprecated, but still widely used terms [13]. The sum of all colors shall not exceed 240–330 %, depending on the material and technology used [14]. Detailed values are provided in the standard series ISO 12647 Graphic technology – Process control for the production of half-tone colour separations, proofs and product on prints, namely in its Part 2: Offset lithographic processes (ISO 12647-2:2013) [15], Part 3: Col set offset lithography on newsprint (ISO 12647-3:2013) [16], Part 4: Publication gravure printing (ISO 12647-4:2014) [17], Part 5: Screen printing (ISO 12647-5:2015) [18] and Part 6: Flexographic printing (ISO 12647-6:2012) [19].

1.2.5 Knockout and overprint

If the transparency of an artwork is not changed when preparing the printing data, the fills and strokes in the artwork will be opaque because the top color knocks out the area underneath unless the stroke or fill is set to overprint [20]. Knockout and overprint techniques are explained in Fig. 2.

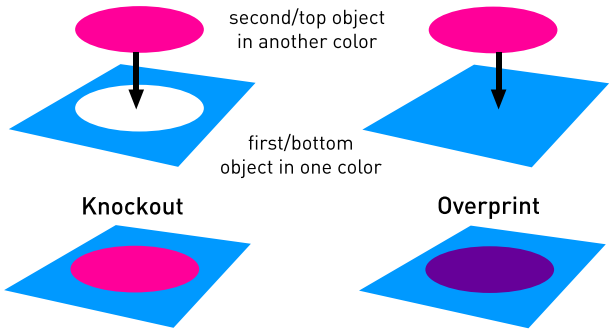


Fig. 2: Knockout and overprint principle (adapted from [21])

Problems with commonly used black color, which is usually set to overprint are explained in [12, 22]. Since the print black is not completely opaque, objects in other process colors seem as showing through, or the image may not be saturated. For larger areas, therefore, rich black (100 % K with an addition of 20 to 60 % of one or more process colors) is used. When the lower saturation is not an issue, another solution is to set black color to knockout (and not to overprint).

1.2.6 Trapping

In the printing industry, trapping has different meanings in prepress and printing [23]. In printing, the trapping parameter is the ability of the ink (layer) of one color to receive the following ink

(layer) of another color on top of still-wet ink [1]. In prepress, trapping is a technique that is used to compensate for problems with the registration of the individual colors in printing [23]. When printing on a white substrate, it is suitable to create trapping [24]. It is an overlap of two adjacent objects printed in different colors (Fig. 3) [24]. If the overlaps are not created, the white substrate may remain unprinted and shows through due to the incorrect color register [24]. No trapping is required for overprinted strokes or fills, as the overprint prevents any gaps between adjacent colors [20].

Fig. 3: Misregistered sample text a) without trapping, b) with trapping

1.2.7 Transparency

For PostScript and older PDF (Portable Document Format) formats (older than PDF 1.4), each additional object fully covers the appropriate part of the objects below it and is opaque, except for those that are set to overprint [1]. The graphic designer can optionally apply transparency to any objects when creating printing data, which can then be affected by several objects at once [25]. When saving to PostScript or PDF 1.3 and older formats, transparency must be flattened because it is not supported [1]. It converts the image to one or more objects with 100 % coverage [1]. There are several benefits to using transparency in newer PDF formats, such as reducing the amount of failed data where transparency has been merged inappropriately (low resolution, making it impossible to convert spot colors to process colors, etc.) and making it easier to edit printing data (flattened data normally contain tens to hundreds of elements) [12]. This makes printing data simpler, so they usually have a smaller data volume, and their processing is accelerated with a properly set workflow [12].

1.3 Color management

In prepress, it is also important to pay attention to color management and colors in general. Color management aim is to unify color reproduction on all types of reproduction devices, and if it is accurate, it is possible to get the expected output when the printing data is good quality [1]. Standard, CMYK subtractive process colors add the dominant use of CMYK color spaces and common practice of converting all content to CMYK as a consequence [1]. Since the CMYK gamut (range of reproduced colors) may not be sufficient in some cases, it is possible to use spot colors, such as Pantone, HKS (Hostmann-Steinberg Druckfarben, Kast + Ehinger Druckfarben, and H. Schmincke & Co.), etc., inks with a given shade, to reproduce, for example, colors that lie outside the gamut and they can also be used when printing shades within narrow tolerances [1]. Some printing machines, such as inkjet printing machines, use extended gamut

printing, typically with the use of more than four process colors [26]. This is one of the reasons why it can be appropriate to preserve images in RGB additive color space when creating graphics since the RGB gamut is larger, as shown in Fig. 4 [26].

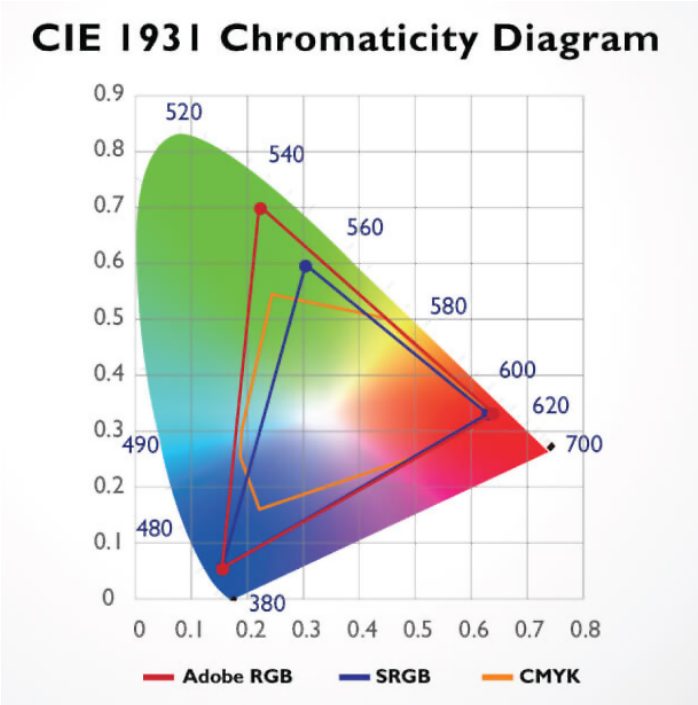


Fig. 4: Comparison of gamuts of widely used RGB color spaces – Adobe RGB and sRGB (standard RGB) with default CMYK color space in CIE 1931 Chromaticity Diagram [27]

1.3.1 Calibration and characterization

It is also important to calibrate and characterize devices to reproduce repetitive jobs more easily and to ensure the possibility of predictable output. During calibration, several basic parameters are set, which are described in detail in [1, 28], as well as the characterization (profiling) that follows after the calibration. Characterization is used to record the settings of the calibrated device and how the device reproduces particular colors [1, 28].

1.3.2 Standardization

For printing machines, standardization, where are used reference profiles produced based on printing tests is also used [1]. The term standardization means that printing machine settings are adjusted according to the standard conditions under which the profile was created (e.g. by the European Color Initiative group known as ECI) [1]. Graphic designers then use CMYK output profiles, which are freely available, (e.g. PSOcoated_v3.icc, which has FOGRA[1] 51 as a characterization data reference) to prepare printing data [29]).

[1]German-based Research Institute for the graphic arts involved in maintaining several ISO standards concerning color management and printing [30] .

1.3.3 Color profiles and conversions

The fundamental concepts of color conversions are explained in [1]. The first one is the color profile, usually in the form of an ICC (International Color Consortium) profile. It is a data file that defines the relationship typically between RGB and CMYK values and their corresponding color coordinates from the independent PCS[1] (Profile Connection Space) that describes the color appearance. To convert color coordinates from one device space to another, the source and destination profiles are required. In the case of conversion from RGB to CMYK, the source profile assigns absolute color values from device-independent space to the original device-dependent RGB values, and then device-dependent CMYK values are generated from these values using the destination profile (Fig. 5).

Further details related to conversion are also described in [1]. When converting, it is necessary to take into account the gamut differences of individual devices, when some colors have to be replaced with others. The particular method of conversion is called rendering intent. There is a saturation method, perceptual method, and colorimetric absolute and relative methods. The saturation method replaces colors that cannot be reproduced with colors of the same saturation, so it is not suitable for prepress. The perceptual method replaces all colors so that visually perceived differences between individual colors of the original image remain preserved. However, in this conversion, the appearance of all colors is changing. The colorimetric method keeps the colors within the destination gamut unchanged and replaces colors that cannot be reproduced with the closest reproducible color. The absolute method preserves the white point of the source gamut, while the relative method shifts the white point to the white point of the destination gamut. Therefore, the absolute method is suitable for proofing. The relative method is used for profile-to-profile conversions in normal job processing when the gamut differences are not significant. However, if a significant loss of detail would occur, it is advisable to use the perceptual method.

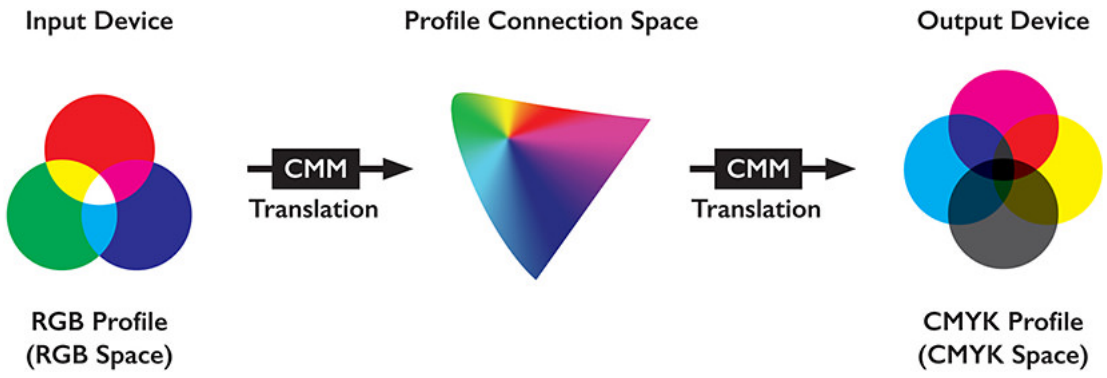


Fig. 5: Color profiles conversion from RGB to CMYK over Profile Connection Space with demonstration of an CMM (color management module) engine that does all calculations of color conversion based on profile information [31]

[1]The central node used in an open color management system. It is presented by a device independent color space [1].

1.4 Page description languages

Output raster images for printing are usually created from sources defined using a page description language [1]. The following description of the main PostScript characteristics relevant for this work is based on [32]. PostScript is an important page description language. It is a interpretive programming language with graphics capabilities. It can work with text, vector objects, and raster objects. PostScript works with graphical operators that determine the necessary parameters for each object. It uses an interpreter for further processing that gradually executes individual instructions. As stressed in the preface of [32] Postscript technology have changed the overall process for printing and it became the industry page description language standard.

1.5 Portable Document Format

The following overview of the main PDF characteristics relevant for this work is based on [33]. PDF is derived from PostScript, but it is more structured, making it easier to view and edit documents, since it allows working independently with individual pages and with objects on a particular page. For rendering individual objects on a page, it originally used the way when the next object fully covers up the existing objects in a given area (opaque imaging model). However, newer versions also support the transparent imaging model. When saving to older PDF versions (PDF 1.3 and earlier), the partial transparency image must be converted into one with 100% opacity (transparency flattening). In PDF documents can be found device color spaces (DeviceGray, DeviceRGB, DeviceCMYK)[1], CIE-based color spaces (CalGray, CalRGB, Lab and ICCBased)[2] and special color spaces (DeviceN, Separation, Indexed and Pattern)[3]. There can be up to five different definitions in PDF format that relate to the size of its pages. It is a MediaBox, a rectangle that is used to specify the default user space, CropBox, a rectangle defining the region that is expected to be displayed or printed, BleedBox, a rectangle defining the size of a page with bleed, TrimBox, a rectangle defining finished size of a page after trimming and ArtBox, a rectangle defining the area with the page meaningful content (the area covered by artwork).

Nine versions of the format have been released up to now: PDF 1.0; PDF 1.1; PDF 1.2; PDF 1.3; PDF 1.4; PDF 1.5; PDF 1.6, PDF 1.7 [1] and PDF 2.0 [34].

Nowadays, PDF format is the most commonly used format in prepress process, which is reflected by development and publication of the international standard series ISO 15930 Graphic technology – Prepress digital data exchange using PDF, namely its

[1]Color spaces that "directly specify colors or shades of gray that the output device is to produce" [33].

[2]Color spaces that "specify colors in a way that is independent of the characteristic of any particular output device" [33].

[3]Special color spaces that "add features or properties to an underlying color space" [33].

Part 1: Complete exchange using CMYK data (PDF/X-1 and PDF/X-1a) (ISO 15930-1:2001) [35], Part 3: Complete exchange suitable for colour-managed workflows (PDF/X-3) (ISO 15930-3:2002 [36], Part 4: Complete exchange of CMYK and spot colour printing data using PDF 1.4 (PDF/X-1a) (ISO 15930-4:2003) [37], Part 5: Partial exchange of printing data using PDF 1.4 (PDF/X-2) (ISO 15930-5:2003) [38], Part 6: Complete exchange of printing data suitable for colour-managed workflows using PDF 1.4 (PDF/X-3) (ISO 15930-6:2003) [39], Part 7: Complete exchange of printing data (PDF/X-4) and partial exchange of printing data with external profile reference (PDF/X-4p) (ISO 15930-7:2008) [40], Part 8: Partial exchange of printing data using PDF 1.6 (PDF/X-5) (ISO 15930-8:2010) [41], and also standard series ISO 16612 Graphic technology – Variable printing data exchange, namely its Part 1: Using PPML 2.1 and PDF 1.4 (PPML/VDX-2005) (ISO 16612-1:2005) [42], Part 2: Using PDF/X-4 and PDF/X-5 (PDF/VT-1 and PDF/VT-2) [43], and standards ISO 16613-1:2017 Graphic technology – Variable content replacement – Part 1: Using PDF/X for variable content replacement (PDF/VCR-1) [44], ISO 19593-1:2018 Graphic technology – Use of PDF to associate processing steps and content data – Part 1: Processing steps for packaging and labels [45], ISO 21812-1:2019 Graphic technology – Print product metadata for PDF files – Part 1: Architecture and core requirements for metadata [46], GWG (Ghent Workgroup) [47] and PDFX-ready [48] specifications. Its aim is reliable viewing of digital documents independent of software, hardware, or operating system [49]. For discussion of the PDF workflow that is common in prepress, it is relevant to describe certain specifics of the PDF documents intended for print. Therefore, the following sections present its versions, standards and specifications used in print workflow.

1.5.1 PDF versions used in the print workflow

Versions 1.3, 1.4, and 1.6 are often used in prepress. This statement is based on the standards used in the graphic arts industry, which are based on these formats. Standards PDF/X-1a that are based on versions 1.3 and 1.4 are often used in the Czech Republic, while a standard PDF/X-4 based on the 1.6 format opens up new possibilities. It is reflected, for example, by [1, 12]. The specification of these versions is in [50, 51, and 52], respectively functions significant for prepress of these versions are summarized in [1]. The following overview is based on [1]. Version 1.3 support RGB, CMYK and spot colors, the definition of parameters regarding halftone screening, color management with ICC profiles support, objects with a smooth color gradient, trapping, DeviceN color space, Type 1, Type 3 and TrueType fonts, and also fonts with CID codes, trim box, bleed box. Overprint options have been extended compared to the previous format 1.2 as well. In PDF 1.3, images with 16-bit depth per channel cannot be used and the file shall not contain transparency (it must be flattened before saving to PDF) [12].

In version 1.4, considering the prepress, it is supported partial transparency and raster images with transparency mask, expanded options for printer marks, options to add and specify an output intent[1] (backward compatible with PDF 1.3); also, the maximum possible page size increased from 45 to 200 inches [1].

Compared with PDF 1.4, version 1.6 supports layers (introduced in version 1.5), OpenType fonts embedding and 3D graphics can be inserted and viewed [1]. This version also supports a larger maximum page size, up to 15 000 000 inches [1]. Also images with 16-bit depth per channel are supported [52].

The latest PDF format is PDF 2.0. The fundamental concepts of new capabilities concerning the printing industry are explained in [53, 54]. The changes in PDF 2.0 are in the page-level output intent, while only one output intent object could have be saved to PDF up to now. PDF 2.0 allows defining page-level output intents. It may be practical for magazines where a single PDF contains all the magazine pages, both cover and inside pages, but they will be printed differently.

Furthermore, the changes in PDF 2.0 concern BPC[2] (Black Point Compensation). It taking into account the differences between the maximum black source and target color space during color conversion [54]. BPC is mainly used to convert an image from a larger gamut to a smaller gamut, but in some cases, its usage leads to unsatisfactory results [53].

In PDF 2.0, it can be specified whether or not to use BPC [54]. It can be used for the whole job or individual elements [53, 54]. The last significant change is the possibility to specify spot colors in the output intent libraries. Spectral measurement values for printing on an unprinted substrate and printing on a black preprinted substrate can be entered for each spot color used in the PDF [54]. This information can help users better reproduce spot colors. [54]. The latest PDF format, PDF 2.0, is described in more detail in ISO 32000-2: 2017 [34].

1.5.2 Commonly used PDF/X standards

The PDF/X standards defined in the series of ISO standards 15930 [35–41] specify the requirements on a PDF document intended for the exchange of printing data. These standards define which options of PDF format should not be used and what information the printing file must contain [1]. Their aim is to ensure reliable data exchange with the possibility of the highest level of automation [1].

[1]Describes the final destination device that will be used to reproduce the color in the PDF [55], usually by choosing a suitable ICC profile [12].

[2]Technique that help maintain details in dark and light tones due to the different range between the white and black point of the source and target gamut [1].

On the basis of [1, 12, and 56], the most widespread PDF/X standard is PDF/X-1a:2001. The following overview of its important requirements is based on ISO 15930-1:2001 [35]. This standard focuses on a blind exchange and its most important requirements are PDF 1.3, definition of MediaBox, TrimBox or ArtBox, output intent, all fonts embedded and information whether trapping has been set. Colors can be defined using spot colors, DeviceGray, DeviceCMYK, DeviceN, and Separation color spaces (and also Indexed and Pattern color spaces if their base color space is one of the previously listed spaces). PDF/X-1a:2001 compliant file shall not contain encryption dictionary, actions and JavaScripts[1].

There is also new version of this standard from 2003, PDF/X-1a:2003, based on the higher PDF version 1.4. All differences and specifications are described in ISO standard 15930-4:2003 [37]. Since, apart from a few details, PDF/X-1a:2001 is the same as the new revision PDF/X-1a:2003, recipients requiring PDF/X-1a:2003 must be able to process both formats [56]. Therefore, a PDF/X-1a:2001 file can be sent even if a company asks the graphic designer for PDF/X-1a:2003 [56].

The newer, in accordance with [57] less widespread version PDF/X-4 defined in ISO 15930-7:2008 [40] has different specifications. The main differences in comparison with PDF/X-1a are according to [40] following: PDF/X-4 is based on PDF 1.6 and there are allowed ICC profiles for individual objects. JPEG2000[2] compression is supported, CIE-based color spaces, use of optional content (often known as layers), and transparency are also allowed.

PDF/X-5 is according to ISO 15930-8:2010 [41] suitable to exchange printing data that refers to other PDF/X files, or, for example, for printing data using multi-channel output conditions. It is used mainly for variable data and transactional printing. Regarding the latest PDF 2.0 format, there is ISO PDF/X-6 standard with more detailed information in ISO/DIS 15930-9, Graphic technology – Prepress digital data exchange using PDF – Part 9: Complete exchange of printing data (PDF/X-6) and partial exchange of printing data with external profile reference (PDF/X-6p and PDF/X-6n) using PDF 2.0 [58].

There are more of these PDF/X standards, but since they are not commonly used by printing companies, they are not described here.

[1]Scripting language for web pages, but many non-browser environments also use it, with regard to prepress, for example, Adobe Acrobat [59].

[2]Newer image compression standard and coding system of JPEG with a wavelet-based technology with choice of lossless or lossy compression [60] and support 16-bit depth [40].

1.5.3 PDF/X Plus

As discussed in [61], PDF/X standards determine only the basic requirements for PDF intended for printing, but they do not specify the conditions for a particular printing process or printing technique. These include, for example, minimum image resolution, etc. More detailed specifications derived from PDF/X standards are called PDF/X Plus. The most known are the GWG and the PDFX-ready specifications. The position of PDF/X Plus is shown in Fig. 6.

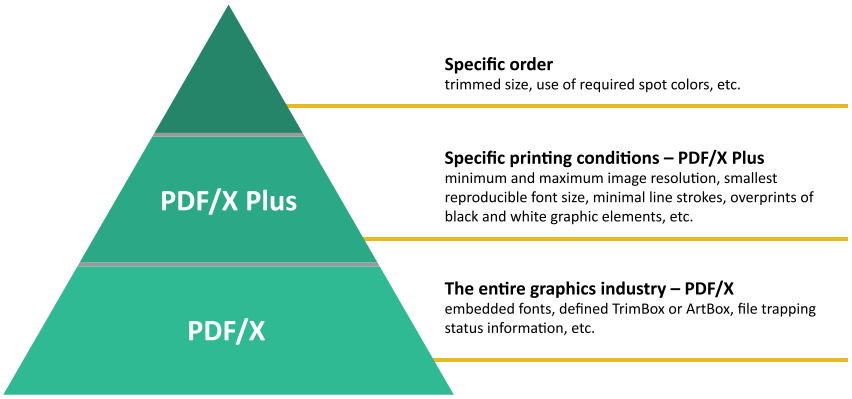


Fig. 6: Position of PDF/X Plus compared to PDF/X and specific order (adapted from [12])

GWG specifications

According to [62], GWG is a working international group that makes recommendations for the creation, processing, and transfer of the printing data. Its mission is to provide specifications and recommendations for the efficient exchange of PDF files. These specify requirements for PDF to ensure the highest quality of production. Specifications can be found as preflight profiles in the most used applications in professional publishing workflows (in Adobe Acrobat Professional, Enfocus PitStop, etc.) [63]. GWG 1v4 specifications from 2008 are based on the PDF/X-1a:2001 standard, while newer GWG2015 specifications are based on the PDF/X-4 standard [64]. GWG2012 transitional specifications are also based on the PDF/X-4 standard and allow all PDF/X-4 specific features, but they are limited to CMYK variants [65]. Specifications are tailored for individual printing technologies or market segments (sheet-fed offset, web-fed offset, magazine advertisements, etc.) [66]. GWG also offers the Ghent PDF Output Suite, a test suite designed to test whether the workflow is in accordance with PDF/X standards [67].

PDFX-ready specification

PDFX-ready is an association established in Switzerland that is a member of the GWG group [48]. It aims to promote the use of PDF/X standards for printing data [48]. The association provides free information, settings, and preflight profiles based on GWG specifications [68] in as simple and user-friendly form as possible [12]. According to [69], this group provides two

versions of specifications. PDFX-ready V1.3, which are based on PDF/X-1a:2001 standard and PDFX-ready V2, which are based on PDF/X-4 standard. Specifications can serve as preferences for exporting PDFs from Adobe InDesign and QuarkXPress (page layout software) or as preflight profiles [69]. There is also PDFX-ready Output-Test V3.0 [70]. With these test pages, printing companies can check whether their workflow complies with PDF/X-4 or not. The pages contain test elements, which are allowed in PDF/X-4 (some of them are not PDFX-ready compliant for error visualization).

1.6 The most common problems in printing PDF

As reported by David van Driessche in PDF Survey results [71], the GWG surveyed 2017 major PDF issues in the graphics industry with 1 109 respondents. Although the PDF format is reliable, preparing printing data by graphic designers may not be. The most common problems reported by respondents are the following. The too low resolution of images was reported by more than 70 % of respondents. The use of incorrect color space and missing bleed was reported by more than 50 % of respondents. More than 40 % of respondents stated that fonts are not embedded in the PDF. Transparency problems were reported by more than 30 % of respondents as well as embedded incorrect spot colors. Around 30 % of respondents reported problems with overprints, too high tone value sum, incorrect ICC profiles in the PDF, wrong file size, and problems with flattened transparency. More than 20 % of respondents reported that colors are not reproduced correctly, output intent is missing or is wrong, conversion of CMYK colors to spot colors differ from the expected result, and technical elements are not defined properly (data for die-cutting, embossing, spot varnishing). Other less common problems were corrupt files, incorrect CMYK separations, missing objects, RIP (raster image processor) errors, incorrect use of optional content and others. The results are shown graphically in Fig. 7.

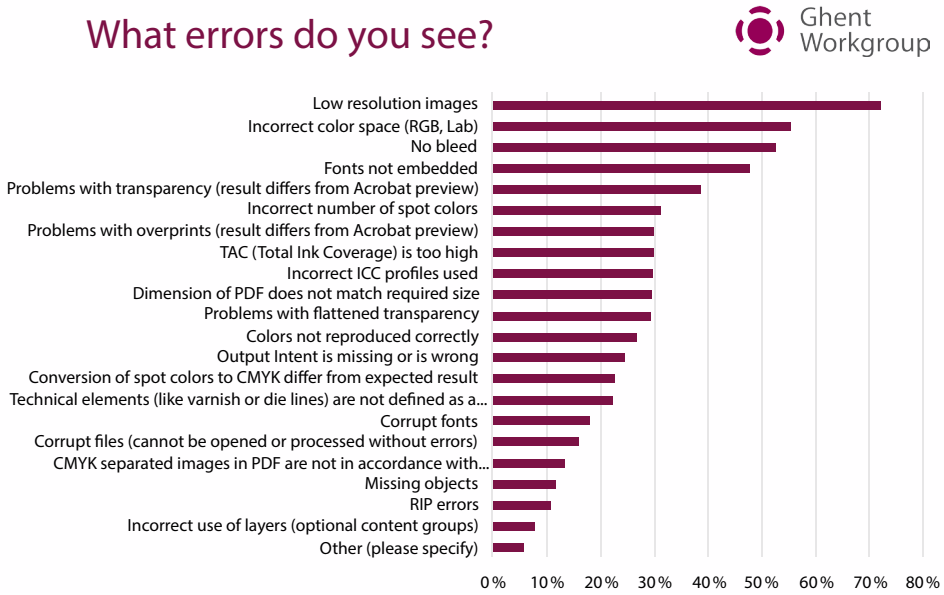


Fig. 7: The most common problems in printing PDF according to the GWG survey (adapted from [71])

Another study was conducted by GATF (The Graphics Arts Technical Foundation) in 2002 with questions about the most common problems in prepress [72]. 88 % of respondents stated that the problem in prepress is poor preparation of printing data by customers or graphic designers, even though 78 % of respondents provided settings to help them with preparation [72]. The the most common problems are summarized in [73]. 22.2 % of respondents reported problems with non-embedded fonts. 11.5 % of respondents reported missing or poorly set trapping. 10.9 % of respondents stated that files are defined with incorrect color space. 7.8 % of respondents stated that scanned images are in a poor format, suitable for use on the internet. 7.4 % of respondents reported a problem with incorrect document size. 5.3 % of respondents reported that part of the graphic design is not linked. 5.2 % of respondents reported badly set or not set bleed. 4.6 % of respondents stated that they lacked proof from the customer, how the final print should look like, which can cause problems with verification of elements on the page and others. 4.5 % of respondents reported missing printing data after submission by graphic designers or customers. A small percentage of respondents stated that the images have too low or too high resolution.

1.7 PDF normalization

The use of the term normalization is not uniform. Generally, it is a modification of received printing data so that they can be easily processed in a given workflow. According to Esko [74], normalized PDF differs from regular PDF in the following areas – external references, color space, document-level metadata, and object-level metadata. Working with the accordingly normalized PDF files with external references can lead to faster processing, in particular, when normalized PDF refers to a significant amount of external image data. Also, the normalized PDF can only contain objects in the final print color space (most often CMYK and some spot colors). Thus, RGB or CIE-based color spaces are converted to CMYK during normalization. Finally, the PDF normalized this way contains XMP (Extensible Metadata Platform) metadata, as well as metadata for specific objects, such as barcodes. In the case of Kodak, normalization settings are connected with the conversion of PostScript files to reliable PDF pages as a part of refining process [75]. The term refining applies to converting the supported input files to PDF, which includes also other modifications, such as color transformations, trapping, etc. [76]. Also other commercially available workflow systems support input files in more formats, such as TIFF, EPS[1] (Encapsulated PostScript), JPEG, PNG[2] (Portable Network Graphics), etc., in the case of Xerox FreeFlow Core [77].

[1]Document format used as a graphics file format for transmitting graphic data. It is no longer used in modern workflows [12].

[2]Widely used file format on the internet that supports lossless data compression for storing raster images [78].

1.8 Adobe Acrobat

Adobe Acrobat is a group of desktop applications that were published with the first PDF version specification [1]. In this application, it is possible to easily create, edit, share, review, and sign PDF documents from anywhere on any device [79]. That is the reason why it is the essential software of printing companies, DTP (desktop publishing) studios and graphic designers. Besides, many prepress software are offered as plugins to Adobe Acrobat. For the processing printing data is important mainly “Print production tools”, where are functions associated with prepress such as output preview, preflight, adding printer marks, etc. Adobe Acrobat can also automatically trap color documents using the Adobe In-RIP Trapping module, which is available on Adobe output devices that support Adobe In-RIP Trapping [80].

1.9 Optional content (layers)

According to [81] the term “layers” refers to OCGs (Optional Content Groups), which is used to create multi-layered content from true page content in a PDF. Any drawn object can be attached to an OCG, and visibility can be then controlled. From a technical point of view, it is a logical construction inside a PDF file that has either a true (the object is drawn) or false (the object is not drawn) state.

1.10 Preflight

The fundamental description of preflight is explained in [1]. A large number of technical errors that occur in the printing data can be found by checking the appropriate parameters of the PDF document, which is also known as preflight. The same source states that due to the extent of the checks, automated software tools, also known as preflight tools, are utilized. Preflight consists of checking selected parameters of the PDF file, specified in the preflight profile. The result of the preflight is either that the file is correct and can be further processed, or there is a warning that some parameters may cause problems during further processing. It is up to graphic designer / operator to make a decision based on evaluating individual warnings, whether some action needs to be taken or not.

1.11 Variable data and transactional printing

Digital printing machines add the possibility to print variable data, because there is no need to create printing forms [1]. Thus, new image creation is possible for each printout. Each printout can then carry different information, as shown in Fig. 8. However, it is also necessary to adjust the preparation of printing data, where it is appropriate to use software

that can work with variable data. That is the reason why variable data comes with a specific requirement on processing during raster image processing [12]. Repeating static objects is necessary to store in memory, while they connect with personalized elements during the processing of printing data [12]. For variable data and transactional (VT) printing was created PDF/VT format, described in ISO standard 16612-2:2010 [43]. It uses PDF 1.6, and it is based on PDF/X-4 and PDF/X-5 [12]. Its goal is explained in [12]. It is to eliminate disadvantages of previous formats such as PPML[1] (Personalized Print Markup Language), Metacode[2], VIPP[3] (Variable-Data Intelligent PostScript Printware), VPS[4] (Variable Print Specification), etc. The problem is that most of these formats are owned by the technology manufacturer and also that they are not easily viewable before printing.

PDF/VT is designed to enable variable data and transactional printing in a variety of environments, including hybrid workflows involving both conventional and digital printing, and can be processed as a normal printing PDF document (preflight, viewing, color management, etc.) [43].

Fig. 8: Example of variable data printing [82]

1.12 Imposition

Nowadays in the digital era, imposition is an integral part of the prepress PDF workflow. It can be more or less automated with different software solutions. Imposition is for frequently repeating tasks of more pages into one sheet almost essential, because it can save a lot of time,

[1]An XML-based standard printer language for variable data and transactional printing defined by PODi. It is device and manufacturer independent, but specific implementations may differ and may not be compatible [12].

[2]Language defined by Xerox for variable data processing [12].

[3]A PostScript-based language from Xerox. It allows storing pre-rasterized repeating objects into memory and then combines them with variable data [12].

[4]A PostScript-based format owned by Kodak. It works with nonreusable and reusable types of elements. Reusable elements are raster image processed and subsequently used with variable data [12].

misunderstandings, and makes work better arranged [83]. Each printing machine has a certain maximum sheet size that can be printed [84]. Other, usually smaller formats, can be printed as well, but it is economical to print on an area as largest as possible and then cut bigger sheets into smaller ones [84]. Example of imposition is shown in Fig. 9.

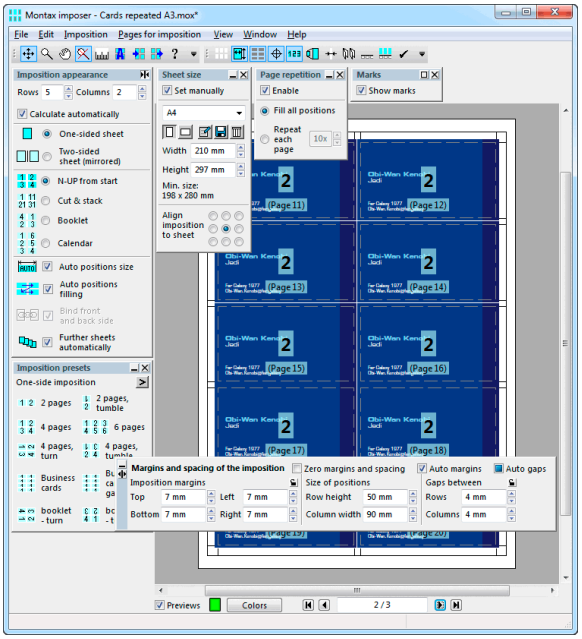


Fig. 9: Example of step and repeat imposition of business cards on the one-sided sheet using Montax imposer [83]

1.13 Conversion a PDF file on a raster image processor

The last step that needs to be done before printing or before creating a print form is converting the PDF file to a raster image – bitmap with pattern of dots. According to [12], printing data are translated to commands on a raster image processor by the interpreter with CPSI (Configurable PostScript Interpreter) or APPE (Adobe PDF Print Engine) technology. Then the renderer draws the individual objects into one raster image with specific resolution (of the output device), and then the rasterizer executes a conversion to a bitmap with halftone dots. The result of this process is a bitmap with halftone dots. For the transformation of an image into a printable form, i.e. creating the halftone pattern, two basic techniques described in [1, 85] are used. As these sources state, AM (amplitude-modulated) screening divides the image area into a regular grid of screen cells, and the maximum halftone dot size depends on the size of the screen cell. The geometry of the dots is chosen according to the character of the printed matter (e.g. circular, elliptical, square, etc.). The final printed image is composed of regularly distributed dots. The second type is FM (frequency-modulated) screening. There is no regular screen in this type of screening, but the corresponding number of individual dots are randomly placed into the screen cell, based on an algorithm. FM is useful, for example, for fine details in darker areas; it can create a wider gamut and smaller details than AM screening. With AM, the individual separations must be

rotated, most commonly to C (75°), M (15°), Y (0°), K (45°). Within FM screening, the dots are randomly distributed to eliminate the screen angle problem; thereby, moiré is eliminated. Some raster image processors also use hybrid technology.

1.13.1 Adobe PDF Print Engine, Configurable PostScript Interpreter

It is preferable to use a raster image processor with the newer APPE technology since the older PostScript language has certain limits, and when receiving printing data in PDF, it is needed to convert them, while APPE does not need to convert incoming PDF data into Postscript but can process it directly [12]. Therefore, it is possible to use PDF files, which contain native transparency, different color spaces, ICC profiles, etc. APPE technology is the most appropriate when using PDF/X-4 workflow [12].

Older CPSI based raster image processors cause problems with files with non-PostScript compatible features such as transparency [86], which is according to GWG [71] one of the mentioned problems when preparing PDF documents that can lead to poor output. Using APPE technology can solve the transparency problem.

Besides, APPE raster image processors can use ICC profiles to render elements, support PDF/VT, 16-bit color depth, and can also be integrated into JDF (Job Definition Format) workflows [12]. Even hot folders can be integrate into the raster image processors for automation, as shown in the video using the ONYX Thrive raster image processor [87].

1.14 Data transmission

The following description of how data are transmitted in the printing industry is based on [88]. Due to the large volumes of transmitted data, more emphasis is put on the transmission system in the printing industry compared to conventional electronic communication. In prepress, data transfer can be divided into two categories. Communication with customers takes place via telecommunication networks (Internet). Transferring digital documents within a printing company is mostly via LAN (Local Area Network). This network consists of computers connected over short distances. If one computer works as a central, it is a client–server network. In the client–server arrangement, the central computer provides specialized services, and the other computers serve as workstations. The server can then provide a variety of resources: for example, access to files on a mass storage drive as a file server, print server, communication server, etc. The solution is called on-premise and common workflow systems work on such a principle (it is probably the most common option) [77]. In order to operate such a workflow, it is necessary to own a server, as can be seen, for example, from [77].

Nowadays, some prepress software, workflow systems or their modules are browser-based or cloud-based. Browser-based software solutions use HTTP (HyperText Transmission Protocol) as their main communication protocol and run only with an active internet connection [89]. A combination of the server-side script such as ASP[1] (Active Server Pages), PHP[2] (Hypertext Preprocessor), etc., and the client-side script such as JavaScript embedded in a HTML[3] (Hypertext Markup Language) are used in a browser-based application [89].

Cloud-based software solutions work with the help of cloud data that can run in the offline mode, and their functioning does not depend on a web browser [89]. These are considered as a combination of browser-based and desktop applications [89]. An example is Apogee Cloud, which offers using the existing Apogee products on the private and secure Agfa's cloud [90]. Some companies offer SaaS (software as a service) option, which also applies to companies that supply prepress software [91]. It is one of the software distribution models in which a provider makes applications available to customers over the Internet [91], and type of cloud-based application [89]. Companies then do not have to invest in dedicated hardware [92]. As an example is Agfa Cloud Hosting, described in reference [92].

1.15 Proofing

A cheap way how to provide to a customer visual copy of the processed printing data online without the need to create a color-accurate hard copy proof or soft proof in a company is over the Internet. For approval workflows over the Internet can be used commercially available software and modules of workflow systems for prepress. A company without appropriate software can create its approval workflow based on e-mail, FTP[4] (File Transfer Protocol), etc. As a part of approval workflow, customers can according to S. Poláček (email communication, January 20 to February 5, 2020) check how job data looks like during job processing or after raster image processing.

[1]Microsoft's server-side scripting engine that produce dynamically-generated web sites [93].

[2]A server scripting language that is suited for web development [94] .

[3]A markup language for creating documents that a web browser can display [95].

[4]A network protocol for transfer files between client and server [96].

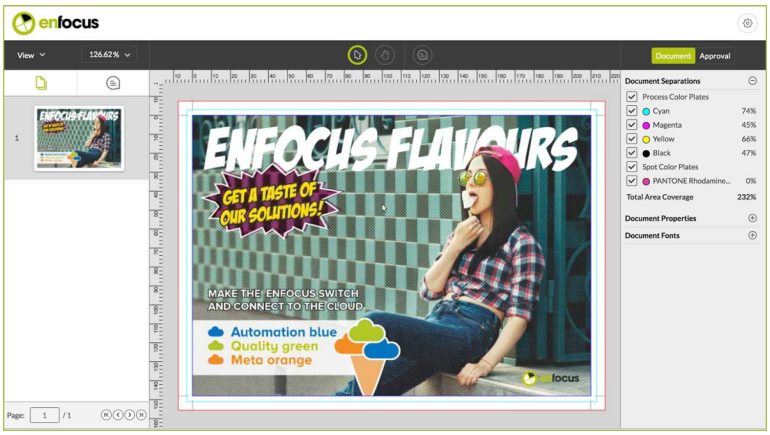


Fig. 10: Example of the environment in the online approval software – PDF Review Module (Enfocus Switch) [97]

A more complex but still fast option is soft proofing. As specified in the standard ISO 14861: 2015 Graphic technology – Requirements for colour soft proofing systems [98], and ISO 12646: 2015 Graphic technology – Displays for colour proofing – Characteristics [99], a true-to-color preview displayed on a monitor. As follows from [98, 99], a properly working color management, monitor quality, which must be capable of displaying colors that match production printing, and hardware calibration are essential to assess color fidelity.

The last option is hard copy proofing specified in the standard ISO 12647-7:2016 Graphic technology – Process control for the production of halftone colour separations, proof and production prints – Part 7: Proofing processes working directly from digital data, where the color output of production printing is simulated [100].

2 Prepress workflow automation

Thanks to digitalization in prepress, a high degree of automation can be achieved. Automation can be advantageous in terms of elimination of routine tasks, error rate, processing complex tasks, the ability to process multiple volumes of jobs, etc.

2.1 Workflow and automation

The fundamental concept of a workflow in the printing industry is explained in [12]. It is a series of operations that need to be done to achieve a particular goal. It consists of individual processes, which mutually communicate. In general, an output from one process is an input for a subsequent process. In the printing industry, it is possible to consider workflow like all activities from receiving an order, to prepress, press and postpress, up to expedition.

The fundamental view at mechanization and automation brings [101]. Mechanization is a process where machines replace humans during strenuous or stereotypically repetitive work. Automation is a step beyond mechanization. It replaces human control activity and resources by technical devices, for example, machines, which carry out predetermined tasks.

In prepress, automation is mainly about appropriately selected software, its settings, and optimization of the workflow so as to eliminate as much as possible the necessary human intervention.

Currently, it is very effective to automate routine activities such as prepress and other repeating activities during the job processing [12]. As it emerges from the questioning of printing companies, which decided to automate their routine activities, it is a long way, but also small steps of automation are an economical and competitive advantage [12]. Article [102] describes why it is convenient to use workflow automation in prepress. Since companies in the printing industry face shorter runs, and faster processing, automation is becoming a crucial capability. Workflow automation tools can reduce errors and save time. They also provide accurate and automatic color matching, avoid re-entry of information, and much more.

2.2 Job Definition Format and Job Messaging Format

The communication standard JDF is based on XML[1] (eXtensible Markup Language) and its integration into the whole process from prepress to finishing are the part of automation in the printing industry that exceeds the PDF workflow [103]. Its use in companies facilitates mutual communication between individual parts of the workflow [12]. It is a format for a job definition,

[1]A markup language for the exchange of a wide variety of data with a simple and readable form of transmitted information [12] .

originally developed by Adobe, Heidelberg, Agfa, and MAN Roland [104]. Its main tasks and targets are summarized in [1]. As this source states, JDF is supposed to contain structured data and a complete job specification with instructions for all steps of processes. Its main target is to reduce the need for decisions and interventions of the operators with fast data sharing over the network and to provide the ability to process a larger quantity of files for print.

JDF includes a JMF (Job Messaging Format) that allows sending instructions and information about events such as start, error, status, results, etc. [1]. Its communication may be unidirectional or bi-directional [1]. On top of that, JDF is built upon the existing formats with a similar purpose, such as the PJTF (Portable Job Ticket Format) and PPF (Print Production Format) for transferring production data from prepress to printing and finishing [88].

JDF format is only a means, but not the complete automation [105]. It is a data format, but not the process [105]. JDF format can be implemented in all parts of the printing companies, except for incompatible technology [105]. Practical knowledges are summarized in [12]. Based on this source, in praxis, it is common for a particular implementation of JDF to use only part of the specification, which is necessary for a specific workflow or device. Different pieces of information are important for a digital printing machine, for converting lines, and for a planning system. Some printing companies implement this format into production only in part, but others, mostly large printing companies, do it globally on a large scale. Therefore, JDF integration can have different levels, from communication between devices or software to complete company interconnection, including communication with the information system, however, it needs the use of products with some kind of JDF support.

The reason why JDF format can be used by different printing companies differently (possibility to use JDF differently is one of the fundamental intentions) is because it is not a product, which can be purchased on shelves, but a project whose implementation takes a lot of time and a lot of money during preparation and deployment [106].

JDF's function is to provide metadata, which can be used to describe the entire lifecycle of a print job [107]. Metadata are structured information about the job or file that are processing by a company, and may contain any information related to work in a printing company, e.g. production specifications, output intent, finishing details, shipment information, job identification, etc. [108]. Working with metadata is also necessary, for example, when connecting prepress workflow system to information system, or when working with W2P[1] (web-to-print) solution. Utilization of metadata enables to create intelligent automation [108]. JDF includes also other functions, such as inquiring devices and identify their JDF capabilities and also providing a command and control language that is used to direct devices in the company, both by information system or workflow [107].

[1]Technology that offers a possibility for creating online print production using embedded templates on a website alongside a strategy that creates a new scope in the market and brings a new marketing potential [109].

As with the PDF format, there are several versions of the JDF format, and it is still evolving. Ten versions of the format have been released up to now: JDF 1.0; JDF 1.1; JDF 1.1a; JDF 1.2; JDF 1.3; JDF 1.4; JDF 1.4a; JDF 1.5; the latest version JDF 1.6 and XJDF (Exchange Job Definition Format) (JDF 2.0), a simplified version of JDF for faster and easier integration [104]. More detailed information about individual formats can be found in the JDF specifications [104].

Parts of the specification regarding the way data are exchanged via hot folders, or HTTP (Hypertext Transfer Protocol) that offers firewall support and secure connections via TLS (Transport Layer Security), formerly SSL (Secure Sockets Layer) when using HTTPS (HyperText Transfer Protocol Secure) are also important for automated systems [104].

2.3 Other metadata processing

Although the JDF format has been developed specifically for the graphic arts industry, and one of its functions is to provide metadata [107], it does not mean that all prepress applications can process only this single format to work with metadata. Other formats can be encountered.

Metadata can be part of the printing data itself or in a separate format [108]. In a separate format, these are most often XML metadata, including formats based on XML, such as JDF [108], but also MAXML[1] (Multi-Channel Access XML) [110]. For transformation XML documents into other XML documents can be used XSLT (Extensible Stylesheet Language Transformations) format [111]. Information in the form of metadata can also be exchanged via the CSV (Comma Separated Values) format, which is evident, for example, from the CSV Lookup application within the Appstore (the online marketplace for Switch functionality) [112]. It is a plain text file that contains a list of data and uses comma character (or semicolons) to separate data, used for data exchange between applications [113]. Graphic files (not just printing data) itself can include metadata in the e.g. XMP format, IPTC (International Press Telecommunications Council) format, or EXIF (Exchangeable Image File) format [114].

However, different metadata may carry different information. For example, XMP metadata is mainly used for storing information about page components or about the PDF document itself (contact details of the author [115], information regarding trapping, information for future use regarding preflighting [76], etc.), but structure of XMP metadata is not suitable for defining a product and its parts [115]. As with XMP metadata, this applies to IPTC metadata, in which it is possible to incorporate, for example, title, description, keywords, photographer's information, copyright, or EXIF metadata, which carry information about the settings that author used, for example, during photographing [114]. According to V. Matuštík (email communication,

[1] An XML-based definition language designed for needs to deploy applications on many access channels simultaneously. It enables to create one application definition and have it instantly accessible [116].

January 20 to March 2, 2020) and M. Šaněk (email communication, March 5 to April 4, 2020), the first group of metadata, which are transmitted separately, is suitable for defining a product and its parts.

Enfocus Switch itself can process XML, JDF, and XMP metadata [108]. Xerox FreeFlow Core can process JDF [77], but also offers Manifest Automation from Xerox, based on CSV format [117]. Workspace module from OneVision itself is based on XML, but formats such as CSV or JDF can be easily used for integration [118]. Some companies use only JDF format in their software solutions, others do not publicly disclose any information. It is important to mention that this Chapter discusses only the formats supported by the most common workflow prepress systems. Other systems may be able to process other formats.

2.4 Hot folders

Hot folder is a folder that allows the user to process files such as PDF and other file types without having to open them manually in an external program [119]. A hot folder is a folder that is associated with a set of functions and settings and mere placing a PDF document file into a hot folder will launch the associated program and output the processed file without having to start this application [120].

2.5 Databases

Databases have become substantial for the printing industry [121]. By using them, the production process becomes much more flexible and adaptable [121]. Two types of databases are commonly used in the graphic arts industry. There are databases for the management of digital assets in the form of various media – MAM (Media Asset Management) systems, also referred to as cross-media databases [121], which use, for example, applications for remote approval and proofing such as Dalim ES [122]. Workflow systems can usually also communicate with external relational databases (open database connectivity communication), such as Enfocus Switch using Database Module [123]. Relational databases keep the necessary data in tables and allow manipulate them conveniently, usually using a special language, SQL (Structured Query Language) [124].

2.6 Information systems for the printing industry

In terms of prepress, it is important to mention information systems. The following description of their capabilities is based on [88]. An information system is a system for data collecting, data processing, data storing, and data accessing through people and technical means. The purpose

of information systems is to use information effectively. In the printing industry, production is on demand, and individual jobs can differ in both technology and used materials. Therefore, an information system must be tailored to this on-demand production, and universal information systems cannot be used. In the printing industry, the term MIS (Management Information System; not a managerial information system but information system at the level of support for the implementation of jobs and operational management) is used for an information system.

The term ERP[1] (Enterprise Resource Planning) or the combination of MIS/ERP is also usual, as can be seen e.g. in [125]. Only the general term information system is used further in the thesis. There is an effort to interconnect information system with technological control, including prepress, to maximize and utilize the automation of job processing [88]. The connection can be made using a program that provides data transfer and communication between individual devices or programs (it means using an interface) [88]. According to Heidelberg [126], the information system is supposed to be able to automatically select the cheapest possible variant of production, automatically calculate prices, provide current status, etc. It also facilitates the management of central warehouse and transportation and therethrough ensuring availability. It allows getting an accurate overview of all stocks, from raw materials over tools to finished products. Some of the workflow systems offer besides other modules also information system. For example, Heidelberg offers Prinect Business Manager [126], and Efi offers several information systems within Business management (MIS/ERP) belonging to Efi Productivity Suites [127].

2.7 PDF Workflow

PDF workflow can be imagined as a sequence of different processing tasks before printing, from preparing files for print, up to raster image processing [12]. Tasks like preflight on the customer (or graphic designer) side, data transfer, job creation, preflight and normalization after receiving printing data by the printing company, and imposition are between these operations [12]. Also, color management, quality and correctness inspection and proofing may be also included in the prepress workflow. A more detailed diagram of PDF workflow is shown in Fig. 11. PDF workflow is one of the most critical parts of most printing companies [12]. It is due to the long-term change in the job structure, to which printing companies may not be able to respond flexibly [12].

[1]A system that managing business processes in a company like planning, sales, marketing, human resources, etc., it links different systems of a company together [128].

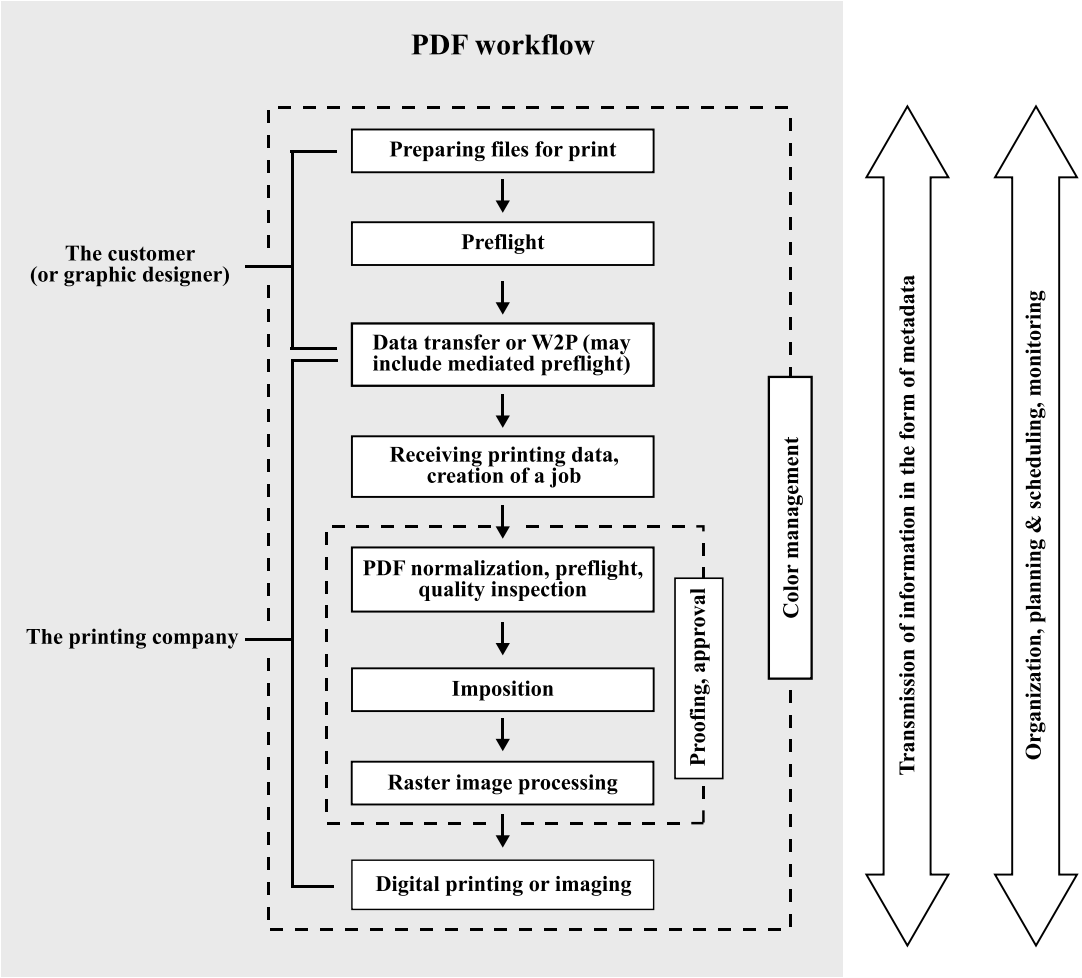


Fig. 11: Individual phases in PDF workflow and other processes related to job processing before printing. The individual steps can be more or less interconnected, depending on the degree of automation.

2.8 Possibilities of prepress automation

2.8.1 Workflow systems

According to [12], there are different types of systems for the automation of the printing industry. Some complex workflow systems can be able to cover the whole workflow, not only PDF workflow and production workflow, but there can also be tools that cover business and managerial activities. These systems consist of individual modules from one manufacturer that communicate with each other via metadata and hot folders, which also improves the connection between software and devices, and thus the communication with the user [129]. Since they may be also modular, companies can buy only that modules that really need. The best example is the Enfocus Switch, modular software solution, as all modules are purchased separately [130]. Another example is Kodak Prinergy that has only several modules in its basic configuration, and many other modules can be purchased optionally based on company requirements [131]. Some complex systems for automation can cover also other parts of the workflow, not just the most

common basic needs of PDF workflow. For example, Prinect offers modules covering business and economy of production, web interfaces, production management, also modules covering production itself, modules related to color workflow, and modules for packaging production [132]. However, it always depends on the particular supplier.

Among the prepress systems from different manufacturers, the most used are according to Lozan and Kulka [12] Prinect from Heidelberg, Apogee from Agfa, Automation Engine from Esko, Prinergy Workflow from Kodak, Switch from Enfocus, XMF from Fujifilm, and Pace and PrintSmith from Efi. Except Enfocus Switch, these systems belong to the most widely used ones also according to the results of the GWG survey [71], together with Xerox FreeFlow Core, HP PrintOS, Canon PRISMA Platform and Dalim ES/Dalim Twist. Instead of Efi Productivity Suite (Pace, PrintSmith, etc.) mentioned by Lozan and Kulka [12], GWG includes Fiery Workflow Suite [71]. However, over 20 % of respondents stated in the GWG survey that they use another workflow system [71]. This can include Enfocus Switch and many other systems on the market, such as RICOH TotalFlow, OneVision Software solutions, Helios (application of HELIOS Software GmbH), etc. However, these types of systems are generally very complex, expensive and demanding to implement [12]. Therefore, a thorough analysis and calculation of return on planned investment are appropriate for implementation [12]. Some companies do not use commercial systems and either program their prepress system on their own, or use the tailored one.

These systems care about the same thing, to automate the entire prepress workflow. However, each company chooses a slightly different approach. On top of that, some companies adapt their modules and workflows for packaging, digital printing, offset printing, or for another type of production.

2.8.2 Individual tools

For smaller printing companies, which do not have the financial budget to implement workflow systems or can not use their potential, a different approach is used [12]. It is a step by step deployment of individual software solutions for prepress automation (these solutions may be from various manufacturers) into individual parts of the PDF workflow [12].

There are more or less automated software solutions for customer preflight mediated by a printing company, data transfer, job management, preflight and corrections, imposition, raster image processing, color management, variable data printing, etc. Besides, the company can select and purchase some modules of some complex workflow systems separately.

Some of these software solutions support hot folders, batch processing or only actions without the possibility of processing multiple printing data. The pros are if individual

modules or applications support metadata processing. For example, imposition software tilia Phoenix can import product orders from CSV or directly from PDF, create detailed XML datasets with all output files, output as imposed PDF including JDF, generate PDF or XML reports, etc. [133]. Similarly, within Job Ticket, Enfocus Connect supports XML, TXT (text) and CSV formats for storing metadata [12]. It always depends on the particular application whether it supports metadata and what kind. There is also an advantage if the application provides an open API (Application Programming Interface), as tilia Phoenix [133] does or CLI (command-line interface) as Callas pdfToolbox [134] or Enfocus PitStop [135] does, or other interface for possible integration. For example, a company can utilize Enfocus Switch (or another workflow prepress system that can integrate other applications) for the connection of software solutions used, where metadata can also be utilized.

According to [12, 109], the advantage of automation using Enfocus Switch is that the company can start with basic steps that are represented as problems of the workflow and after successful automation of these steps further develop the system or split the entire workflow into smaller parts and automate them gradually. Such an approach can reduce the risk of failure; smaller automated steps are also positive with respect to the original, non-automated processes.

2.8.3 Interconnection of different modules and applications from different manufacturers

Using modules from only one company can be limiting and also some companies do not cover the entire PDF workflow. Therefore, it is often beneficial and nowadays in most cases possible to combine individual modules, information systems and third-party applications from different vendors so that the resulting workflow meets the needs of a particular company. This is evident, for example, from [12, 136, and 137]. It is advantageous to connect them in some way to further increase the automation. It can be achieved in several ways; each company offers a slightly different approach.

The first, simple solution is to create an external hot folder, which overcomes missing interfaces [138]. Such an approach is used, for example, by Xerox FreeFlow Core [77] and Workspace Pro / Workspace Pro X module from OneVision Software [138]. Another possibility of how to interconnect different programs or modules is to use open API which is publicly available to software developers [139]. Only the target application (integrated one) needs to provide API [140]. Control application needs access to the complete API, as, for example, Enfocus Switch provides, but also utilizes within the Scripting module [141]. Only then, additional functions that meet the specific needs of the printing company to interact with third-party applications can be implemented [141]. Such an approach is offered by HP PrintOS [142] and according to M. Plaček (email communication, January 22 to March 31, 2020) also by Canon PRISMAproduction.

Another option offered, for example, by Xerox FreeFlow Core, is the use of external CLI integration [77]. Its function is to receive text commands and constructs them into functions [143], thus offering fast and easy integration of applications on a variety of platforms [134]. As with the open API, the target application must offer a CLI and the control application needs to enable access to the use of the CLI within an automated workflow, as, for example, Xerox FreeFlow Core does [77].

The differences between API and CLI are explained in more detail in [143]. Open API and CLI are offered by many individual software solutions and by some modules of workflow systems as well. When applications are connected, they can transfer needed information to each other.

Some companies providing workflow systems do not publicly disclose how is the communication implemented. For example, they have a module that takes care of it, but they don't have the information publicly available. An example can be the Connect Module from Esko Automation Engine [144].

2.8.4 Graphical workflow creation

From the automation point of view, workflow systems allow rule-based workflow creation. The view expressed by Kodak [145] is that one of the strengths of workflow systems for prepress automation is their ability to generate workflows that can respond to system events as soon as they occur. These systems support a graphical workflow creation where a user can create workflow without programming knowledge; some systems allow non-linear workflows that can make decisions (such as Esko Automation Engine) [146]. Workflow can be customized to carry out action A when event E occurs [131]. The sequence of operations can be then performed automatically, without operator intervention. The creation of basic but also complicated workflows is intuitive and uncomplicated [147]. This also applies to other workflow systems for prepress. Individual functions of the Automation Engine can be unlimitedly interconnected between itselves on an endless canvas [147]. An example of a workflow in the Esko Automation Engine is shown in Fig. 12.

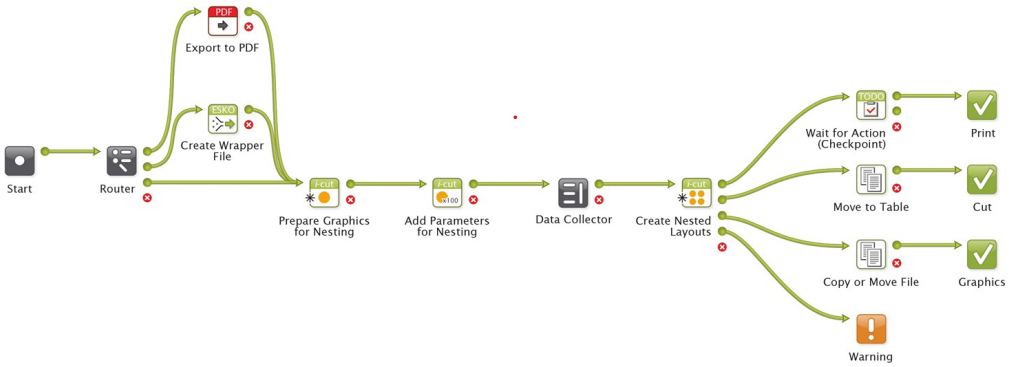


Fig. 12: Example of workflow creation in Esko Automation Engine [148]

2.8.5 Advantages of using workflow systems for prepress automation

As stated by Esko [149], the implementation of the Automation Engine can reduce errors in prepress by 80 % and simultaneously increase efficiency and performance of prepress and related processes. This is more or less confirmed by Summit Print Corporation [150], digital printing company for labels that uses HP Indigo digital presses – the WS6000 and the WS6600. This printing company declares reduction of prepress errors by 75 % thanks to the implementation of the Esko Automation Engine. Kodak declares that implementation of the rule-based automation can increase productivity by 10–20 % [131]. Properus printing plant states that Enfocus Switch has helped the business by reducing errors and complaints [151]. Prior to implementation, the printing company had been incapable to manually check printing files due to the large amount of data, and had left checking of printing files only on a pressman [151]. In the case of Polypress printing company, the implementation of Enfocus Switch reduced stress between departments, improved output quality and simultaneously reduced the irreplaceability of workers; as a result, it even have reduced complaints by 50 % [152].

According to Esko [149], a company should handle up to 40 % more jobs with implementation of Automation Engine without the need to increase the number of employees. Deploying the Enfocus Switch in Polypress printing plant have helped to save time by 40 % [152]. Heidelberg states that integration of Prinect modules can lead to a reduction in processing time per one operation by 2/3 of the time [153]. Further, Kodak states that implementation of the rule-based automation reduce prepress costs by 30–60 % and even can increase profit by 1–2 % [131].

Some printing companies in case studies of XMF mention advantages such as intuitive environment and ease of use of automated functions, integrated processes such as imposition, seamless integration throughout the facility, and more [154].

Many workflow systems and their modules have even been awarded by the InterTech Technology Awards among the top innovative technologies in the printing industry, such as HP PrintOS, Enfocus Switch, Esko Automation Engine, and others [155]. However, the awards also got some individual applications for prepress, as well as other segments in the printing industry not related to prepress [155].

2.9 Overview of selected products for prepress automation

This Chapter brings an overview of the most used prepress systems and their modules as well as individual software solutions, which can be used in different parts of the workflow. For the selected systems, a brief description is provided. The coverage of individual processes by the workflow systems and their particular modules is summarized in Tab. 1 and Tab. 2 for systems with and without the price information available, respectively. Tab. 3 shows selected individual

software solutions, which can be used as an alternative or complement to workflow systems. It is important to note that only the main features are considered as the complete listing is out of the scope of this work.

Agfa Apogee, Arkitex and Asanti

As can be seen in [129], Apogee by Agfa offers four possible implementations, Apogee Render, Apogee PlateMaker, Apogee Manage, and Apogee Integrate. Apogee Render and Apogee PlateMaker are limited solutions with only some features. Apogee Manage and Apogee Integrate differ only in the MIS link module (JDF/JMF based integration) and Postpress Link (JDF based setup of finishing equipment) included in the basic version of Apogee Integrate. Both solutions are suitable for prepress automation needs and offer comprehensive workflow coverage. Apogee functions are divided into six categories, Integrated Workflow Management, Quality Enhancer, Proofing Enhancer, Connectivity Link, Digital Film Manager & Raster Processing, and Scalability. These categories include individual modules, which are already in the basic package or can be additionally purchased. However, none of the basic configurations offers all modules, many modules are optional; so it is up to a company, which part of prepress workflow wants to develop and automate the most.

In addition to Apogee that is designed primarily for commercial printing, Agfa offers Arkitex [156], an automated newspaper prepress sotware, and Asanti [157], an automated prepress sotware for sign and display production.

Canon PRISMA workflow software

Based on the information from M. Plaček (email communication, January 22 to March 31, 2020), Canon PRISMA workflow software (formerly Océ PRISMA workflow software) also offers prepress software solutions. Canon PRISMAprepare is a software designed for prepress. Canon PRISMAproduction is a robust solution that also offers many prepress modules including advanced features. Canon Cosmos is a workflow system for automated work with printing data. It monitors the inputs and manipulates them based on defined workflows. Canon PRISMAdirect is a solution that helps to process more orders in less time thanks to simplified job acquisition. The individual systems are built to form one rich prepress ecosystem. For example, it is advisable to run PRISMAprepare and PRISMAdirect or PRISMAproduction and Canon Cosmos simultaneously thanks to complementary functionalities.

Canon PRISMA workflow software products can be used across a transactional, office network, commercial printing, and central reprographic environments combined with the systems and processes that are already implemented [158].

Dalim Software GmbH

Dalim Software offers Dalim ES and Dalim Twist. Dalim ES contains modules for document management, collaboration, revision management, time tracking, task management, campaign management, and project management [159]. Dalim Twist is a flexible production workflow engine for preflight, color management, raster image processing, trapping, and practically any other automation requirements [160]. Dalim Twist is used by all types of printing plants – digital print, gravure, web and sheet-fed offset [161]. Equally, Dalim ES could be used, for example, for the production of newspaper advertisement, catalog pages, or a series of labels [161].

Efi Fiery Workflow Suite & Efi Productivity Suites

Efi offers prepress-related modules within the Fiery Workflow Suite [162]. Besides, many of these modules can be purchased together with Business Management (MIS/ERP) within Efi Productivity Suites [127]. For example, with the Efi Pace, it is possible to purchase individual modules within the Midmarket Print Suite [163]. In addition to Efi Pace, Efi also offers other information systems for printing companies, such as Efi Monarch, Efi Radius, Efi Technique, Efi PrintSmith Vision, and more [127]. Other modules and options may also be available with these solutions. Efi modules are suitable for multiple industries. For example, Efi Radius is included in Efi Packaging Suite, Efi PrintSmith Vision in Efi Quick Print Suite, Efi Monarch in Efi Enterprise Commercial Print Suite, etc. [127].

Enfocus Switch

Enfocus Switch was designed as a complementary and vendor-neutral automation solution that allows users to more utilize existing technology and workflow solutions [164]. The Enfocus Switch itself does not offer many modules for individual prepress operations like other workflow systems for prepress automation as can be seen from [130]. However, the Configurator module allows the integration of external applications into the Switch streams to enable automation of complex workflows [137]. Integration is available for a variety of applications areas; individual partners and supported applications can be found in [165].

Esko Automation Engine

Esko Automation Engine is designed mainly for packaging. According to T. Nejedlík (email communication, January 20 to April 4, 2020), the basic bundle is commonly supplied with Base Module, Job Management Module, Processor Module, Layout Module, Reporting & 3D Module, and Viewing & QA Module; other modules can be purchased separately. More Esko

packaging products that can be integrated into the workflow can be found within the Esko Software Platform [166]. Besides, Esko offers other prepress and packaging software separately.

Fujifilm XMF

Fujifilm XMF workflow is also a modular system with a scalable architecture for prepress automation [167]. Based on the information from V. Matuštík (email communication, January 20 to March 2, 2020), the environment combines XMF Workflow as a core and XMF Remote. XMF Workflow consists of individual modules covering PDF workflow. XMF Remote provides online submission and approval solution that can be optionally integrated with XMF Complete. Also, version with fewer features XMF Remote Express can be purchased. Fujifilm offers different XMF bundles. XMF Complete includes all features required for the workflows and its automation. XMF Processor has fewer features than XMF Complete; it is better suited for small prepress houses or printing companies. XMF Prepare and XMF Producer have the least features. XMF Prepare is suitable for companies that already have a raster image processor solution and are looking for automated desktop PDF creation. XMF Producer provides imposition, and allowing multiple users to create a printing PDFs. None of the packages contains all the features, some of them can be purchased as an option. However, some packages do not allow the purchasing of some features. Gateway is a slightly different product; it is used to receive TIFF files from any third-party workflow, and includes a Gateway CTP[1] (computer-to-plate) Class Driver that drives any supported CTP device. XMF Workflow is a PDF workflow for offset and digital print applications.

Heidelberg Prinect Workflow

Prinect from Heidelberg is a robust and comprehensive automated solution that covers an entire printing company, not only prepress. Prinect includes modules covering business and economy of production, web interfaces, many modules covering production management and also production itself, modules related to color management, and modules for packaging production [132]. For PDF workflow, Prinect Prepress Manager is the most basic tool for managing all jobs before printing. Prinect Prepress Manager is modular, and therefore scalable [168]. Its software modules include, for example, automatic conversion, preflight, imposition, raster image processing, calibrating, proofing, approving, etc. [168]. Printing plant can choose whether it wants to use Prinect Prepress Manager with digital or offset printing machines. The optional Digital Print Connector ensures that the data prepared by Prinect Prepress Manager can be output on digital printing systems from HP, Xerox, Canon, or NexPress as well as on proofers or platesetters [168].

[1]Imaging technology where created printing data are output directly to a printing plate [1].

Helios (application of HELIOS Software GmbH)

Helios Software offers various products – HELIOS Universal File Server, Base, EtherShare, PCShare, WebShare, WebShare Manager, IT Monitor Server, ImageServer, PDF HandShake, PrintPreview, Tool Server, Script Server, Virtual Server Appliance and Document Hub [169]. Differently combined products form individual solutions – Cloud Collaboration, HD Color, Image Processing, Proofing, WebShare Connectivity, Workflow Automation and File Server [169]. Helios software is not suitable only for printing companies, but also for retail, industrial, newspapers, publishers, photographers, studios, advertising agencies, premedia, video & entertainment, etc. [170]. Workflow Automation supports hot folders, automation via scripting, etc. and it can integrate and automate Helios applications with other applications, processes, and workflows, thereby create an advanced printing workflow with scalable automation [171].

HP PrintOS

HP PrintOS includes various prepress modules, such as Site Flow as a core for workflow automation [172], Box, Imposer, Composer, Jobs, Print Beat and more. HP PrintOS is suitable for HP Indigo digital press, HP PageWide web press, HP Scitex press, and HP Latex printer customers [142].

Kodak Prinergy

Kodak calls its prepress workflow Kodak Prinergy. The core for automating all the activities and modules is the Rules-Based Automation Software [131]. As follows from [131], this solution makes it possible to automate any common manual activity, business processes, and workflows. Kodak Prinergy has only several modules in its base, and many other modules can be purchased based on the company requirements. Also, Kodak offers the Kodak Prinergy Evo Workflow, which is a low-cost solution for companies not currently needing a fully automated workflow [173]. All tools offered within Prinergy can be found in [174]. Prinergy Workflow software offers solutions for commercial and packaging printing across offset, flexography, digital and gravure production [175].

OneVision Software AG

OneVision Software AG offers many modules related to prepress [176]. From the automation point of view, the Workspace, Workspace Pro and Workspace Pro X are important modules that offer opportunities to define and automate production steps [177]. It can be purchased

individually or as a part of packages for commercial printing, wide format printing, book printing, label printing, and image editing [178].

Xerox FreeFlow Core

Xerox FreeFlow Core offers three possible bundles – Xerox FreeFlow Core as a base software, Advanced Prepress optional module, and Advanced Automation optional module [77]. With the purchase of these optional modules, the list of things that Xerox FreeFlow Core can do and automate is growing [77]. Besides, the Output Management and Variable Data optional modules can be purchased [77]. According to M. Šaněk (email communication, March 5 to April 4, 2020), this product is best suited for digital commercial printing, but it can also be used for offset printing.

Summary

As it follows from the description of complex software solutions for prepress, companies developing these systems care about the same thing – to cover the entire prepress workflow by automation. However, each company chooses a slightly different approach. On top of that, some companies adapt their workflows more for packaging printing plants, others for digital or offset printing.

Pricing policy

It is necessary to mention that according to T. Nejedlík (email communication, January 20 to April 4, 2020) and M. Spurný (email communication, April 27, 2020), the pricing policy is complicated, especially for workflow systems, and it cannot be generalized. Commonly, the base price is paid including the price for annual maintenance, or service contracts, which includes technical support, as confirmed by M. Spurný (email communication, April 27, 2020), V. Macejka (email communication, January 20 to March 3, 2020) and V. Matuštík (email communication, January 20 to March 2, 2020). According to V. Matuštík (email communication, January 20 to March 2, 2020), some modules, such as XMF Remote can be purchased only for a certain period of time, e.g. as a yearly subscription. For a large number of workflow systems, but also standalone server applications; these fees are mandatory, they can be included in the annual maintenance.

In most cases, however, it is advisable to pay for a consulting company that will propose and deploy the most suitable solution as, for example, Grafie does with Enfocus products (V. Macejka, email communication, January 20 to March 3, 2020). Sometimes, the most suitable solution can be proposed directly by the supplier of the particular system, which applies, among

others, to Fujifilm products (V. Matuštík, email communication, January 20 to March 2, 2020). It is obvious that some systems are installed by consulting companies, some directly by the supplier, but it also depends on the situation on the market in a given country.

Since the software companies usually offer different types of packages with different functions, performance, and automation options, different packages are different in price (T. Nejedlík, email communication, January 20 to April 4, 2020, V. Matuštík, email communication, January 20 to March 2, 2020, M. Šaněk, email communication, March 5 to April 4, 2020, and M. Spurný, email communication, April 27, 2020). Therefore, it is first necessary to determine what the workflow system should bring and solve. Within one workflow system, the price differences between different installations can be in the hundreds of thousands up to millions of CZK.

However, in the opinion of the author of this thesis, it is also advisable to pay for regular updates not only in the case of workflow systems but also for desktop applications, as prepress is very dynamic and companies that develop software solutions release frequent updates.

Tab. 1: PDF workflow covered by various workflow systems and modules including prices – first part

PDF workflow	**Workflow system / modules**	
	Prices (without VAT)	
Name	**Agfa Asanti**	**1 Efi Fiery Workflow Suite** **2 Other Efi Applications**
Basic bundle and/or core module and its price	consist of: a) Asanti Render [179] – Starting price: 4 660 USD [180] b) Asanti Production [181] – Starting price: 4 490 USD [180] c) Asanti Enhancers [182] d) Workflow Enhancers [157]	Individual modules can be purchased separately within Fiery Workflow Suite [162] or within Efi Productivity Suite together with one of the information systems [127]. **1** Fiery JobFlow – Prepress workflow automation [187]
Mediated preflight	×	×
	–	–
Data transfer	PrintSphere [183]	**1** Fiery JobFlow [187]
	N/A	**N/A**
Job management	✓[182]	**1** Fiery Central [188] | **2** Efi PrintFlow [189] | **2** Efi Metrix Planning and Imposition Software [190]
	N/A	**N/A**
Preflight + changes	Asanti Preflight [184]	**1** Fiery JobFlow: a) Fiery Preflight – requires a Fiery Graphic Arts Package, Premium Edition, b) preflight, correct file (based on Enfocus PitStop Pro) [187]
	N/A	**N/A**
Color management	Agfa Color Management [184] | IntelliTune for Sign & Display [184] | PrintTune [185]	**1** Fiery Color Management [162] | **1** Fiery ColorRight Package [191]
	N/A	Efi Color Profiler Suite 5 (one part of Fiery Color Management): 58 910 to 87 320 CZK [192] | **N/A**
Quality inspection	×	×
	–	–
Imposition	nesting, tiling [184]	**1** Fiery Impose [193] | **2** Efi Metrix Planning and Imposition Software [190]
	N/A	**N/A**
Raster image processor	Asanti Render [184]	**2** Fiery XF 7 [194]
	N/A	61 430 to 131 820 CZK [192]
Proofing	✓[184]	**1** Fiery Graphic Arts – Pro Package [195] / Package, Premium Edition) [196] | Fiery XF 7 [194]
	N/A	**N/A** | 10 710 to 68 120 CZK [192]
Metadata processing	JDF/XML [184] | SQL database [182]	**2** Fiery JDF [197] (included in Fiery Productivity Package [198])
	N/A	**N/A**
Hot folders	✓[180]	**2** Fiery Hot Folders [199] (included in Fiery Productivity Package [198])
	N/A	**N/A**
Variable data	Asanti StoreFront [186]	**1** Fiery FreeForm Create [200] | **1** Fiery Variable Data Printing Solutions [201]
	N/A	**N/A**
Interconnection	**N/A**	**2** Fiery API | Efi integrated solutions | integration of several common workflow solutions [197]
	N/A	**N/A**
Other modules / functions	**N/A**	**1** Efi MarketDirect StoreFront [202] | **1** Fiery JobMaster [203] | **1** Fiery Compose [204] | **2** Efi Business Intelligence [205]
	N/A	546 025 CZK [192] | **N/A**

N/A data not found; – illogical information; ✓ supported functionality; × module or price does not exist

Tab. 1: PDF workflow covered by various workflow systems and modules including prices – second part

PDF workflow	Workflow system / modules	
	Prices (without VAT)[1]	
Name	**1 Enfocus Switch** **2 Other Enfocus Applications**	**1 Esko Automation Engine [216, 217]** **2 Other Esko Applications**
Basic bundle and/or core module and its price	1 Core Engine: 64 560 CZK or 12 910 CZK / year [206]; (annual maintenance 20 % of the price with all permanent licenses except for Connect YOU and PitStop Pro)	1 Base Module + bundle: 20 000 to 80 000 EUR (common order for a company: 800 000 to 4 000 000 CZK)
Mediated preflight	2 Connect YOU | 2 Connect ALL [207]	×
	3 850 CZK | 90 390 CZK [206]	–
Data transfer	2 Connect YOU, ALL [207] | 2 Connect SEND [206]	×
	↑ | 38 740 CZK [206]	–
Job management	1 Reporting Module [208]	1 Job Management Module | 1 Device Manager
	25 820 CZK [206]	included in bundle | **N/A**
Preflight + changes	2 PitStop Pro [209] | 2 PitStop Server [210]	1 Processor Module
	18 980 CZK or 7 440 CZK / year | 77 470 CZK or 30 990 CZK / year [206]	included in bundle
Color management	×	1 Color Module
	–	**N/A**
Quality inspection	×	1 Viewing & QA | 1 Global Vision
	–	included in bundle | **N/A**
Imposition	×	1 Layout Module
	–	included in bundle
Raster image processor	×	2 Imaging Engine [218]
	–	20 000 to 50 000 EUR, advanced screening: 15 000 to 25 000 EUR
Proofing	1 PDF Review Module [97]	1 Color Module: Pack Proof [219] 2 WebCenter [220] | 2 Share & Approve [221]
	103 300 CZK [206]	**N/A** | 30 000 to 100 000 EUR | 222.5 to 5 833 EUR / month [222]
Metadata processing	1 Metadata Module (XML, JDF, XMP) [108] | 1 Database Module (SQL) [123]	1 (XML, XMP, SQL queries and JDF/JMF) [223]
	64 560 CZK | 64 560 CZK [206]	included in bundle
Hot folders	1 [211] | 2 PitStop Server [210]	1 [224]
	↑	included in bundle
Variable data	×	2 Dynamic VDP [225]
	–	150 to 155 EUR / month [225]
Interconnection	1 Configurator Module [212] in combination with 1 Metadata Module [108] or with 1 Database Module [123] | 1 Scripting Module [213]	1 Connect Module
	38 740 CZK + ↑ ↑ | 64 560 CZK [206]	12 000 to 25 000 EUR
Other modules / functions	1 Web Services Module [214] | 1 Client Module [215]	1 Reporting & 3D module | 1 Automated Flexo Platemaking
	77 470 CZK (for both two modules together) | 64 560 CZK [206]	included in bundle | **N/A**

N/A data not found; – illogical information; × module or price does not exist; ↑ see above (already mentioned information)

[1]The information about annual maintenance for Enfocus products is provided by V. Macejka (email communication, January 20 to March 3, 2020) and if not indicated otherwise, price information for Esko is provided by T. Nejedlík (email communication, January 20 to April 4, 2020)

Tab. 1: PDF workflow covered by various workflow systems and modules including prices – third part

PDF workflow	Workflow system / modules	
	Prices (without VAT)	
Name	**Fujifilm[1] 1 XMF Workflow[1] 2 XMF Remote[1] 3 XMF ColorPath[1]**	**Helios Software solutions**
Basic bundle and/or core module and its price	1 bundles: 73 297 to 680 911 CZK 2 (requires XMF Workflow Complete); 308 196 CZK or 57 779 to 135 299 CZK / year; also in express (simplified) variant: 57 779 to 78 483 CZK / year 1, 2 – annual maintenance: 18 658 to 74 631 CZK / year 3 – 18 858 Kč (price only for integration); distributed and supported by FNAC	1 HELIOS Universal File Server products: EtherShare, PCShare, WebShare, IT Monitor Server, iPad Document Hub, WebShare Manager: 2 950 to 5 900 EUR or 1 269 to 2 537 EUR / year 2 complete bundle: 11 900 EUR or 6 417 EUR / year [227]
Mediated preflight	2	WebShare Connectivity [228]
	↑	included in 1 [227, 229]
Data transfer	2	WebShare Connectivity [228]
	↑	↑
Job management	1 Queue Management and Status Reporting	2 Workflow Automation [171]: Consist of Tool Server [230] and Script Server [231]: Requires ImageServer license | 1 IT Monitor Server [232] | 1 Document Hub [233]
	included in all bundles	included in 2 or 4 800 EUR or 2 160 EUR / year |↑|↑ [227]
Preflight + changes	1 XMF Preflight	PDF HandShake [234, 235]
	included in some bundles, otherwise 93 286 CZK	included in 2 or 3 700 EUR or 1 665 EUR / year [227]
Color management	3 (optional in some 1 bundles) | ink saving (optional in some 1 bundles)	HD Color [236] – Requires: PDF HandShake [235] | ImageServer [237]
	↑ | 204 634 Kč	included in 2 or ↑ [227]
Quality inspection	×	×
	–	–
Imposition	1 XMF Impose | 1 Imposed JDF Input	×
	included in some bundles, otherwise 31 096 to 62 193 CZK | included in some bundles, otherwise 31 096 CZK	–
Raster image processor	1 JDF Native APPE raster image processor	×
	Included in some bundles; Advanced Screening: 80 249 CZK AM or FM, 140 435 CZK FM and AM	–
Proofing	1 Inkjet Proofer Connection | 2D viewer, 3D viewer (included in some bundles) | 2	PrintPreview [238] | 1 WebShare for remote proofing [239]
	optional in some bundles: 27 285 to 49 152 CZK |↑|↑	3 400 EUR or 1 530 EUR / year [227] | included in 1
Metadata processing	1 (JDF/JMF)	XMP/EXIF: Requires ImageServer license [237] HELIOS SQL desktop database engine [240]
	×	↑
Hot folders	1 [226]	2 Workflow Automation [171]: Tool Server [230] and Script Server [231]: requires ImageServer license
	×	↑
Variable data	×	×
	–	–
Interconnection	1 MIS Connector | 1 Certain number of approved desktop applications	CLI [240]
	120 373 CZK | **N/A**	**N/A**
Other modules / functions	XMF PrintCentre | XMF Gateaway (requires purchase of the ROOM Proof option)	requires Virtual Server Appliance 2.0 [241] for Cloud Collaboration [242]
	N/A | 20 062 + 74 631 CZK	**N/A**

N/A data not found; – illogical information; × module or price does not exist; ↑ see above (already mentioned information)

[1]If not indicated otherwise, the information for Fujifilm XMF is provided by V. Matuštík (email communication, January 20 to March 2, 2020).

Tab. 1: PDF workflow covered by various workflow systems and modules including prices – fourth part

PDF workflow	Workflow system / modules	
	Prices (without VAT)[1]	
Name	**OneVision Software**	**Xerox Free Flow Core:** **1** Base; **2** Advanced Prepress; **3** Advanced Automation [77]
Basic bundle and/or core module and its price	common order for a company: 15 000 to 50 000 EUR plus mandatory service contracts | essential module for workflow automation: Workspace Pro X [243]	**1**: 80 000 CZK **2**: + 120 000 CZK **3**: + 100 000 to 120 000 CZK (common order for a company: 350 000 to 370 000 CZK)
Mediated preflight	×	×
	–	–
Data transfer	×	×
	–	–
Job management	Workspace Pro X [243] | Workspace Balance [244]	Output Management optional module | **1** job management and status | **1** print management and status | **3** automated printer and finisher selection [77]
	N/A	150 000 CZK |↑|↑|↑
Preflight + changes	Asura [245] | Solvero [246]	**1** [77]
	N/A	↑
Color management	Asura [245] | Solvero [246] | [247]	**2** [77]
	N/A	↑
Quality inspection	Asura [245] | Solvero [246]	×
	N/A	–
Imposition	Autoimpose – Speedflow Impose [248]	**1** [77]
	N/A	↑
Raster image processor	HD RIP [249]	×
	N/A	–
Proofing	×	×
	N/A	–
Metadata processing	XML (formats such as CSV or JDF can be used for integration as well) [118] | Database Connector [243]	**1** (JDF/JMF) | **3** (JMF/XSLT) | Manifest automation from Xerox (CSV) [77]
	included in Workspace Pro X [118]	×
Hot folders	✓ [243]	**1** [77]
	included in Workspace Pro X [243]	×
Variable data	Asura [245] | Solvero [246]	Variable Data optional module [77]
	N/A	80 000 CZK
Interconnection	Workspace Pro X [243]	**3** external hot folder | **3** external CLI [77]
	N/A	×
Other modules / functions	Cloud [250] | Commercial Print Extension [251]	×
	N/A	–

N/A data not found; – illogical information; × module or price does not exist; ✓ supported functionality; ↑ see above (already mentioned information)

[1]The price information for OneVision Software is provided by M. Spurný (email communication, April 27, 2020) and the price information for Xerox FreeFlow Core is provided by M. Šaněk (email communication, March 5 to April 4, 2020).

Tab. 2: PDF workflow covered by various workflow systems and modules (without acquired prices) – first part

PDF workflow	Workflow system / modules	
Name	**Agfa Arkitex**	**Agfa Apogee**
Basic bundle and/or core module	**1** Arkitex Production **2** Arkitex Enhancers [252]	bundles: **1** Apogee Render | **2** Apogee Manage | **3** Apogee Integrate | **4** Apogee PlateMaker [129]
Mediated preflight	**1** Arkitex Portal [253]	Apogee WebApproval [267], optional in **2**, **3** [129]
Data transfer	**1** Arkitex Portal [253] | **2** PrintSphere [183]	Apogee WebApproval [267], optional in **2**, **3** [129] | PrintSphere [183]
Job management	**1** publisher planning, approval, device management, multi-site distribution, etc. [254]	**2**, **3** multi-flow production plans [129]
Preflight + changes	**1** [254]	**1**, **2**, **3** Apogee Preflight [129]
Color management	**2** Arkitex OptiColor [255] | **2** Arkitex IntelliTune [256] | **2** Arkitex Enhance OptiInk [257]	Apogee Color Quality Manager [268] | conversion of spot colors to CMYK using the Pantone® libraries [127] | Ink Tune [269] | PressTune [270]
Quality inspection	×	Raster Preview, optional in **1**, **2**, **3** [129]
Imposition	**1** Impose [258]	Apogee Impose, optional in **2**, **3** [268] | **2**, **3** imposition based on PJTF and JDF [129]
Raster image processor	**1** raster image processor [259] | **2** advanced screening [260, 261]	**1**, **2**, **3** Adobe PDF Print Engine [268] | advanced screening [129]
Proofing	**1** Arkitex Portal [253] | **2** Arkitex Veripress [262]	Apogee WebApproval [267], optional in **2**, **3** [127] | hardcopy proofing, optional in **1**, **2**, **3** [129] | integrated soft proofing, optional in **1**, **2**, **3** [271]
Metadata processing	XML, MAXML, PJTF, JDF/JMF [110]	JDF/JMF [129], XML [272]
Hot folders	✓ [110]	✓ [273]
Variable data	×	Apogee StoreFront [274]
Interconnection	**N/A**	Connectivity Link, optional and/or included in some bundles [129]
Other modules / functions	Arkitex Cloud [263] | **1** Arkitex Newsdrive [264] | **2** Arkitex PressRegister [265] | **2** Arkitex Analyst [266]	Apogee Cloud [90] | **1**, **2**, **3** Acrobat Pro Toolbar [129] | and more

N/A data not found; ✓ supported functionality; × module does not exist

Tab. 2: PDF workflow covered by various workflow systems and modules (without acquired prices) – second part

PDF workflow	Workflow system / modules	
Name	**Canon PRISMA workflow software**[1]	**Dalim Software GmbH**
Basic bundle and/or core module	software: **1** PRISMAprepare | **2** PRISMAdirect | **3** PRISMAproduction | **4** Océ COSMOS	**1** Dalim ES – specialized collaborative solutions for media content | **2** Dalim Twist – productive, modular software engines [280]
Mediated preflight	**2**	**N/A**
Data transfer	**2**	**2** online data submission [160]
Job management	**2**, **3** centralize job order and job management [275] | **3** Batch Monitor	**1** Project Management & KPIS (key performance indicator) [281] – document management, revision management, time tracking, task management, campaign management, project management [159] | **2** job monitoring [160]
Preflight + changes	**1** [276] | **3** PDF Preflight + Make Ready	**1** [160] | **2** [161]
Color management	**1** [276] | **3** InkControl | **3** PDF Preflight + Make Ready	**2** [160]
Quality inspection	×	**2** VisualCompare tool [160, 161]
Imposition	**1** [276] | **3** Professional Document Composer	**N/A**
Raster image processor	×	**N/A**
Proofing	**1** Online Soft Proofing [276]	**1** online proofing software [122] | **2** proofing [160]
Metadata processing	XML, JDF/JMF [277]	**1** (EXIF, IPTC, XMP) | **2** (XML, SQL database, JDF) [161]
Hot folders	**1** [276], **3** [278], **4** [279]	**1** | **2** [161]
Variable data	**1** [276]	**N/A**
Interconnection	**3** open API | **3** Xerox connectivity	integration – Open API [282]
Other modules / functions	**3** Accounting module and reporting	**N/A**

N/A data not found; ✓ supported functionality; × module does not exist

[1] If not indicated otherwise, the information for Canon PRISMA workflow software is provided by M. Plaček (email communication, January 22 to March 31, 2020)

Tab. 2: PDF workflow covered by various workflow systems and modules (without acquired prices) – third part

PDF workflow	Workflow system / modules	
Name	**Heidelberg Prinect Workflow**	**HP PrintOS**
Basic bundle and/or core module	essential prepress applications: **1** Prinect Prepress Manager [168] | **2** Prinect Portal [283] | **3** Prinect PDF Toolbox [284]	**N/A**
Mediated preflight	**2** [285]	Box [299]
Data transfer	**2** [285]	Box [299] | Site Flow [172]
Job management	Prinect Scheduler [286]	Site Flow [172] | Jobs [300] | Print Beat [301]
Preflight + changes	**1** (Heidelberg Preflighter) [168]	Site Flow [172]
Color management	**1** Color Transformations [168] | Prinect Color Toolbox [287] | Prinect Multicolor Toolset [288] | **3** Color Editor [284]	Color Beat [302]
Quality inspection	**3** PDF Assistant [284]	×
Imposition	**1** or individual – Prinect Signa Station [289] (Packaging Pro [290]) | **3** Imposition Editor	Imposer [303]
Raster image processor	**1** Prinect Renderer [168] | Prinect MetaDimension [291]	×
Proofing	**1** [292] | **2** [292, 293, and 294]	×
Metadata processing	Prinect Integration Manager (JDF/JMF) [295]	JDF/JMF [304]
Hot folders	✓ [296]	✓ [305]
Variable data	**3** Barcode and VDP Editor [284]	Composer [306]
Interconnection	**N/A**	Open API [142]
Other modules / functions	**3** other tools | Prinect Web-to-Print Manager [297] | Prinect Smart BI [298]	Media Locator | Substrate Manager | Resource Manager | Knowledge Zone | Service Center | Partner Ecosystem [142]

N/A data not found; ✓ supported functionality; × module does not exist

Tab. 2: PDF workflow covered by various workflow systems and modules (without acquired prices) – fourth part

PDF Workflow	Prepress system
	Prices (without VAT)
Name	**Kodak Prinergy**
Basic bundle and/or core module	1 System + Application Features [307] 2 Supporting Applications [307] 3 Optional add-ons [307] Essential module for workflow automation: Rules-Based Automation Software (RBA) [131]
Mediated preflight	3 Insite Prepress Portal [308]
Data transfer	3 Insite Prepress Portal [308]
Job Management	1 Digital Job Ticket Editor / Presets [307] | 1 Digital Job Track [307] | 3 Dynamic Print Planning [309] | 3 Digital Press Management [131]
Preflight + Fixups	1 Preflight+ [131]
Color management	1, 2, 3 color management [131]
Quality inspection	3 Acrobat plugins: PDF Compare [131]
Imposition	2 Preps [310] | 2 Pandora [311] | 3 Packaging Layout Automation [131]
Raster image processor	1 Adobe CPSI, APPE [312] | 3 screening solutions [131]
Proofing	2 Proofing Software [313] | 3 Insite Prepress Portal [308] – possible extension with PressProof software [314] and Matchprint Virtual Technology [315] 1 Virtual Proofing software [316]
Metadata processing	XML [317] , JDF/JMF [318], PPF, PJTF [131], XMP [76]
Hot folders	✓ [319]
Variable data	**N/A**
Interconnection	Business Link [131]
Other modules / functions	3 Decision Analytics | 3 File Archive and Backup | 3 other Acrobat Plugins [131, 307] | 3 Insite Creative Workflow [131, 320]

N/A data not found; ✓ supported functionality

Tab. 3: PDF workflow covered by selected individual prepress applications

PDF workflow	Prepress individual applications
	Prices (without VAT)
Mediated preflight	**N/A**
	–
Data transfer	Quatrix [321] | Fileflow [322]
	9 to 12 USD / month – Professional; **N/A –** Enterprise [323] | 200 to 2 250 EUR + annual fee [322]
Job management	sPrint One [324]
	N/A
Preflight + changes	Adobe Acrobat Standard DC/Pro DC [325] | Callas pdfToolbox Desktop/Server [326][327] | FlightCheck [328]
	8 499 to 12 136 CZK [329] or 12.99 to 14.99 USD / month [325] | 499 EUR / 4 799 EUR [330] | 199 EUR [328]
Color management	basICColor [331] | PressPerCent [332] | Alwan color expertise [333]
	N/A | 250 USD [332] | **N/A**
Quality inspection	GlobalVision [334] | EyeC Proofiler [335]
	Starting from 395 USD / month [336] | **N/A**
Imposition	Callas pdfToolbox [326] | PLDA [337] | Quite Imposing [338] | DynaStrip [339] | Montax imposer [83] | TiliaLabs Phoenix [340] | TiliaLabs Griffin [341] |
	↑| 399 EUR (10 490 CZK) [342] | 19 770 to 74 970 CZK [343] | 2 245 to 4 495 GBP [344] | 75 to 595 USD [345] | **N/A** | 1 200 USD / year [346]
Raster image processor	Onyx Thrive [347] | Caldera [348]
	3 319 to 8 095 USD [349] | 1 295 to 14 880 USD [350]
Proofing	RealVue 3D Packager [351] | RealVue 3D Publisher [352] | MediaMarkup [353] | Remote Director [354]
	3 500 GBP [351] | **N/A** | 0 to 499 GBP / month [353] | **N/A**
Variable data	XMPie [355] | FusionPro [356] | PrintShop Mail Connect [357]
	starting from 810 USD [358] | 1 500 USD / year [359] | 1 025 CAD / year [360]

N/A data not found; ─ illogical information; ↑ see above (already mentioned information)

3 Individual prepress steps and software solutions used for its automation

The following Chapter describes the real options of software solutions that can be used in the various prepress steps. From the existing applications and modules, only the interesting ones are listed; the offer on the market is for some parts of the prepress much wider.

3.1 Preparing files for print

Graphic designers on a customer side should always be familiarized with the requirements on the printing data as specified / provided by the printer. Since graphic designers often make mistakes when preparing the printing data, a printing company should try to assist them as much as possible. If a company has regular customers, it is a good idea to make clear how to prepare printing data. It can lead to the minimization of errors and the satisfaction of both sides. However, if a company has a dynamic and changing clientele, it should try to make data preparation easier for them. At least partial automation of the mediated preflight can lead to the reduction of errors and time spent on a job. However, the graphic designer on a customer side should preflight printing data before sending to the printing company.

3.1.1 Instructions for data preparation

The first solution how to help graphic designers without any automation is to place instructions on how to prepare the printing data for the specific printing company, together with preflight profiles – own, GWG, PDFX-ready, etc., and ICC profiles – own, Fogra, SWOP[1] (Specifications for Web Offset Publications), etc., on the printing company website. Each company uses different workflows, different technologies, and procedures, thus what may be acceptable in one company may not be in the other.

3.1.2 Preflight by graphic designers in a graphic software

The first preflight in the prepress workflow should always be carried out by a graphic designer on a customer side. Preflight does not have to be performed only for the printing PDF but it can be used already during the creation of printing data. A page layout software like Adobe InDesign [361], QuarkXPress [362] and Affinity Publisher [363] offers built-in preflight that can be used at any time when creating printing data. QuarkXPress has this feature connected with Job Jackets, which is based on JDF and contains specifications and rules for creating and inspecting layouts [362]. As can be seen in [364], custom preflight profile can be created in Adobe Indesign that check links, colors, images and objects, text, and documents.

[1]Specifications for standardization of printed materials used in the United States [12].

Also subcategories can be selected from these categories, such as image resolution in category images and objects, etc. QuarkXpress [365] and Affinity Publisher [366] has a similar approach, but some categories differ. The main difference is that while Adobe InDesign [364] and Affinity Publisher [366] only finds the problem, QuarkXpress can also fix it [365]. CorelDRAW, a vector graphic editor, offers preflight when exporting printing data [367]. However, some applications that can also be used to create printing data, such as vector graphic editor Adobe Illustrator, do not have these features. For such applications, it can be used, for example, the Adobe Illustrator plugin from Esko, DeskPack, which, however, may not be available to everyone due to its price [368]. Another solution can be the relatively affordable Markzware FlightCheck software, which can check not only PDF documents but also native file formats of applications such as Adobe InDesign, Adobe Illustrator, Adobe Photoshop, QuarkXPress, CorelDRAW, and others [328].

3.1.3 Droplet

Another solution can be creating a droplet or series of droplets in Adobe Acrobat that can be offered, for example, to a customer or a graphic designer on a customer side to preflight. The creation of a droplet is shown in Fig. 13 a. Droplets are small applications (Fig. 13 b) for automated processing, which represent a particular preflight profile [369]. A droplet can be an effective means for unified preflight within a printing company or between various collaborating entities [370]. It can be useful, for example, for elimination of prospective technical problems with receiving printing data from graphic designers as it is easy to transfer the droplet from computer to computer and thus make it available; however, each computer launching droplets must have Adobe Acrobat Professional installed [370]. It is also easy to run a droplet, only by dragging and dropping the PDF file on the droplet icon [369].

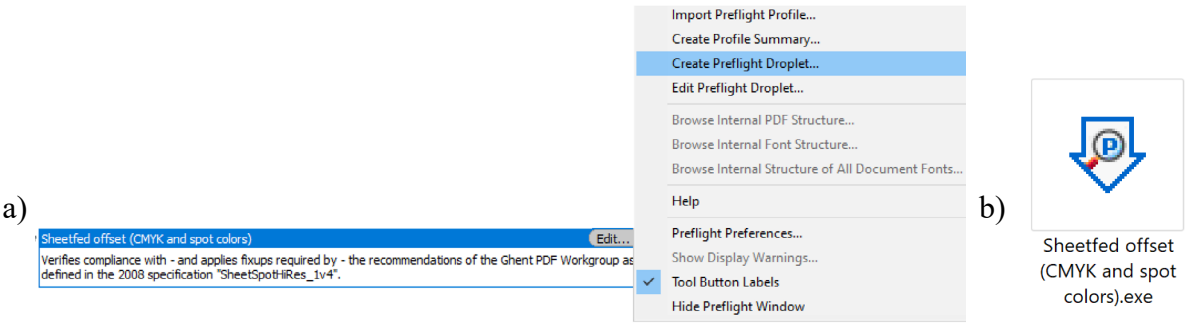


Fig. 13: Example of a) creating a droplet in Adobe Acrobat X Pro Professional, b) created droplet as a standalone application

3.2 Data transfer, mediated preflight and proofing

The next step after preflight by a graphic designer on a customer side is receiving data by a printing company. The frequent solution in the past was personal handing over of printing data. Nowadays, it is exceptional, and it can be seen mainly in the case of copy centers. A more common option is transferring data online. Some printing companies can have data transfer implemented in an online order form or W2P solution, some printing companies use FTP storage, some can receive printing data only via e-mail communication or via public storage.

However, there are software solutions for data transfer, for example, between customers and printing companies or between colleagues in a printing company. These include Quatrix [321] and Fileflow [322], but also more complex software solution, such as Agfa PrintSphere [183] tailored directly for printing companies. It can also automatically forward data (including soft proofs) to the particular Apogee, Asanti or Arkitex prepress job, or it can be integrated into any other workflow solution [183].

Another group consists of modules or software solutions, which also take care of data transfer from customers to printing companies, but, besides that, they have built-in preliminary preflight, and proofing and approval system. These include, for example, Agfa Apogee WebApproval [267], Fujifilm XMF Remote [371], Kodak InSite Prepress Portal [308] and WebShare Connectivity from Helios Software [228]. Such functions are also offered by Heidelberg Prinect Portal [283] (formerly Prinect Remote Access [372], now integrated into Prinect Portal with other browser-based Prinect modules [373]).

The following overview of the main functions of these applications is based on the descriptions of these modules in [228, 267, 308, 371, and 372]. In such programs, customers can create a new order, specify it as needed, and then upload it for the preflight and approval on the printing company side, which can be done immediately without prepress department intervention. Then, preflight reports can be shared with customers. Customers can view, review, annotate, proof, or edit individual pages directly. It reduces the workload of prepress operators. After acceptance of printing data, the customer can get an automatically generated proof file for approval (mostly based on raster image processed data).

If the customer has a monitor set up and operated in conditions under ISO standards 14861: 2015 [98] and 12646:2015 [99], soft proofing can also be performed. Advanced soft proofing functions can be used, for example, within the Kodak InSite Prepress Portal after purchasing the Matchprint Virtual Technology module [315]. The fundamental needs and functions of this module are explained in [315]. It requires a Mac system and a calibrated monitor on the side of the approver. Subsequently, the approver can remotely approve or reject color-managed pages in Smart Review. This approach can be especially beneficial if a printing company cooperates with, for example, graphic studios.

Color-accurate remote soft proofing is also possible to achieve with the Remote Director application, which has a built-in Calibrator [354]. In addition, Agfa offers hard copy proofing including remote option [374].

Enfocus has separate applications for data transferring, preflighting and proofing. First one, Enfocus Connect, is a software solution that connects the one who creates the files for print with the one who accepts them [12, 207]. The following description of this application is based on [12]. It is a software solution that connects the one who creates the files for print with the one who accepts them. This means a connection between a graphic designer on a customer side with a printing company. Enfocus Connect enables the creation of PDF files from almost any application; it creates printing data via virtual printer on the side of a graphic designer. The virtual printer creates PDF via PostScript. This program does not require installation and allows a graphic designer to create and preflight printing data according to the printing company specifications using PitStop Professional (without the sender having to own it), enter job information that the printing company can accept in the form of metadata, and then send the document to the printing company if everything including the printing data is without any problem. The connector can request additional information from the user, which is then sent via connector into the company with printing data. Printing data can be sent/received via e-mail, FTP server, dropbox, or direct connection with the automated workflow system. Enfocus Connect can be used both independently and as a part of a solution with Enfocus Switch software.

The Enfocus Switch also offers a PDF Review Module [97]. The following description of this module is based on [97]. It is a module for creating an automated workflow based on the approval of PDF files by customers. PDF is automatically uploaded to the server before printing and the preview is sent to the customer to approval. For a fully automated e-mail based PDF proofing solution, it is also recommended to purchase the Switch Metadata Module [108]. This module is important for working with metadata [108]. Besides, Enfocus Switch Web Services Module allows anonymous connections for an unlimited number of users [214].

Esko offers proofing, approval workflow, and other tools for cooperation using WebCenter [220]. Besides, Esko offers application Share & Approve that is also suitable for approval workflow and it can create 3D mockups from 2D printing data for more realistic previews of various packages [221]. Other tools for proofing and approval workflow include Remote Director [354] or MediaMarkup from Brighter Tools [353], among others.

Last but not least, some modules or applications collect printing data from e-mail, W2P, FTP servers, public or corporate storages, etc. These include the HP PrintOS Box [299], PRISMAdirect (M. Plaček, email communication, January 22 to March 31, 2020) (Fig. 14), and others. They can also have a built-in preflight. The workflow based on collecting printing data from e-mail, including metadata, based on a similar principle as HP PrintOS Box [299] and PRISMAdirect (M. Plaček, email communication, January

22 to March 31, 2020), can also be defined, for example, in the Enfocus Switch using a pickup tool that retrieves email messages and sends it to the Enfocus Switch flows "Mail receive" [375, 376]. It is achieved by accepting only MIME[1] (Multipurpose Internet Mail Extensions) attachments [375].

Fig. 14: Diagram illustrating PRISMAdirect functionality [377]

A comparison of several selected data transfer and proofing software solutions and their functions is shown in Tab. 4.

Tab. 4: Comparison of several data transfer & proofing modules and software; the term data transfer means the sending of printing data to the company, not the approval process

Company	Module / software	Data transfer	Proofing and approval	Preflight
Agfa	Apogee WebApproval [267]	✓	✓	✓
Agfa	PrintSphere [183]	✓	×	×
Brighter Tools	MediaMarkup [353]	×	✓	×
Canon	PRISMAdirect (M. Plaček, email communication, January 22 to March 31, 2020)	✓	×	✓
Enfocus	Enfocus Connect [12, 207]	✓	×	✓
Enfocus	PDF Review Module [97]	×	✓	×
Esko	WebCenter [220]	×	✓	×
Esko	Share & Approve [221]	×	✓	×
Fujifilm	XMF Remote [371]	✓	✓	✓
Heidelberg	Prinect Portal [372]	✓	✓	✓
Helios Software	WebShare Connectivity [228]	✓	✓	✓
HP	PrintOS Box [299]	✓	×	✓
Kodak	InSite Prepress Portal [308]	✓	✓	✓
Maytech	Quatrix [321]	✓	×	×
N/A	Fileflow [322]	✓	×	×
N/A	Remote Director [354]	×	✓	×

N/A not identified; × not supported functionality; ✓ supported functionality

[1]Specification for the format of non-text e-mail attachments [378].

3.2.1 Benefits of using mediated preliminary preflight

Preliminary preflight on a customer side can be advantageous for printing companies. It is confirmed by Y. Liao and X. Lü [379] in a study concerned with setting up the optimized preflight. The study used the Enfocus software (PitStop Pro and Connect); however, the results can be to some extent applied to any software that performs a mediated preflight. Results show that when more complex preflight profile is set, more errors can occur on the customer or graphic designer side, but fewer errors then occur on the printing company side. It is because Enfocus Connect requires files for print without errors. If there are printing files without complex graphic motives, and the creator is not familiar with requirements from the company, it is acceptable to use only the basic preflight profile, checking only the essential parameters such as document size, transparency, bleed, resolution, and other parameters important for print with an acceptable quality. On the contrary, comprehensive preflight settings, including PDF/X verification, font checks (embedding, size, type, etc.), tone value sum, image compression, etc., should be used in cases when a graphic designer on a customer side is very well acquainted with the exact requirements of the printing company on the PDF files for print and also when the high quality of the resulting printout is required.

As Liao et al. calculated, using a complex preflight profile, the overall error probability is up to 1.8 times smaller than when using the preflight profile with basic settings. Based on the results of this study, optimized customer preflight could minimize prepress time, and reduce the probability of returning printing data for editing. Therefore, in the studied case, Enfocus Connect has a positive impact on the time spent on preflight and troubleshooting with an average reduction by 3 hours using a comprehensive preflight profile, compared to the situation, when the customer does not use preflight. Time saving, of course, has a positive effect on the economy of the whole process of order processing.

Either way, printing companies should pay attention to the data transfer workflow, because according to GATF, some printing companies may have problems that, when they receive files, the customer does not send a printing data or does not send a proof [73].

3.2.2 Proofing in a printing company

Besides remote proofing, Kodak offers proofing software for employing the inkjet printers [313]. Likewise, Agfa offers within Apogee integrated hard copy (not only remote) and soft proofing [271]. According to V. Matuštík (email communication, January 20 to March 2, 2020), Fujifilm XMF Workflow also offers Inkjet Proofer Connection. Another solution is Pack Proof within the Color Module in Esko Automation Engine [219]. In the case of soft proofing, if the workflow system that the company uses does not have such capabilities, or if a company does

not use a workflow system it still can use a separate program such as Adobe Photoshop with a calibrated monitor [380].

3.3 Job management

After receiving printing data, an order is created. The order can be entered into the information system manually or automatically, based on the metadata, for example, when the company uses Enfocus Connect [12], or another solution that can obtain metadata from the customer. It is also advantageous when orders can be tracked across production, when it is possible to automatically sort individual jobs and when a statistical evaluation of orders can be carried out automatically.

In addition to information systems, there are also modules within workflow systems related to the job creation and organization. They can usually communicate with the information system using metadata, which is evident, for example, from MIS link module (JDF/JMF-based integration) offered by Agfa [129]. They can contain various information as needed, such as order ID, due date, customer information, customer representative contacts, as well as graphic specifications such as barcodes, inks, halftoning options; one example of such solution is Job Management module from Esko [217].

3.3.1 Planning and scheduling

According to Y. Liao and X. Lü [379], in printing companies, job sorting is often irregular and job organization is based on the worker experience, expected printing time and current workload of the printing company. For this reason, these printing companies can’t determine whether the time utilization is maximal or not.

This can be solved using the software for planning (what and how [381]) and scheduling (when and who [381]) based on the real-time machine capacity data.

Planning and scheduling software solutions are often combined, so they will be presented together. Most of these solutions help if they are linked to a workflow of a printing company. They are suitable for work prioritization for a large number of jobs, and for optimizing capacity utilization across the company [131, 286]. They can determine the optimal production plan, combine tasks to optimize the workflow, automatically identify the optimal production path for each job, and thus reduce not only the time, but also the overall efficiency required for scheduling [131, 189, and 286]. It is achieved thanks to considering available machines, staff availability, job requirements, various limitations, material availability, and tools availability [189]. Some solutions even allow remote access and are cloud-based, such as Dynamic Print Planning from Kodak [309]. The operator then sees everything on the digital schedule board (Fig. 15). Using

such solutions, orders can be planned faster, more flexibly, and more easily [286]. One of the solutions is sPrint One, which can be licensed as an OctoSprint from OctoBoost or as a Dynamic Print Planning from Prinergy [324]. Also, the service provider Impressed offers integration of sPrint One into existing workflows such as those based on Enfocus Switch, and Printplus offers integration with their information system [324]. Other similar solutions to sPrint One are Prinect Scheduler [286], Efi PrintFlow [189], and others.

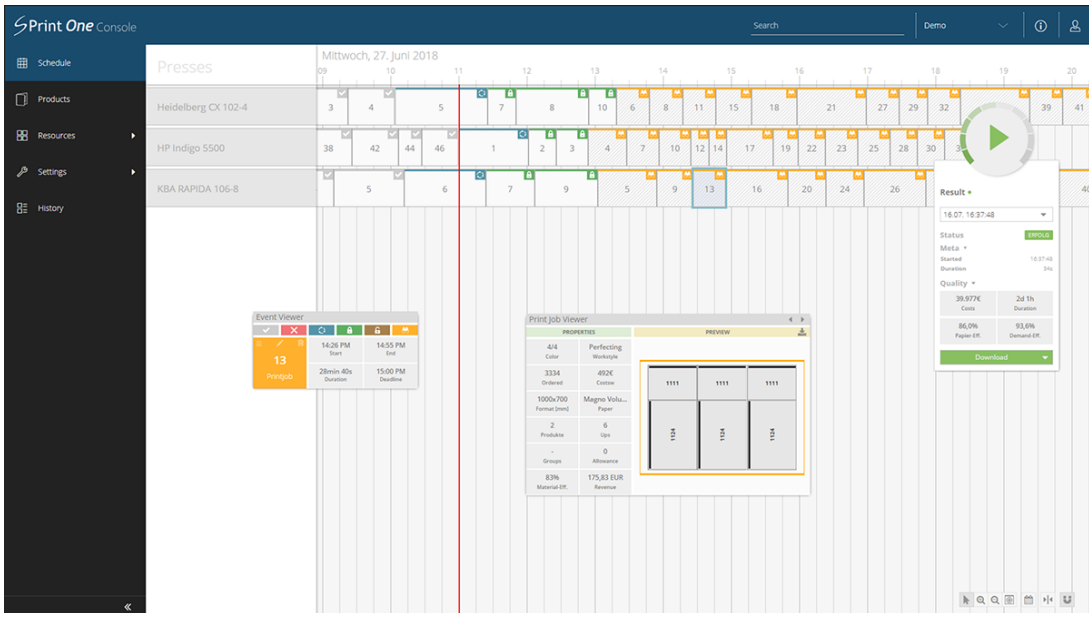


Fig. 15: Example of the environment in the sPrint One [382]

Another solution is offered within the Fujifilm XMF workflow in the XMF Client and Queue Manager described in [383] as well as within the Xerox FreeFlow Core in the Job Management and Status and Printer Management and Status [384]. Here can be seen all activities, monitor individual devices, etc. [383, 384]. Xerox FreeFlow Core can be extended with Output Management optional module [77], which is according to M. Šaněk (email communication, March 5 to April 4, 2020) the most beneficial when a printing company has multiple Xerox digital printing machines because Xerox FreeFlow Core can then split and distribute work among different printing machines to use them efficiently.

Y. Liao and X. Lü [379] did calculations concerning time saving using optimized sorting of files for print. They considered theoretical time spent of prepress, theoretical time spent of printing, and theoretical time spent of finishing. They assumed that sorting of files is often irregular in printing companies, thererefore, they recommend for such companies the shortest processing time rule. It is a priority order rule that determines the job requiring the shortest processing time will be processed first [385]. It was calculated that sorting files for print from the shortest to the longest can reduce time by 10 % in the whole production process [379]. Therefore, it could be useful to printing companies without automated workflows that use planning and scheduling modules.

As stated M. Plaček (email communication, January 22 to March 31, 2020), the ratio of time spent on production management, error recovery, settings (such as paper replacement), etc., increases significantly with smaller orders; which can be solved, for example, by the Batch Monitor module within Canon PRISMAproduction, which groups similar and similarly processed tasks.

Planning can also be used in case of imposition. For example, Efi offers Metrix Planning and Imposition Software [190]. In terms of planning, all devices, supplies, standards, etc., can be stored in the Metrix database [386]. As a result, the Matrix engine can determine how many print sheets are required, the optimum layout on the sheet, the most efficient printing method, sheet size, etc., which greatly automates and speeds up print preparation [386].

Nowadays, these functions are according to M. Spurný (email communication, April 27, 2020) partly included also in other workflow systems/software such as Agfa Apogee, Kodak Prinergy or Fujifilm XMF workflow.

3.3.2 Visualization and dashbroad creation

Another option is to employ software solutions for visualization of production data. An optional module of the Enfocus Switch, the Reporting Module allows creating own dashboards to visualize production [208]. Job files can be monitored using a customizable dashboard across each step of the job processing [208].

Similarly, Efi Business Intelligence [205] provides visual performance dashboards for business analysis, delivering the printing company's current view of its business thanks to integration with Efi's information system and thanks to collecting data from the entire printing company. It offers easy browsing of data according to time periods, customers, etc., in the form of fast, graphical snapshots, and the advantage is also a web-based solution accessible from anywhere. All results can be easily analyzed, including what-if analyzes.

Kodak also offers an application for analytical decisions within Prinergy – the The Decision Analytics Dashboard [387].

3.4 Preflight and corrections by a printing company

3.4.1 Adobe Acrobat

Besides droplets, semi-automatic processes in Adobe Acrobat, such as preflight and corrections can significantly facilitate work. According to [388], Adobe Acrobat uses for a preflight the preflight engine from Callas Software, which from the eighth version of Adobe Acrobat offers the opportunity to fix found problems automatically, not just to detect them.

The opportunity to utilize the engine for batch processing or within the action wizard (batch processing was use with older Adobe Acrobat versions, before version Adobe Acrobat X) using batch sequences and droplets is also useful from the workflow point of view [388].

Details related to the batch sequence in Adobe Acrobat are described in [389]. The batch sequence is a series of commands which control the operation of Adobe Acrobat during the processing of a particular group of PDF documents. It can help to facilitate routine tasks, eliminate errors, but it can even help to do some tasks, which would be difficult to carry out without batch sequence. From the prepress point of view, it is possible to deploy profiles for data check or data correction into the batch sequence. The batch sequences have the advantage of combining multiple commands into one batch sequence. A useful function in batch processing is the processing of the content of a particular folder, which resembles the use of hot folders. A user can determine where the final PDF documents will be saved. Saving into another folder again partially simulates the function of hot folders. However, the launch of batches is not fully automatic. Adobe Acrobat cannot be launched from a command line with a specified batch as a parameter or using JavaScript. The batch must be started manually, however, it is only one click on an action button. Transfer from a computer to another computer is much more complicated than droplet transfer.

3.4.2 Enfocus PitStop

Since Adobe Acrobat does not include all functions used for printing data processing, there are other applications and plugins to extend the functionality of Adobe Acrobat. Widely used plugin for prepress in Adobe Acrobat is Enfocus PitStop Pro [12]. It is a plugin that extensively expands the possibilities associated with prepress like preflight and automatic corrections of most common problems, and also allows the prepress operator to edit files from within Adobe Acrobat [209]. The description of several tools/ways in Enfocus PitStop Pro is based on [12]. The first one are Global Changes, predefined document editing tasks. These functionalities are easy to use and can be saved as an editable Action List. From the automation point of view, it is efficient to use Action Lists with a large number of predefined actions; it is also possible to create or edit custom actions. QuickRun can combine Action Lists, Global Changes, and Preflight Profile in one command Action List can be inserted into other Enfocus products. Enfocus offers also Enfocus PitStop Server, which is an individual hot folder based application that can be used to perform recurring prepress activities in printing companies [210]. It works on the principle of hot folders and, unlike Enfocus PitStop Pro, it is a separate program [210]. According to V. Macejka (email communication, January 20 to March 3, 2020), this solution is often supplied in a bundle with Enfocus Switch.

3.4.3 Callas pdfToolbox

Another available application or plugin into the Adobe Acrobat (depending on user's choice) is Callas pdfToolbox [390]. As follows from the description of this software [390], it is a software with features similar to Enfocus PitStop Pro.

Callas pdfToolbox offers an easy-to-use Switchboard, with many predefined actions that are ready for use and can fix many common problems [326]. It is also possible to create custom or modify existing Checks, which search PDF files for specific properties, Fixups that allow the user to modify files according to specific criteria and Profiles that link Checks and Fixups together [391]. Also, Process plans can be used to run Profiles, Checks, or Fixups one after another in the required order [391]. There is also an option of pdfToolbox Server, hot folder based application, as is the case of PitStop Server from Enfocus. [327].

3.4.4 Summary of available applications

As follows from the discussion [392], it is not possible to clearly say which one from the existing applications is the best in general. Each one can have its own advantages for a particular user or workflow. Therefore, it is recommended to try and compare more of them and decide which one suits the most.

Besides the options mentioned above, there are FlightCheck from Markzware [328], CGS ORIS PDF Tuner [393] as well as Solvero [246] and Asura [245] from OneVision and many more. Since they are not used as widely as previous ones, they are not described here in more detail.

3.4.5 Economical and time impact of using preflight

Y. Liao and X. Lü [379] examined the economical and time savings when using Enfocus PitStop Server. Since the errors of some items in the preflight do not affect the printing process and print quality, they are acceptable for further processing. If these items are included in the preflight, this will result in many more errors, longer processing times, and lower throughput of files for print. The authors recommend the concept of prepress tolerance when creating preflight schemes. Some items cannot be omitted in preflight, such as font embedding, color space, image resolution, etc. Preflight for these items is required before printing, and their tolerance must be set to zero. The remaining possible issues are appropriate to be set as generating a warning only. The results of this study show that the success rate of preflighted files was 100 % when a preflight profile was based on tolerance. However, when a preflight profile was based on comprehensive control, the rate of success of the preflighted files was only 62.5 %. Therefore,

this study proposes the concept of preflight tolerance for files for print on the side of printing companies. The findings of [379] can be applied also to the Callas pdfToolbox Server.

3.4.6 Comparison of preflight tools built-in in workflow systems

Workflow systems for prepress automation, if not featuring the own preflight solution, usually offer built-in Enfocus PitStop [135] or Callas pdfToolbox technology [134]. Both ones offer for their integration CLI option [134, 135], and SDK (Software Development Kit) option [394, 395] that contains a collection of shared libraries, accompanying header files, documentation and samples [395]. Enfocus states that company can decide how features will be presented to users, whether using its own interface or built-in API [395]. According to Callas, pdfToolbox SDK offers APIs for development and deployment environments [394]. Callas also states that there are minimal differences between CLI and SDK [394]. However, compared to the CLI, pdfToolbox SDK has the possibilities to manipulate preflight profiles, including editing, splitting, etc., in the code [394]. All solutions are designed to provide seamless development integration into the given application or workflow [134, 135, 394, and 395]. A more detailed comparison of technology for selected workflow systems and standalone solutions can be seen in Tab. 5.

Tab. 5: Comparison of preflight tools

Application/plugin/module	Preflight technology
Adobe Acrobat Standard DC | Pro DC	Built-in Callas software technology [388]
Agfa Apogee	Apogee Preflight | built-in Enfocus PitStop technology [396]
Callas pdfToolbox Desktop | Server	Callas software technology [326, 327]
Canon PRISMA	Built-in Enfocus PitStop technology (M. Plaček, email communication, January 22 to March 31, 2020), [397]
Efi Fiery Workflow Suite	Fiery Preflight | built-in Enfocus PitStop technology [187]
Enfocus PitStop Pro | Server	Enfocus PitStop technology [209, 210]
Esko Automation Engine	Built-in Enfocus PitStop technology [217]
Fujifilm XMF Workflow	Built-in Enfocus PitStop technology (V. Matuštík, email communication, January 20 to March 2, 2020)
Heidelberg Prinect Prepress Manager	Heidelberg Preflighter | built-in Enfocus PitStop Technology [168]
Helios Software	Built-in Callas pdfToolbox technology [234]
Kodak Prinergy	Built-in Callas pdfToolbox technology [131]
Markzware FlightCheck	FlightCheck technology [328]
OneVision Software: Asura | Solvero	Own technology [245, 246]
Ricoh TotalFlow	Built-in Enfocus PitStop technology [398]
Xerox FreeFlow Core	Built-in Callas pdfToolbox technology (M. Šaněk, email communication, March 5 to April 4, 2020)

3.5 Quality inspection

Some printing companies may also utilize quality inspection software solutions. The first function is comparing two different files. It may be a comparison of different versions of the same file, of different files, between file types (for example, the PDF file with a raster file), etc. [217]. During this process, errors can be detected in files [217]. A simple comparison of the two PDF documents is possible in Adobe Acrobat [399]. Prinect offers more advanced comparisons within its PDF Assistant plugin (Adobe Acrobat plugin), within Prinect PDF Toolbox [284, 400]. Adobe Acrobat plugin, PDF Compare, is also offered by Kodak within Prinergy [131]. Further, PDF editor Solvero from OneVision offers Compare documents function [246].

Agfa offers Raster Preview enabling to view separations and zoom in to dot level, where can be inspecteded rendered job results [129]. Zoom is included also in some applications used for proofing and approving presented in Chapter 3.2, such as PDF Review Module from Enfocus [97]. Esko offers advanced tools within the Automation Engine [217]. Viewing & QA module includes unlimited zoom, separation view, detailed measuring, comparing files, but there is also barcode scanning and braille reading [217, 401].

Even more advanced control quality features are offered by Global Vision, which can be purchased, for example, as a built-in module in Esko Automation Engine [217]. Its functions include comparison of different file types, detection of text and copy errors, proofreading of foreign languages, detection of graphics errors, simultaneous inspection for step-and-repeat jobs, verification and gradation of barcodes and generation of a graphics inspection report, text inspection report, and barcode inspection report [334]. There are also features concerning printing, such as compare hardcopy to digital files with GlobalVision Print Inspection. However, GlobalVision Scanners are required for these functions [334]. EyeC Proofiler also offers similar features [335]. It can be just as easily integrated into an existing workflow, for example within the Automation Engine [402]. This type of quality inspection applications is mostly utilized in the packaging industry, as it is evident from [403].

Enfocus PitStop has in the new 2020 version Computer Vision technology that enables to check the visual content of a PDF file [404]. Both Enfocus PitStop Pro and Server with this technology can search for specific images, shapes and logos, considering also their size or rotation, and check for their presence [404].

3.6 Color management and its automation

In a correct PDF/X-4, all color spaces different than CMYK (normally RGB) must contain embedded ICC profiles for all relevant objects [12]. Only in this way is it possible to make a correct conversion to the set output intent [12].

The following text presents some software and modules that can be used for different parts of color management. However, some companies either do not have the information publicly disclosed or do not cover advanced features in color management at all.

Color-related changes can be customized using conventional preflight and data editing software (Adobe Acrobat, Enfocus PitStop, etc.) [12]. Color space can be changed either in document or directly in a specific object [12]. Conversion of spot colors to process colors can be done using Adobe Acrobat [405]. There, can be converted all spot colors to process colors, mapped a spot color to a different spot color or createed an ink alias for a spot color [405]. Further, Callas pdfToolbox and Enfocus PitStop can also convert colors, including spot colors [406, 407]. Also DeviceLink conversions can be done, for example, in Enfocus PitStop [407] and Callas pdfToolbox [406].

There are also software solutions for spot color management. For example, within the Color Module, Esko Automation Engine offers PantoneLIVE [219]. Fujifilm offers XMF ColorPath Brand Color Optimizer [408]. Efi offers Fiery Spot Pro [409]. However, it is also important to control the conversion of spot colors to process and eliminate spot colors where possible [410]. It is one of the Equinox [410] features within the Esko Automation Engine Color Module or Prinect Multicolor Toolset [288].

Another part that should be covered by the software is calibration and characterization (which is necessary, among others, for soft proofing and hard copy proofing). For example, X-Rite offers with software i1Profiler i1Pro 3 spectrophotometer [411]. The complex prepress workflow systems usually include this functionality as well. Prinect Multicolor Toolset includes Calibration Tool and Profile Tool [288]. Besides, it can be checked the quality of important print process parameters using Quality Monitor [288]. Efi offers all in one solution within Fiery Color Profiler Suite [412]. Kodak offers ColorFlow Pro software [413]. Fujifilm XMF ColorPath Organizer controls the use of ICC profiles created by ColorPath Sync [414]. Within Apogee, ColorTune Output [415] for printer and ColorTune Display [416] for monitor calibration and characterization can be acquired. The color management is then controlled by the Apogee Color Quality Manager [268]. Again, if the workflow prepress system does not have such functionality, or if a printing company does not use any workflow system, a separate application such as basICColor display [417], basICColor print [418], basICColor dropRGB [419], basICColor CMYKick [420], and basICColor catch [421] can be purchased.

For some printing companies, it may be beneficial to use software solutions that can create DeviceLink profiles and control black generation, since it can save ink and therefore reduce printing costs. Fujifilm XMF uses according to V. Matuštík (email communication, January 20 to March 2, 2020) ColorPath InkSave, Esko Automation Engine offers Ink Saving [422] functionality within the Color module, OneVision offers Inksave Pro [247], Agfa offers InkTune [269] and Kodak offers Ink Optimizing Solution module [423]. Prinect also

offers control black generation within Prinect Prepress Manager [424]. Alternatively, an individual program such as basICColor print [418], basICColor DeviL [425] and basICColor gHOST 2 [426] can be used. Basic CMYK–CMYK DeviceLink profiles are predefined and can be utilized for conversions also in Enfocus PitStop [407].

3.7 Imposition and its automation

Printing data can be imposed in many ways. It can be chosen between affordable Adobe Acrobat plugins, individual programs, or software solutions that are part of workflow systems. Besides using hot folders, automation can be done in two ways. Template-based imposition is the most common technique for automated imposition [427]. Jacobs et al. [428] came up with the system that automatically selects the appropriate template based on the content. There is also software, which creates page layout according to rules (rule-based imposition) [427]. Then the template library is not required for this type of workflow [429]. As stated by Kodak [429], in the case of Prinergy, information systems, databases, or job entry must be able to provide good and comprehensive JDF data. Working with JDF is also required to incorporate template-based imposition software into the workflow [429].

It should also be stressed that different production requires different functions of imposition software. For wide format imposition software, it is useful to cover functions for step and repeat, tiling/paneling (Fig. 16), and nesting (ganged imposition) where pieces from multiple jobs are combined (Fig. 17). It is evident from the offer, for example, Agfa within Asanti offers these two functions [184]. Nesting is suitable wherever continuous feed machines are used. Not only it enables the economical use of paper, but also saves ink and maximizes efficiency [430]. However, in imposition software for commercial production, it is also appropriate to cover other areas of imposition, such as standard multiple page (N-up) imposition, two-sided imposition, work and turn imposition, cut and stack imposition, booklet imposition (perfect bound for glued flexible binding, cross fold, etc.), imposition for table calendar, etc. [431]. For the packaging imposition software, it is appropriate to use the step and repeat function that uses a CAD[1] (computer-aided design) file layout as the task's input file [290, 311].

[1]Computer technology for product designing and technical documentation [432]. In the printing industry, it is used for packaging design [433].

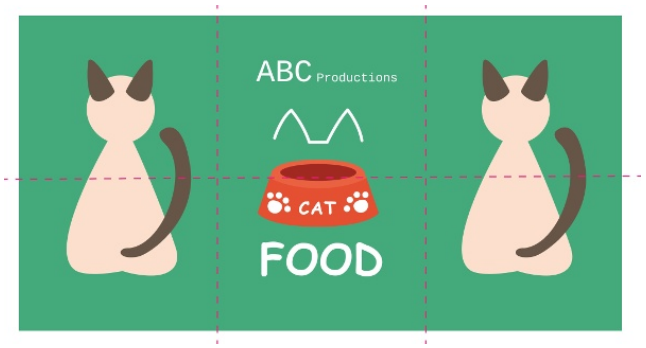


Fig. 16: Tiling/paneling function example [434]

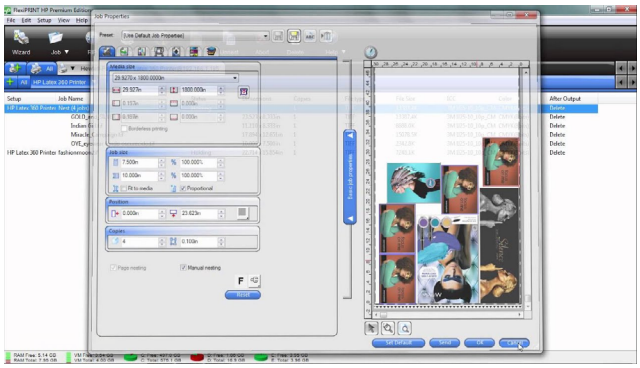


Fig. 17: Nesting function example [435]

For large format printing, imposition software such as tilia Griffin (which can be easily implemented, for example, into the Enfocus Switch) can be used [341, 346]. Wide-format imposition is offered, among others, also by Agfa within Asanti [184], Fujifilm XMF Producer for wide format (V. Matuštík, email communication, January 20 to March 2, 2020) and OneVision within Wide Format Automation Suite [436].

Probably the largest number of software in this area is available for routine commercial imposition. These include applications such as Montax imposer [83], PLDA [337], Quite Imposing [338] and DynaStrip [339], or modules of workflow systems such as Kodak Preps [310], Apogee Impose [437], imposition module in XMF Workflow (V. Matuštík, email communication, January 20 to March 2, 2020), AutoImpose or Speedflow Impose from OneVision [248], Prinect Signa Station [289], Efi Fiery Impose [193] and so on. Other imposition solutions are HP PrintOS Imposer [303], imposition in XeroxFreeFlow Core [77], imposition in Canon PRISMAprepare, or Professional Document Composer within Canon PRISMAproduction (M. Plaček, email communication, January 22 to March 31, 2020) and more. Also in this segment, nesting can be useful.

The Prinect Signa Station Packaging Pro [290] and Kodak Pandora [311], which can be automated using the Kodak Packaging Layout Automation [131], belong to software specialized in packaging imposition. It can be also chosen an individual program such as tilia Phoenix [340], which can be easily implemented, for example, into the Enfocus Switch [438].

Some solutions can handle a wide range of products, from labels, folding cartons, corrugated, digital, commercial print, signage to display production, such as the Esko Automation Engine Layout module [439]. The use of nesting may also be beneficial in packaging imposition.

As stated by S. Brekalo et al. [427], problematic in terms of imposition is mainly the fact that graphic designers try to make imposition manually by themselves. Automation of imposition can bring many benefits to an enterprise. This mainly involves increasing production by shortening delivery times, reducing the price of production, providing a potential chance for automatic generation of personalized documents. Also, the errors caused by humans decrease with automation and automated workflow can work outside working hours.

3.8 Raster image processing

3.8.1 Individual raster image processors

There are many raster image processors on the market. Some of them are offered primarily separately, such as ONYX Thrive (APPE) [347], Caldera raster image processors (APPE) [348], and Fiery XF 7 (FAST RIP) [194]. Some may be an optional or core part of workflow systems. While Esko offers the Imaging Engine, which is based solely on APPE technology (T. Nejedlík, email communication, January 20 to April 4, 2020), Prinergy includes two raster image processors for rendering PDF files: Adobe CPSI and Adobe PDF Print Engine [312], which is also the case of Prinect MetaDimension [291]. On the other hand, raster image processing inside the Heidelberg Prinect Prepress Manager via the integrated Prinect Renderer is performed using Adobe PDF Print Engine [440]. Raster image processing solutions are also offered by XMF Workflow (APPE) (V. Matuštík, email communication, January 20 to March 2, 2020), Agfa Apogee (APPE) [129], OneVision [249], and other companies.

3.8.2 Setting the raster image processor

On the company side, it is also important to set the raster image processor so that printing data are not devalued [12]. The described setting is based on [12]. Modern raster image processors have the possibility of selecting the APPE or CPSI technology, or one can be set as preferred, and the other can be used when the first has a problem. The type and density of the raster can be also determined. With some raster image processors, it is possible to change the rotation of individual separations, or define the shape and size of the printing dots. Some raster image processors can also convert colors, for example, from spot colors to process colors. It is also appropriate to forbid the use of embedded font set, preferably fonts embedded in the PDF document are supposed to be used. Overprints should not be changed without the customer's permission (the exception may be a smaller black text where overprint can help). Trapping

can also be set on raster image processors. It is also good to set correctly color management. Older CPSI raster image processors may have problems with ICC profiles attached to a PDF file since they are not supported (in these raster image processors). In this case, the color conversion must be ensured in the preceding step. Newer APPE raster image processors can work with ICC profiles; color management is then set according to the information in the PDF document.

4 Survey in prepress and its automation

The theoretical part is followed by a survey of the current use of prepress automation, problematic areas in prepress, and software tools across randomly selected companies in the Czech Republic. Altogether 94 companies completed the questionnaire. The survey was conducted in Czech. The translated version of the questionnaire is shown in annex A.

To analyze the selected parameters of prepress and its automation in detail, the first three questions in the survey concerned general information about involved companies.

4.1 The main type of production

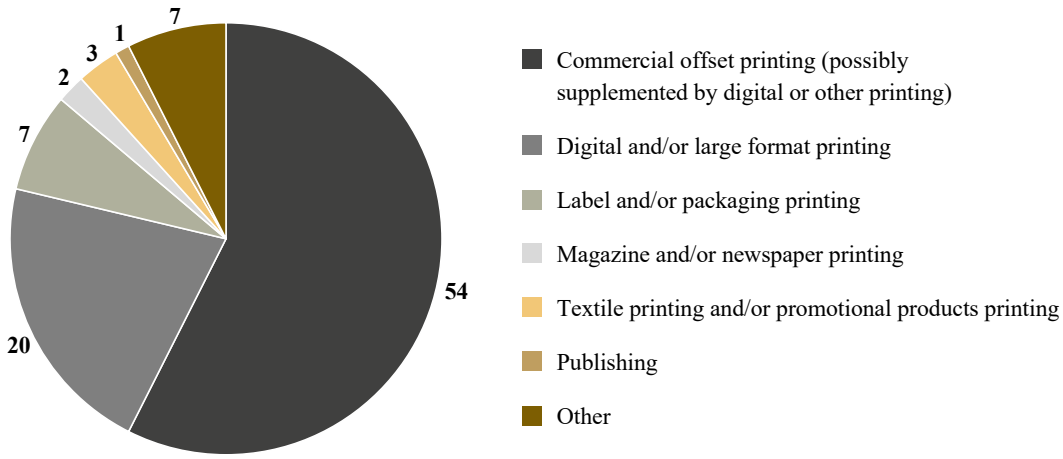


Fig. 18: Survey responses to the question: What is the main type of production of your company?

As shows Fig. 18, the largest group of companies involved in the survey were commercial offset printing companies. This group contains more than half of all respondents. It was predictable, given the structure of the print market in the Czech Republic. The second-largest group represents the sector of digital and/or large format printing. It was also expected, given that this market grows, although this group was almost three times smaller than the previous one. The rest make up less than a quarter of all respondents, from which the companies who answered "Other" provided as the main type of production letterpress printing and die-cutting, manufacture of paper packaging, signmaking, and orientation systems, screen printing (probably using this technique for something different than for textile printing and/or promotional products printing, or in combination with other printing techniques), and printing of digital media. There was also one company, which combines more printing techniques.

4.2 Number of employees

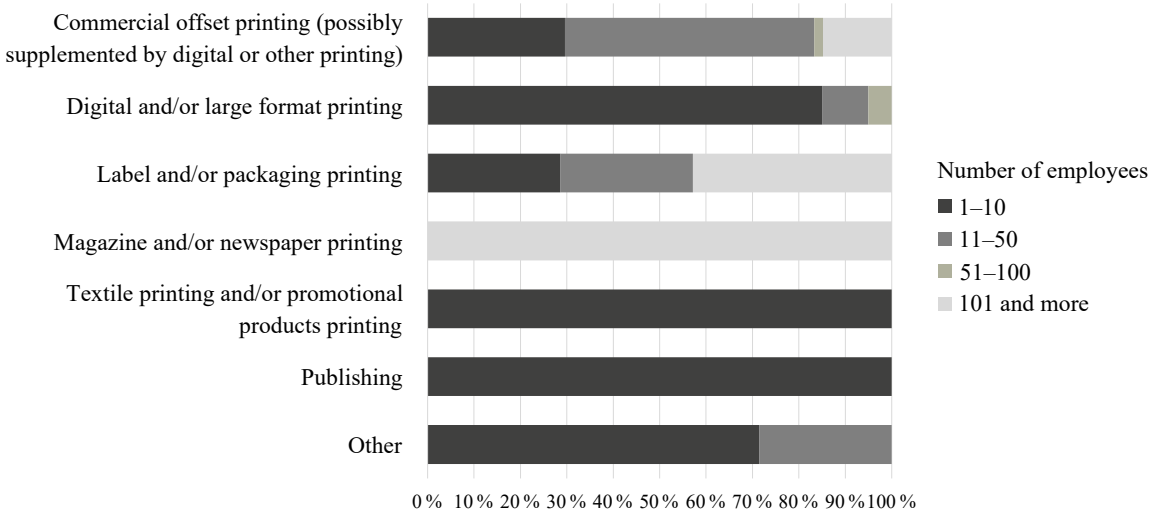


Fig. 19: Percentage representation of survey responses to the question: How many employees work in your company?, represented according to the main type of production

The size of the involved companies in terms of the number of their employees is shown in Fig. 19. All size categories are represented in the largest group of respondents, commercial offset printing companies, with more than a half (54 %) of them having 11–50 employees. On the other hand, the smallest companies prevail in the second largest group, digital and large format printers (85 % with 1–10 employees).

While both small and large companies are represented in label and packaging printing, the two companies producing magazines and/or newspapers have above 100 employees, and the remaining ones mostly have 1–10 employees. Interestingly, the smallest group among all companies consists of those with 51–100 employees.

4.3 Number of orders received per day

Figure 20 analyzes the number of daily processed orders across individual groups of respondents. For commercial offset printing, the largest number of companies belongs to the group, which processes 11–20 orders a day and employs 11–50 employees, while the smallest companies mostly process 10 or fewer orders per day. In digital and large format printing sector, the distribution is shifted and the majority of companies process more than 10 orders a day even when they belong to the smallest ones. Two companies with higher number of employees process over 100 orders a day. Such a high number of orders is reported also by one large company with more than 100 employees in the label and packaging printing sector, in which the numbers span the whole range.

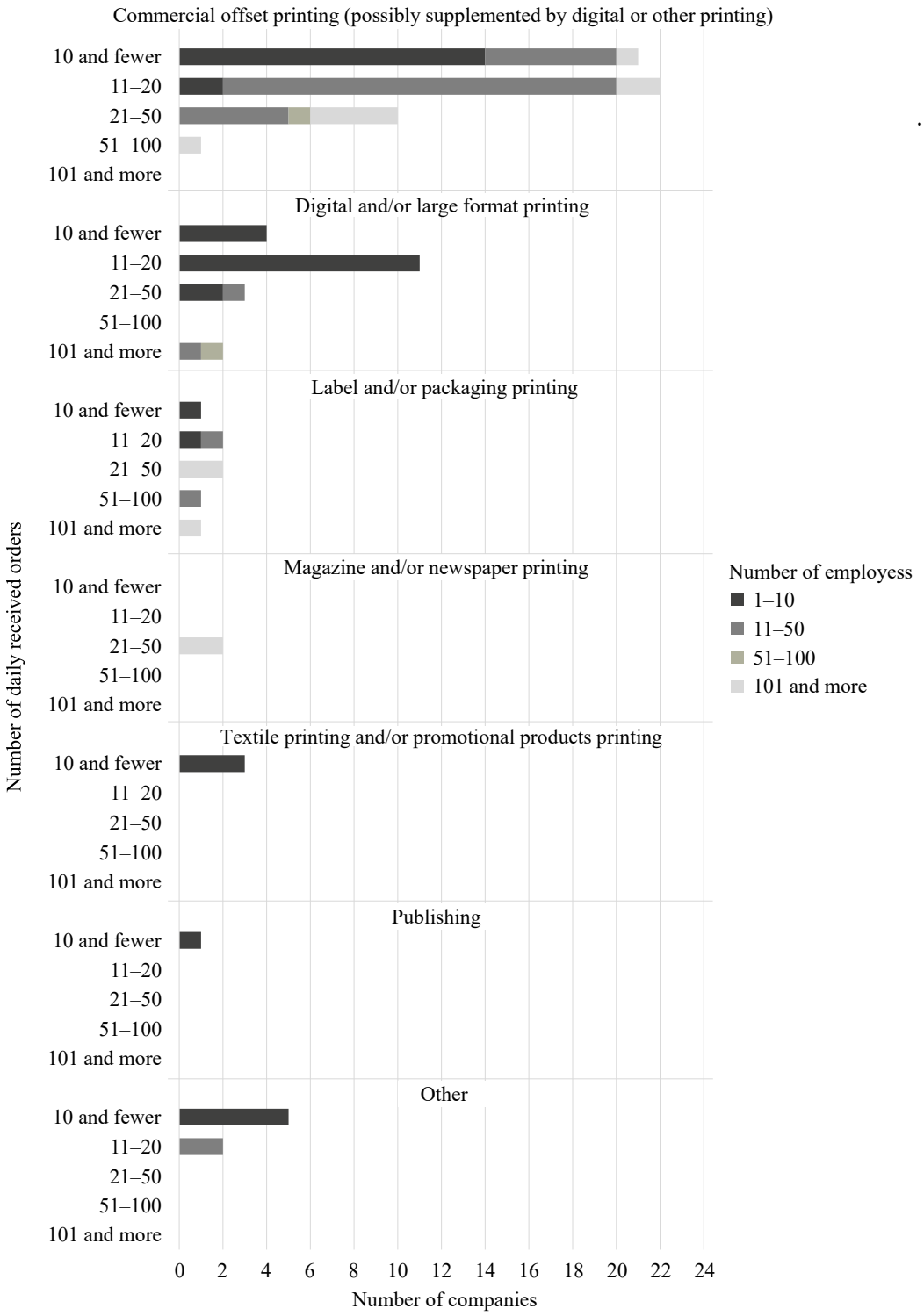


Fig. 20: Survey responses to the question: On average, how many orders do you receive per day?, represented according to the main type of production and number of company employees

4.4 Support of graphic designers or client/customer in the preparation of printing data

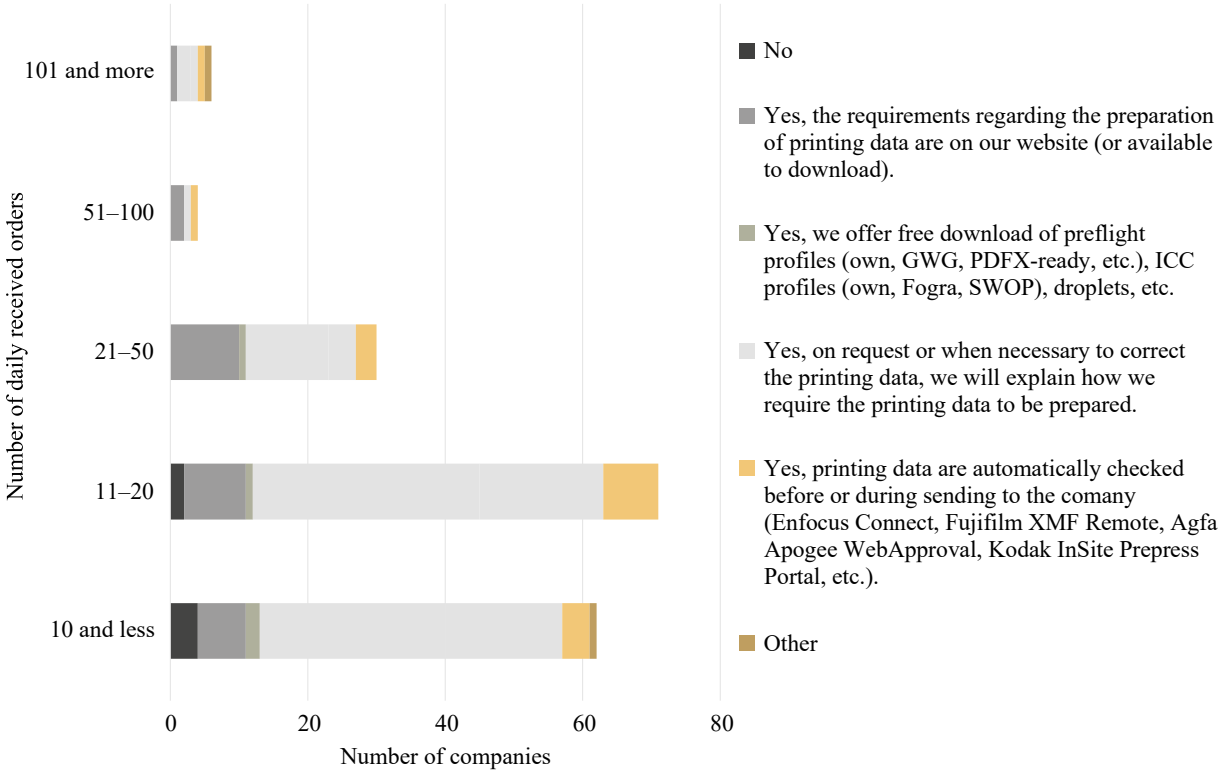


Fig. 21: Survey responses to the question: Do you support graphic designers or customers in preparing printing data?, represented according to the number of daily received orders

Fig. 21 shows how and whether companies support graphic designers or customers in preparing printing data. Besides, the graph is designed to show a potential difference in the approach of companies with more daily received orders. The answer "Yes, on request or when necessary to correct the printing data, we will explain how we require the printing data to be prepared." has a similar representation for companies receiving per day to 50 orders. With a higher amount of orders, it is slightly lower. However, the sample of companies receiving more than 50 orders per day is considerably smaller and thus less representative. When considering only the companies that have checked this option as the only answer, the frequency gradually with slight fluctuations decreases with an increasing number of daily processed orders.

On the contrary, communicating information via a website generally show an increasing trend with the growing number of processed orders. The use of automatic preflight has a larger representation only in companies that process large volumes of orders (more than 50 per day), yet it appears across all categories. The respondents, who do not provide any kind of support, process a small number of orders a day only. Also, a few companies offer profiles or droplets for download; this option is used the least. Several companies stated that they solve the situation with their graphic studio, where they process orders without having to deal with how to graphic designers or customers in the creation of printing data.

The results show that the support of graphic designers or customers from the side of companies could be better, thus avoiding a certain percentage of errors in the preparation of printing data. Companies should consider sharing more information, for example, on websites, on how they require to prepare printing data, since it usually is individual. This option should be an absolute standard, which is not. Offering preflight profiles, ICC profiles, or droplets could solve many misunderstandings between the client/customer and the company and reduce the percentage of issues arising due to the lack of communication between the parties involved in the data preparation. Automatic preflight before or when sending data to a company could be one of the most efficient solutions.

4.5 Problems in different prepress areas

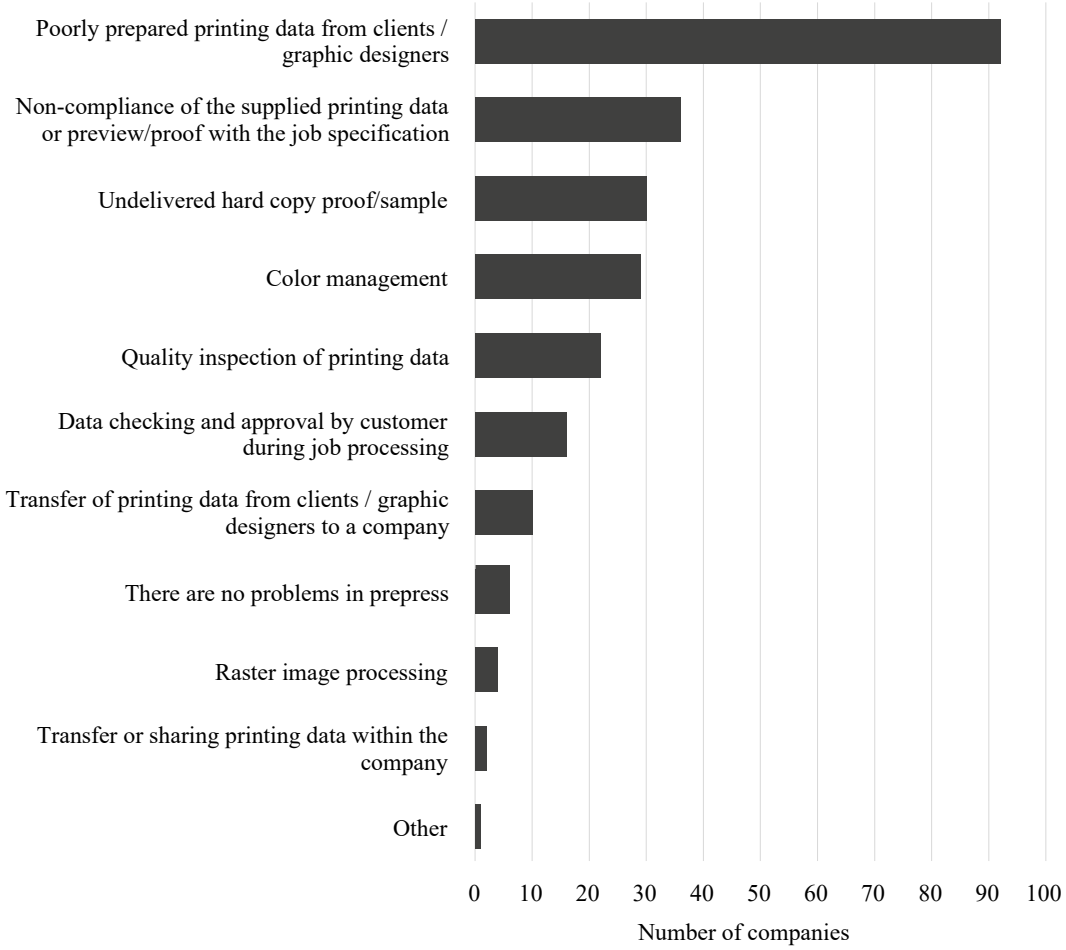


Fig. 22: Survey responses to the question: In which areas of prepress you encounter problems?

Another part of the survey concerned problems in prepress (Fig. 22). Almost all respondents encounter problems with poorly prepared printing data. Up to some extent, this can be solved automatically using preflight and data fixing software. The second and third most frequent problems cannot be solved automatically; however, they can be significantly reduced by improving the communication with client/customer. The following four areas are more on

the company side and can be more or less automated to reduce the number of issues. Very few problems were reported in the remaining two areas. Besides the predefined options, one company mentioned a problem with the data preparation for metallic colors.

4.6 The frequency of selected problems

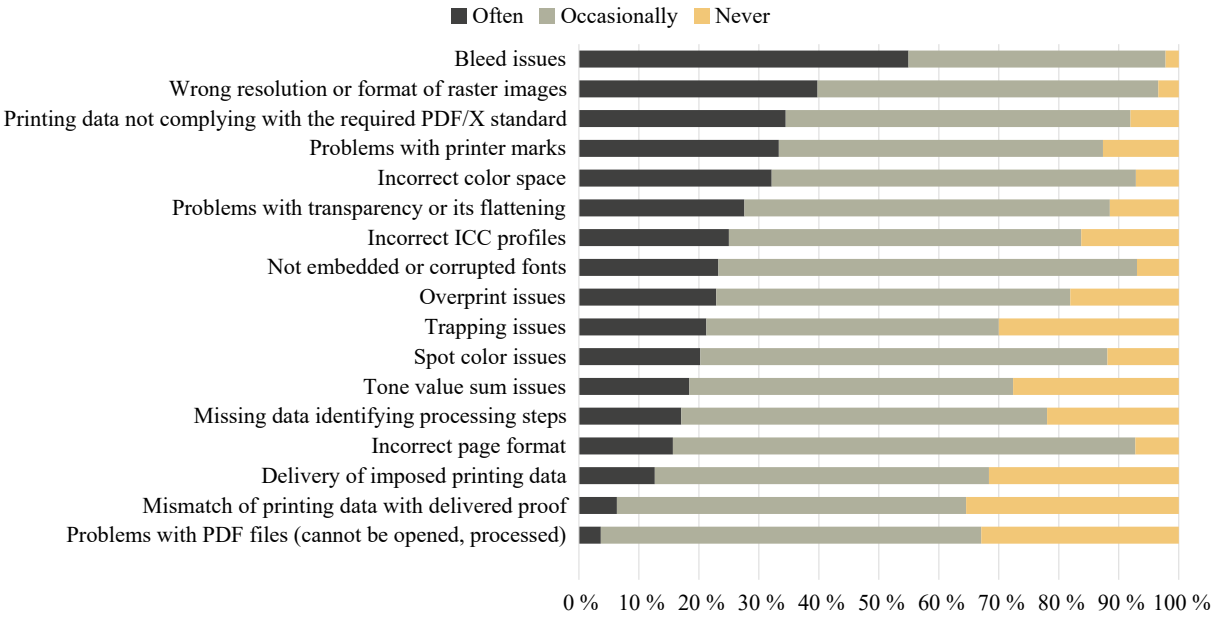


Fig. 23: Percentage representation of survey responses to the question: If you answered "Poorly prepared printing data from clients / graphic designers" in the previous question, please specify how often you encounter each type of problem.

As already mentioned, survey responses to the previous question confirmed that poorly prepared printing data are the most common problem in prepress. Based on the surveys conducted by GATF [72, 73] and GWG [71], this was expected; therefore, the following question addressed this problem in more detail. The results are presented in Fig. 23. The most frequent answer across all categories except bleed issues was that the problem occurs occasionally. In most cases, therefore, it is relevant to consider the responses "often" and "never".

The most common problems are bleed issues and wrong resolution or format of raster images with the highest percentage of responses "often" and the lowest percentage of responses "never". The other categories with less than 10 % of responses "never" include problems with printing data not complying with the required PDF/X standard, incorrect color space, not embedded or corrupted fonts and incorrect page format. So the problems in these six categories belong to those that are, at least from time to time, encountered by almost all companies.

The two least common types of problems are problems when PDF files cannot be opened or processed and when printing data does not match with delivered proof. These categories show the lowest percentage of responses "often" and the highest percentage of responses "never".

The other problems never encountered by almost one third of respondents include the issues related to the imposed data, trapping and the tone value sum.

4.7 Time needed to solve the problems

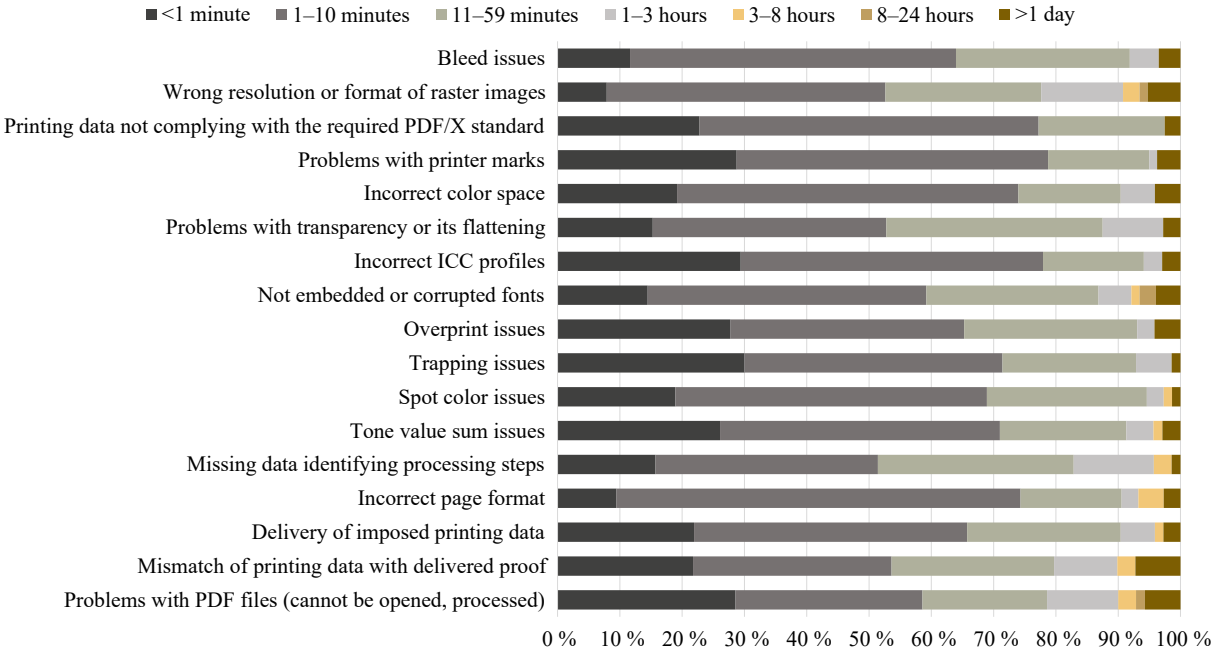


Fig. 24: Percentage representation of survey responses to the question: How long does it typically take you to solve the problems you sometimes encounter according to the previous question?

In the next part of the questionnaire, respondents were asked how time-consuming it is to solve the problems related to poorly prepared printing data. There were several choices from less than 1 minute to more than 1 day. As shown in Fig. 24, on average, the highest number of respondents can solve these problems in 1–10 minutes. Other large groups are "<1 minute", and "11–59 minutes". The results indicate that the majority of companies solve the problems in an automated or semi-automated way. Dealing with the problems, which take more than 10 minutes to be solved in almost one-half of responding companies, and approximately 20 % of respondents even need more than an hour, seem to be less automated. Among these, the most time-consuming is to deal with the missing data for processing steps, problems with transparency or its flattening and wrong resolution or format of raster images; this issue also has the lowest percentage of responses "<1 minute".

4.8 The ways of solving the most common problems

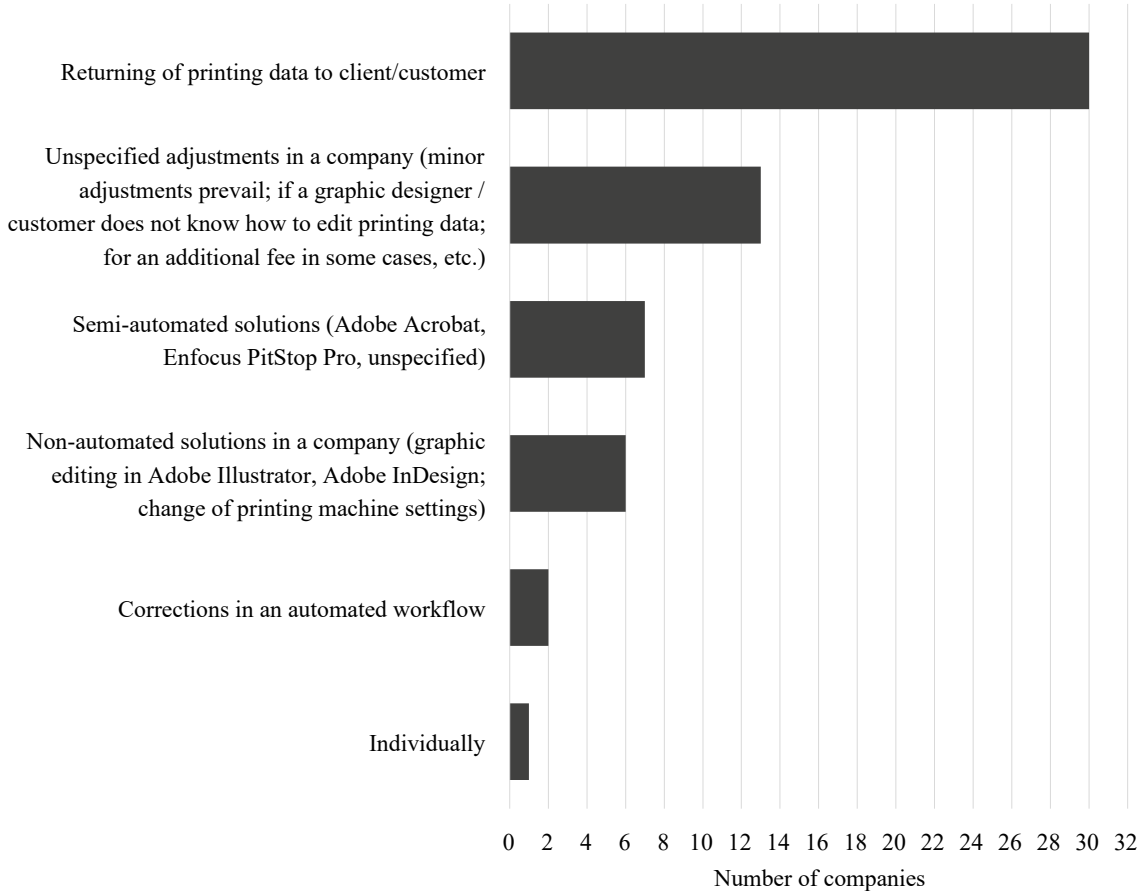


Fig. 25: The summary of survey responses to the optional open question: How do you solve the most common problems in prepress?

This optional question was answered by 53 respondents (56 %). As illustrated in Fig. 25, in most cases, respondents reported that poorly prepared printing data are returned to the customer or graphic designer. "Therefore, a question is whether respondents who only quickly returned poorly prepared printing data to the customer did not check a quick solution to the particular problem." It was found out that the vast majority of respondents who responded that always returning printing data to the client/customer for editing also very often reported a very short time for the necessary data corrections. Among their answer to the question „How long does it typically take you to solve the problems you sometimes encounter according to the previous question?" is more than half of the answers „<1 minute" and „1–10 minutes", which is not technically possible. These two responses occurred in more than 50 % of respondents. Therefore, in terms of time needed to solve the problems, the situation may be worse than shown in Fig. 24. Respondents probably checked the time to send the data back to the client/customer

The second largest group includes unspecified corrections of printing data in a company. However, respondents stated they often do so only for minor repairs, if a client/customer does not know how to correct printing data. Some companies charge extra money for printing data fixing. The other approaches include semi-automated solutions for editing printing data, where

Adobe Acrobat and Enfocus PitStop Pro were mentioned, non-automated solutions of graphical editing of printing data in applications such as Adobe Illustrator and Adobe InDesign, and changing printing machine settings. Only two respondents replied that they solve problems in prepress with an automated workflow. The responses show that respondents mainly commented on the part of poorly prepared printing data.

4.9 Time for checking and processing correctly prepared PDF file

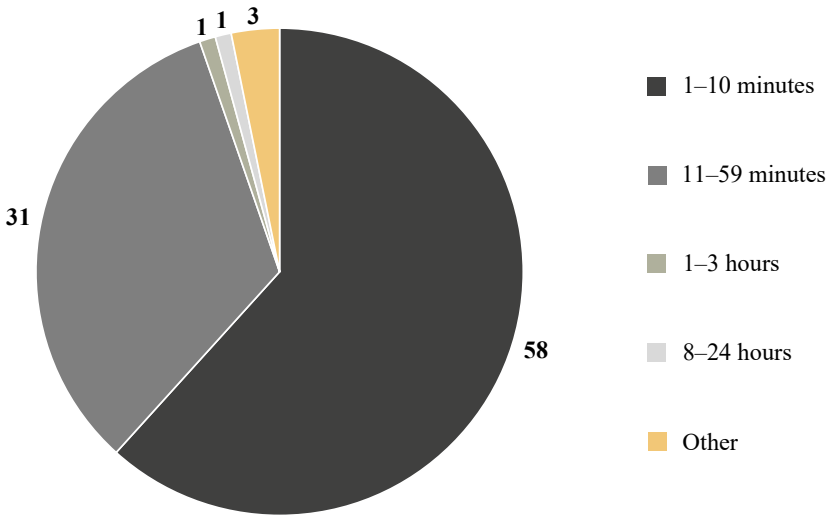


Fig. 26: Survey responses to the question: How much time does it approximately take you to check and process a correctly prepared printing PDF (from its receiving up to raster image processing)?; only the options with at least one answer are included

Another question concerned with the time needed to check and process a printing PDF. As can be seen in Fig. 26, almost two thirds of respondents reported that they can do it in 1–10 minutes, and almost one third in 11–59 minutes. Only a few respondents reported longer time; the options "3–8 hours", and "more than 1 day" remained unused. Two respondents noted that it cannot be generalized, due to the diverse production. A different time takes a multi-page brochure and a flyer.

From the results, companies seem to be able to process correct PDFs within the companies quickly. It confirms that the low efficiency in prepress is mostly caused by poorly prepared printing data that need correction, which is often due to the lack of communication between a client/customer and a company.

4.10 Number of jobs with poorly prepared printing data

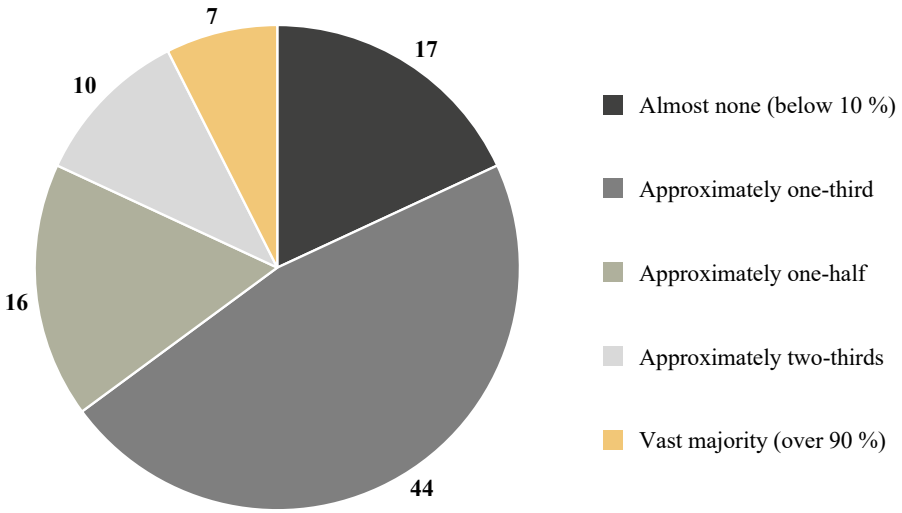


Fig. 27: Survey responses to the question: How many jobs are delivered with poorly prepared printing data?; only the options with at least one answer are included

When examining how frequently the companies encounter jobs with incorrect printing data, almost half of the respondents reported that this happens in approx. one third of cases; for about one third of respondents, it even makes a half or more jobs (Fig. 27). The options "None" and "All" remained unused.

4.11 Workflow systems used in prepress

Another question concerned workflow systems in prepress. Figure 28 is designed to show the use of individual prepress workflow systems across the market segments. Largest group of respondents do not use any workflow system, but only independent programs and different modules from different manufacturers, which can communicate with each other in some cases, but connection may be complicated. Of the systems themselves, Heidelberg Prinect is the most widely used among the respondents. Other workflow systems commonly used in the Czech Republic are relatively balanced in numbers. Interestingly, some companies use their tailored-programmed workflow system and one company stated that they use three workflow systems. The situation among printing companies is quite satisfying. The responses suggest that almost every second company uses a prepress workflow system, while the second half uses independent programs and different modules from different manufacturers. Interestingly, Xerox FreeFlow Core has been checked by three commercial offset printing companies, even though this workflow system is most effective for digital and large format printers, however, Xerox presses can supplement offset printing machines in these companies. Esko Automation Engine, which

is the most suitable for label and packaging printing, was also checked by one respondent from the group of commercial offset printing companies. The options HP PrintOS, Ricoh TotalFlow, Canon Prisma, Dalim Twist/ES, and Helios Software solutions remained unused; among the other systems, one respondent reported the use of Caldera Nexio.

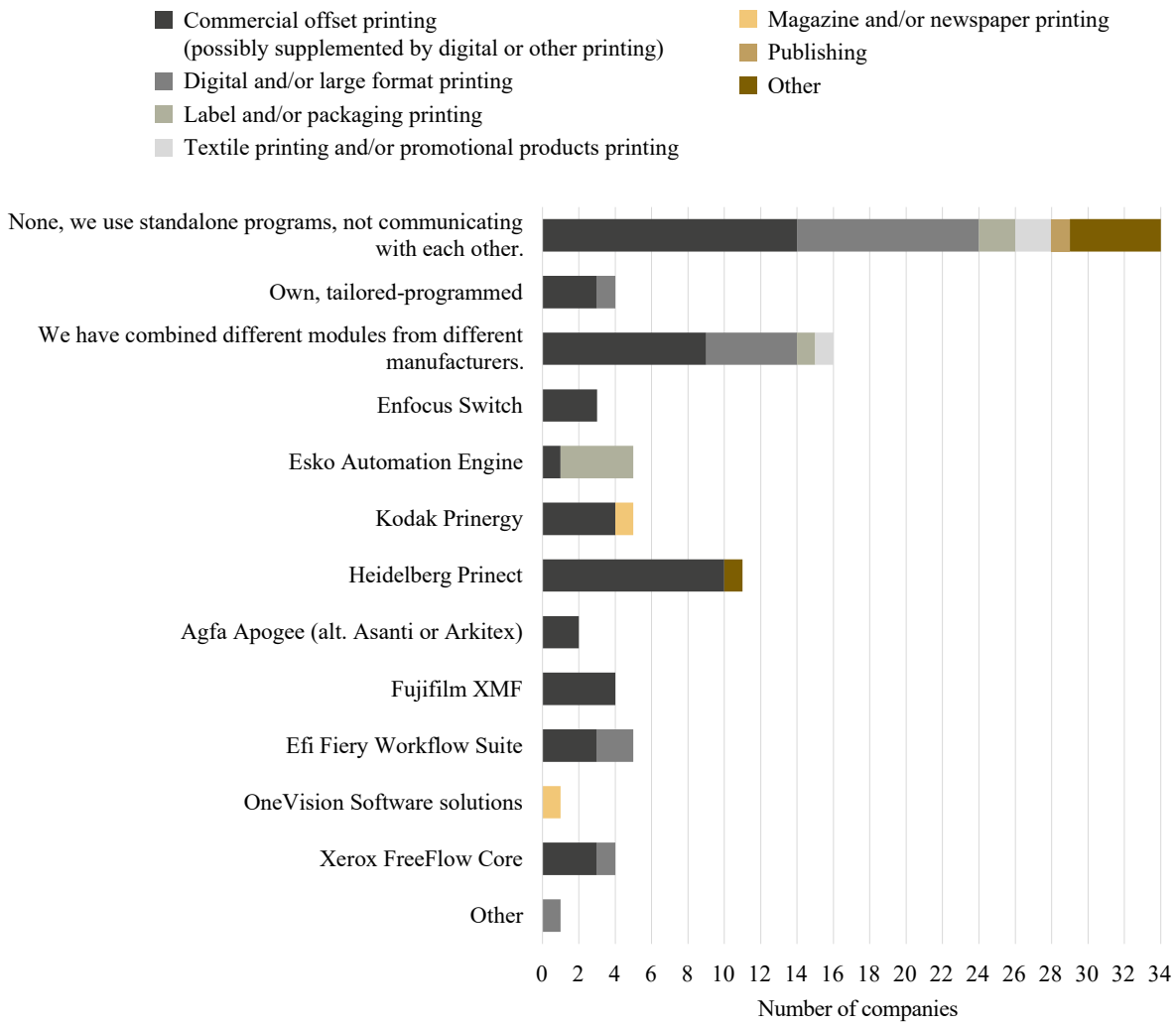


Fig. 28: Survey responses to the question: Which workflow system do you use in prepress?, represented according to the main type of production; only the options with at least one answer are included

4.12 Preflight and corrections of printing data

Another question concerned preflight. Figure 29 is designed just like previous, to show how different types of companies carry out preflight. The most commonly used software is Adobe Acrobat, followed by Enfocus PitStop Pro. Almost a quarter of respondents reported that they only carry out a visual data check, which can cause the most problems.Although almost half of the respondents reported that they use a workflow system, only 13 use built-in preflight; that is less than every third of them. These results show that companies likely do not use all functions of workflow systems. Only several respondents use Enfocus

PitStop Server and Callas pdfToolbox Desktop or do not preflight and fix data at all. Some companies carry out preflight differently, among the answers are for example CGS ORIS PDF Tuner, Alwan Color Expertise, CorelDRAW, and other not fully specified or confusing information. Although Callas pdfToolbox Desktop and Enfocus PitStop Pro are applications with a similar purpose, much higher use of the Enfocus PitStop Pro can be seen among the respondents. This may be because there is no Callas pdfToolbox Desktop reseller on the Czech market, while Enfocus PitStop Pro is sold, for example, by Amos Software.

Interestingly, commercial offset printing companies use predominantly Enfocus PitStop Pro and Adobe Acrobat, while digital and large format printers use mostly Adobe Acrobat and do not preflight, nor they fix data (only a small number of them use Enfocus PitStop Pro). The options Markzware FlightCheck and Callas pdfToolbox Server remained unused.

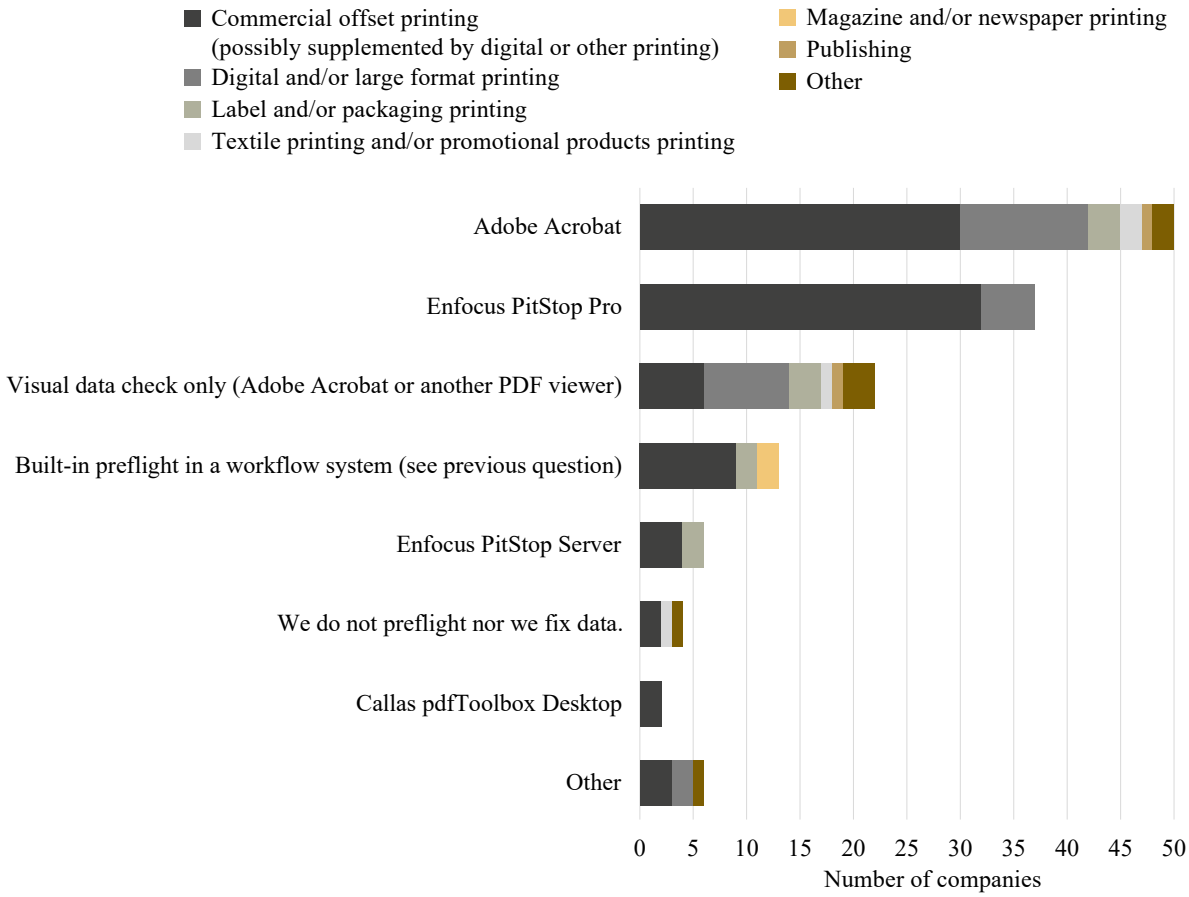


Fig. 29: Survey responses to the question: How do you do preflight or fix printing data?, represented according to the main type of production; only the options with at least one answer are included

4.13 Coverage of other prepress areas except preflight

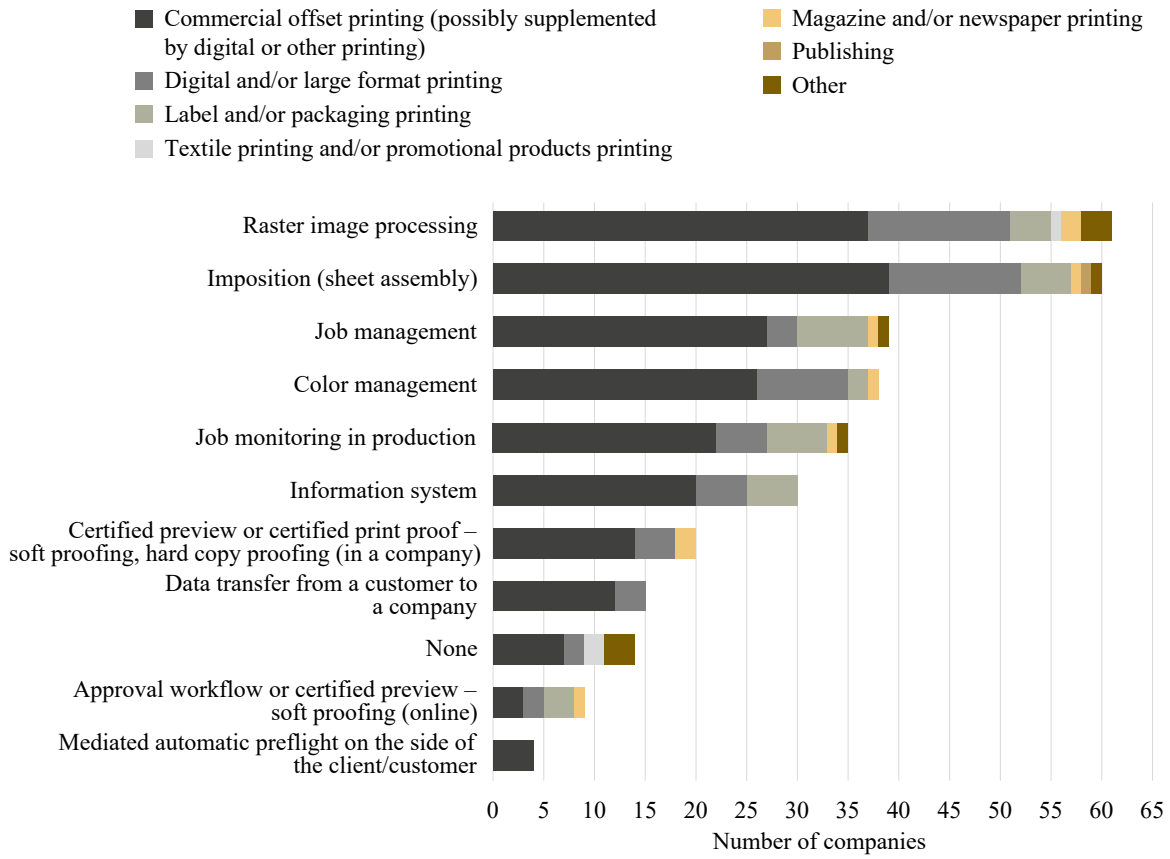


Fig. 30: Survey responses to the question: Which other areas of prepress except for preflight do you have software covered?, represented according to the main type of production; only the options with at least one answer are included

The following question concerned software coverage of other prepress areas (Fig. 30). Respondents were supposed to state which additional areas have covered in addition to the preflight. Overall, the highest software coverage is seen in raster image processing and imposition, but still only about two-thirds of respondents reported they carry out raster image processing and imposition, even though these software solutions should be the basic equipment of any printing company, besides the preflight.

Job management, color management, job monitoring in production, and information system are covered in less than half of companies. Less than a quarter of the respondents reported that they have a software covered certified preview or proofing in a company, and data transfer from a customer to a company. Least respondents have covered approval workflow or certified online soft proofing and mediated automatic preflight on the side of a client/customer. Some respondents reported that they cover nothing except preflight, which can fundamentally delay jobs. This is especially significant for companies that receive 10 and fewer orders per day.

Most digital and large format printers use raster image processing and imposition software, slightly less color management, and other areas are not well covered, while among commercial

offset printing companies the difference is less significant. For label and packaging printing companies, the situation is even more balanced. It is also interesting that companies a little more offer certified preview or certified proofing in a company than approval workflow or certified preview online. In some cases, for example, for expensive or complex jobs, offline solutions have advantages, but online solutions can significantly reduce job processing time and may be often sufficient.

Overall, software coverage could be better; it would help companies with faster and more automated processing of printing data. More attention to prepress software should be definitely paid by digital and large format printers.

4.14 Specific programs and modules

In this optional question, respondents were asked to answer which specific programs and modules do they use for the prepress areas given in the previous question (see Fig. 30). Unfortunately, greater involvement of companies was expected for this question. Only 30 companies answered the question. Some of them stated, for the second time, which software do they use for preflight, although it was not required. Therefore, only a few additional software solutions were obtained.

Interestingly, one company that offers mediated preflight and sending data to their company using Enfocus Connect reported that clients/customers are not interested in it and prefer to send data to the company on their own.

Concerning job management, one company mentioned KHS-AI software. It is a system from Komori that receives job data from the information system and integrates control of the press [441]. It is, therefore, more print automation software than prepress automation software. Another company mentioned Microsoft Excel, which is software that can only be used to process a small number of orders. Some respondents did not name modules directly but only wrote that their prepress workflow system covers the necessary areas (Esko Automation Engine modules, Heidelberg Prinect modules, XMF Workflow modules). All other software solutions are summarized in Tab. 6.

Tab. 6: The summary of survey responses to the optional open question: Which specific programs and modules do you use for the mentioned prepress areas?

Mediated preflight	Imposition	Color management	Raster image processing	Job management	Information system	Workflow system
Enfocus Connect	PLDA	Konica Minolta Color Centro	Harlequin RIP	KHS-AI	Own information system	Esko Automation Engine modules
×	PLDA	Konica Minolta Color Centro	ONYX RIP	Microsoft Excel	CICERO	Heidelberg Prinect modules
×	PLDA	PressPerCent	Prinect MetaDimension	×	×	Fujifilm XMF workflow modules
×	PLDA	basICColor gHOST	×	×	×	×
×	PLDA	×	×	×	×	×
×	Kodak Preps	×	×	×	×	×
×	Kodak Preps	×	×	×	×	×
×	Kodak Preps	×	×	×	×	×
×	Quite Imposing	×	×	×	×	×
×	Quite Imposing	×	×	×	×	×
×	Prinect Signa Station	×	×	×	×	×
×	Prinect Signa Station	×	×	×	×	×

× not answered

4.15 Simplifying routine work in prepress

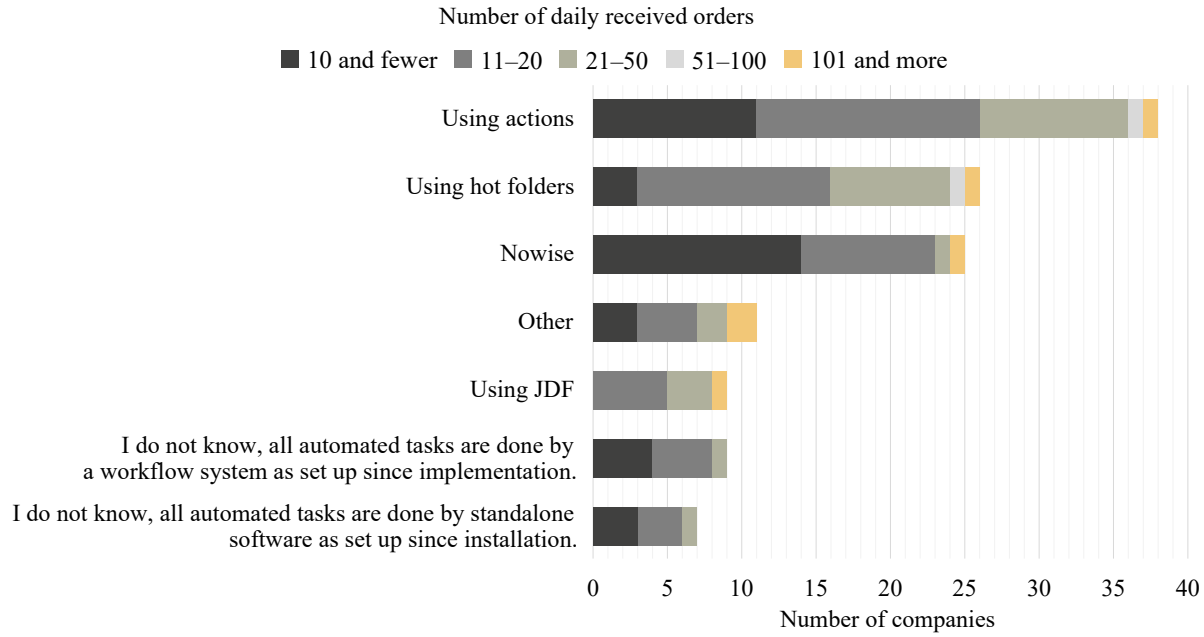


Fig. 31: Survey responses to the question: How do you simplify routine work in prepress?, represented according to the number of daily received orders

Another question concerned automation; the graph in Fig. 31 is designed to show how the trend of automation is changing with the different amounts of daily received orders. Most respondents stated using actions, which means using Action Lists in Enfocus PitStop Pro, preflight profiles, batch processing in Adobe Acrobat, Callas pdfToolbox, etc. While this is not a fully automated solution, it can greatly speed up work. Some respondents noted in the answer other ways, such as definition of keyboard shortcuts, setting appropriate programs for easier operation, etc. A large number of companies also use hot folders; there is a smaller representation of companies that process 10 or fewer orders per day though.

Group of respondents who use JDF format for automation is smaller. However, none of the respondents reported using a different format, such as XML or CSV, in their company (the question was not asked directly, but it was possible to write own answer). The reason is probably that these formats (including JDF) are mostly processed by workflow systems set up since implementation. This is also reflected in the fact that several respondents answered they do not know, because all automated tasks are done by standalone software or workflow system as set up since implementation.

More than a quarter of companies do not deal with prepress automation at all, even though prepress is a part of the job that can be widely covered by automation. On the contrary, it seems that the highest number of companies try to deal with automation at least partially, using actions or hot folders. However, they do not utilize the advantage of other options, such as metadata forwarding. It is important to realize that for companies, which do not receive many orders a day, complete automation may not be a goal or a suitable investment. When comparing groups of respondents according to daily processed orders, it is clear that companies with an increasing number of received orders try to deal with automation more.

4.16 Respondents' familiarity with standards and specifications

In the next question, respondents were asked which PDF standards and specifications are they familiar with (Fig. 32). Almost every respondent is familiar with PDF/X standards, while PDF/X Plus specifications are much less known among respondents. Looking back at the results shown in Fig. 21, the answer "Yes, we offer free download of preflight profiles (own, GWG, PDFX-ready, etc.), ICC profiles (own, Fogra, SWOP), droplets, etc." was very underrepresented. The answers to this question explain the reason for that. It is logical that if respondents do not have sufficient knowledge in this sector, nothing can be provided to clients/customers. When companies begin to deal with it, a substantial decrease in error rate can be expected for printing data they receive.

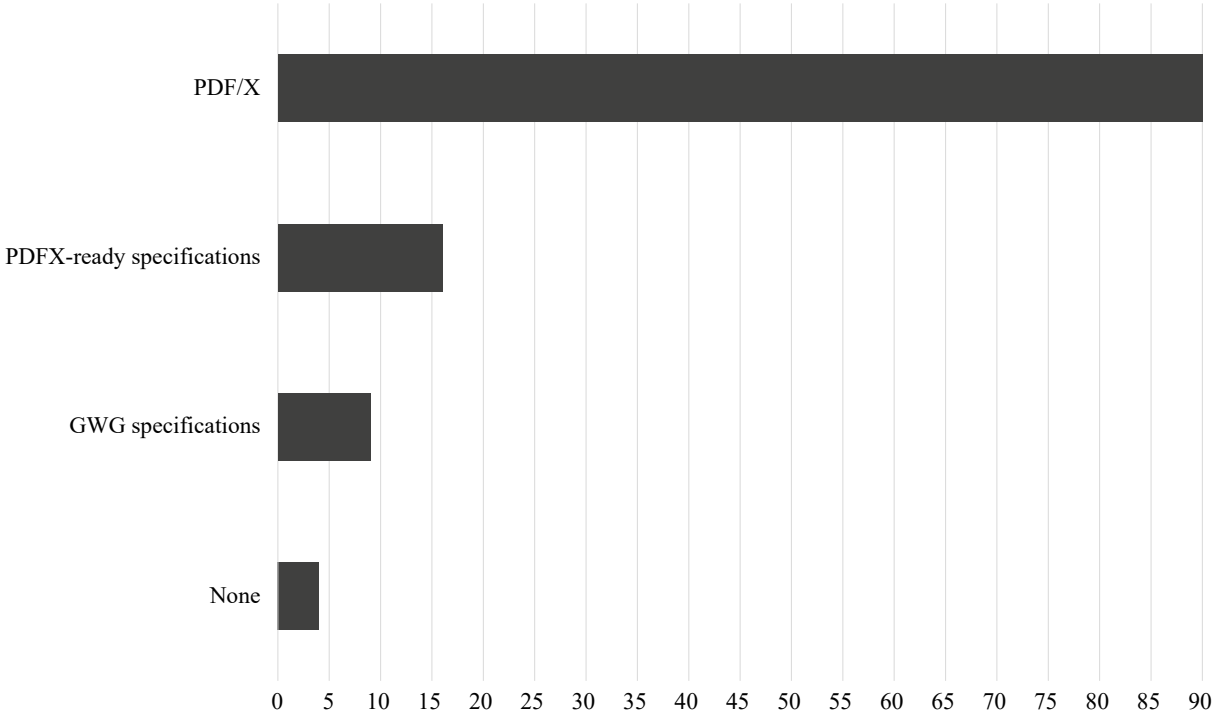


Fig. 32: Survey responses to the question: Which PDF standards and specifications are you familiar with?; only the options with at least one answer are included

4.17 PDF standards and specifications used by respondents

The last question also concerned standards and specifications, but respondents were asked which PDF standards and specifications do they use. Most respondents reported the use of PDF/X-1a:2001 standard. This corresponds to the statement that PDF/X-1a:2001 is the most widespread of the PDF/X standards in the Czech Republic [1, 12, and 56]. PDF/X-4 is also a widely used standard, or at least companies can process it. Respondents who checked PDF/X-4 often also checked PDF/X-1a:2001. It is, therefore, logical that companies working with PDF/X-4 standard should be able to process the older standard, PDF/X-1a:2001. Respondents could have also fill other standards and specifications, but none of the respondents used this option; therefore, other PDF/X standards are unlikely to be used often. About a third of respondents reported using their own setting (based on standards/specifications). This may be due to specific technical requirements that do not cover any specifications, or unfamiliarity with PDFX-ready and GWG specifications. Some respondents also reported that they do not edit received printing data and print what the customer sends. This method is not reliable nor recommended. Each company should be in control of what data customers send. Only several respondents use PDFX-ready V1.3, PDFX-ready V2, and GWG2015 specifications. The options with the other specifications (GWG 1v4 and GWG2012) remained unused. In terms of specifications, the situation in the Czech market is poor, and almost no companies use it in the printing industry.

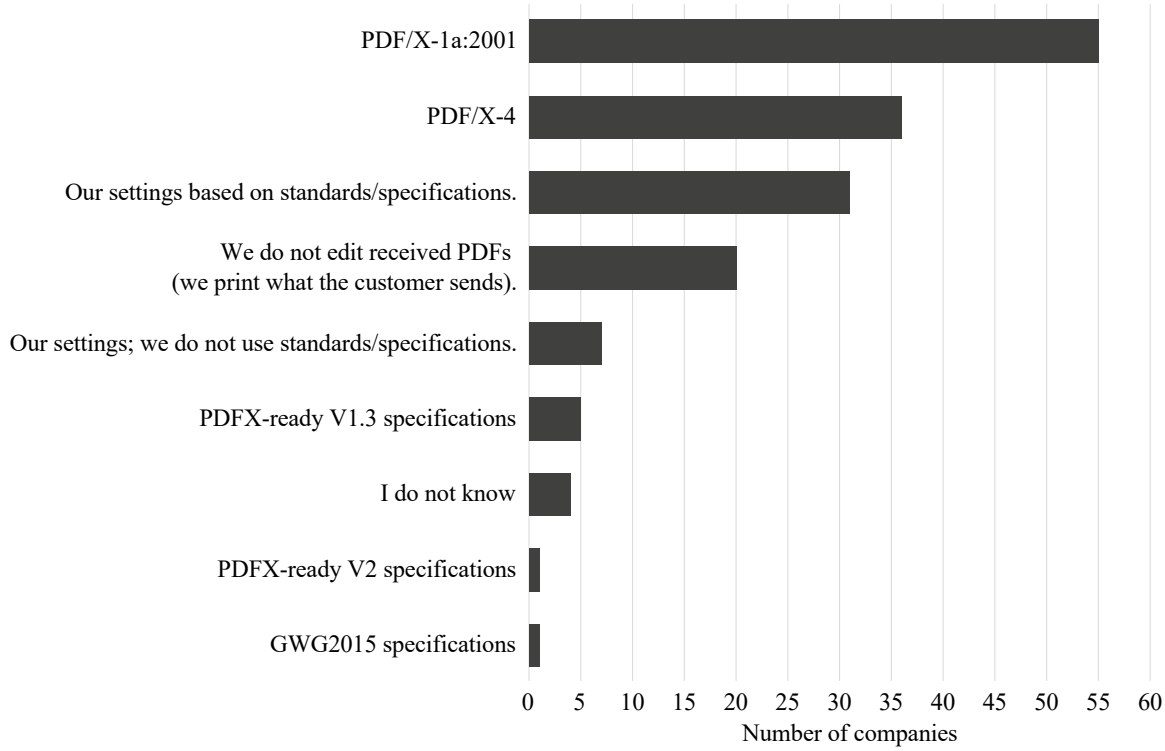


Fig. 33: Survey responses to the question: Which PDF standards and specifications do you use in your workflow?; only the options with at least one answer are included

4.18 Summary of the survey

There was quite an interest in the survey, altogether 426 companies were addressed of which 94 completed it. It is approximately 22 % of the addressed companies. From 94 companies, 13 of them asked for results, which is almost 14 % of participating companies. This may indicate the interest of these companies in education in prepress. It should be mentioned that the evaluation of the survey was quite complicated due to the inconsistent use of terms. For example, the survey included answers that companies perform preflight using PLDA, Adobe Illustrator, Adobe Photoshop, CorelDRAW, etc., which may be the case for the last three, but preflight can be done only manually and only if the company accepts the source data. Similarly, in terms of workflow systems, companies referred to Quite Imposing or Adobe Acrobat, which are not workflow systems but only applications for a certain part of the prepress. For PDF standards and specifications used, some respondents provided information such as PDF version 1.3 (Acrobat 4) or Fogra 32, indicating a misunderstanding of the question. Similarly, when asked if companies support graphic designers or client/customer in the preparation of printing data, there was an answer that a company uses Enfocus PitStop Pro in a company, which may indicate that the company is not aware about the possibilities of support and checking the printing data before they arrive. In this case, Enfocus PitStop can be incorporated into own solutions, e.g. W2P, etc. (for example, in the CLI variant). Some companies repeatedly try to consult problematically prepared printing data with customers; however, from the author's own

experience with real jobs, preventing these problems by using appropriate application or portal seems to be a more effective option. It would be good to educate graphic arts workers in this regard, since understanding the issue can facilitate a large amount of work.

It is worth mentioning that although there are many tools for prepress and its automation that simplify job processing, some companies still try to control the entire workflow manually, some of which probably do not know the possibilities at all. If companies have some software tools available, they do not make full use of them, which means that many companies return badly prepared files to the customer, although the vast majority of problems can be prevented or repaired automatically and then remotely approved of corrected by the customer. On the other hand, some companies are well informed about prepress and its automation.

5 Number of installations of prepress software and additional information from suppliers and distributors

In the next part of the work, the suppliers and distributors of the selected solutions were asked how many individual software installations they sold in the Czech Republic. The results are summarized in Tab. 7. Some representatives also provided additional information, also included in Tab. 7.

Tab. 7: Information from suppliers and distributors of selected applications and workflow systems

Prepress software	Number of installations in the Czech Republic	Additional information
Esko Automation Engine[1]	30–40 installations	25 Automation Engine installations by Macron systems, of which 15 in full Automation Engine configuration
Fujifilm XMF[2]	25 installations of XMF Workflow; 10 installations of XMF Gateaway	There are no installations of XMF Remote and XMF ColorPath in the Czech Republic.
Enfocus Switch[3]	< 20 installations	Worldwide, up to 10 000 installations are sold every ear. Most installations in Europe have Benelux and Germany, but from Eastern Europe, the Czech Republic and Poland have the most installations.
Enfocus PitStop Server[3]	Tens of installations	Often sold with Enfocus Switch in bundle
Enfocus PitStop Pro[3]	Thousands of installations	Used not only by printing companies, but also by graphic designers
Enfocus Connect[3]	< 10 installations	Enfocus Connect is not very well sold.
Xerox Free Flow Core[4]	> 32 installations	In some cases, Xerox supplies Xerox Free Flow Core as a bundle with printing machines, at a more affordable price. These installations are not included.
Canon PRISMA workflow software[5]	Strictly internal information	**N/A**
OneVision Software[6]	1	Due to its price, OneVision Software is almost unsaleable on the Czech market; 95 % of customers using some prepress workflow in the Czech Republic would not use OneVision Software namely, Asura module and, according to Valido findings, probably do not even need it. The structure of OneVision products is complicated; for example, Asura exists in several versions, and functional modules and service packages are then purchased additionally.
Efi Metrix Planning and Imposition Software[6]	Probably none	**N/A**

N/A no information

[1]T. Nejedlík (email communication, January 20 to April 4, 2020); [2] V. Matuštík (email communication, January 20 to March 2, 2020); [3] V. Macejka (email communication, January 20 to March 3, 2020); [4]M. Šaněk (email communication, March 5 to April 4, 2020); [5]M. Plaček (email communication, January 22 to March 31, 2020); [6]M. Spurný (email communication, April 27, 2020)

6 Comparison of selected prepress operations using different automation tools

As two of the issues examined in this part of the practical work that tests the options of automated prepress solutions, the problems with printer marks and bleed, were chosen because they belong to the most common ones. The third issue in focus concerns the problems with the missing data for processing steps. Although this problem does not belong to those encountered most often, it is still rather common, and at the same time it turns out as being more difficult to automate according to the survey results (see Chapter 4). The companies could thus benefit from learning about the available automation possibilities in more detail.

Adobe Acrobat X Pro, Callas pdfToolbox Desktop 11, Xerox FreeFlow Core 5.4.1, Enfocus PitStop Pro 2020, and Esko Automation Engine 18.1.0 were selected to compare automation options among the existing software solutions. In Adobe Illustrator, a bookmark (Fig. 34 and Fig. 35) was created as one example of a job for testing, where partial varnishing of the illustration of screen printing is expected. The illustration was also used separately as the second example of printing data, which is expected to be cut on a cutting plotter or using a cutting die after printing, for example in the form of a sticker (Fig. 36). Default printer marks were deliberately added to printing data for both example jobs and a version without bleed and printer marks was also created for the bookmark (Fig. 35). All objects are vector by default, but raster versions were also created and used during testing. The hand-drawn illustration of the screen consists of many objects, so it seems more difficult to select it automatically for possible modifications.

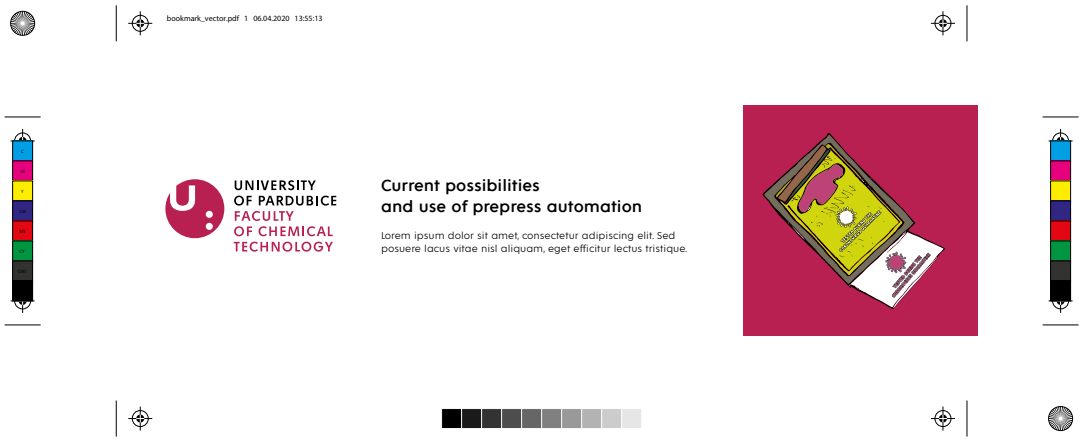


Fig. 34: A preview of the first printing data created for testing – bookmark with the printer marks and without the data for partial varnishing (scale 1 : 2)

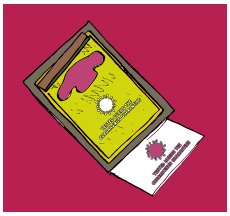


Fig. 35: A preview of the second printing data created for testing – bookmark without the bleed and without the data for partial varnishing (scale 1 : 2)

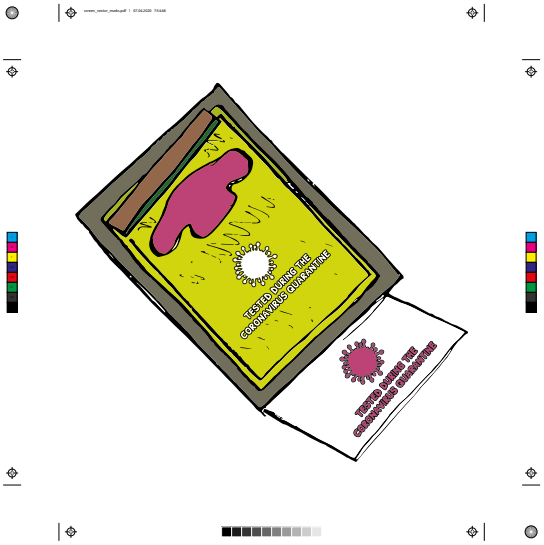


Fig. 36: A preview of the third printing data created for testing – illustration of screen printing with the printer marks and without the data for cutting (scale 1 : 4)

The first aim of testing, common for both examples (Fig. 34 and Fig. 36), is to remove default printer marks (or correct them). The second aim is to add a bleed to the printing data shown in Fig. 35. The third aim is to create a new design element in spot color or in a new layer (or both, it depends on the program and the created workflow) and set it to overprint. In the case of the bookmark, it is the element in the shape of the screen to be varnished, with a fill in the spot color. This is a common method of preparing printing data for varnishing. In the case of the illustration alone, the goal is to add a line around the object to be cut during finishing, with a stroke in the spot color.

6.1 Automation in Adobe Acrobat X Pro

For the first experiment was chosen Adobe Acrobat X Pro. It is an application for working with PDF documents. Its functions important for the purpose of prepress automation can be found in the Tools pane, where the Action Wizard is located, the Navigation pane, where can be imported layers, and the Quick Tools toolbar, where the other suitable tools can be included, for example, Preflight or Edit Object. These panes and toolbar are marked in Fig. 37, showing the Adobe Acrobat user interface. For preflight, it is possible to select or create different

checks (Fig. 38 a) and fixups (Fig. 38 b). These checks and fixups can be combined in profiles (Fig. 38 c). The profiles can then be used within the Action Wizard.

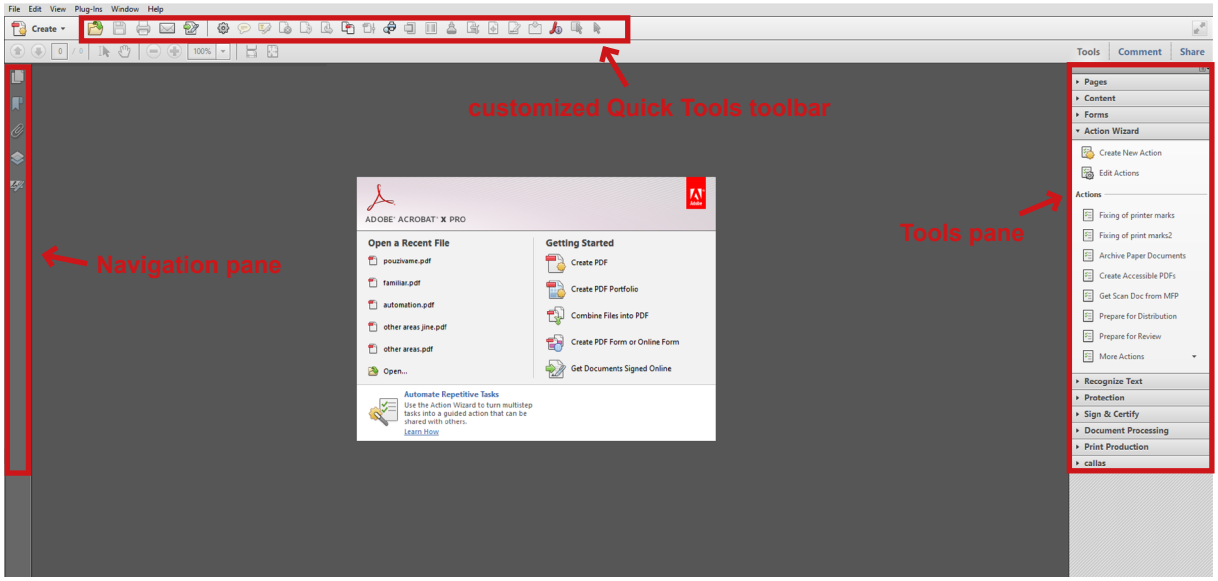


Fig. 37: Example of Adobe Acrobat X Pro user interface including Navigation pane, Quick Tools toolbar and Action Wizard panel in Tools pane

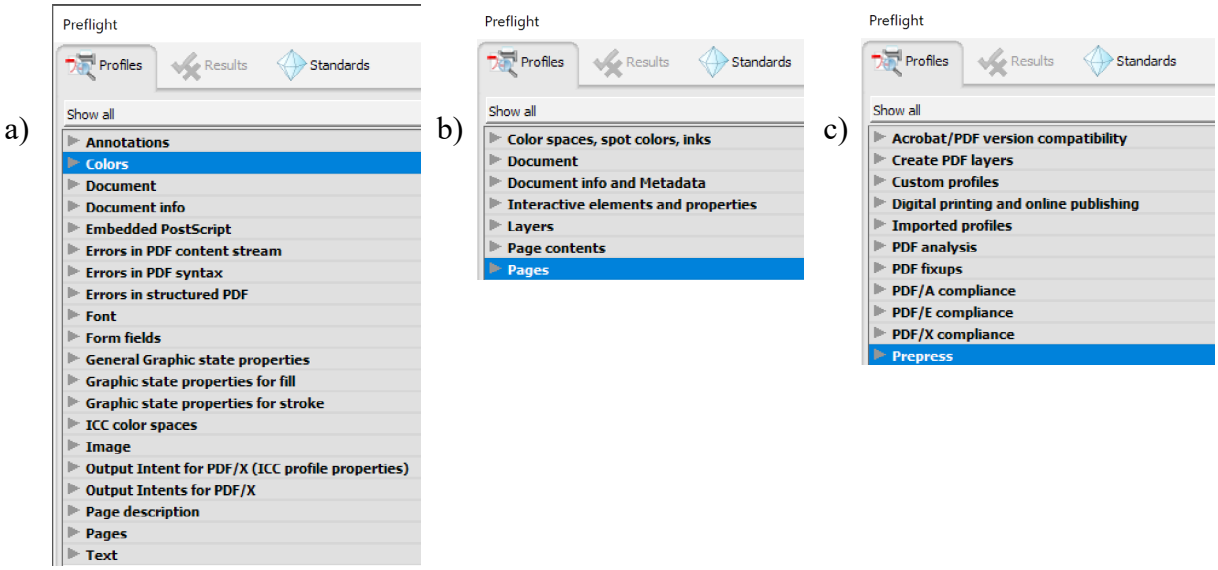


Fig. 38: Example of types of a) checks; b) fixups; c) profiles in Adobe Acrobat X Pro

Improper printer marks can be fixed or removed in Adobe Acrobat X Pro using the Action Wizard. It can be done also without actions, i.e. without any automation, but such a method will not be discussed here. Custom created as well as predefined actions available in the Action Wizard panel are shown in Fig. 39.

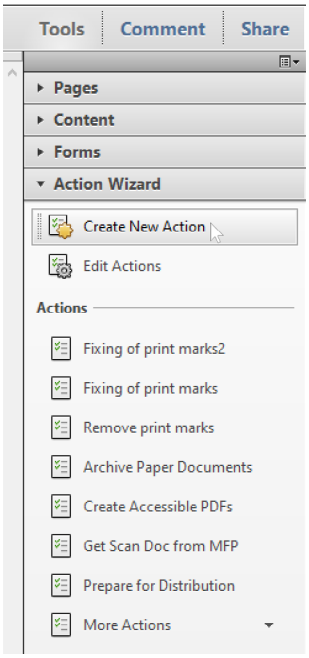


Fig. 39: Example of Action Wizard in the Tools pane of Adobe Acrobat X Pro; the Create New Action command is highlighted

The method is demonstrated using the first version of printing data for the bookmark (Fig. 34). The first step in creating a new action is to click on the respective command (Fig. 39). The definition of the action itself is shown in Fig. 40. It is necessary to define the printing data that should be fixed. From the perspective of automation, it is helpful to set the Adobe Acrobat action to process multiple files that are stored in the selected folder at once. Similarly, a folder to save the corrected data is defined. The individual steps are selected from the list in the left panel. In this example, three steps are used to fix the printing data to meet the assumed requirements: the document with the bleed and crop marks and the corresponding size of the CropBox.

The first step is to remove all printer marks using the corresponding predefined preflight profile. The fixup itself cannot be used, so it is necessary to create a profile from the fixup (based only on the given fixup). A detailed setting is shown in Fig. 41. The second step adds only the crop marks. A detailed setting is shown in Fig. 42 a. In the last, third step, the page is cropped to the size of the TrimBox enlarged by the margins for the bleed and crop marks; the setting is in Fig. 42 b. Once the action is created, all what is needed to do is to paste the PDF with printing data into the appropriate folder and click in Adobe Acrobat to execute the action. All operations run in the background, so there is no need to open the file with the printing data at all. It is only needed to open the wizard and run the action. Figure 43 shows the processed printing data with automatically corrected printer marks and the corresponding CropBox. Another example may be the complete removal of printer marks and cropping the page according to BleedBox. This can be used in cases where the printer marks are not needed at this stage as they will be added during imposition, etc. The procedure would be very similar, only excluding the second step of the action and with the accordingly modified setting for the last step; hence, it is not shown here.

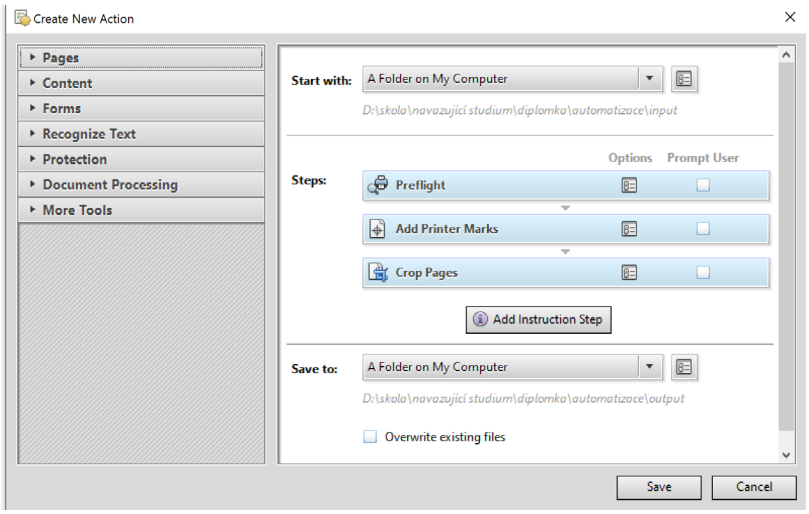
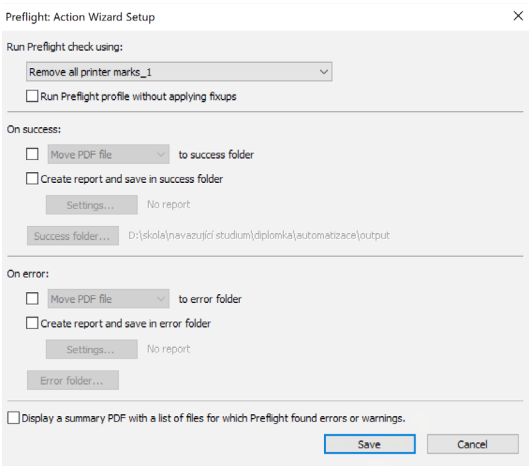


Fig. 40: Example of creating a new action to fix the printer marks in PDF in Adobe Acrobat X Pro

a)



b)

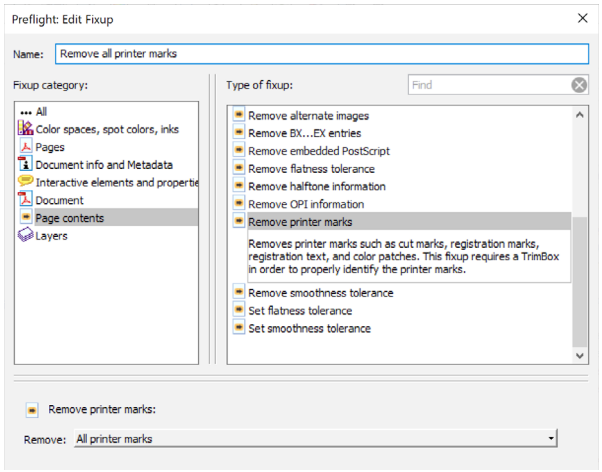


Fig. 41: Example of a) preflight setting to remove all printer marks and
b) detailed setting of the fixup profile of preflight to remove all printer marks in Adobe Acrobat X Pro

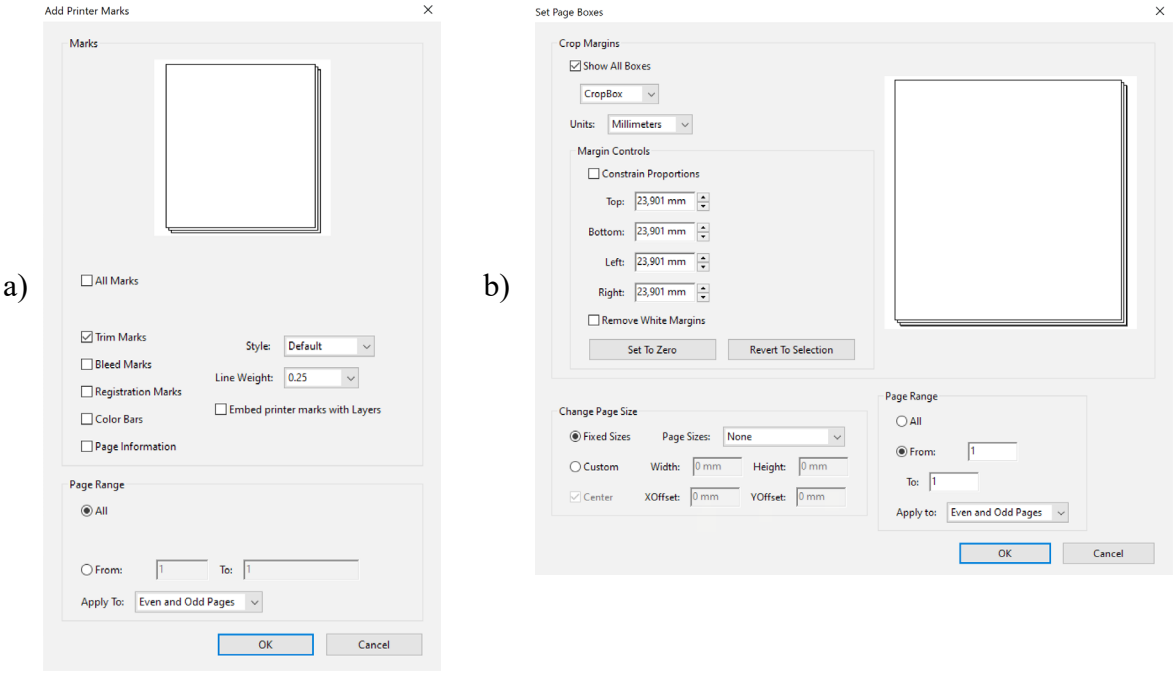


Fig. 42: Example of a) settings to add the trim marks and b) the page boxes settings to crop the page in Adobe Acrobat X Pro

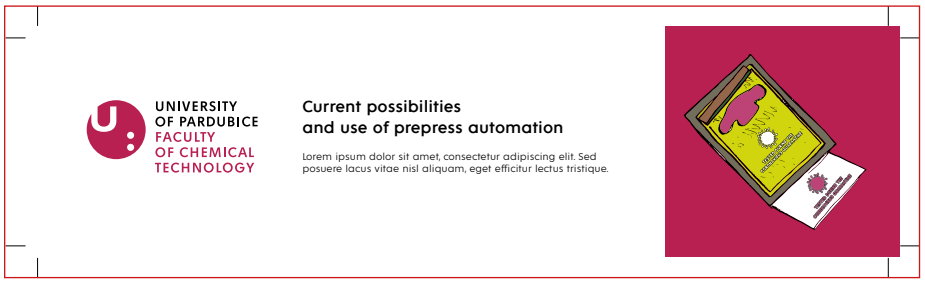


Fig. 43: A preview of the printing data fixed according to the assumed requirements (content with the bleed and trim marks and the corresponding size of the CropBox) using the action in Adobe Acrobat X Pro (scale 1 : 2), the CropBox marked with a red line

In Adobe Acrobat, it is not possible to create missing data for technical elements (varnishing, cutting, embossing, etc.). If the company does not own more sophisticated software for PDF editing, the only solution is to create the missing data for technical elements manually in some graphic software, for example, in Adobe Illustrator. If there are vector objects, which correspond to the area or path for varnishing, cutting, or embossing, the editing of printing data can be completed in a few minutes. From these objects can be created a stroke for cutting or a new, merged object in one specific color for varnishing, etc. However, if the document contains only the raster image or data with flattened transparency without the vector data corresponding to the technical elements in question, the missing data have to be drawn manually or vectorisation can be used. The time needed to accomplish this task depends on the complexity of the design and required precision. It can take up to several tens of minutes or several hours. In this case, it should be considered whether it is not more appropriate to return printing data to the

client/customer. It is also the only option if the company does not have the software enabling to create the desired element. In the case of missing bleed, it is possible to enlarge page size and also the graphics to add bleed, however, it needs manual editing. Similarly, an object for varnishing and cutting could be duplicated and attached to a new layer, but it is not possible to change its color.

6.2 Automation in Callas pdfToolbox Desktop 11

Further, Callas pdfToolbox Desktop 11 was used for testing; during the testing, the version was upgraded from 11.0 to 11.1. In this program, it is possible to solve all selected problems, i.e. problems with printer marks (crop marks, registration marks, color bars, etc.) and bleed and missing data for technical elements (varnishing, cutting, embossing, etc.). For simple tasks, it is sufficient to use predefined adjustments that can be found in Switchboard (Fig. 44 a). If it is necessary to select or create different fixups or checks, it is possible to use the Fixups panel (Fig. 44 b), and the Checks panel (Fig. 44 c). These fixups and checks can be combined in profiles (Fig. 44 d). Fixups are usually based on checks (in order to fix something, it is necessary to select it according to some criteria). To avoid having to run all fixups, checks and profiles successively, it is possible to create process plans from them (Fig. 45). Selected checks, fixups, profiles and process plans can be moved to the Workspace, which is part of the Switchboard. Then, it is possible to run them conveniently without searching. Within the Workspace there are also predefined actions, such as imposition. Fixup creation is illustrated in Fig. 46, check creation in Fig. 47 and profile editing in Fig. 48. After creating or selecting an appropriate check, fixup, profile or process plan, it can be used either the execute button to process file or batch processing (Fig. 49), which can process many files in the same folder at the same time in the same way.

Besides, the checks that are commonly specified in fixups can be set as variable values (Fig. 50). This is useful when it is needed to specify parameters (e.g. selection based on object size). The entire workflow (created, for example, within a process plan) is paused in this step and allows the user to enter the required values.

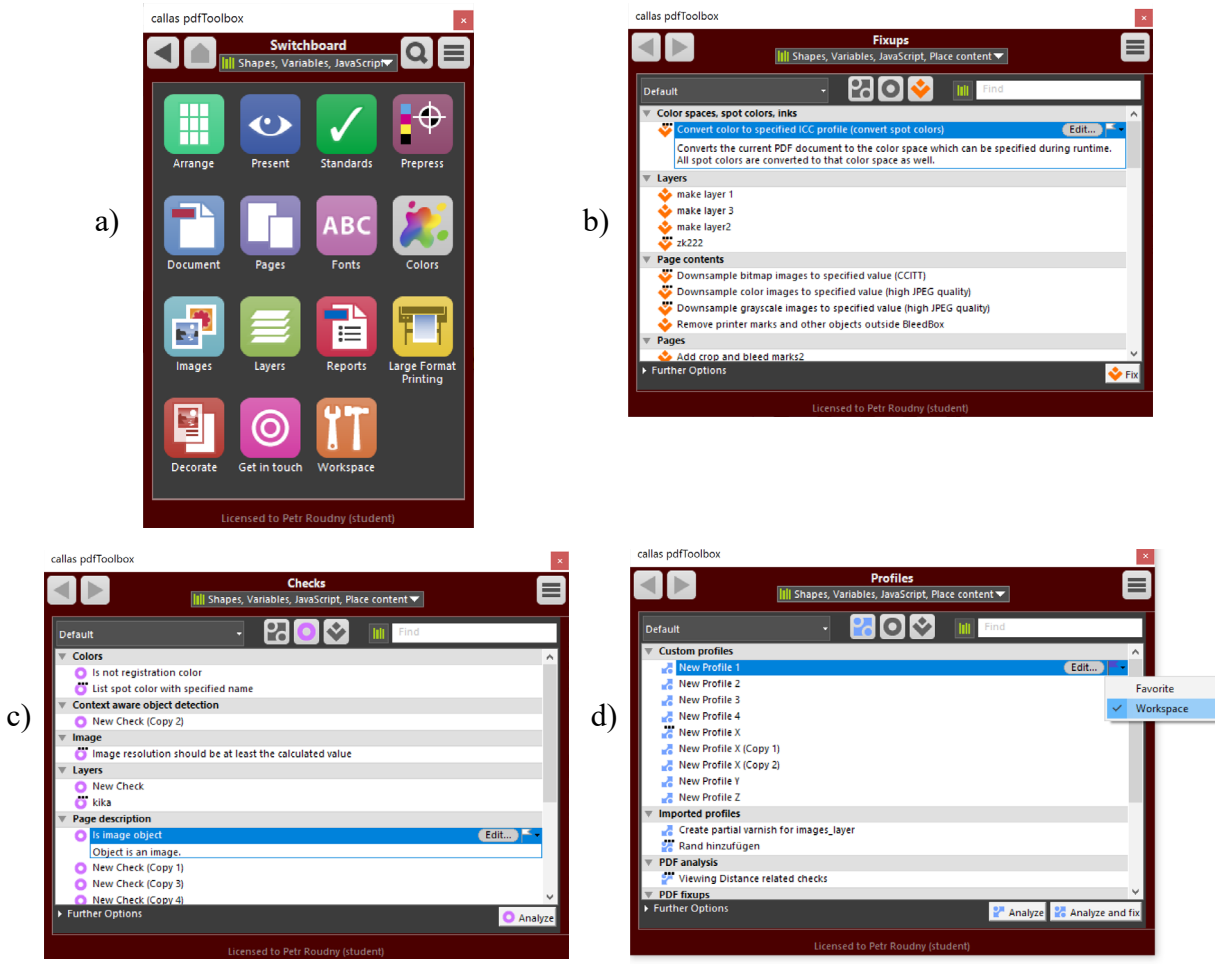


Fig. 44: Example of a) Switchboard b) fixups, c) checks, d) profiles with a demonstration of including a profile in Workspace in Callas pdfToolbox Desktop 11

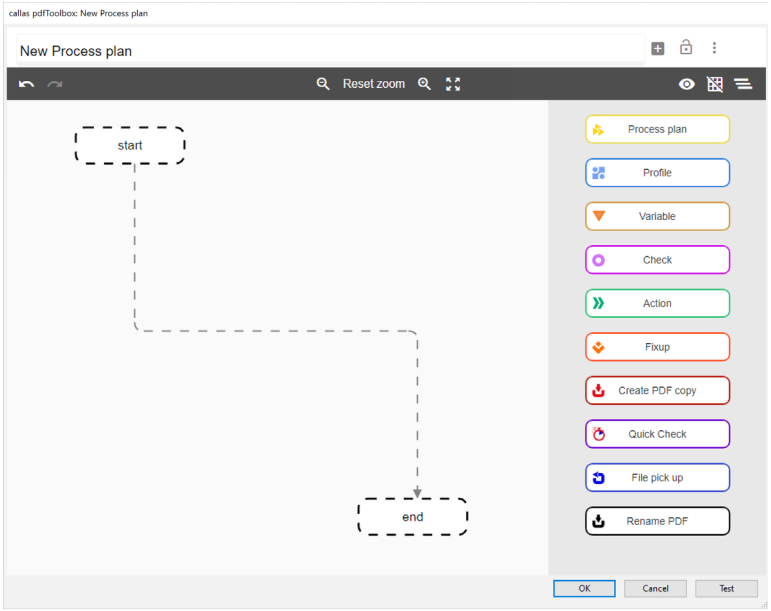


Fig. 45: Example of creating new process plan in Callas pdfToolbox Desktop 11

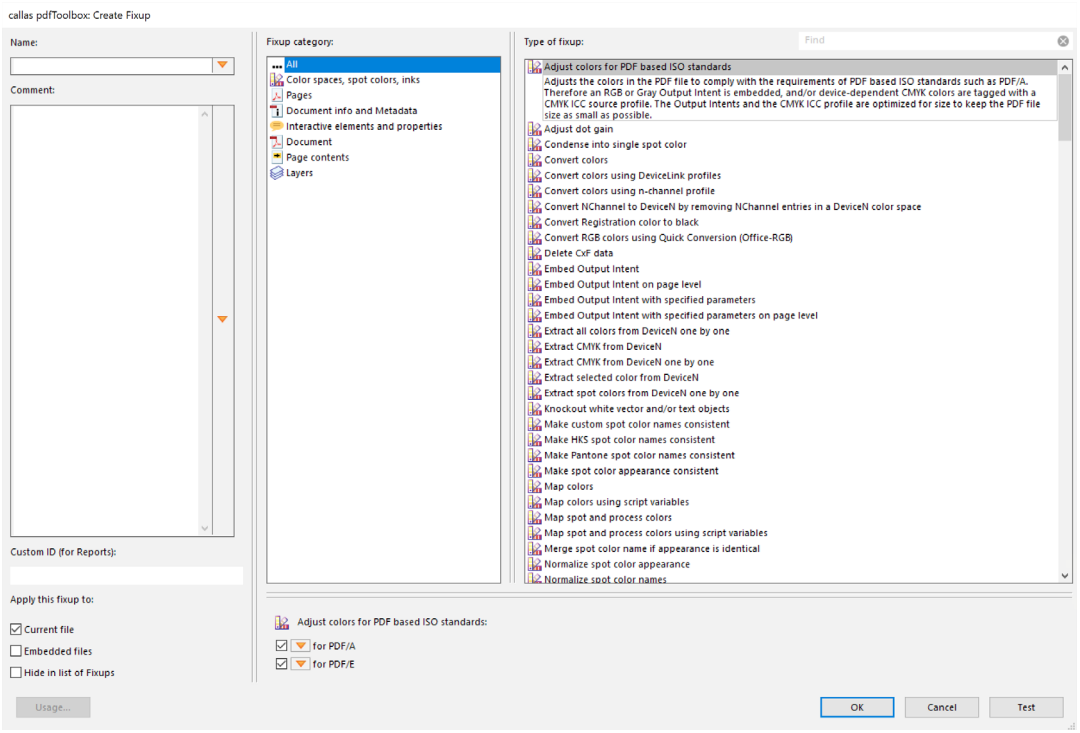


Fig. 46: Example of fixup categories and example of fixup types available in Callas pdfToolbox Desktop 11 when creating a new fixup

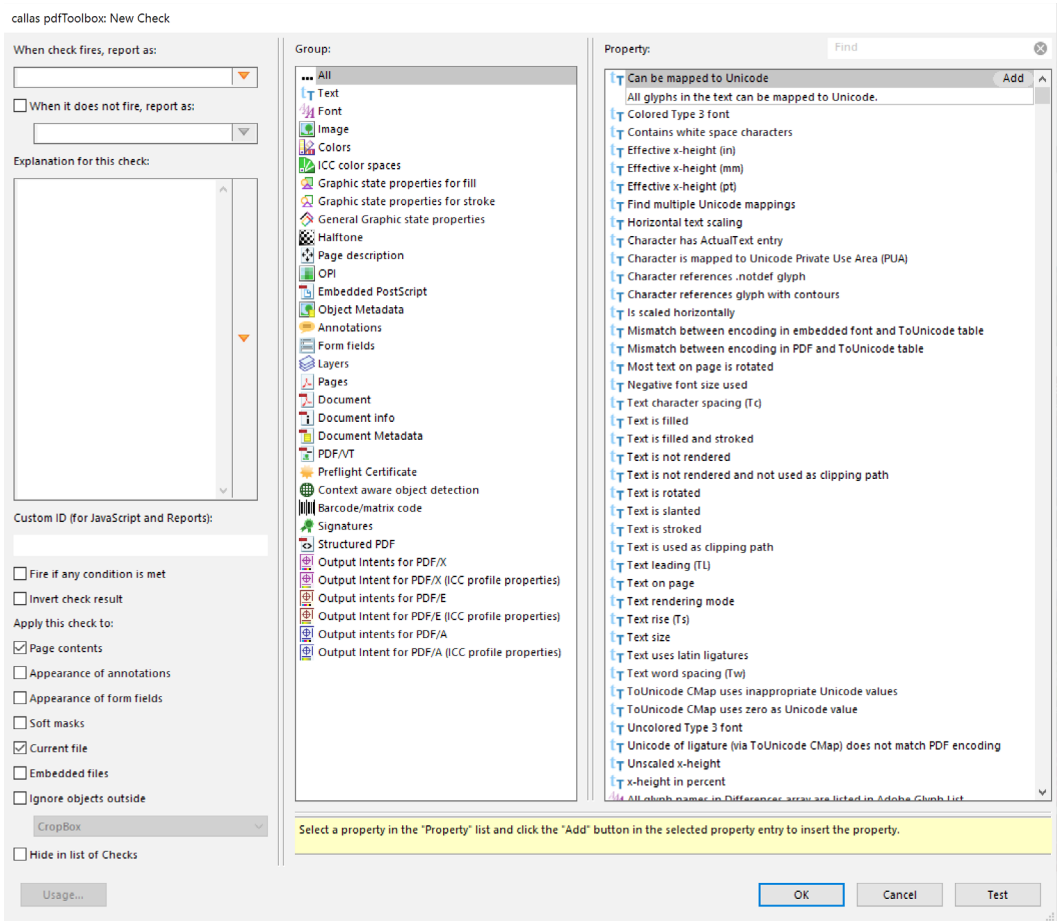


Fig. 47: Demonstration of check groups and example of properties that can be checked in Callas pdfToolbox Desktop 11 and are available when creating a new check

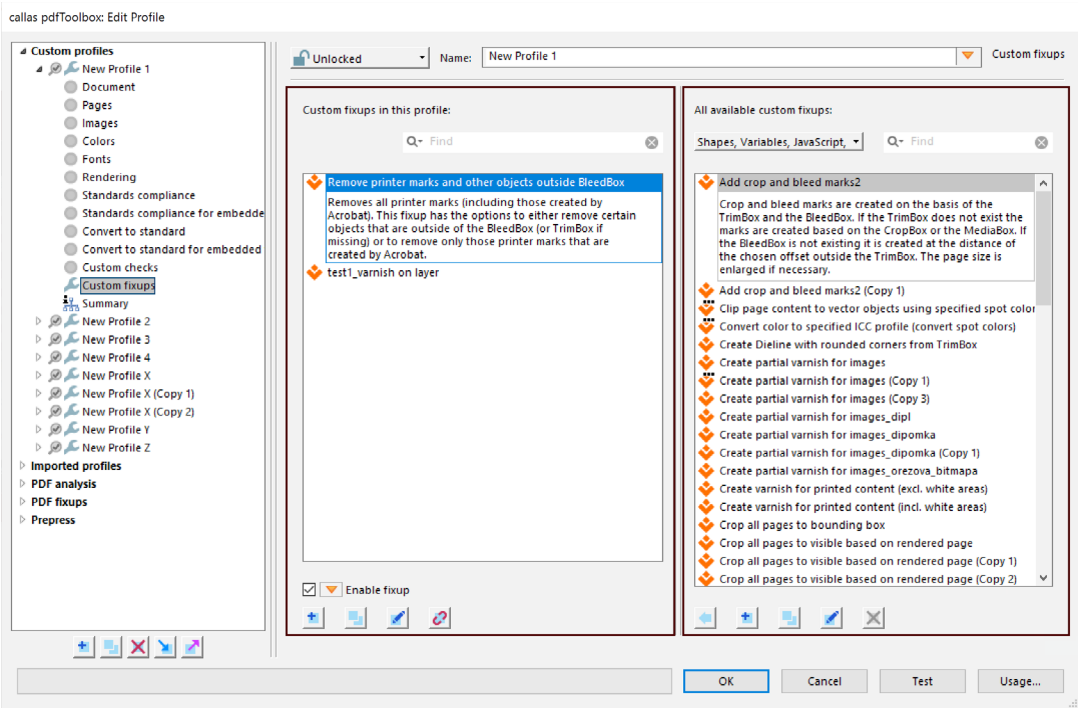


Fig. 48: Demonstration of possible profile settings when editing a profile in Callas pdfToolbox Desktop 11

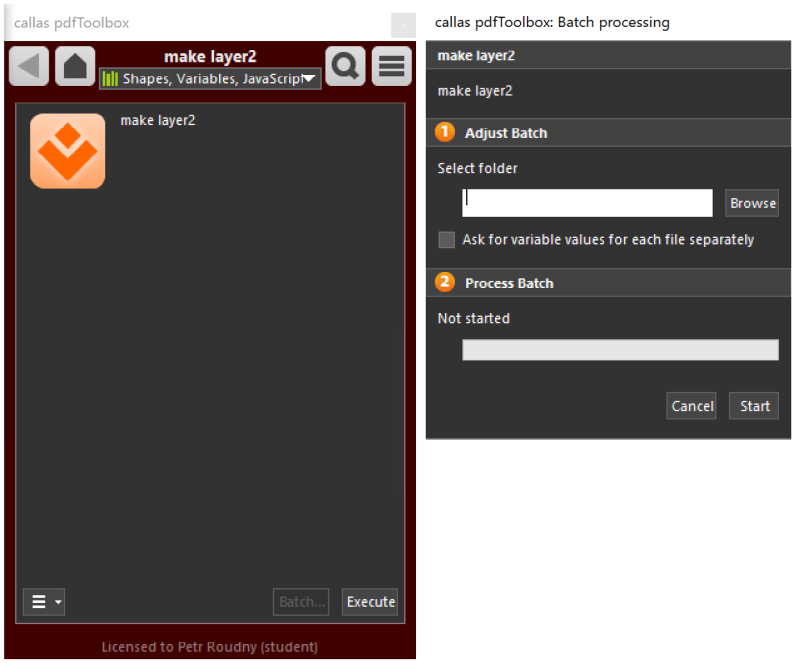


Fig. 49: Demonstration of options to run check, fixup, profile, or process plan using Execute or Batch processing

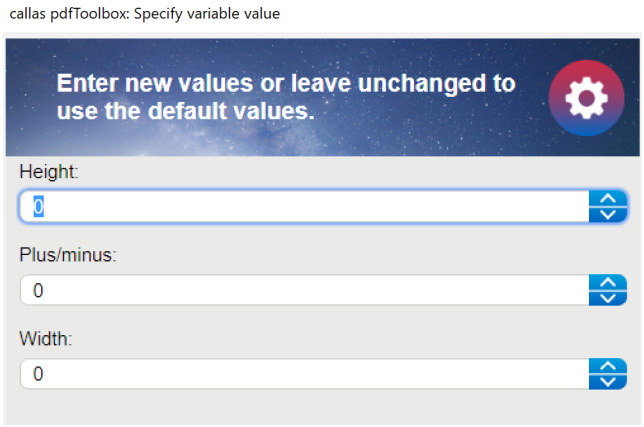


Fig. 50: Demonstration of specification of variable values during processing (of a check, fixup, profile, or process plan) in Callas pdfToolbox Desktop 11

6.2.1 Modifying printer marks

The first step is to use fixups that removes printer marks and other objects that are outside the BleedBox, as shown in Fig. 51. Alternatively, the fixup "Remove page objects that are completely outside of trim area" can be used. In the next step, it is needed to add the required crop marks (bleed marks can be added as well). It can be done using the "Add crop and bleed marks" fixup (it is shown including its settings in Fig. 52). In the last step, it is possible to trim the resulting white area. To do this, it is possible to use the fixup "Crop all pages to visible on the rendered page". This step can be applied only after new printer marks have been added. This fixup including its settings is shown in Fig. 53.

Alternatively, "Set page geometry boxes" fixup can be used. Removing default printer marks and trimming the excess space then can be done in one step by setting the CropBox relative to the TrimBox size (Fig. 54 a). This approach is more straightforward when the necessary printer marks are placed on the sheet later during the imposition. Alternatively, white margins that are currently set to zero (columns "Left", "Bottom", "Right", "Top") can be set to some suitable size, for example, 10 mm. Another option is the same type of fixup used in the next step to create white margins demonstrated in Fig. 54 b. Then, new printer marks can be inserted. However, this step is not necessary when adding new printer marks, it can be just checked "Enlarge page size if needed", as can be seen in Fig. 52. It can be used where only white margins need to be created.

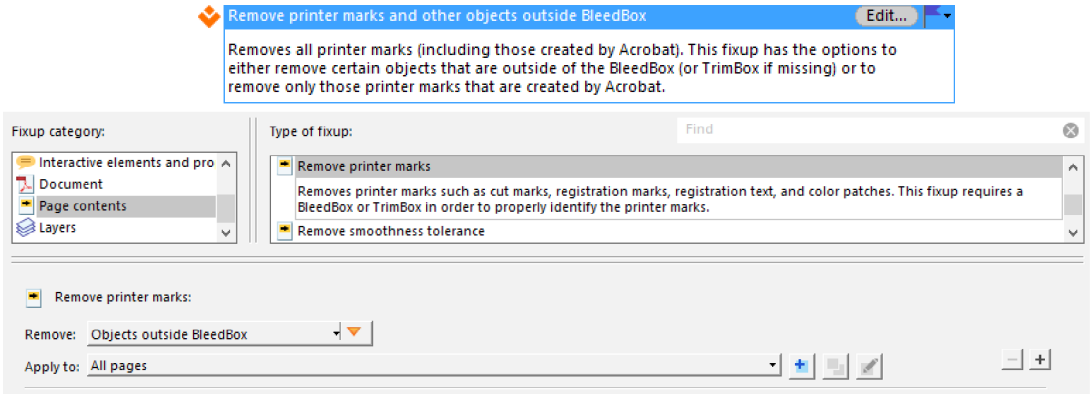


Fig. 51: Example of setting a fixup to remove printer marks and other objects that are outside the BleedBox in Callas pdfToolbox Desktop 11

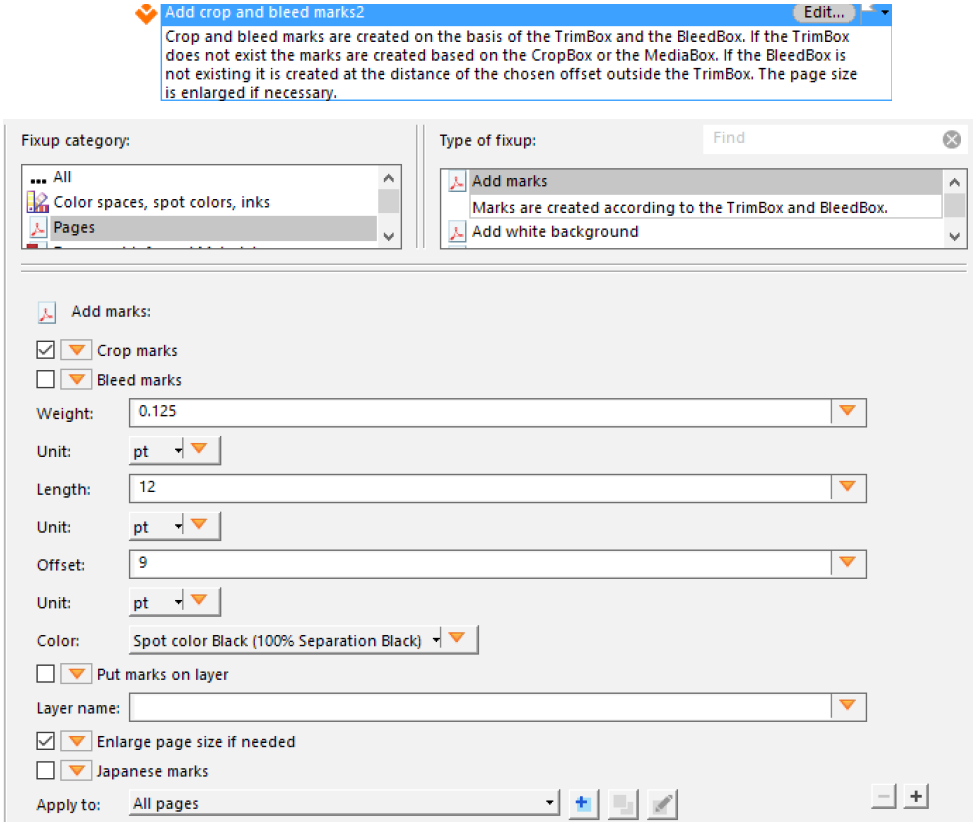


Fig. 52: Example of setting a fixup to add crop and bleed marks in Callas pdfToolbox Desktop 11

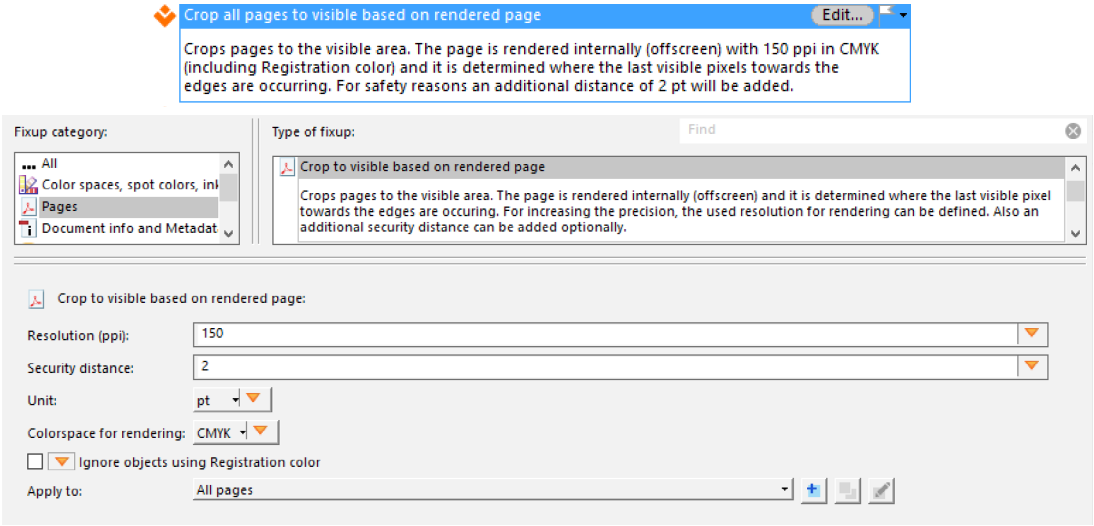


Fig. 53: Example of setting a fixup to crop all pages to the visible area on the rendered page in Callas pdfToolbox Desktop 11

a)

b)

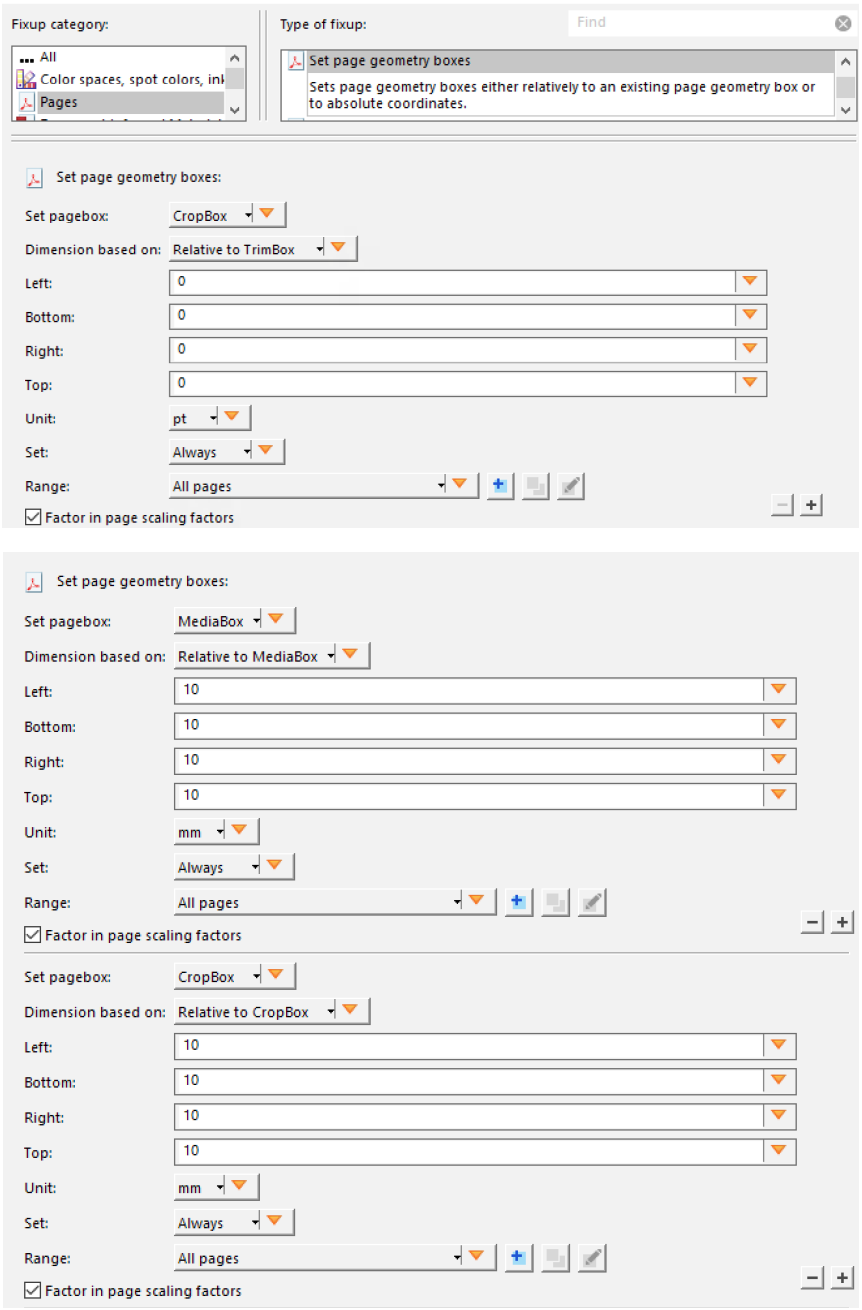


Fig. 54: Example of setting a) a fixup "Set page geometry boxes" that adjusts CropBox relative to TrimBox size and thus crop the page, b) a fixup "Set page geometry boxes" that creates a white margins around the TrimBox in Callas pdfToolbox Desktop 11

6.2.2 Fixing missing bleed

Another solution deals with the missing bleed. The operator can detect the missing bleed either visually or, especially when processing a large number of documents using an appropriate check, for example, examining the presence of a BleedBox as shown in Fig. 55. If the detection of the BleedBox alone would not be enough, it is also possible to select the check "Size of

BleedBox", where the dimension is specified (for example 3 mm), or both checks could be used. Also, check "Object is inside BleedBox" can be used.

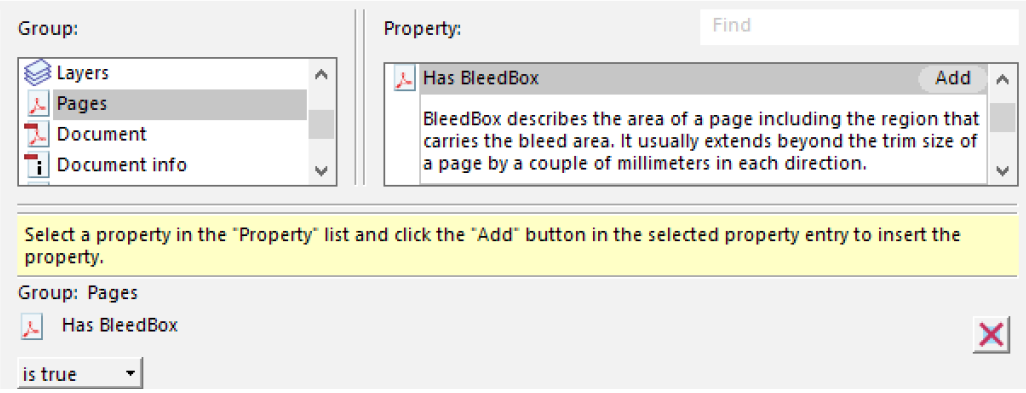


Fig. 55: Example of a check that checking whether the page has BleedBox in Callas pdfToolbox Desktop 11

If the BleedBox (and thus the bleed) does not appear in the printing data, it needs to be added. In the Callas pdfToolbox, there is the "Add bleed" action (Fig. 56) within the Switchboard. It is just needed to set the size of the bleed and the method. The available methods are "Mirror as images (edges and corners)", "Repeat the last pixel as image" and "Mirror page objects". It should be noted that only the "Mirror page objects" method preserves the vector objects in bleed; in other cases, the created bleed is a raster image (which may not be a big problem as it is only a bleed). Therefore, "Mirror page objects" method was used for the demonstration. It can always be chosen whether bleed should be generated only on edges, or on edges and corners. Adding of a bleed can also be found within fixups; the fixup "Generate bleed at page edges" is used for demonstration (Fig. 57). There is also a fixup "Generate bleed by upscaling". Only "Required bleed" (mm) and "Maximum distortion" have to be defined. This fixup stretches the graphics to create bleed from the edges. It is suitable where there are no important elements at the edges (which should not be there anyway) and it is not necessary to maintain a 100 % scale of the object. However, certain distortion results when horizontal and vertical dimensions differ.

The addition of bleed using this fixup can be limited only to those files that lack the BleedBox by changing "Apply to" in the settings from "All" to the corresponding check "Has BleedBox – is true" (as defined in Fig. 55). The second option is to place this check before this fixup and use the fixup only if the check reports an error. The advantage of Callas pdfToolbox is also that it is possible to generate bleed for irregular shapes, which may be suitable, for example, for packaging printing. Within the fixups, there are also other predefined fixups that can be edited.

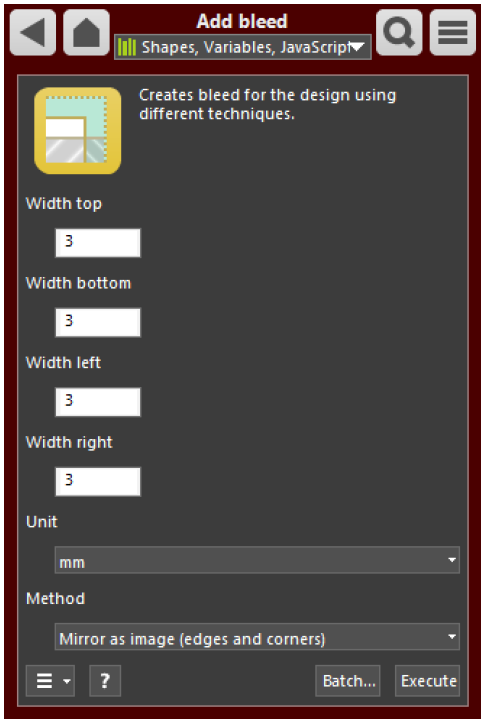


Fig. 56: Example of the “Add bleed” action available in the SwitchBoard of Callas pdfToolbox Desktop 11

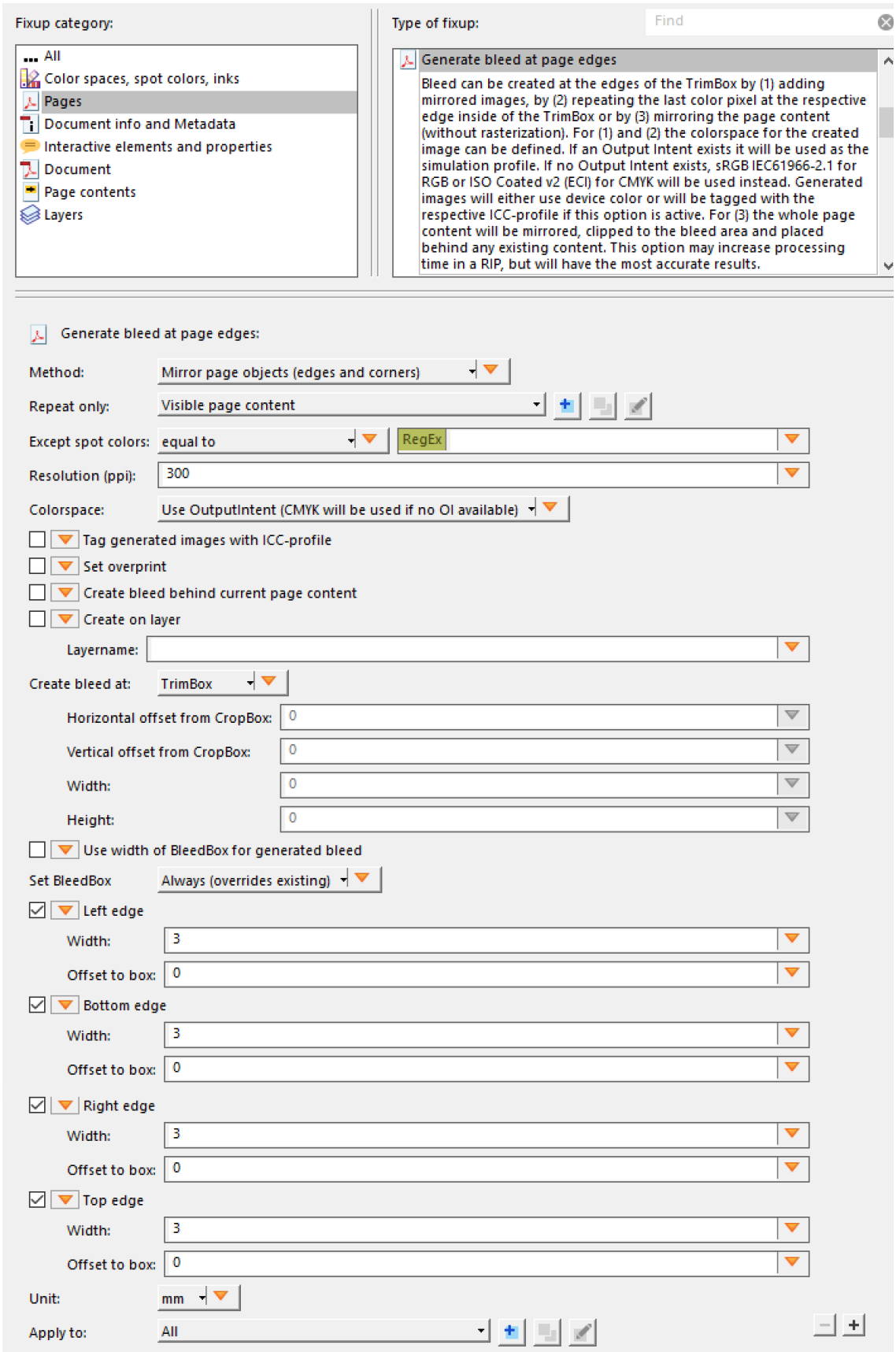
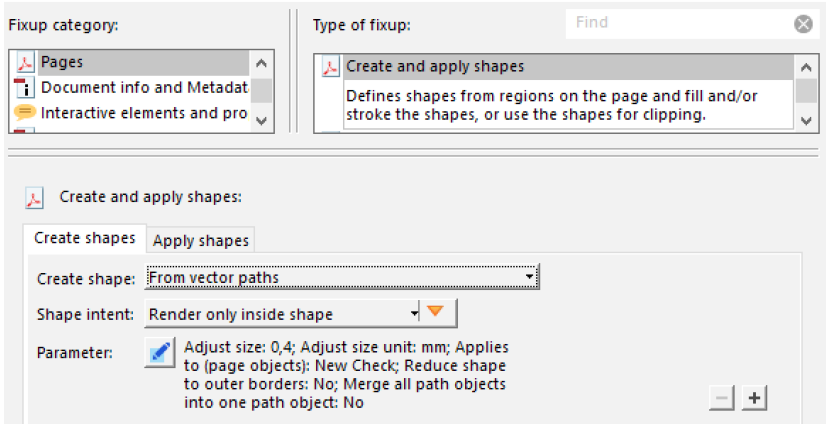


Fig. 57: Example of settings a fixup to generates bleed at page edges in Callas pdfToolbox Desktop 11

6.2.3 Creation of an element for partial varnishing

Another task is to create an element for varnishing for the bookmark (see Fig. 34). In the case of Callas pdfToolbox, some ways have been proposed to create the element. All are based on a fixup "Create and apply shapes" with the parameters shown in Fig. 58 a. Figure 58 a also shows the use with shape creation from vector paths, but it is not a condition. In some cases, it may be more appropriate to use "Create shape from tracing page content". As shown in Fig. 58 b, the varnishing element can also be enlarged. It can be practical due to the manufacturing inaccuracies with varnish application. Fig. 59 a and Fig. 59 b show detailed settings for applying the particular shape for partial varnishing.

a)



b)

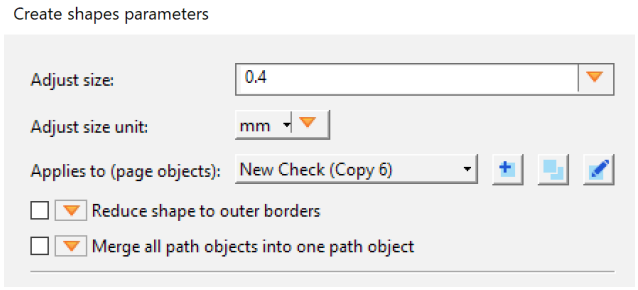
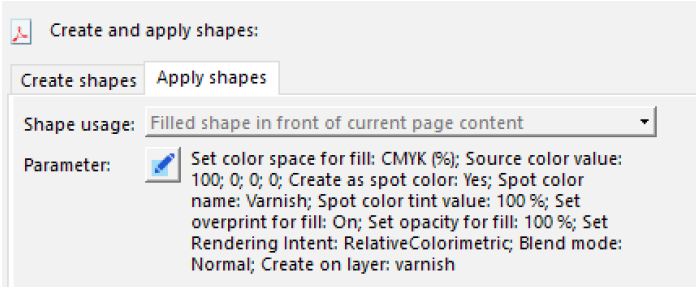


Fig. 58: Example of a) setting a fixup to create a partial varnish using "Create and apply shapes" (setting details for creating shapes), b) the corresponding create shapes parameters in Callas pdfToolbox Desktop 11

a)



b)

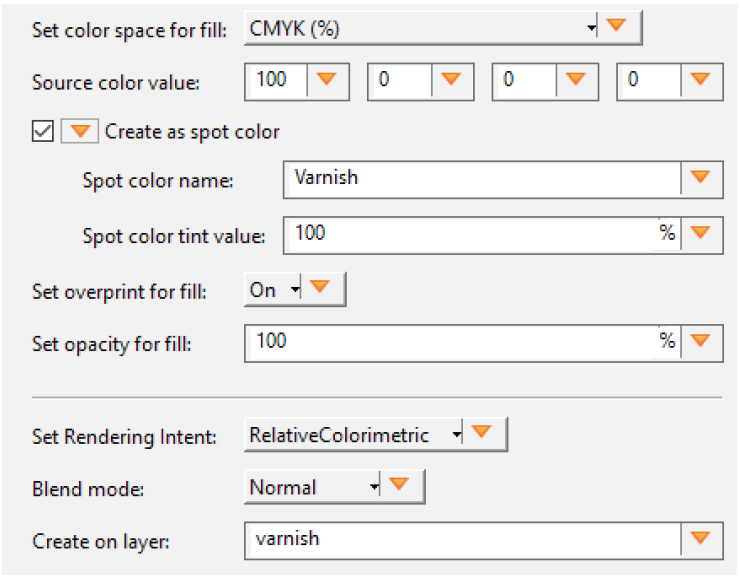


Fig. 59: Example of a) setting a fixup to create a partial varnish using "Create and apply shapes" (setting details for applying shapes), b) the corresponding apply shapes parameters in Callas pdfToolbox Desktop 11

To create a new shape that represents a varnished area, it is necessary to select the object(s) to be varnished. To do this, it is needeed to find a suitable check using "Applies to (page object)", see Fig. 58 b. One way is a selection based on a certain number of nodes in the path. This option could be set to a variable value where a different number of nodes could always be entered. In this case, it is also advisable to set the shape creation from vector paths. Parameters are shown in Fig. 60.

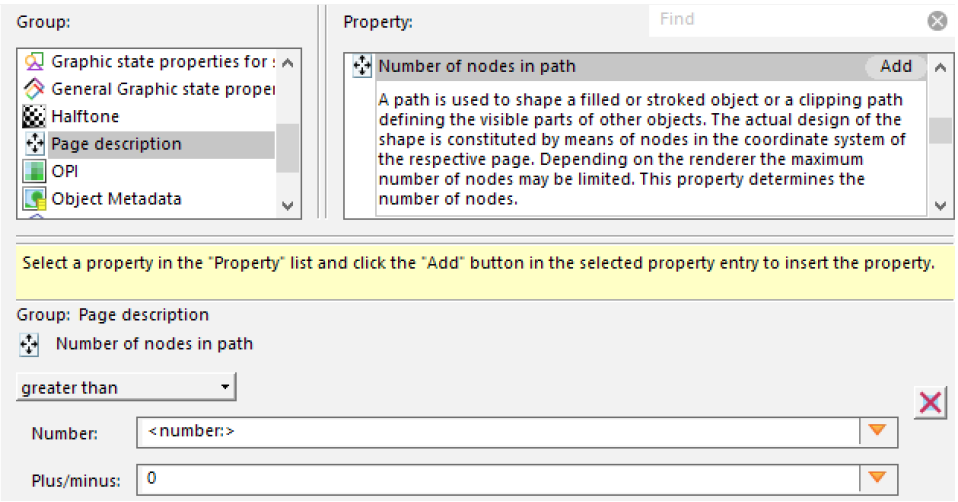


Fig. 60: Example of setting a fixup to create element for varnishing based on the number of nodes in path that is set as a variable in Callas pdfToolbox Desktop 11

The number of nodes in path may not always be easy to estimate. The second option, therefore, uses the size of a filled vector object (Fig. 61). It is only needed to enter the width and height, including the deviation (plus/minus). Alternatively, a range from–to without deviation can be used. The dimensions are entered in millimeters. Here, too, it is advisable to set these parameters to a variable, so that it is possible to enter sizes as needed during processing. In order to perform this fixup properly, it is necessary to change "Create shapes parametres" from "From vector paths" to "From tracing page content (including white areas)", see Fig. 58 a. It expands the settings in "Create shape parametres" (Fig. 62). This is the first condition for selecting a complex screen illustration (the setting selects everything, including the white part – illustration of a paper, which would otherwise remain without the varnished element. All parameters were left at default values except for rendering resolution that was set to 300 ppi. However, the second condition to select such a complex illustration is to set "Reduce shape to outer borders" in the parameters here (it can be seen in Fig. 58 b that it need not to be set for the previous option). Concerning the first job created for the testing – the bookmark, it is then possible to select either the illustration of the screen or, for example, the logo. Then, only the height and width have to be entered (in the case of the screen, approximate size between the size of the logo and the dark magenta background square). If the "Reduce shape to outer borders" setting was not used, complex graphics such as screen composed of many objects of different sizes could not be used to define the area to be varnished, because the smallest size of the object in the screen is smaller than the size of the logo, but there are also a lot of objects larger than the logo. This applies to both grouped and ungrouped data in more complex illustrations. However, for simpler printing data, i.e. for less complex selections, "Reduce shape to outer borders" does not have to be checked and "Create shapes parametres" could be set to "From vector paths".

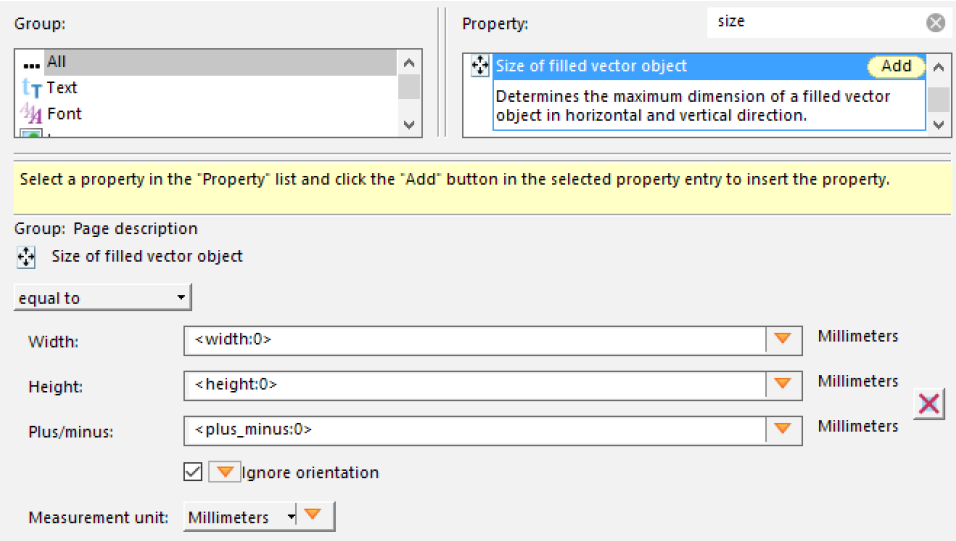


Fig. 61: Example of setting a fixup to create element for varnishing based on a size of filled vector object in Callas pdfToolbox Desktop 11

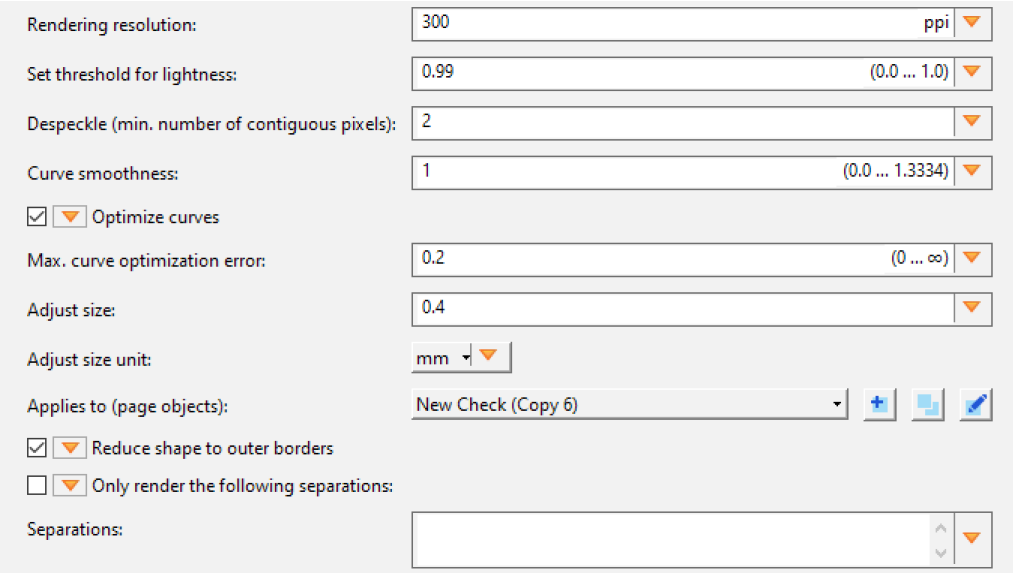


Fig. 62: Example of Create shapes parametres in the fixup that create a partial varnish from filled vector object found by size in Callas pdfToolbox Desktop 11

It is also possible to select objects according to width and height from raster objects, including deviation (plus/minus). Here, however, the dimensions themselves are entered in pixels. Parameters are shown in Fig. 63. It is also necessary to set shape creation from vector paths to from tracing page content (including white areas). This makes possible to select a raster object. It should be noted that once the transparency of the printing data is flattened, and the motif is not isolated on a white background, it is not possible to create a varnished element for the desired motif automatically.

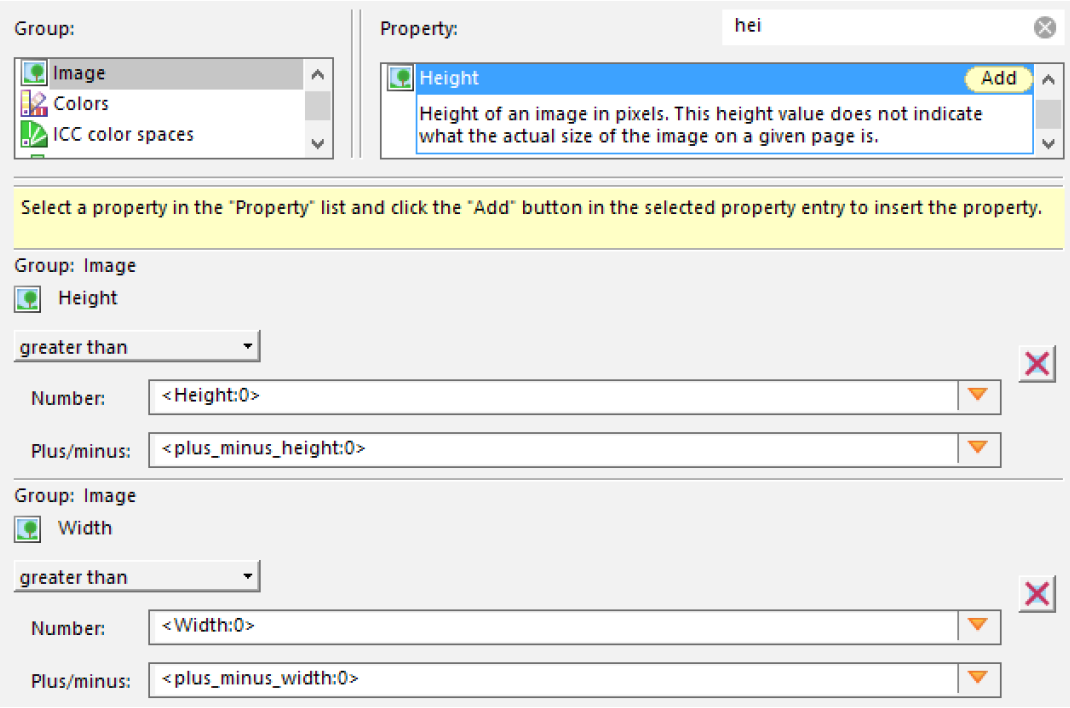


Fig. 63: Example of setting a fixup to create element for varnishing based on raster image height and width in Callas pdfToolbox Desktop 11

The last interesting option that is applicable in the case of the bookmark, but does not have to be for all printing data, is to create a layer from an object that is on top of other object(s). However, this check is not allowed directly for the "Create and apply shapes" fixup (it does not include the group of checks "Context aware object detection"), therefore, a two-step process (two fixups) have to be used. First it is needed to create a layer using the fixup "Put objects on layer". There, a check "Create a layer from an object that is on top of other object(s)" can be used. It moves the selected element to a layer with a given name, in this case with the name "layer". The parameters are shown in Fig. 64 and Fig. 65. The second needed fixup concerns the creation of an element for partial varnish ("Create and apply shapes") on a layer with a specific name ("layer"). Then an element to be varnished is created with the appropriate layer name "varnish" and with a new the spot color. The parameters of this fixup can be used the same as in Fig. 58, but the check has to be based on a layer name, as shown in Fig. 66. Fixup that creates a varnished element from a layer can be effective also if a customer sends printing data, for example, in PDF/X-4 file that contains appropriate layers, or if the element cannot be automatically selected and it is necessary to create a layer with the corresponding object in advance (e.g. using Adobe Acrobat). Then it is just needed to name the layer with the given element properly, and varnished element can be created from it.

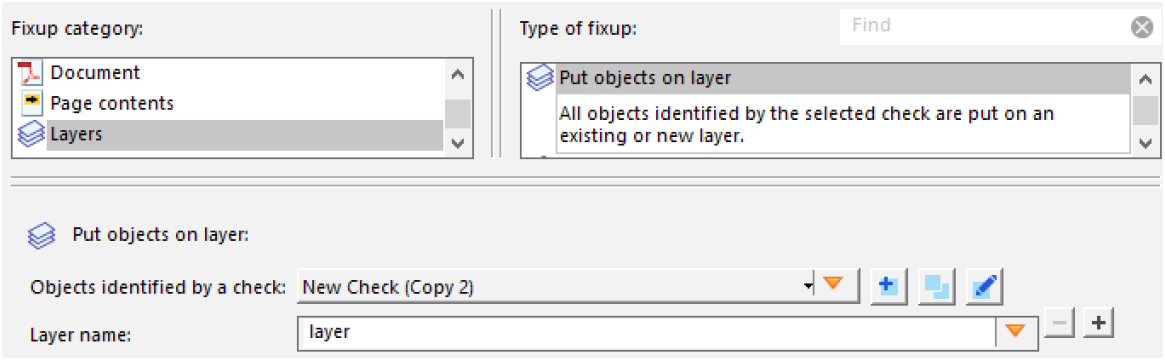


Fig. 64: Example of setting a fixup to put objects on layer in Callas pdfToolbox Desktop 11

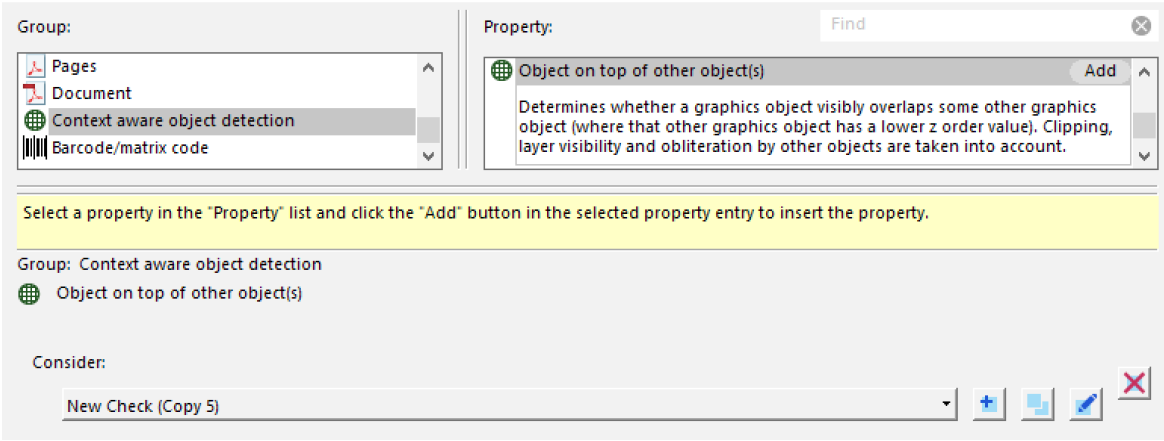


Fig. 65: Example of setting a check to create layer with object on top of other object(s) in Callas pdfToolbox Desktop 11

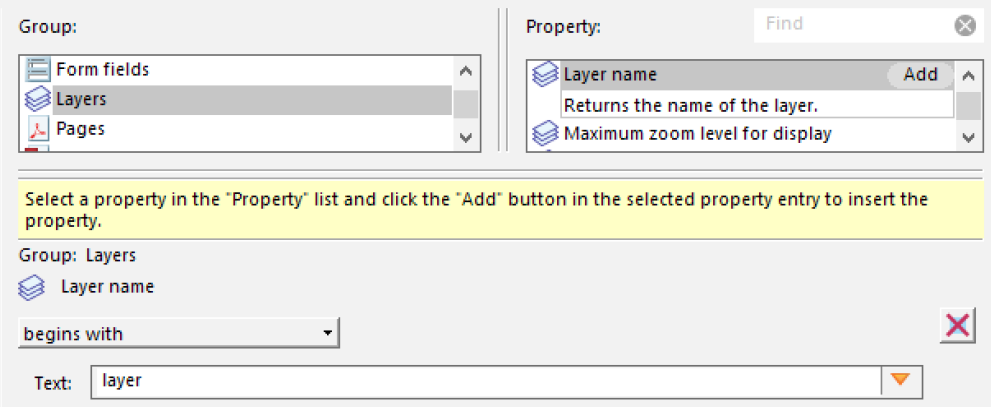


Fig. 66: Example of setting a check to create a partial varnish named “varnish” from a layer named “layer” used in fixup “Create and apply shapes” in Callas pdfToolbox Desktop 11

6.2.4 Other options of creating element for varnishing

While the options for defining the area for partial varnishing mentioned in Chapter 6.2.3 are probably the most widely applicable among printing companies in common practice, other methods and options can also be used. Figure 67 illustrates how to create an element for varnishing based on a vector object. The problem, however, is that the varnished element is created from all vector objects in the printing data. The usability is thus considerably limited, for example, to photography or business card with vector logo to be varnished. Figure 68 shows how to create a varnished element from a raster object. Again, the varnished element is created from all raster objects in printing data. Here it is especially important to set the parameter: Applies to (page objects): Is image object. Generally, as shown in Fig. 69, varnished element can be defined using many different parameters. As can be seen in Fig. 69 a, creating a full-surface varnish would be much easier than creating a partial varnish and can be automated more easily (for example, using the create shape “from BleedBox” function).

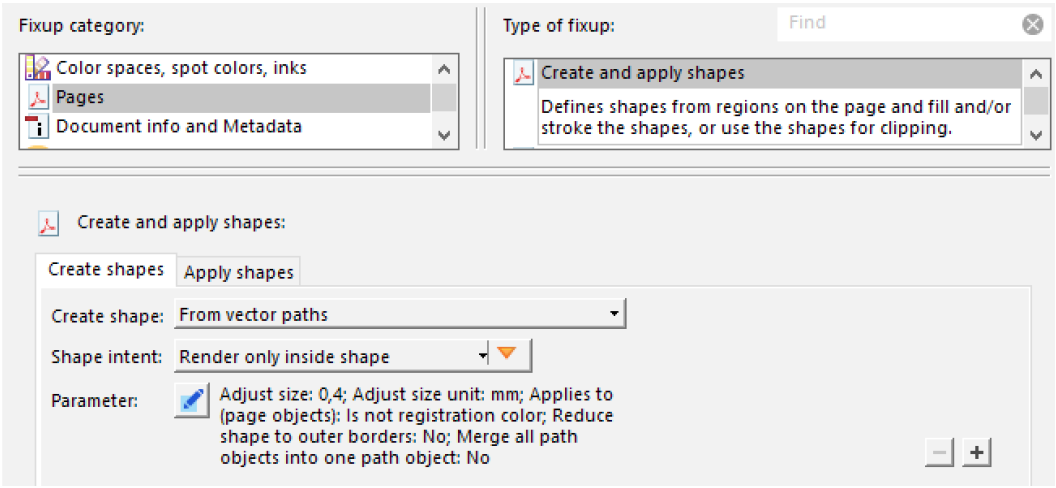
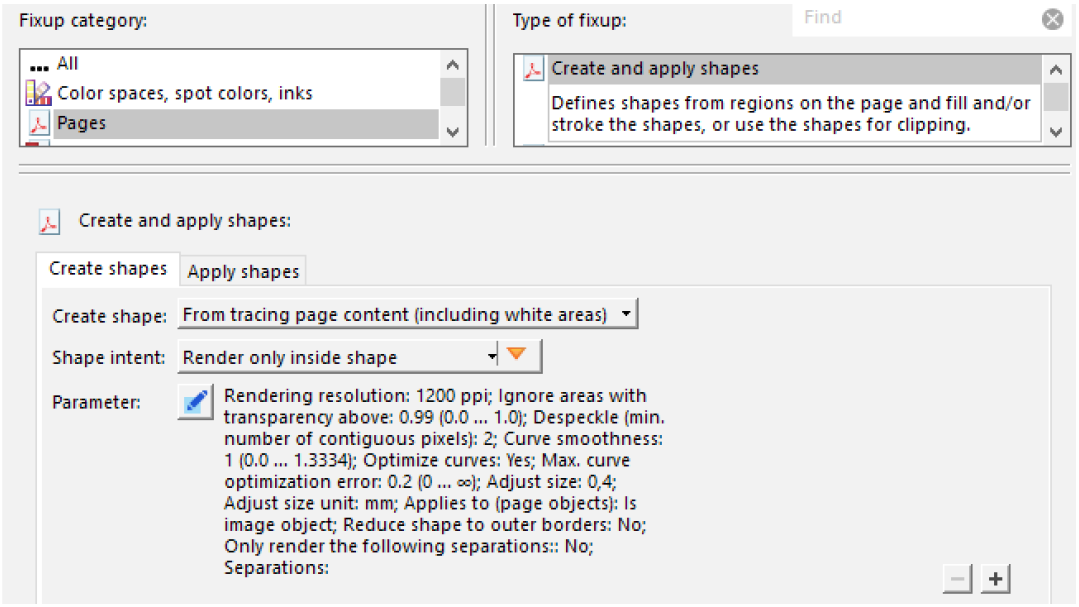


Fig. 67: Example of a fixup to create a shape that defines the varnished area based on the vector paths in Callas pdfToolbox Desktop 11

a)



b)

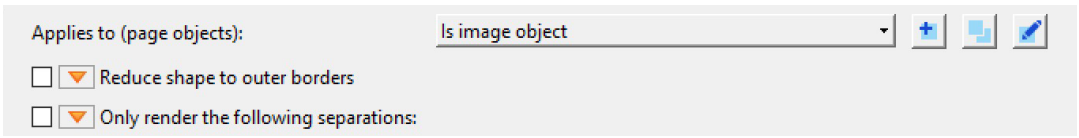


Fig. 68: a) Example of a fixup to a) create a shape that defines the varnished area (from tracing page content including white areas), b) setting of defines the varnished parameters and b) apply it to image (raster) object in Callas pdfToolbox Desktop 11

a)

b)

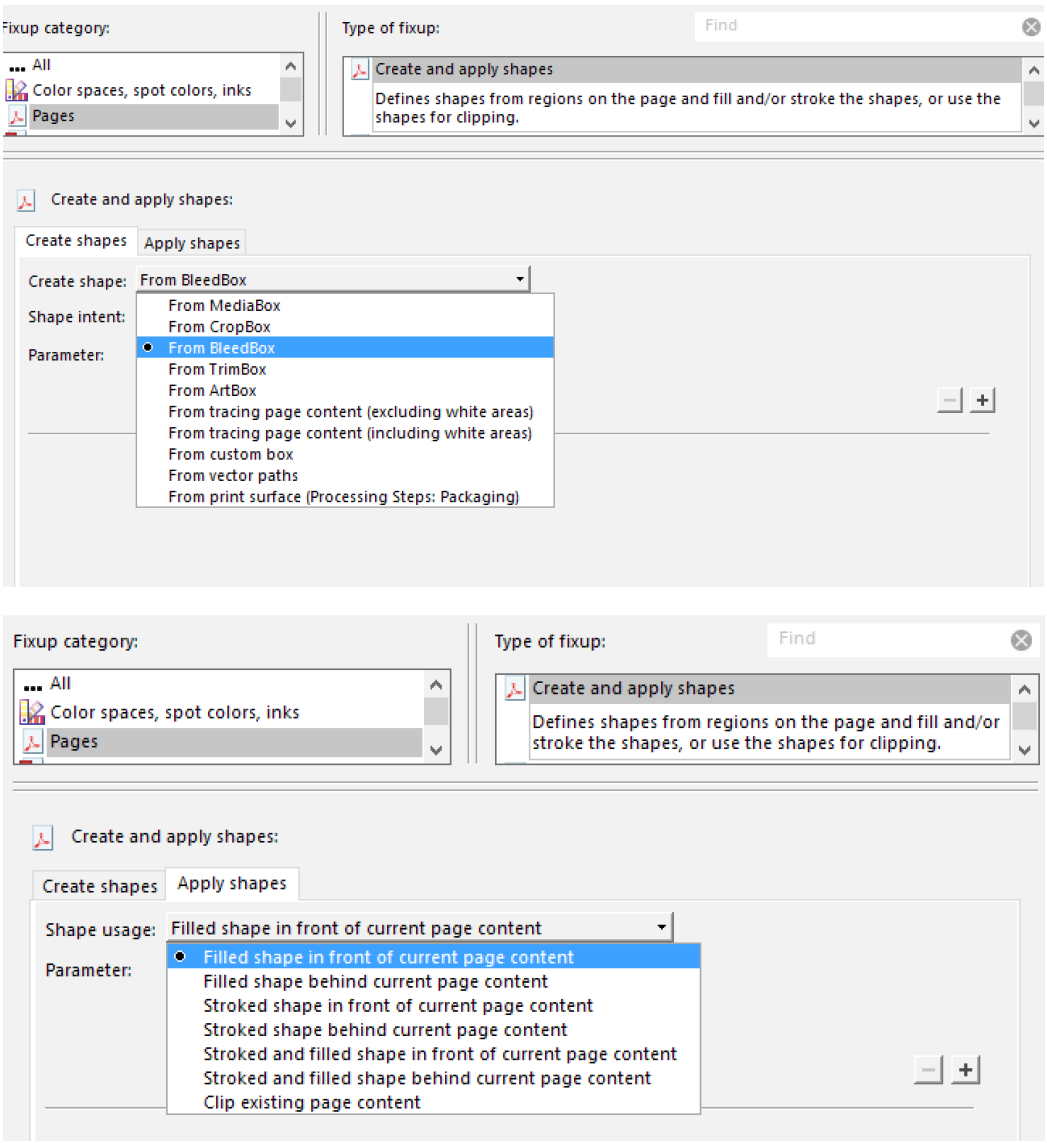


Fig. 69: Example of possibilities of a) creating a varnished element, b) placing it with the appropriate fill and stroke in Callas pdfToolbox Desktop 11

6.2.5 Combination of multiple operations

It is advisable to combine the described fixups for modifying printer marks, generating bleed and creating the varnished element into process plans so that subsequent batch processing is automated as much as possible. The example of process plan that adds the element for partial varnishing and modifies printer marks can be seen in Fig. 70. Instead of fixups modifying printer marks, there can be a fixup that adds bleed, which can be preceded by a check examining whether the document has bleed. Of course, it is possible to run all fixups separately in the Workspace, and it is not necessary to create a process plan from them (it is needed if the efficiency should be increased further). However, using a process plan requires only one run compared to several runs of given fixups.

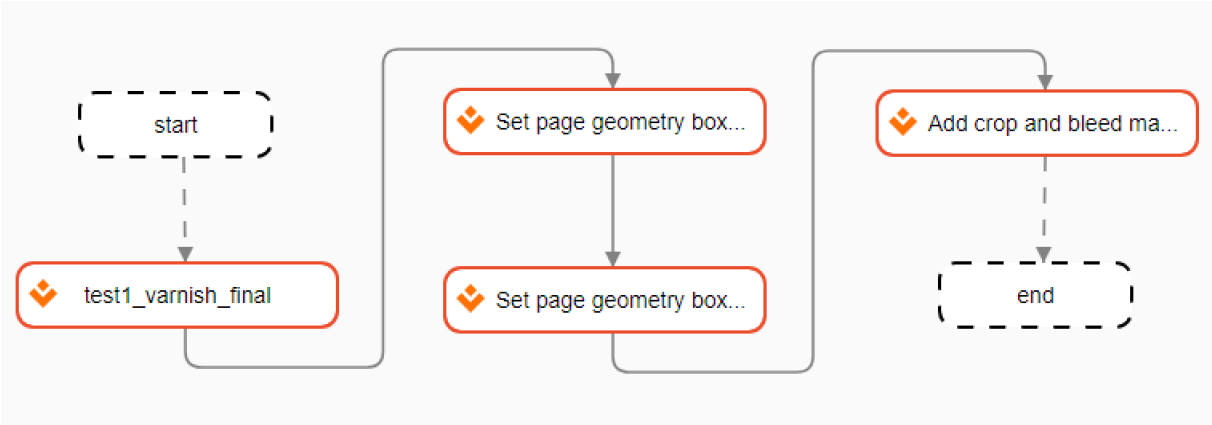


Fig. 70: Combining created fixups that create the varnished element and modify printer marks into one process plan in Callas pdfToolbox Desktop 11

In Fig. 71, the final printing data are displayed, with a newly created layer named varnish. Figure 72 shows that in addition to this layer, a new spot color has been created, also called varnish. Of course, only one of these two options can be used and also the naming convention can be adapted to the specific workflow of a printing company.

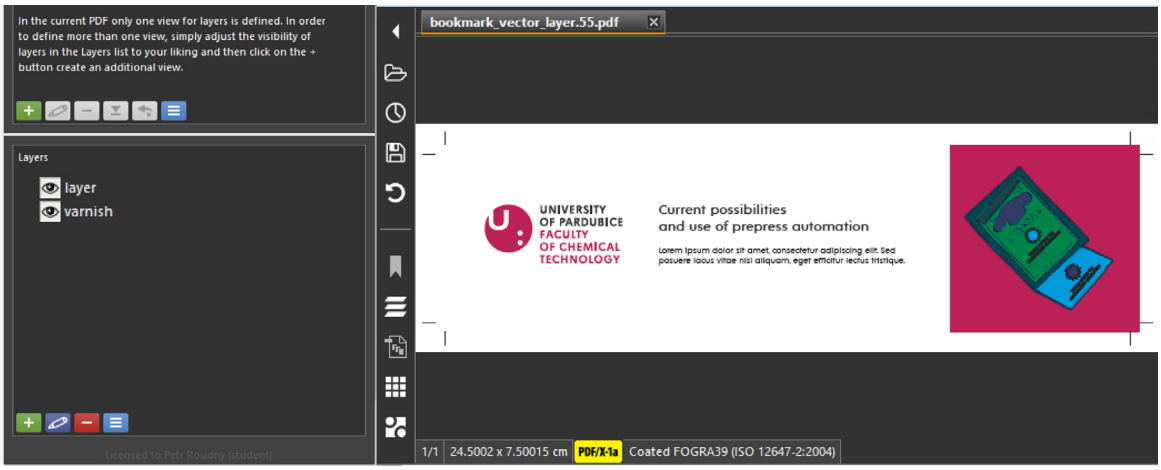


Fig. 71: Modified printing data with new created layer named “varnish” defining the area for partial varnishing in Callas pdfToolbox Desktop 11

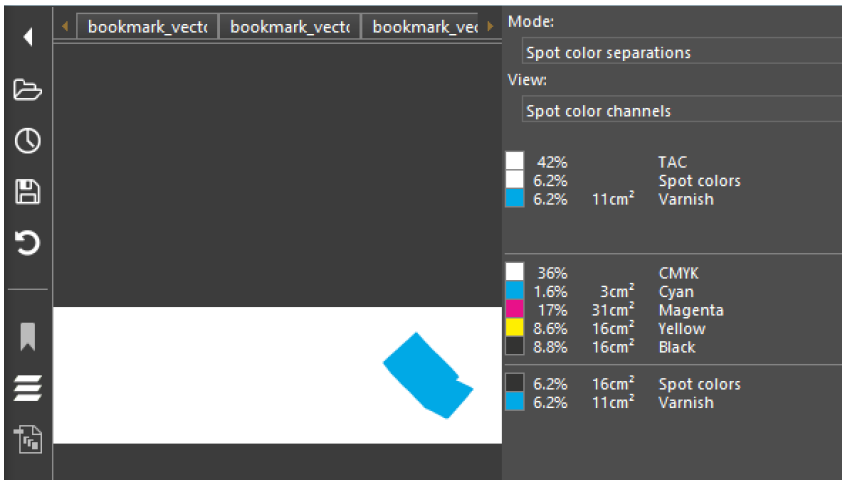


Fig. 72: The newly created object defining the area for partial varnishing and filled with spot color named "Varnish" in the modified printing data in Callas pdfToolbox Desktop 11

In addition, the PDF document can be processed in the pdfToolbox within the process plan even with the imposition of both the varnished element and the printing data itself, utilizing the possibility to incorporate actions, which can be created from some functions within the Switchboard, into process plans. The first step is to create a fixup "Put objects on layer" that creates a "design" layer from all vector objects, all text objects, and all raster images (Fig. 73). Next, it is needed to create fixups that makes visible only the "varnish" layer and hides the "design" layer and vice versa (Fig. 74). The next step is to create the action imposing the document using the Step & Repeat function. The action can be created from some functions within the Switchboard. The procedure to "Create new switchboard action" is shown in Fig. 75. However, it is necessary to create two actions, one that will be used for printing data, with the field "Add cut marks to each page" checked, and the second for the varnished element, not using this option. Splitting of a PDF and its processing in two different ways within created workflow is shown in Fig. 76. First of all, the "Create PDF copy" function is important, which saves the first PDF and then the "File pick up" function, which returns the defined workflow to the required step. In this case to the "Set page geometry boxes". As can be seen, a fixup that adds crop marks is omitted here. The addition of crop marks is already included in the action with the Step & Repeat imposition. Unfortunately, these printer marks interfere with the bleed by default, which cannot be fixed at the user level. Another example is the workflow in Fig. 77, which is similar except that it does not modify default printer marks, but adds bleed. This only applies if the check "Has BleedBox – is true" detects an error. Otherwise, it goes to the next step in the workflow. The imposed printing data and varnishing elements from the first and second example (the resulting printing data are the same for both examples) are shown in Fig. 78. Such workflows can be compiled for all types of created fixups.

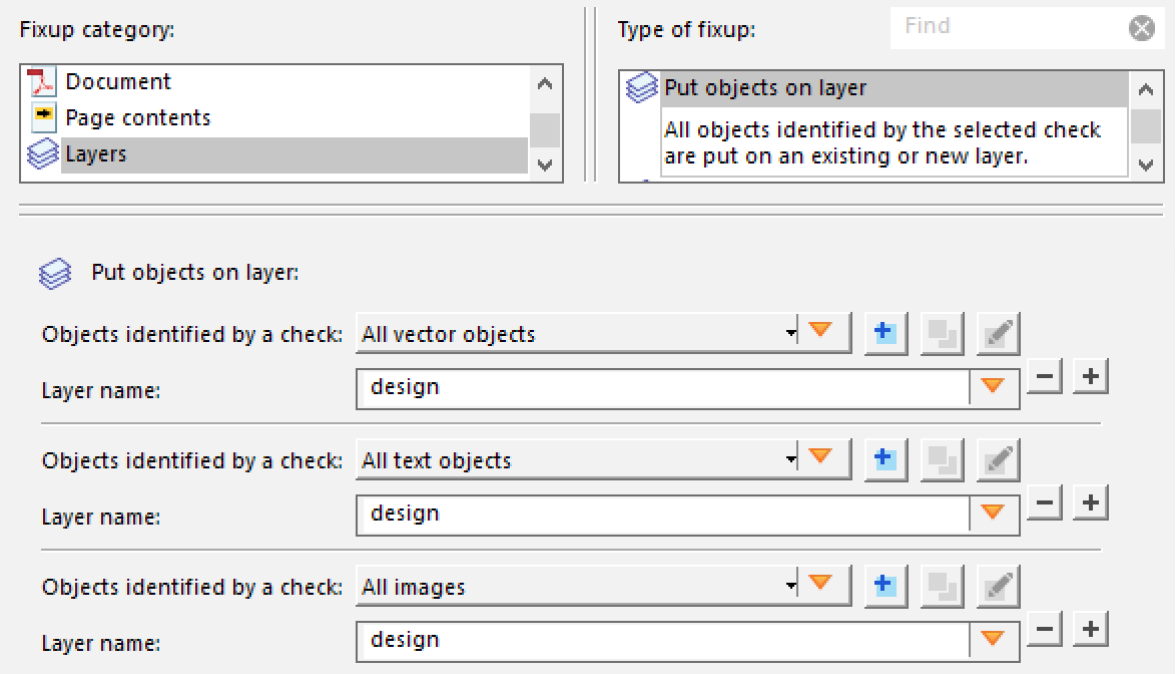


Fig. 73: Example of a fixup to put objects identified by checks "All vector objects", "All text objects" and "All images" on the layer named "design" in Callas pdfToolbox Desktop 11

a)

b)

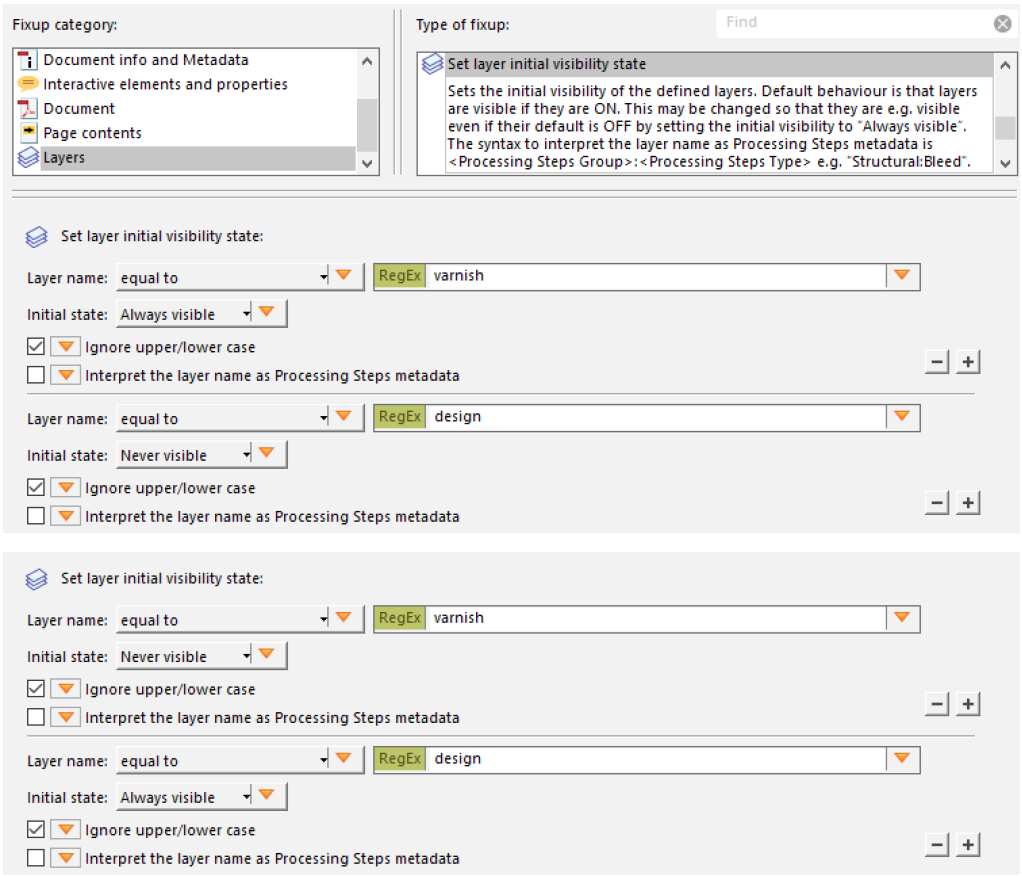


Fig. 74: Example of setting a fixup that a) displays the "varnish" layer for varnishing, and hides "design" layer for printing, b) displays the "design" layer for printing, and hides "varnish" layer for varnishing in Callas pdfToolbox Desktop 11

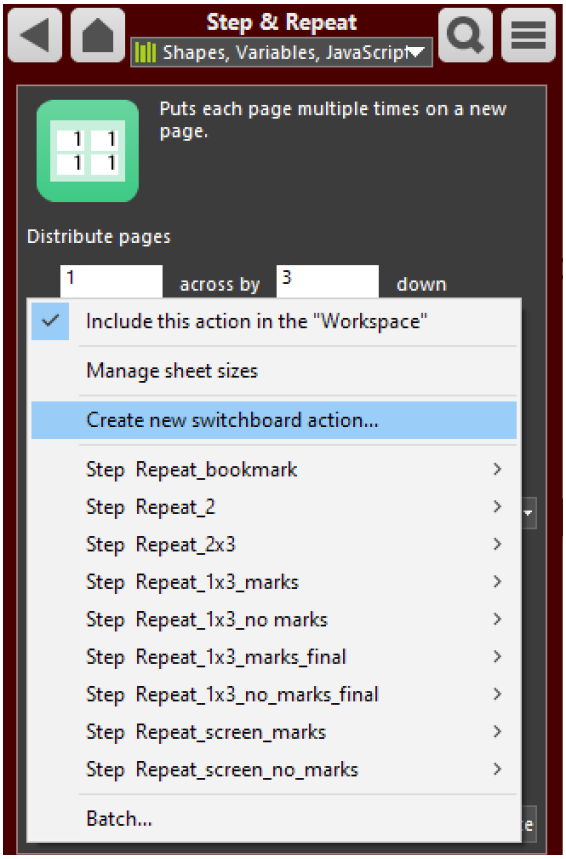


Fig. 75: Example of creating new switchboard action from Step & Repeat function in Callas pdfToolbox Desktop 11

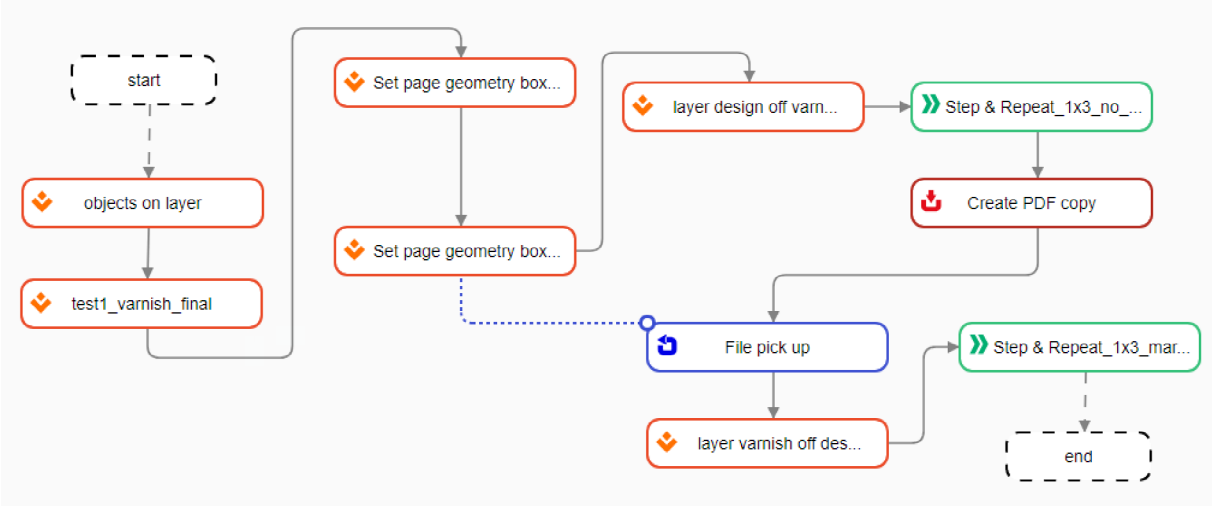


Fig. 76: Example of a more complex workflow that combines fixups creating the varnished element and modyfing printer marks, actions imposing PDF documents and “Create PDF copy” and “File pickup” functions in Callas pdfToolbox Desktop 11

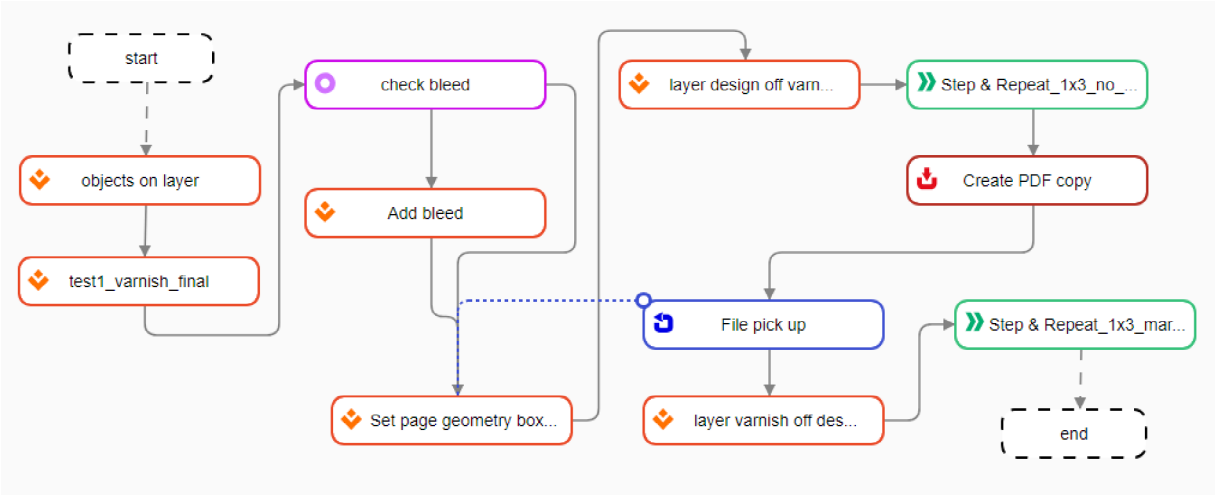


Fig. 77: Example of a more complex workflow that combines fixups creating the varnished element and bleed if missing, actions that imposing PDF documents and “Create PDF copy” and “File pickup” functions in Callas pdfToolbox Desktop 11

a)

b)

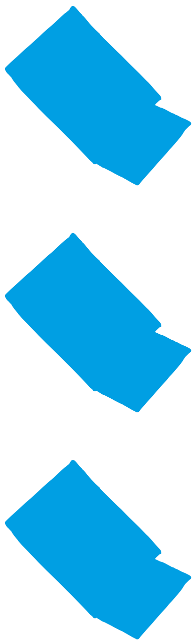


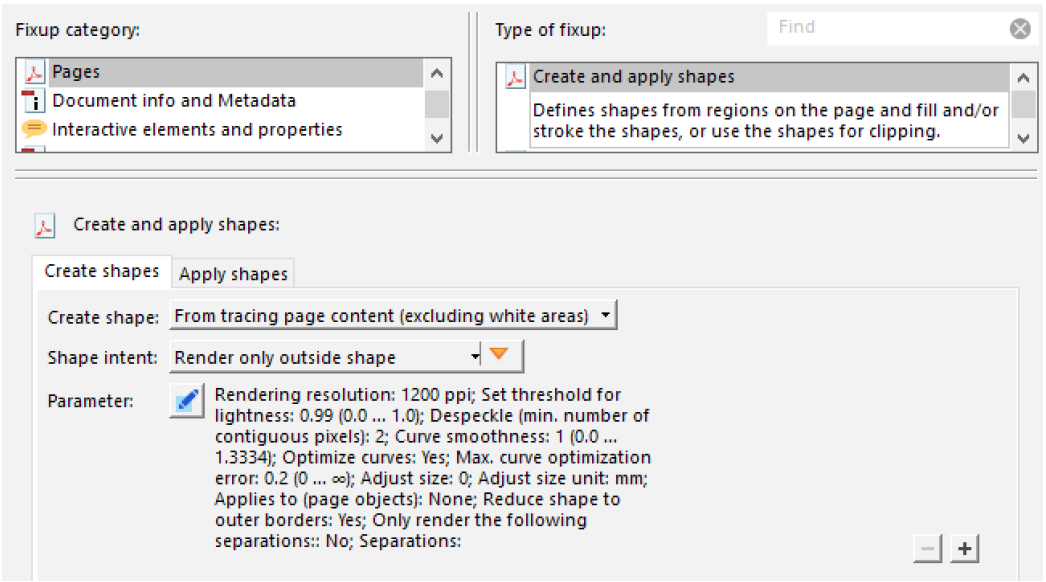
Fig. 78: Example of the resulting a) printing data, b) data for varnishing for the first and second printing data (see Fig. 34 and Fig. 35) processed by the workflow presented in Fig. 77 and Fig. 76 in Callas pdfToolbox Desktop 11 (scale 1 : 2)

6.2.6 Creating a vector path for cutting

The last task is to create a vector path for cutting around the object that is isolated on a white background (again, in a new layer and a new spot color), in this case, for a job with the illustration of screen printing, see Fig. 36.

For this method, it is appropriate to select "Create shape from tracing content (excluding white areas)". Here it is especially important to set the shape intent to "Render only outside shape" and check "Reduce shape to outer borders". All settings are shown in Fig. 79 and Fig. 80. Besides, default printer marks are only removed, not replaced here. The same procedures as in Chapter 6.2.1 can be used, only without the step where new printer marks are added. As in the previous case, everything can be combined and a process plan can be created so that the work is as automated as possible. Created process plan is in Fig. 81. Both the new layer and the new spot color are created, as can be seen in Fig. 82 and Fig. 83. It is up to the needs of the company, what is more appropriate for its workflow.

a)



b)

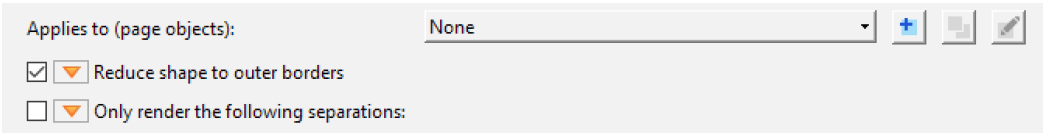
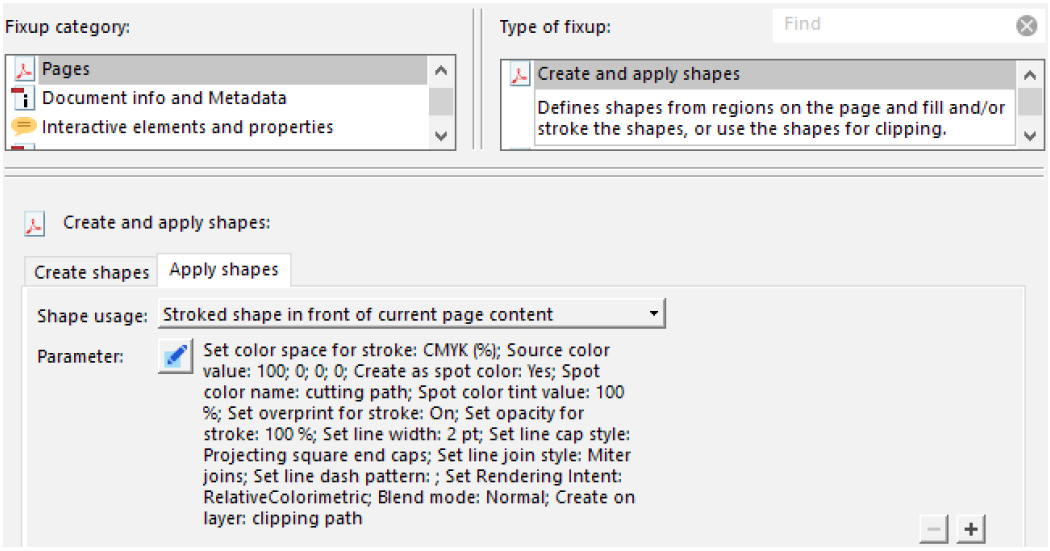


Fig. 79: Example of a fixup to a) create shape from tracing page content (excluding white areas) while rendering only outside shape and its parametres and b) reduce it to outer borders in Callas pdfToolbox Desktop 11

a)



b)

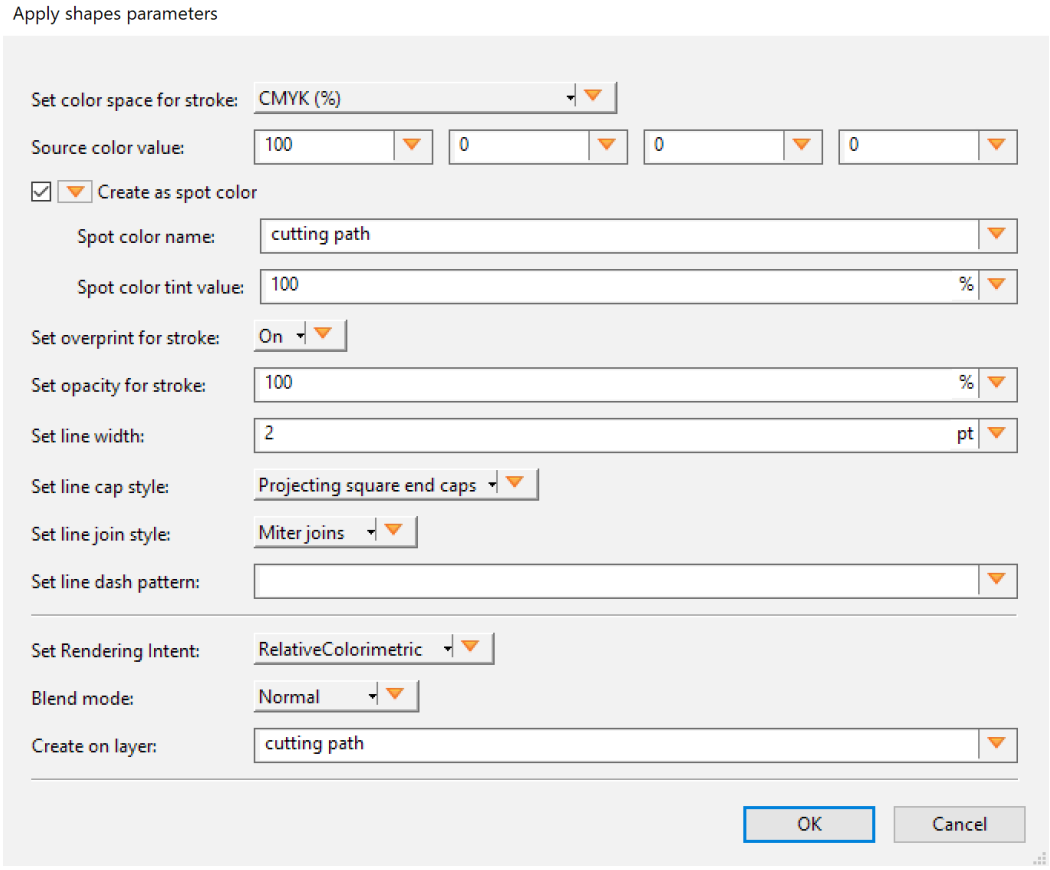


Fig. 80: Example of a) a fixup that applies the created shape as a stroked object with defined in front of the current page content, b) the corresponding settings in Callas pdfToolbox Desktop 11

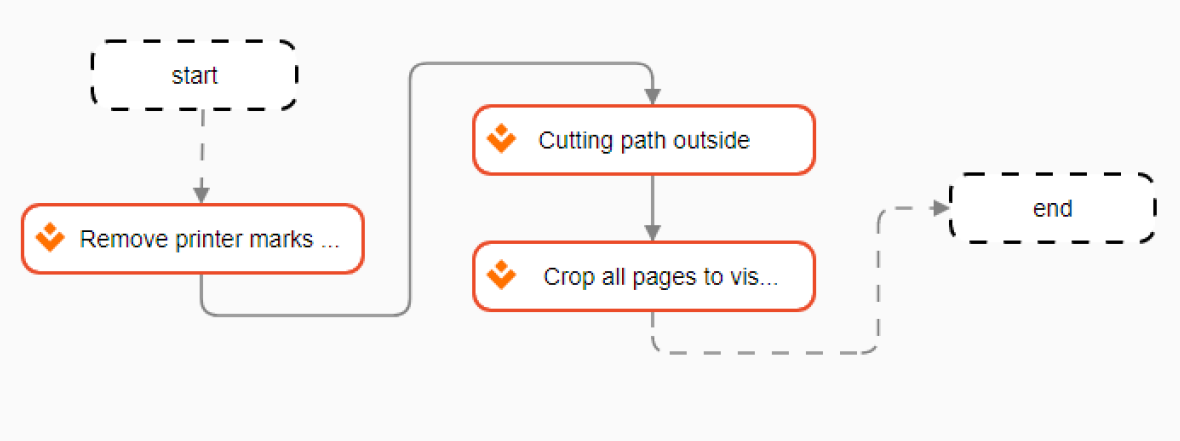


Fig. 81: Example of combining fixups removing printer marks, creating the cutting path and cropping the page to remove the white space into one process plan in Callas pdfToolbox Desktop 11

Fig. 82: Modified printing data with the created layer named “cutting path” defining a path for cutting in Callas pdfToolbox Desktop 11

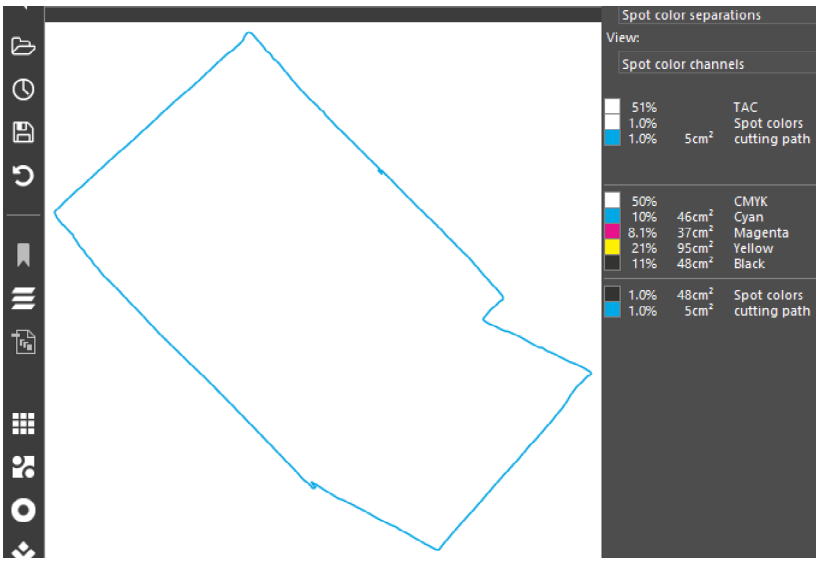


Fig. 83: The newly created object defining the path for cutting with a stroke in spot color named “cutting path” in the modified printing data in Callas pdfToolbox Desktop 11

Here, too, it is possible to create a more complex workflow within the process plan, even with the imposition of both the cutting element and the printing data. The procedure is similar to that presented in Chapter 6.2.5. The only difference is that the A1 format was used to impose 2 × 3 using the Step & Repeat function. Splitting of a PDF and its processing in two different ways within created workflow is shown in Fig. 84. The imposed printing data and varnishing elements from the third example are shown in Fig. 85.

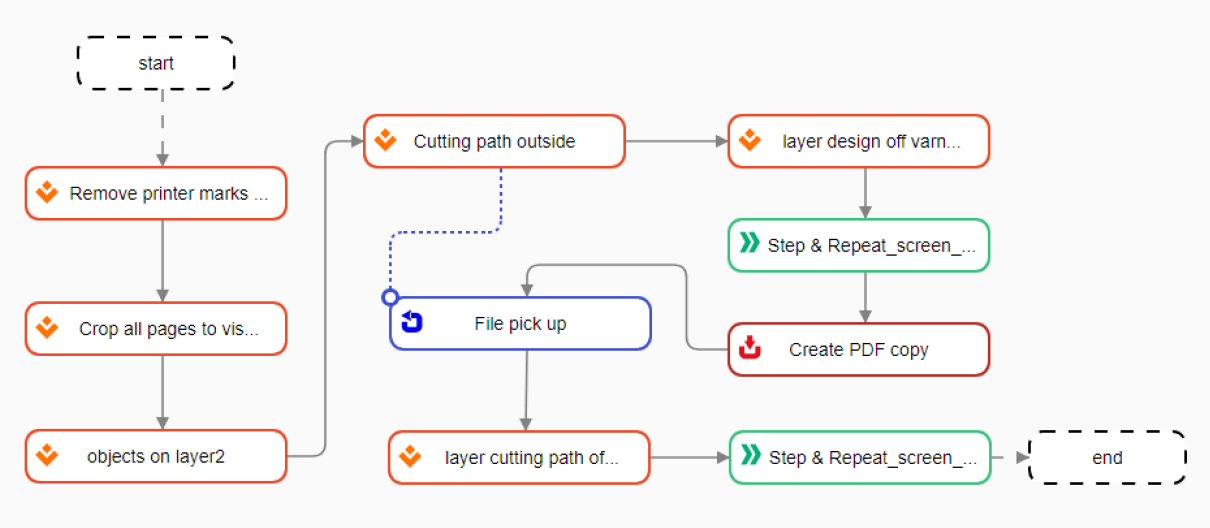


Fig. 84: Example of a more complex workflow that combines fixups modyfing printer marks and creating the cutting element, actions imposing PDF documents and “Create PDF copy” and “File pickup” functions in Callas pdfToolbox Desktop 11

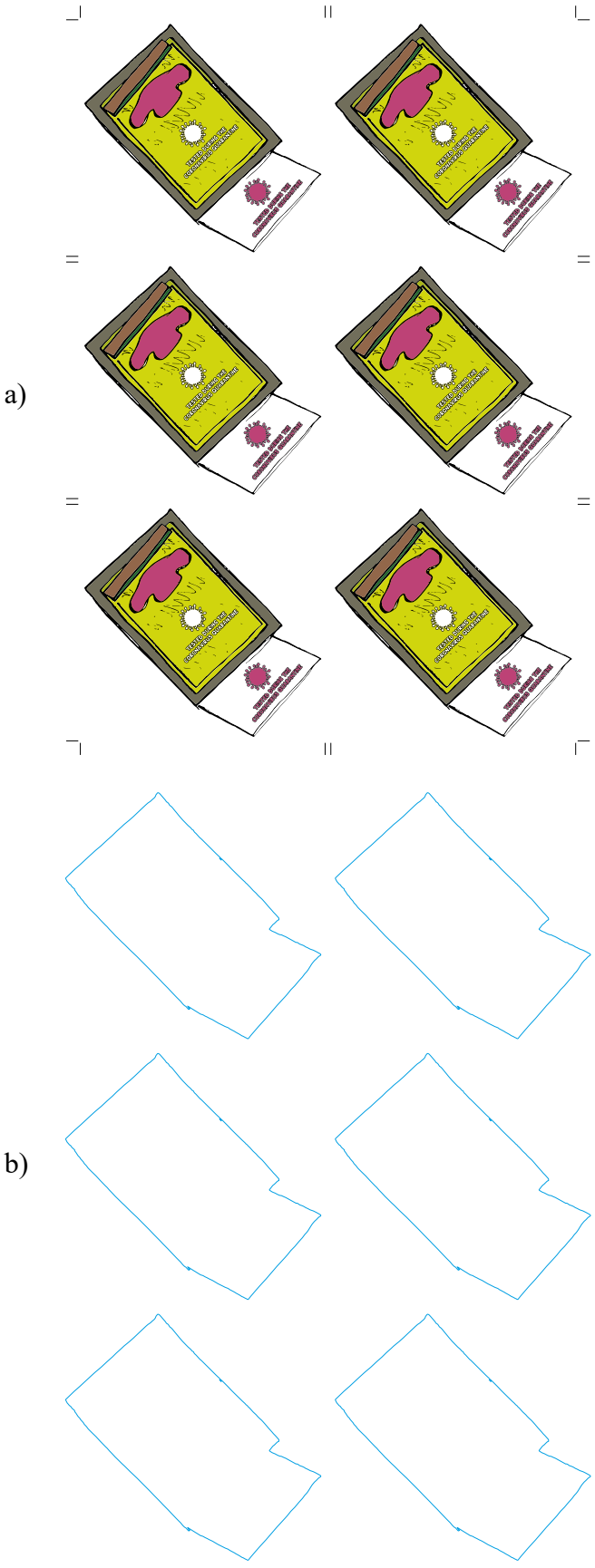


Fig. 85: Example of the resulting a) printing data, b) data for cutting for the third printing data (see Fig. 36) processed by the workflow presented in Fig. 84 in Callas pdfToolbox Desktop 11 (scale 1 : 6)

6.3 Automation in Xerox FreeFlow Core 5.4.1

The next step concerned testing in the prepress workflow system FreeFlow Core from Xerox in the version 5.4.1 (5.4.3 is already available on the market, but the changes are minimal). Since Xerox FreeFlow Core includes built-in Callas pdfToolbox technology, preflight profiles, checks, fixups and process plans created in Callas pdfToolbox Desktop can be loaded and used in Xerox FreeFlow Core. Since the latest version of FreeFlow Core still has a built-in version of Callas pdfToolbox 10.2, while the Desktop application was used in version 11 (Chapter 6.2), it was necessary to verify whether all functions used in version 11 are also available in version 10.2. In this case, all of the presented options are available except for generate bleed for irregular shapes, which, however, has not been used.

Xerox FreeFlow Core workflow with creating a vector cutting path for the second example job (Fig. 36, version in a size of 70 %) is demonstrated below. Likewise, also the other automated procedures defined in Callas pdfToolbox Desktop 11 could be used.

Workflow creation interface – workflow canvas is shown in Fig. 86. In the left column at the top, there are “Components” that can be used in the workflow. In the lower part, there are Presets (of components). In the Workflow list at the bottom of the window, the created workflows can be saved and new workflows can be created using the “Add” button. At the top, there is a blue bar, which can be used to click on other areas than the “Workflow Setup” tab. There is a “Job Management and Status” tab where current jobs can be viewed and edited, with appropriate information about them. For each job, there is a button with the information icon on the right, enabling to display the job properties. Also, the jobs can be submitted here. Another tab is “Print Management and Status”, where information about printing machines is available. There is also information about inks, papers, finishing, etc. It is also possible to create printer destinations here, which are then assigned in the “Workflow Setup” when the “Print” component is selected at the end of the workflow. However, this is important for Xerox printers; to send the job to other printers, the hot folder assigned to that printer must be used. There is also an “Administration tab”, where, for example, a hot folder can be created and linked with an existing workflow. Also, notifications (e.g. for preflight) can be set here or users assigned to FreeFlow Core.

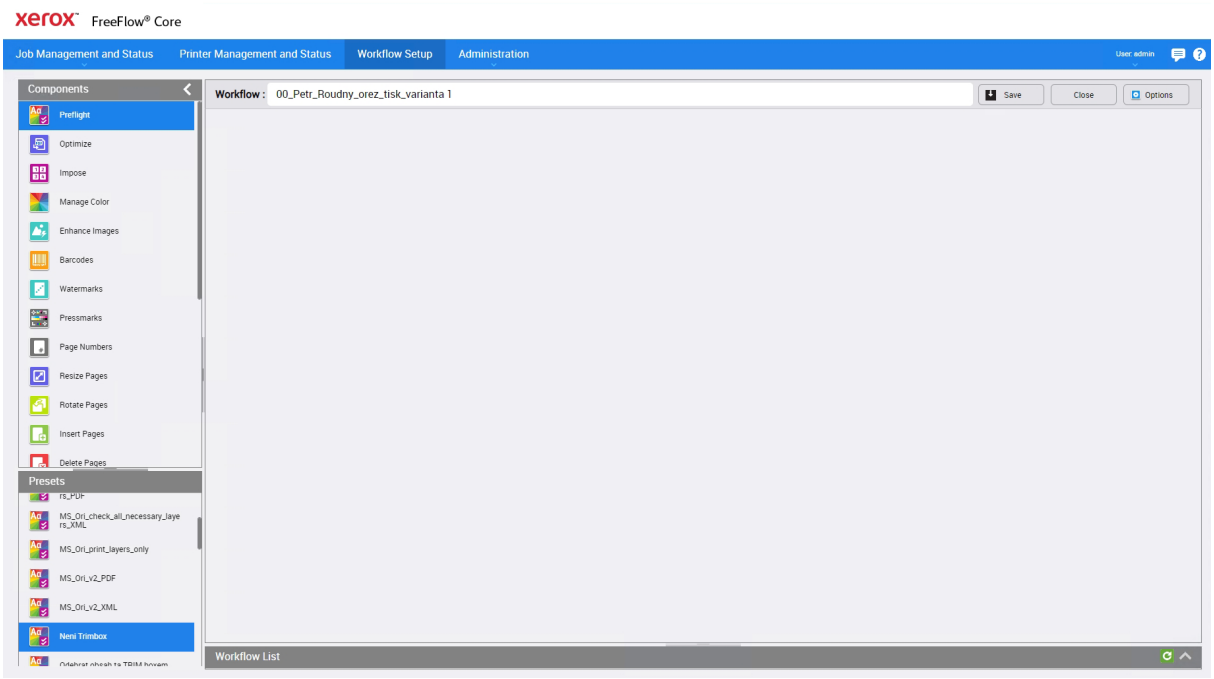
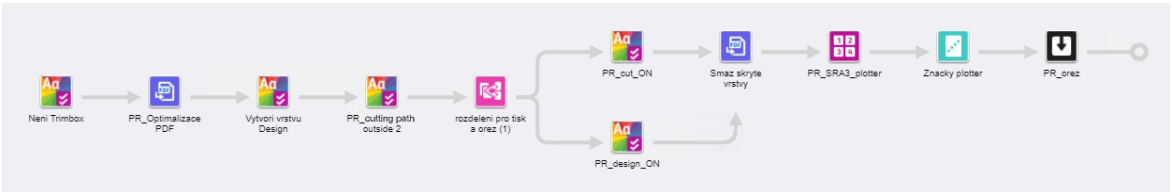


Fig. 86: Example of the Xerox FreeFlow Core user interface – workflow canvas in "Workflow Setup" tab where any workflow can be created using the "Components" pane

Regarding printer marks, Xerox FreeFlow Core has a built-in removal feature, so there is no need to export the respective profiles or fixups from Callas pdfToolbox Desktop. Xerox FreeFlow Core can automate the significant part of the printing data processing procedure. The example demonstrated below does not only concern the removal of printer marks and adding a vector path for cutting. Two versions of the workflow were created, as shown in Fig. 87 a and Fig. 87 b, which can be used to completely process a file along with the two tasks mentioned, from checking and optimizing to saving imposed sheets. The individual steps included in the workflow as well as the reason why two almost identical workflows were created, will be explained below. Created workflows run using a hot folder, which was created and further saves work and time compared to batch processing in Callas pdfToolbox Desktop or Adobe Acrobat.

a)



b)

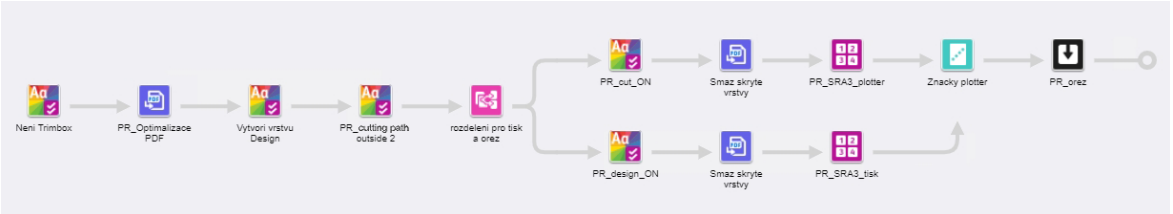


Fig. 87: a) Workflow A, b) Workflow B created in Xerox FreeFlow Core 5.4.1

In the first part of the created workflows, TrimBox is checked, because it is further processed in the workflow, and it is advisable to check whether it is present in the printing data. If there is a problem with the TrimBox, the workflow stops and informs the operator. The TrimBox check settings are shown in Fig. 88.

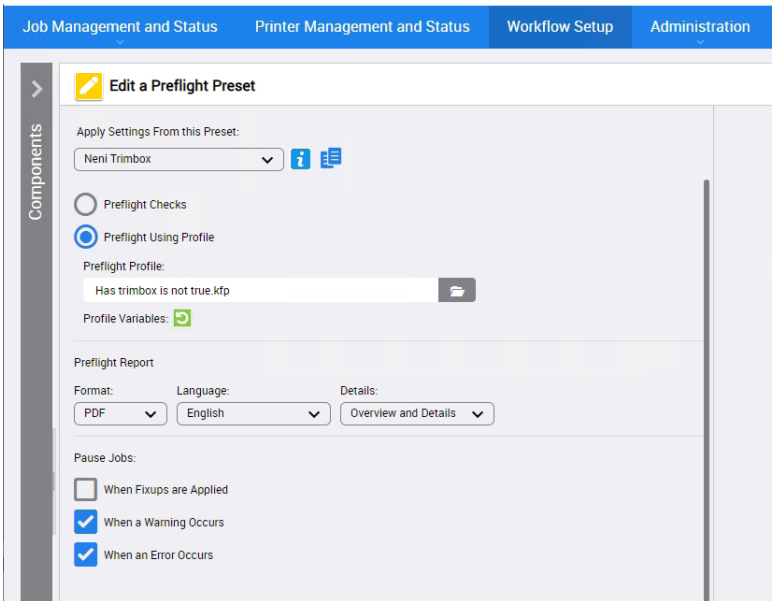


Fig. 88: Example of TrimBox check in Xerox FreeFlow Core 5.4.1 using preflight check

The next step is PDF optimization. Each printing company can choose what is needed in this step; for example, preflight checking if the PDF is compliant with the given PDF/X standard can precede, but it was not used here. In this situation, the optimization includes the removal of unneeded transparencies[1], removal of printer marks and all other objects outside the TrimBox (in case there is anything else than printer marks), and optimization for fast web view (Fig. 89). This optimization does not reduce the quality of the printing data (it does not change parameters, such as compression, resolution, etc.), it only optimizes the data so that it can be viewed faster.

As discussed in Chapter 6.2.6, creating a path for cutting is only applicable to illustrations, logos, and any other graphics that are isolated on a white background. In the next step, a single layer named design is created and all design objects are moved to this layer. The layer is made so that the design could be treated separately after creating another layer with a vector path for cutting. Details of the corresponding fixup created in Callas pdfToolbox Desktop are shown in Fig. 90 and the settings of a preflight preset are shown in Fig. 91.

[1]It removes transparency groups that do not include transparent objects [442]. These are groups of objects in other objects used as a transparency mask [443].

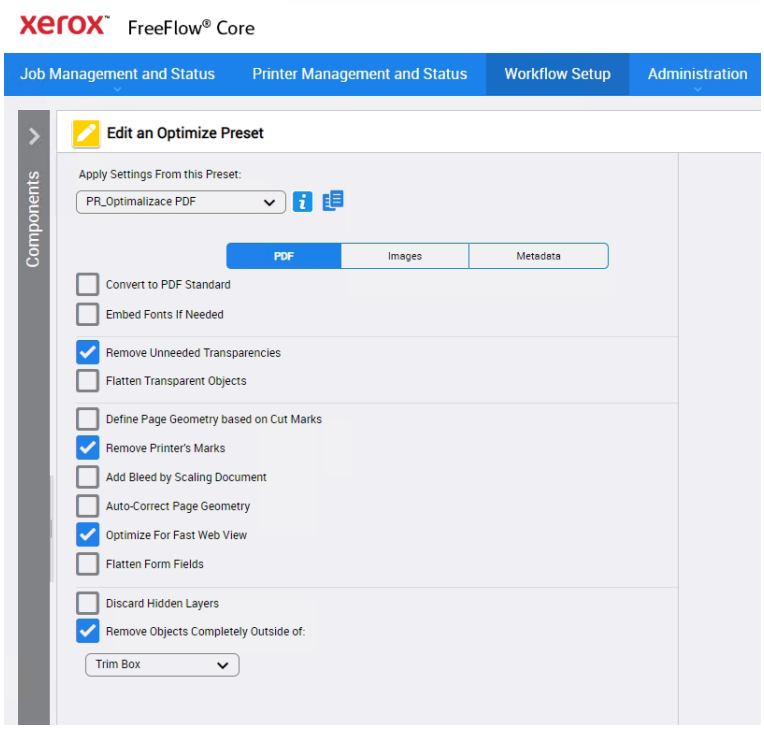


Fig. 89: Example of PDF optimalization settings in Xerox FreeFlow Core 5.4.1

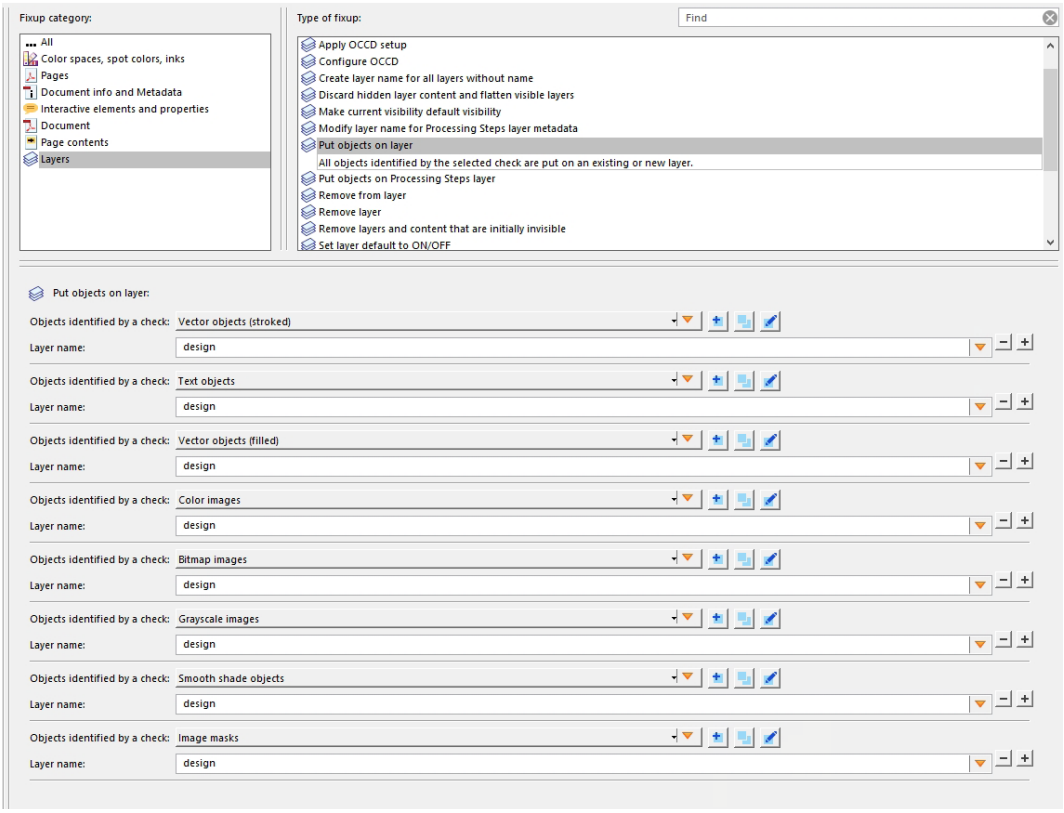


Fig. 90: Example of setting a fixup to create a new layer named design in Callas pdfToolbox 10.2

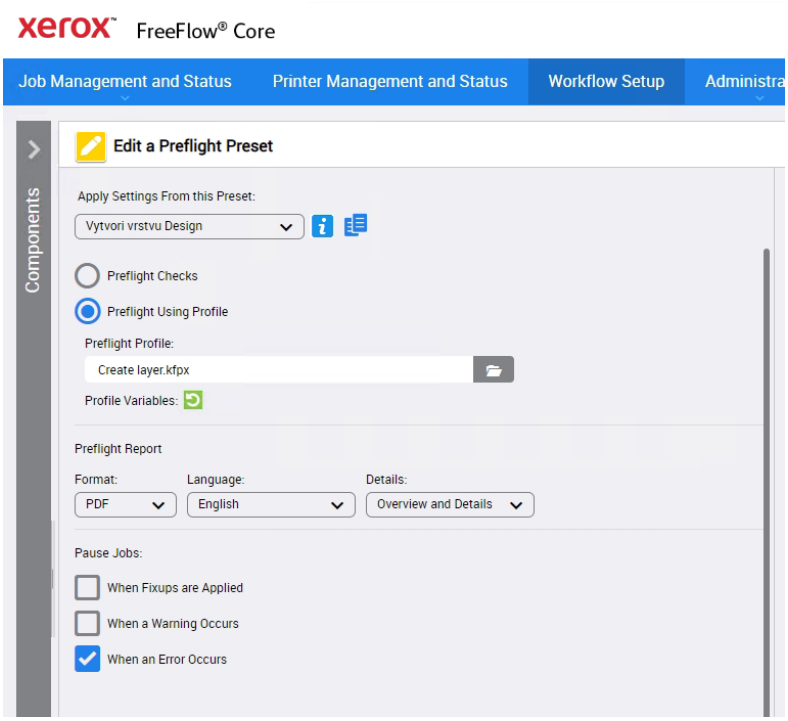


Fig. 91: Example of a setting to create a new layer in Xerox FreeFlow Core 5.4.1

The next step is to create a vector path for cutting. The fixup settings are identical to those in Callas pdfToolbox Desktop 11, see Fig. 79 and Fig. 80. The Xerox FreeFlow Core settings are shown in Fig. 92. If an object for varnishing was created in this step instead of a cutting path, it would be possible to use variables. According to M. Šaněk (personal communication, June 12, 2020), properly defined variables can be used in Xerox FreeFlow Core. Whether using manual change (open preset and change value with each new job) or using data from CSV file. First, it is necessary to define a CSV document with appropriate conditions and variables. A fixup, profile, or process plan based on variables would then always look for the appropriate values of variables, defined in the CSV document created for a given job (however, the CSV file does not have to contain the data itself, it can only provide a link to the data; it depends on the workflow). Then, based on the information found, it would automatically fill in the required values. When using this approach, it is necessary to ensure that the variable values (e.g. the size of the varnished object) are saved to the CSV document, e.g. by the information system.

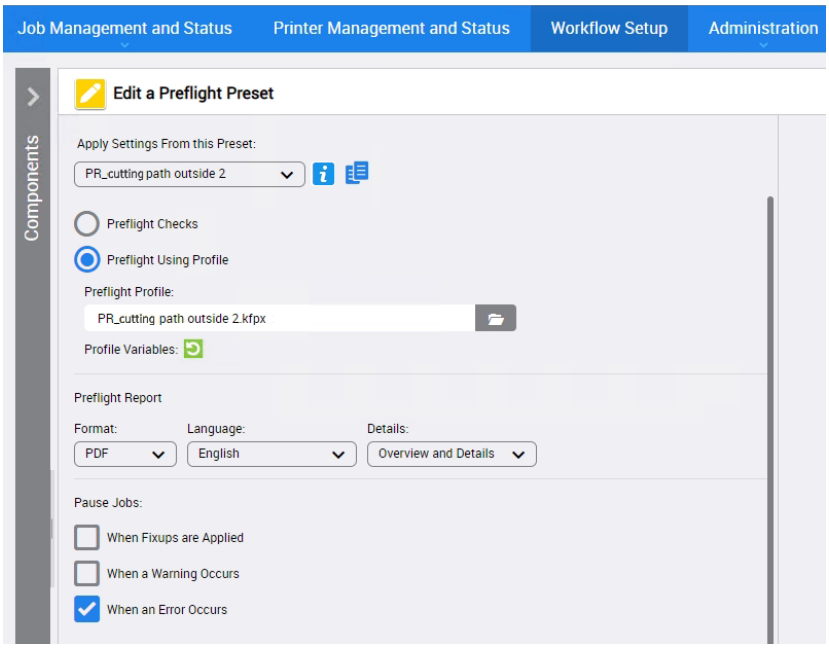


Fig. 92: Example of settings to create a new layer named cutting path with the corresponding element in Xerox FreeFlow Core 5.4.1

In the next step, the two created layers are duplicated into two separately processed documents. Splitting is important so that the printing layer and the cutting layer can be processed differently. It is also important to mention that this feature is only available in Xerox FreeFlow Core Advanced Automation package.

Splitting is based on the visibility of layers. The fixup setting to display the layer that is supposed to be printed, and hide all others in Callas pdfToolbox Desktop is shown in Fig. 93. It comprises only turning the visibility of individual layers on or off. In this case, the layer named “design” is displayed, while all others are hidden. As can be seen, it is also possible to preventively hide layers that might appear in printing data by accident. These are called “varnish” and “layer” in this case. The fixup setting to display the layer with a vector path for cutting in Callas pdfToolbox Desktop is shown in Fig. 94. Here, the layer named “cutting path” is displayed, and the layer named “design” hidden.

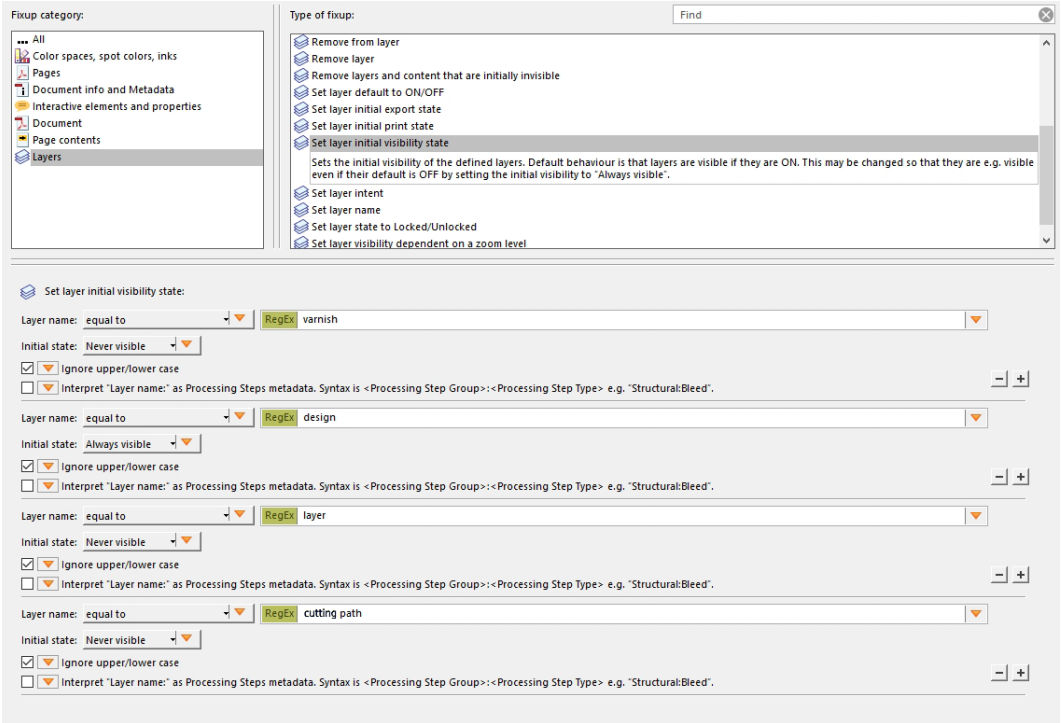


Fig. 93: Example of setting a fixup to display the “design” layer for printing, and hide the others in Callas pdfToolbox 10.2

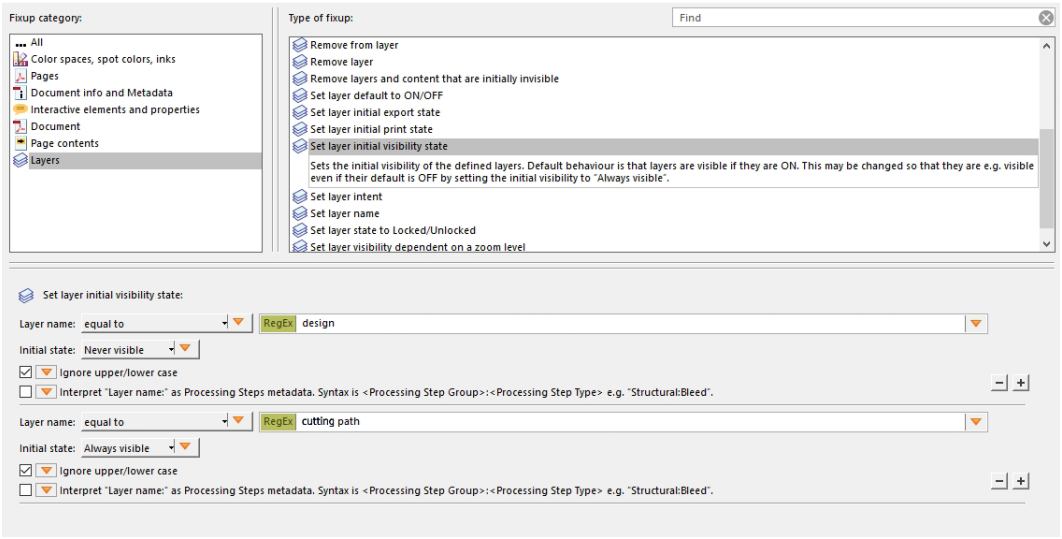


Fig. 94: Example of setting a fixup to display the “cutting path” layer for cutting, and hide the other in Callas pdfToolbox 10.2

Then, the rules used in the splitting process need to be defined in Xerox FreeFlow Core. The settings for the file that is created from the layer used for cutting are shown in Fig. 95. The settings for creating a file from the layer containing the printing data are analogous. Finally, creating two new documents using the “Split Process” is shown in Fig. 96.

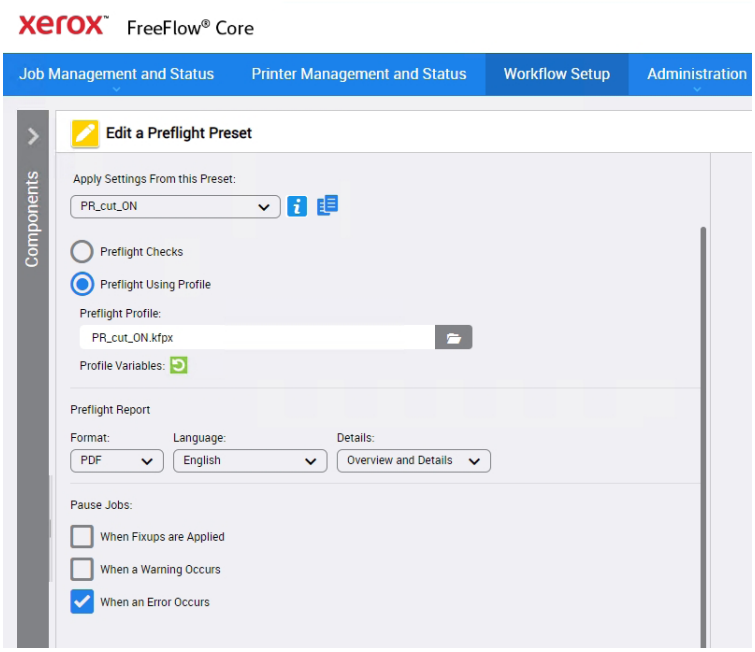


Fig. 95: Example of settings for cutting in Xerox FreeFlow Core 5.4.1

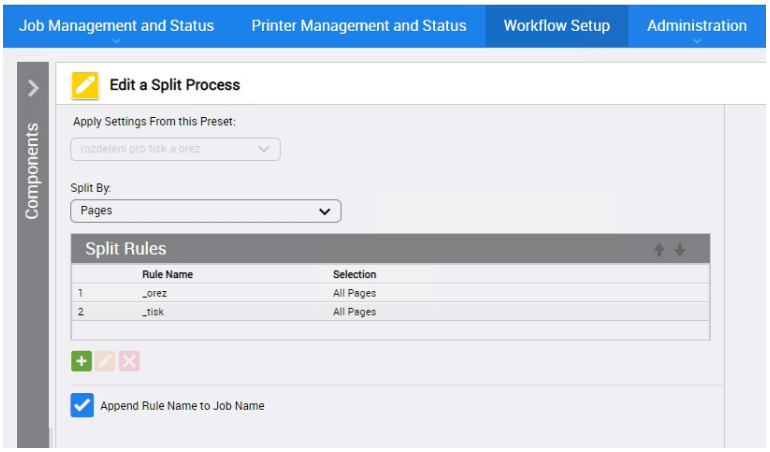


Fig. 96: Example of settings to split the file in Xerox FreeFlow Core 5.4.1

In order to work with split files, it is necessary to remove those layers that were hidden in the previous step. The setting is shown in Fig. 97. Only the layers that were set to visible remain in the separated documents. It is also important to mention that before this step, it is possible to connect the workflow again together and process the two split files in the same way (see the workflow A in Fig. 87). The connection is useful if crop marks will not be added. When the crop marks should be added to the data for printing in the imposition step, the workflow B (see Fig. 87) should be used, because it is not appropriate to add them also to the data for cutting. Different settings of the imposition step can be used for printing data and data for cutting, as there is no need to add crop marks twice in the same place.

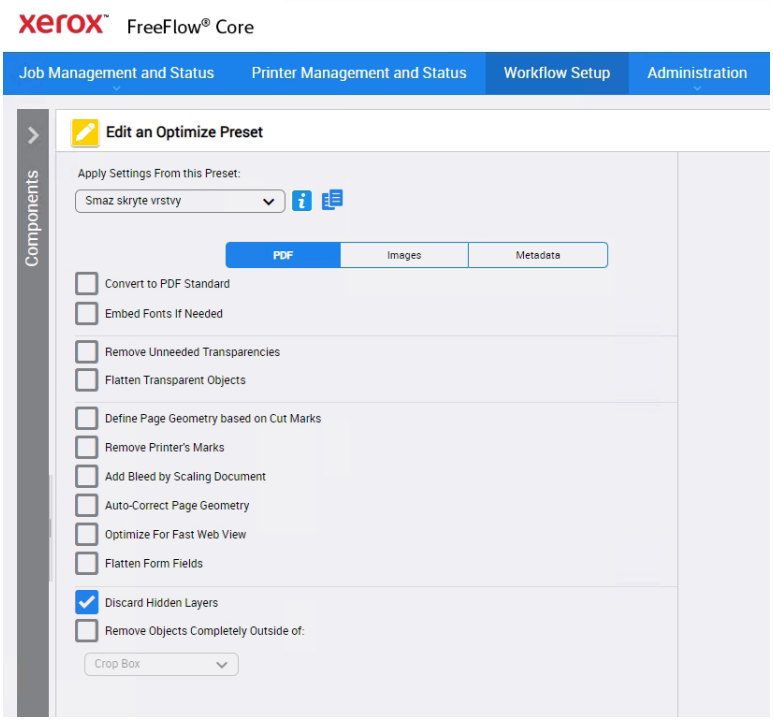


Fig. 97: Example of setting a fixup to remove hidden layers in Xerox FreeFlow Core 5.4.1

In the next step, imposition to a sheet is set (Fig. 98). Each printing company can set imposition as needed; here, the SRA3 sheet was selected. New crop marks are also added in this step (only to the file for printing). In the following step, registration marks for a cutting plotter are added as a watermark to the data for cutting (Fig. 99).

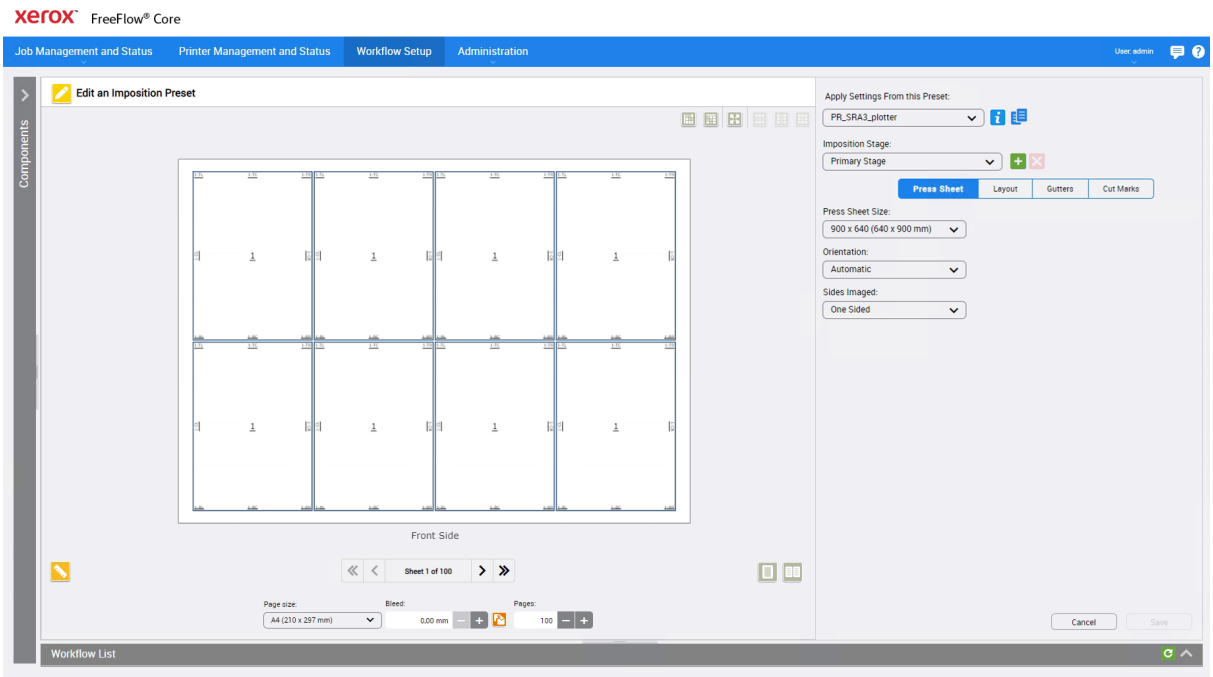


Fig. 98: Example of settings of an imposition on a sheet in Xerox FreeFlow Core 5.4.1

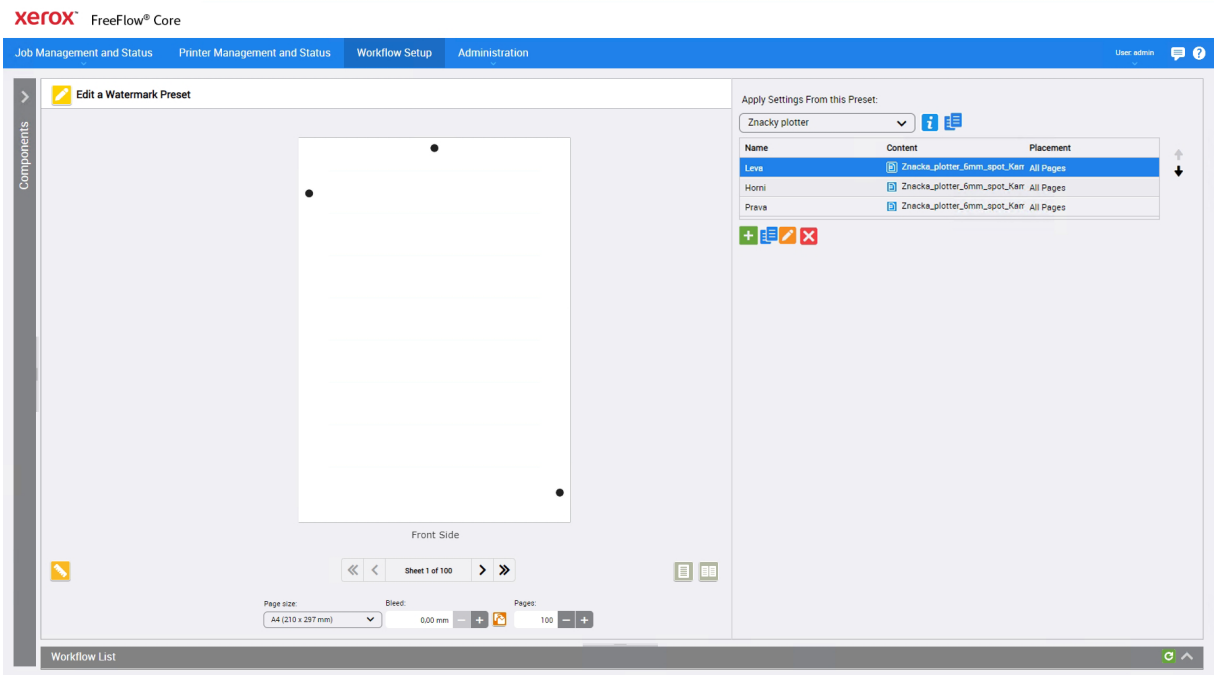


Fig. 99: Example of settings for inserting registration marks for a plotter in Xerox FreeFlow Core 5.4.1

The last step is to save the files (Fig. 100). In usual operation, however, there would be rather an output for printing, possibly supplemented with the option to set a job ticket. The resulting saved printing and cutting data are shown in Fig. 101.

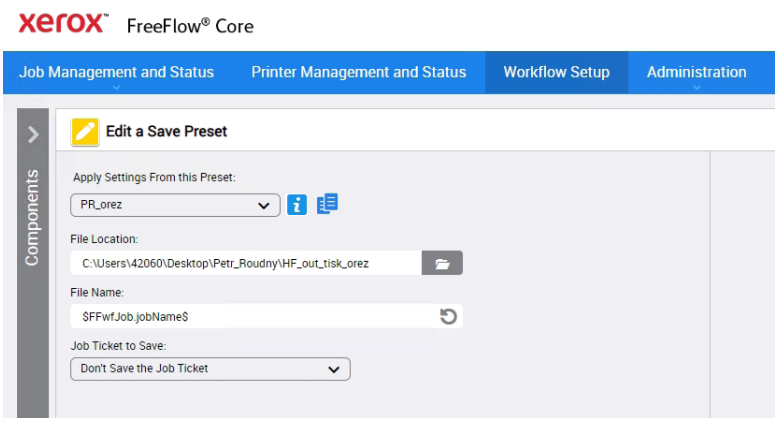
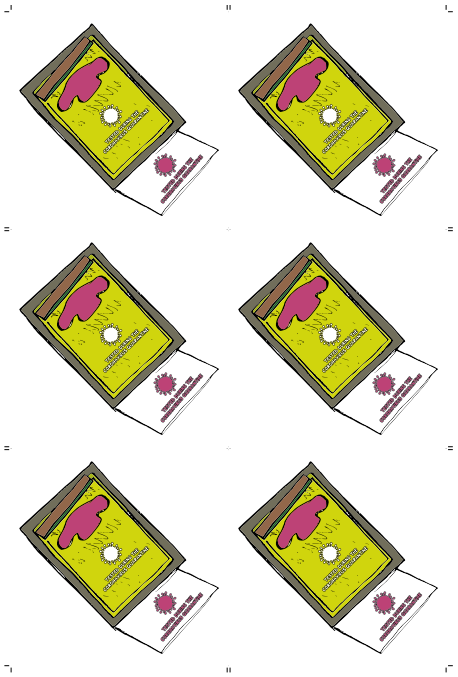


Fig. 100: Example of saving the edited files in Xerox FreeFlow Core 5.4.1

a)



b)

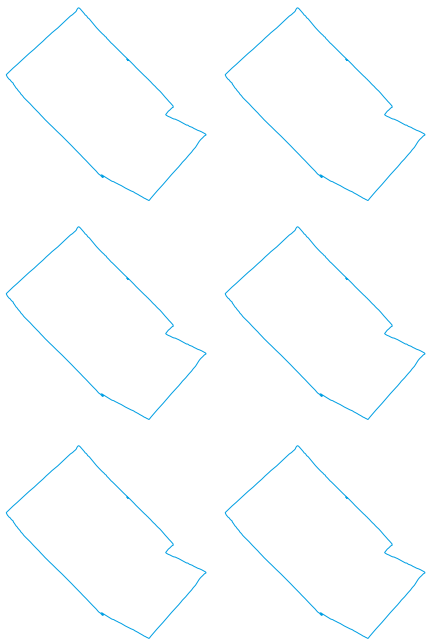


Fig. 101: Example of the resulting a) printing data, b) cutting data for the third printing data (see Fig. 36) processed in Xerox FreeFlow Core 5.4.1 by the workflow presented in Fig. 87 b (scale 1 : 8)

6.4 Automation in Enfocus PitStop Pro 2020

Enfocus PitStop Pro is a program similar to Callas pdfToolbox, but it is only a plugin for Adobe Acrobat. From the perspective of automation are important Preflight Profiles, which only check given parameters (Fig. 102a) and Global Changes (Fig. 102b), predefined document editing tasks that can be saved as an editable Action Lists. The most important are the mentioned Action Lists (Fig. 103), where can be created new ones in addition to predefined ones. The interface for creating new Action Lists is shown in Fig. 104. There are several categories for creating actions – selections, changes, checks, informs, and settings. The individual options are categorized according to what they relate to, for example, Line Art, Position and Size, Color, etc. The advantage over Callas pdfToolbox is that individual edits, which can be combined within Action Lists can also be edited manually in the Adobe Acrobat environment. Actions within the Action List can be found as manual edits. From the automation perspective, it has the advantage that it is possible to record manually performed operations and save them within the Action List. Then, they can be used in an automated form.

The last important part from the perspective of automation is Quick Runs (Fig. 105a) that can combine Action Lists, Global Changes, and Preflight Profiles in one command. The use is, therefore, advantageous where it is necessary to combine several adjustments into one step, as can be seen from Fig. 105b. In this case, for example, creating a varnish or cutting path and modifying printer marks.

As with Callas pdfToolbox Desktop, there is also the possibility to use "Variable Sets", within the so-called "Smart Preflights". They can be used either preset or create new, as shown in Fig. 106 and Fig. 107. In order to use Smart Preflight, it is needed to click "Actions", "Enable Variable Names", and then "Select a Variable" for the action in Action List, that fits best for the particular action (Fig. 108). This creates a Smart Preflight that prompt operator to enter parameters when the Action List is run (Fig. 109).

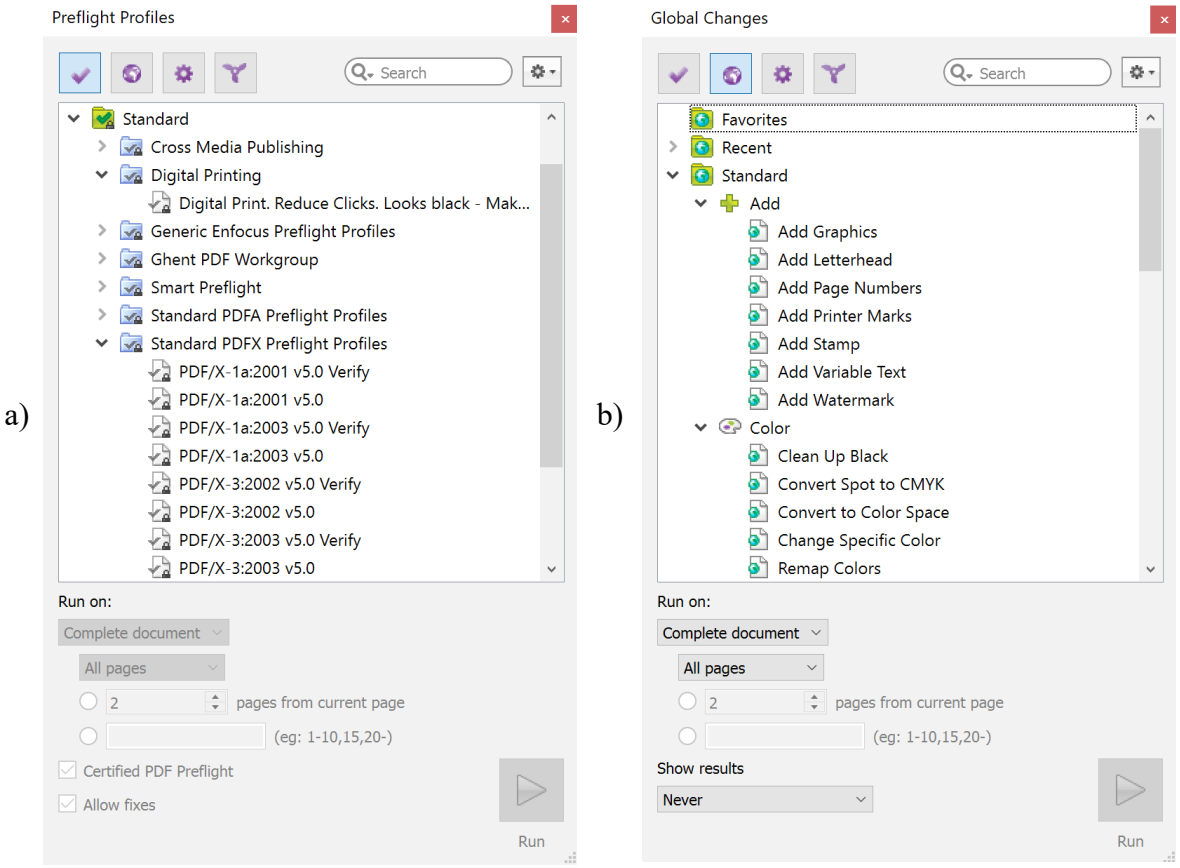


Fig. 102: Example of a) Preflight Profiles pane b) Global Changes pane in Enfocus PitStop Pro 2020

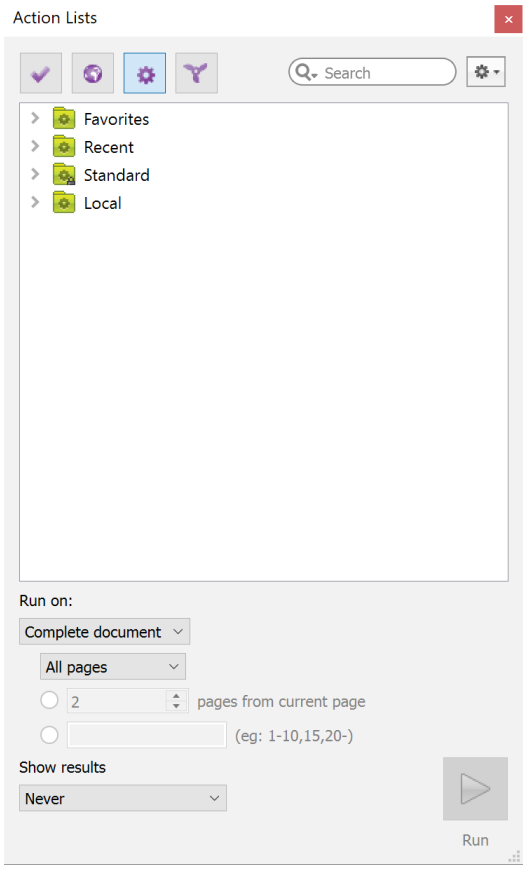


Fig. 103: Example of Action Lists pane in Enfocus PitStop Pro 2020

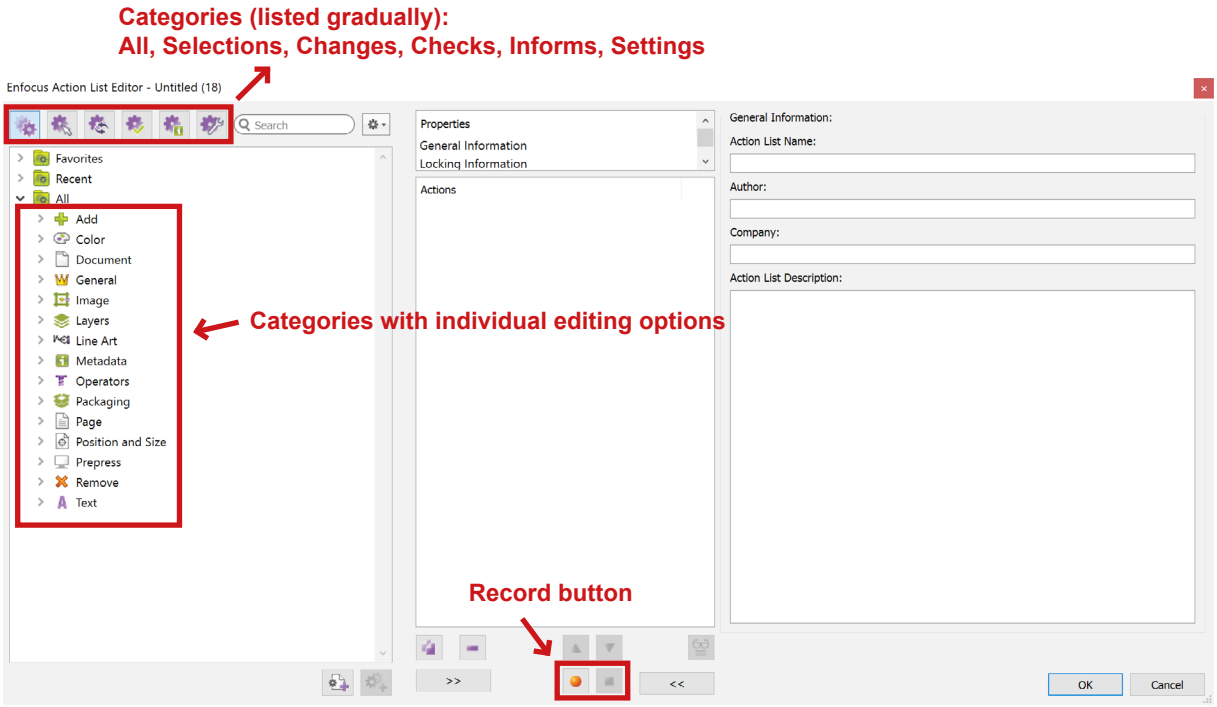


Fig. 104: Example of the interface for creating a new Action Lists including record button and individual categories in Enfocus PitStop Pro 2020

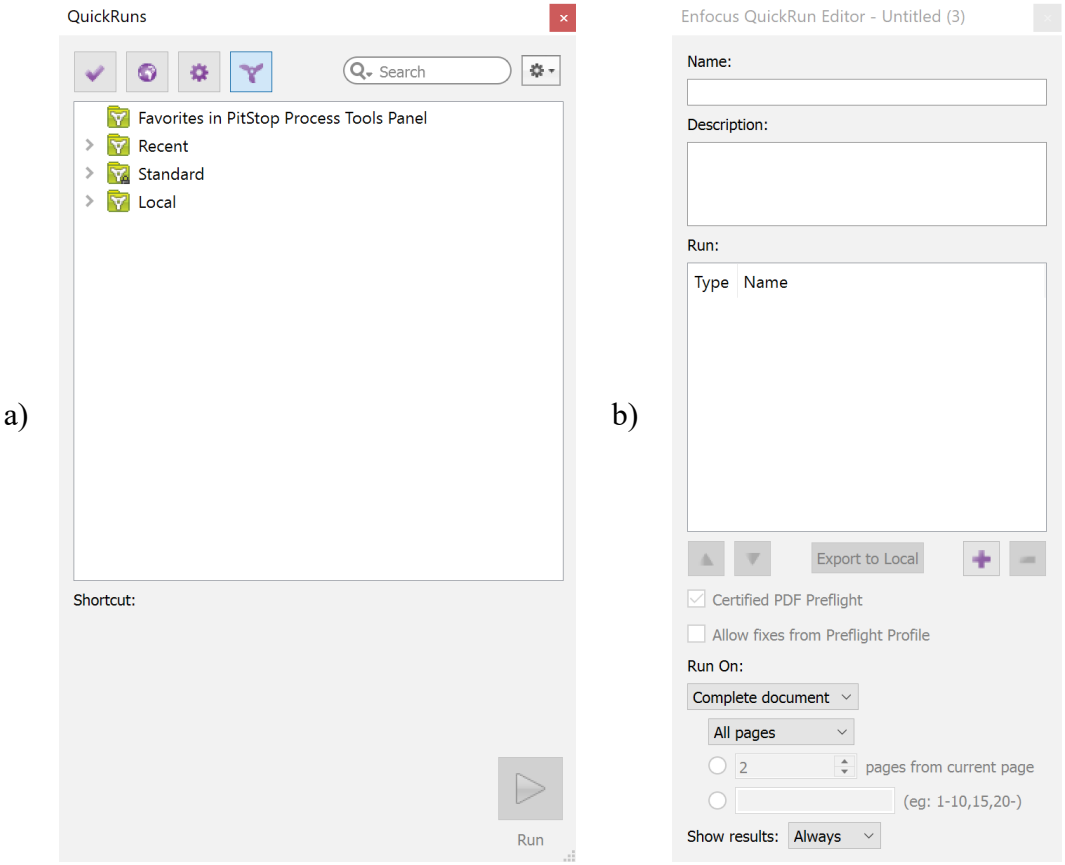


Fig. 105: Example of a) QuickRuns pane b) Enfocus QuickRuns Editor where can be combined different Action Lists, Global Changes, etc., in Enfocus PitStop Pro 2020

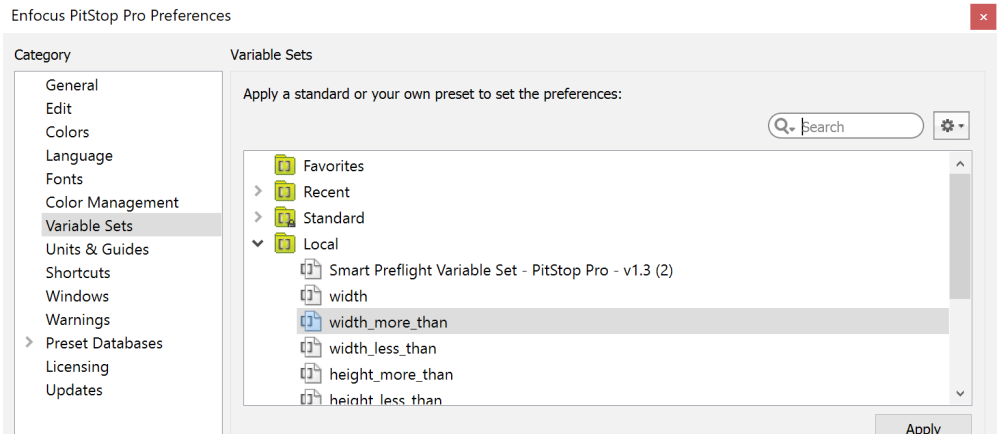


Fig. 106: Example of Enfocus PitStop Pro Variable Sets preferences in Enfocus PitStop Pro 2020

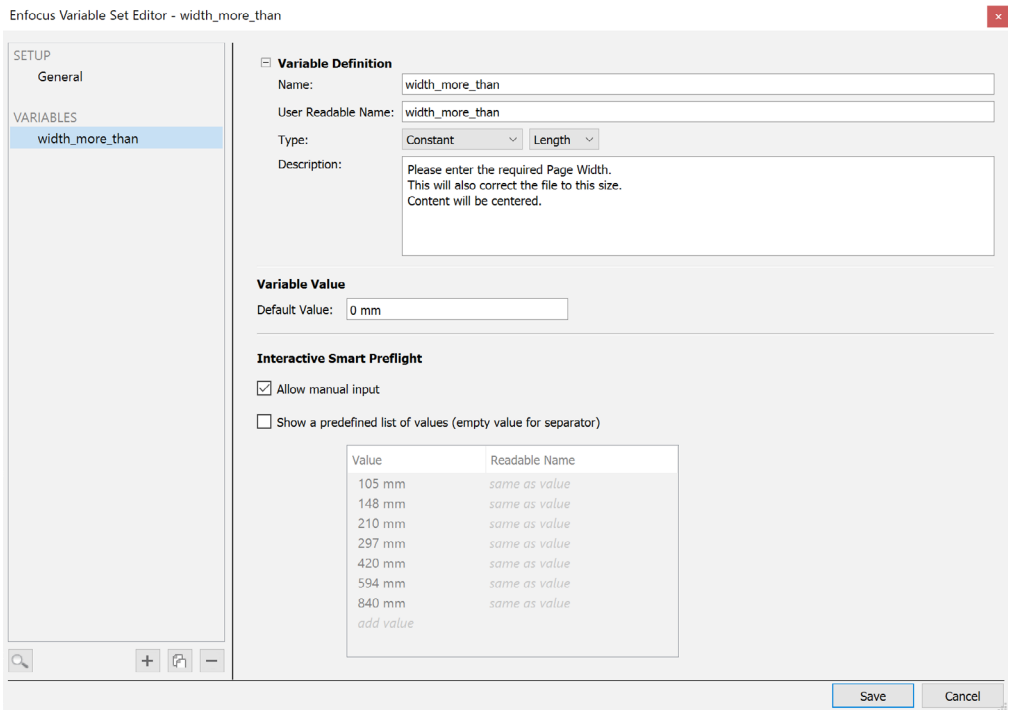


Fig. 107: Example of Enfocus PitStop Pro Variable Set Editor – custom-created interactive Smart Preflight in Enfocus PitStop Pro 2020

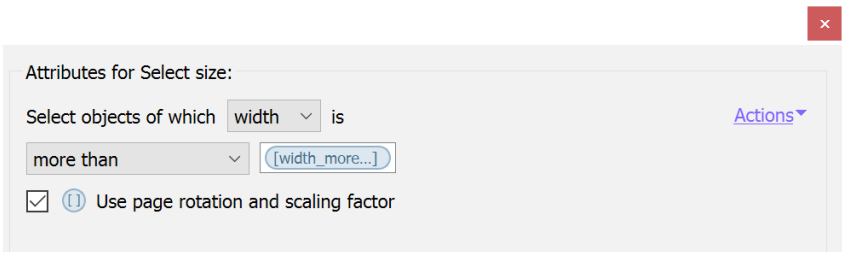


Fig. 108: Example of selected variable within Action Lists that was custom-created in Enfocus PitStop Pro 2020

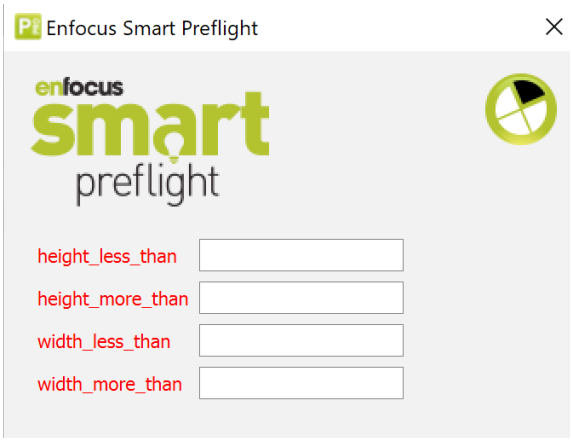


Fig. 109: Example of Smart Preflight that prompt an operator to enter parameters in Enfocus PitStop Pro 2020

Besides, PitStop is characterized by the use of logical operators [444]. The most important are the logical operators AND, for the use of all selected actions, OR, where one or the other specified action is used, and NOT, which serves to exclude unwanted selections [444]. In the case of the bookmark with the printer marks (see Fig. 34), logical operator NOT can be used, for example, to the color of the substrate on which is the illustration of the screen on which the varnishing element is to be created is located. Also, other logical operators can be used, but they are not important for this work.

6.4.1 Modifying printer marks

Also in Enfocus PitStop Pro, it is possible to remove or replace default printer marks as can be seen in Action List in Fig. 110. Default printer marks can be removed by changing the CropBox to the size of one of the remaining boxes, in this case, the BleedBox or TrimBox (Fig. 111 a). In order to add new printer marks, it is necessary to resize CropBox, for example, by 10 mm from left, right, top, and bottom (Fig. 111 b). It can be then added new ones, for example, only trim marks. It can also be added "Select objects outside the BleedBox" action to the beginning, and then use the "Remove selection" action. This will permanently delete the objects that are outside the BleedBox.

PitStop has the disadvantage that it is not possible to define the offset of the trim marks, it can only be chosen between the InDesign style (which, however, interferes with the BleedBox), or between the QuarkXpress style (which, on the contrary, are too offset). In this case, trim marks with QuarkXpress style were selected (Fig. 112). Also as in Callas pdfToolbox, step concerning adding new crop marks can be omitted and the necessary printer marks placed to the sheet during the imposition (PitStop does not allow imposition, so in another program, for example, within Adobe Acrobat interface would be possible to use Adobe Acrobat plug-in Montax imposer).

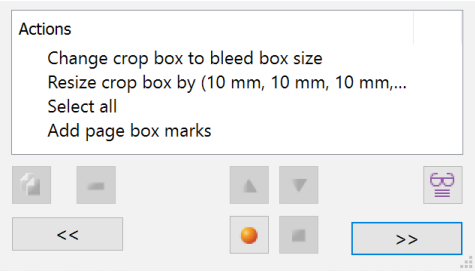
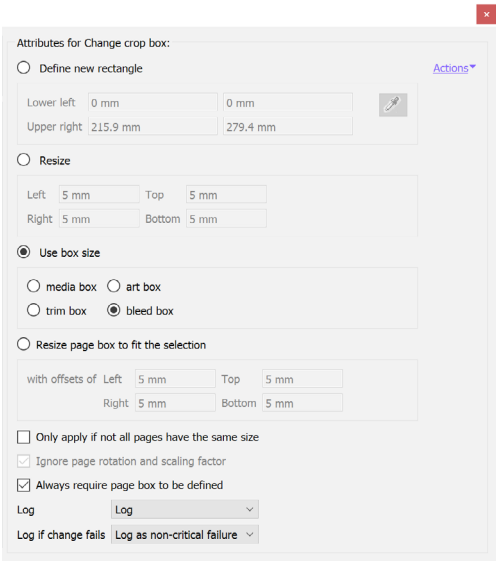


Fig. 110: Example of created Action List to modifies printer marks in Enfocus PitStop Pro 2020

a)



b)

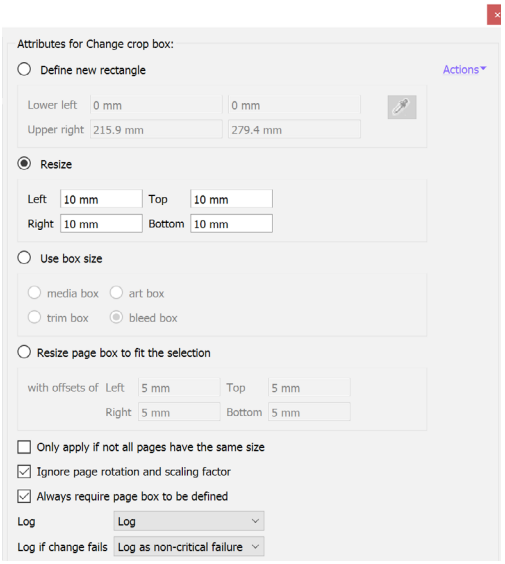


Fig. 111: Example of setting the action to a) change CropBox to BleedBox, b) resize CropBox by 10 mm in Enfocus PitStop Pro 2020

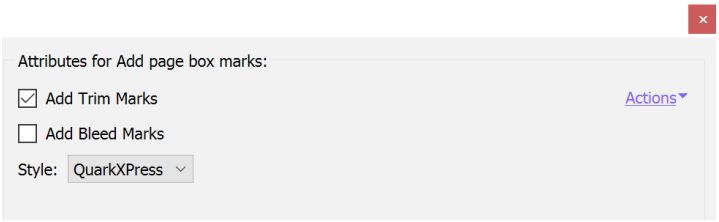


Fig. 112: Example of setting the action to add page box marks – trim marks with QuarkXpress style in Enfocus PitStop Pro 2020

6.4.2 Fixing missing bleed

Also with Enfocus PitStop Pro, the second solution is to add bleed. It can be used preflight to determine whether a bleed is used in a document (Fig. 113). In this case, this was achieved by creating a preflight that checks whether the TrimBox is at least 3 mm remote from the BleedBox (3 mm is the normal size of the bleed). If the bleed in the printing data is missing or is less, this preflight will automatically report an error.

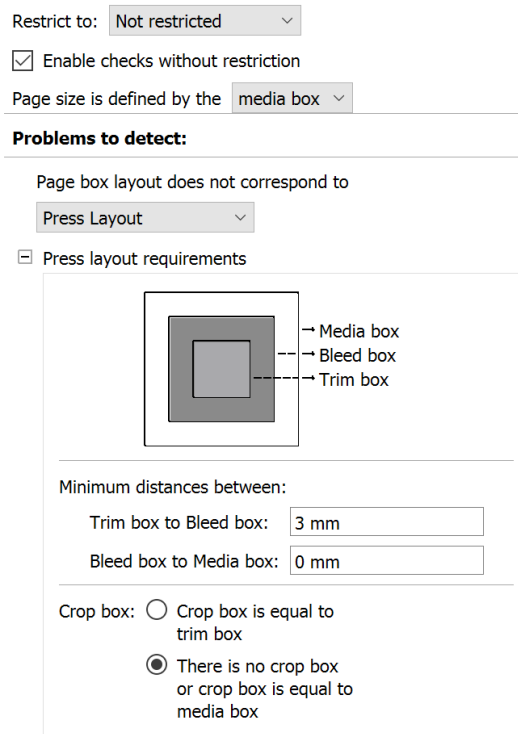


Fig. 113: Example of preflight to check whether the minimum distance between the TrimBox and the BleedBox is 3mm in Enfocus PitStop Pro 2020

When fixing a bleed, it is important to set the page boxes initially. In the first step, the MediaBox is resized to the TrimBox size. In the second step, the BleedBox is resized to the MediaBox size. Subsequently, the size of the MediaBox is enlarged. In this case, by 12 mm on each side, so that QuarkXpress-style trim marks can be placed. Next, the sizes of the ArtBox and CropBox are changed to the MediaBox size. Then BleedBox is enlarged by 3 mm on each side, and bleed is added. At this point, it is possible to select at what distance from the TrimBox the bleed should start and also where it should be added (it is necessary to check left, right, top, bottom). It can also be chosen whether the bleed will be mirrored (by checking off "Only add bleed by mirroring content"), or it will only be an enlargement of the objects (by not checking "Only add bleed by mirroring content"). If vector data is being processed, bleed will be vector; if raster, bleed will be raster.

An interesting solution here is that mirror margins can be set according to page binding. Setting options are in Fig. 114. In the last step, it can also be added an action that adds trim marks. The resulting Action List is shown in Fig. 115. The advantage is also that this Action List does not have to be recorded and then edited, as it is a predefined Action List. It can, therefore, only be adjusted as needed.

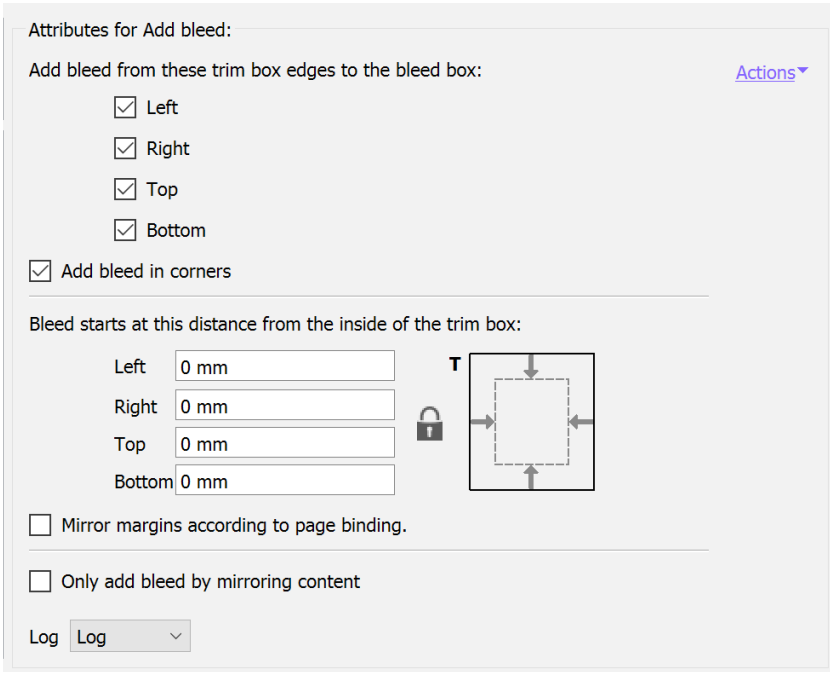


Fig. 114: Example of the action "add bleed" with options in Enfocus PitStop Pro 2020

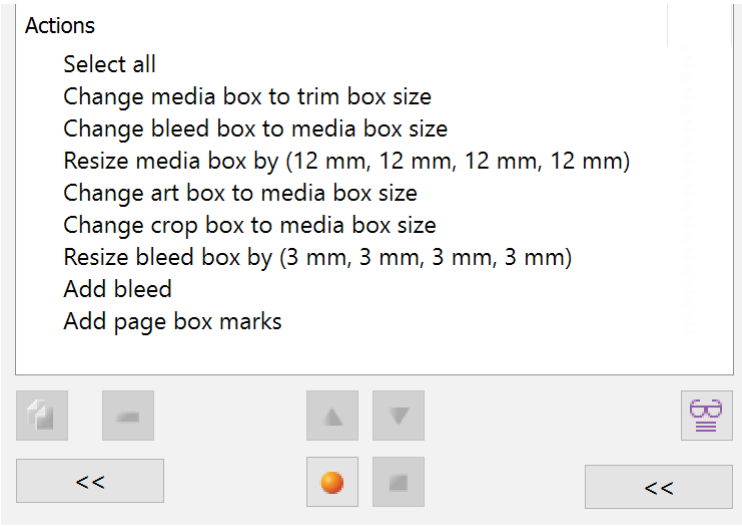


Fig. 115: Example of Action List to add bleed and set page boxes in Enfocus PitStop Pro 2020

6.4.3 Creation of an element for partial varnishing from vector images

Also in Enfocus PitStop Pro 2020 it is possible to create an element for varnishing for example job – the bookmark (see Fig. 34). Several ways have been proposed to create the element. Regarding its creation from vector objects, it is always based on a function that uses "Combine and Divide Shapes", in this particular case, "Unite line art". While the actions modifying the printer marks were set only within the Action List, the element for partial varnishing was first created using the record function in the Action List, and the settings were edited manually. It is always advisable to clean up the created Action List afterwards, as can be seen in Fig. 116.

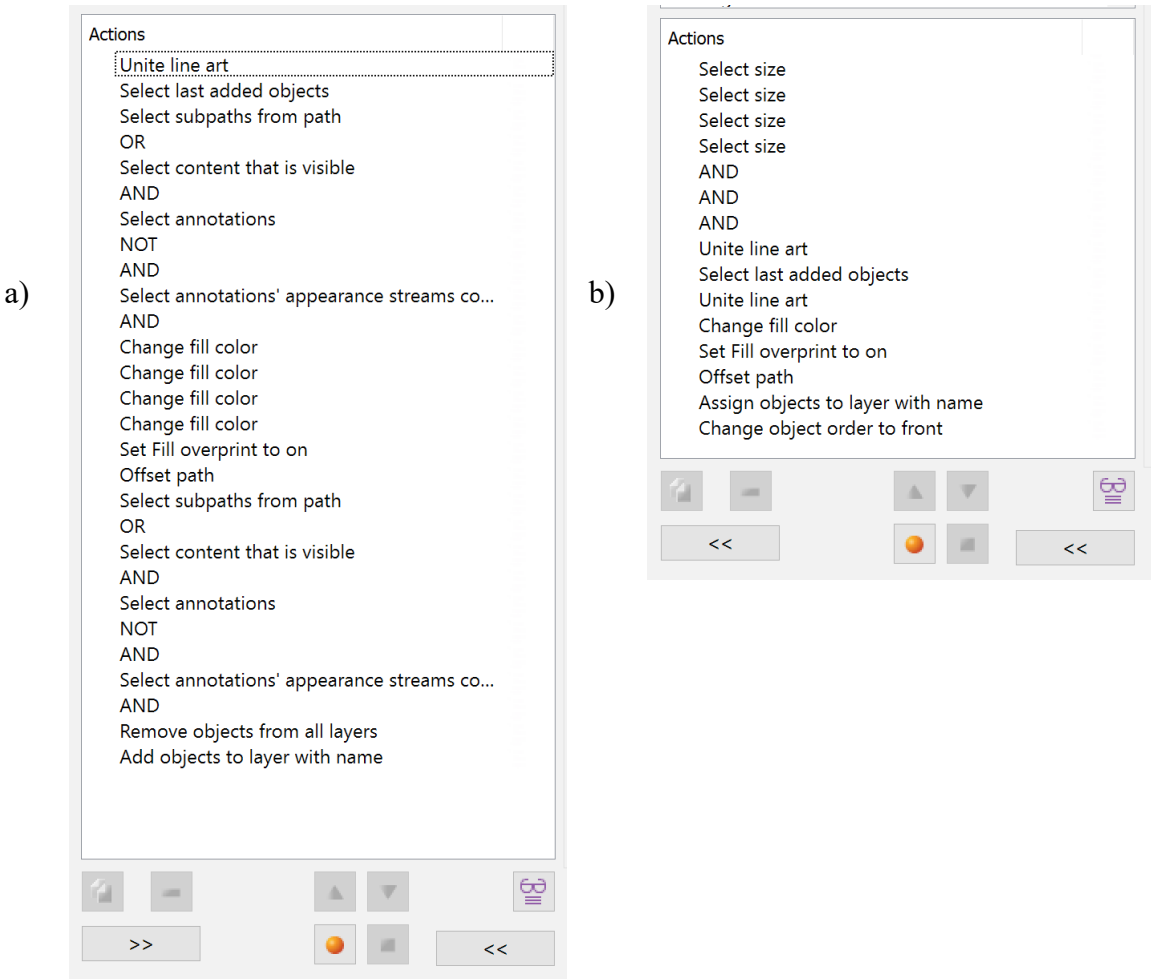


Fig. 116: Example of a) unmodified recorded Action List,
b) modified and simplified recorded Action List in Enfocus PitStop Pro 2020

It is important to add parameters according to which the object is to be selected (Fig. 116 b). It can be set within the Enfocus Action List Editor, by selecting the required action. In this example, the object is selected by size, in particular, according to four parameters – width less than, width greater than, height less than and height greater than. The action is set using Smart Preflight to prompt the operator to enter parameters. In this case, it is necessary to create a new variable set using the Enfocus Variable Set Editor, see Fig. 107. All parameters are set as variable values, see Fig. 108. The advantage of Enfocus PitStop Pro is that the size can be determined rather easily using the "Measure" function.

In terms of size selection, "Unite line art" is used twice in the final Action List. For the second "Unite line art" action, it is less important whether the "Create copy" or "Keep original objects" is selected (when the copy is created, then the object created as the first remains in the data, but it should not cause any problem). This step is used to unify even complex shapes that can contain unwanted features after the first use of the action; in this case, when creating an element for varnishing, occasional holes would remain in the motif of the screen. It is similiar situation as was explained for Callas pdfToolbox, see Chapter 6.2.3. In this particular case, the

illustration of the screen includes also small objects that would not otherwise be selected, and if such a small value was entered as a lower limit, on the contrary, other objects would also be selected. On the other hand, the value of the lower limit set for the original selection also cannot be too high, because then some part (such as the squeegee in this example job) could be omitted regardless the use of the second "Unite line art" action. For simpler motifs (in this case, for example, the logo), the "Unite line art" is not necessary to be used twice times; nevertheless, repeated use does not change the quality of the operation, so it can be included without any problems.

The first action that is used within created Action Lists after making a selection is "Unite line art". This feature is located in the Enfocus Inspector, as shown in Fig. 117. It is also important to check "Keep original objects". As a result, the original object does not change. In the next step, the "Change fill color" function is used, which can be also found in the Enfocus Inspector, as shown in Fig. 118. The color is set to 100 % Cyan in this case. The color can then be converted to a spot color using "Actions" and "Convert to Spot Color (using Preferences)", as shown in Fig. 119. The required spot color can be selected or created within the "Spot Color Picker" (Fig. 120). Then it is needed to set the overprint to on, also within the Enfocus Inspector, as shown in Fig. 121. As in the case of Callas pdfToolbox, also here it is appropriate to enlarge varnishing element using offset path due to the manufacturing inaccuracies with varnish application, as shown in Fig. 122. In the last step, it is necessary to create a layer with a specific name, in this case "Varnish" (Fig. 123). It is also necessary to mention that all actions can also be found in the Enfocus Action List Editor (see Fig. 104).

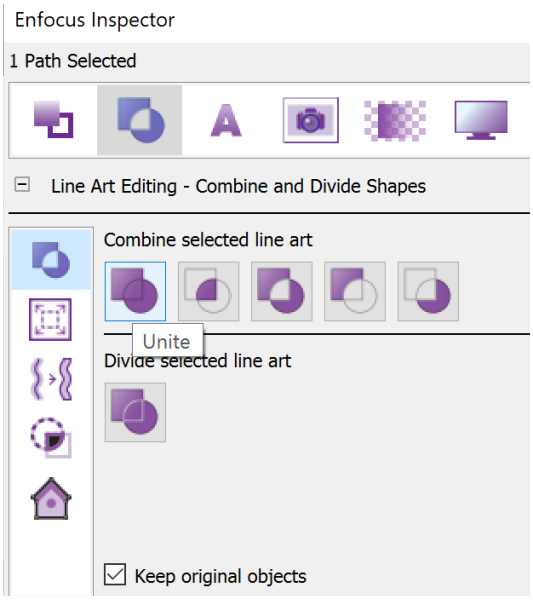


Fig. 117: Example of "Unite" in Enfocus Inspector, which was used within Action List in Enfocus PitStop Pro 2020

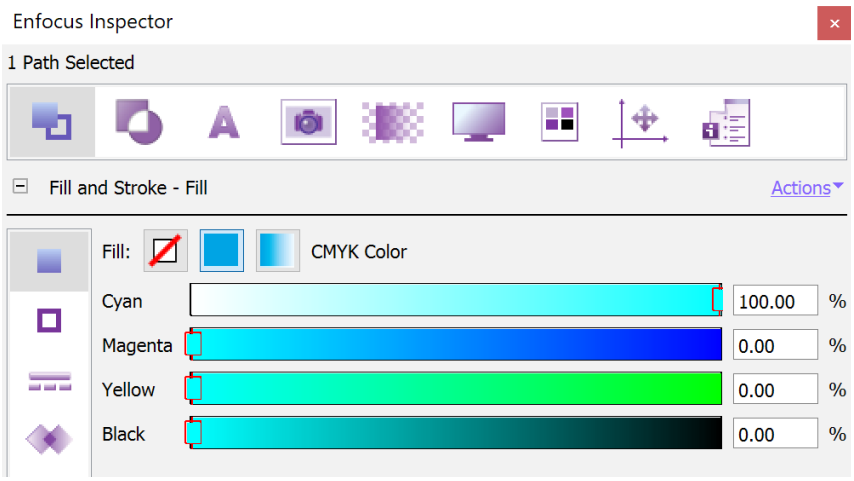


Fig. 118: Example of setting fill color in Enfocus Inspector, which was used within Action List in Enfocus PitStop Pro 2020

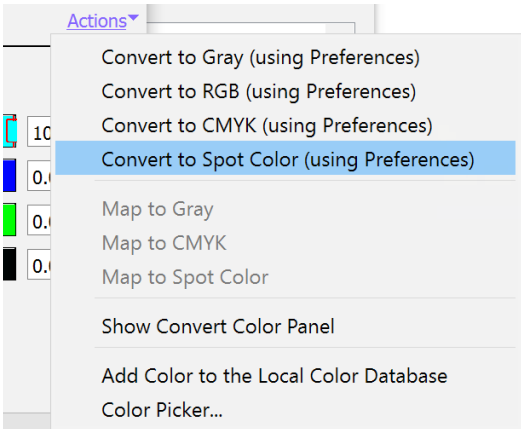


Fig. 119: Example of "Convert to Spot Color (using Preferences)" in Enfocus PitStop Pro 2020

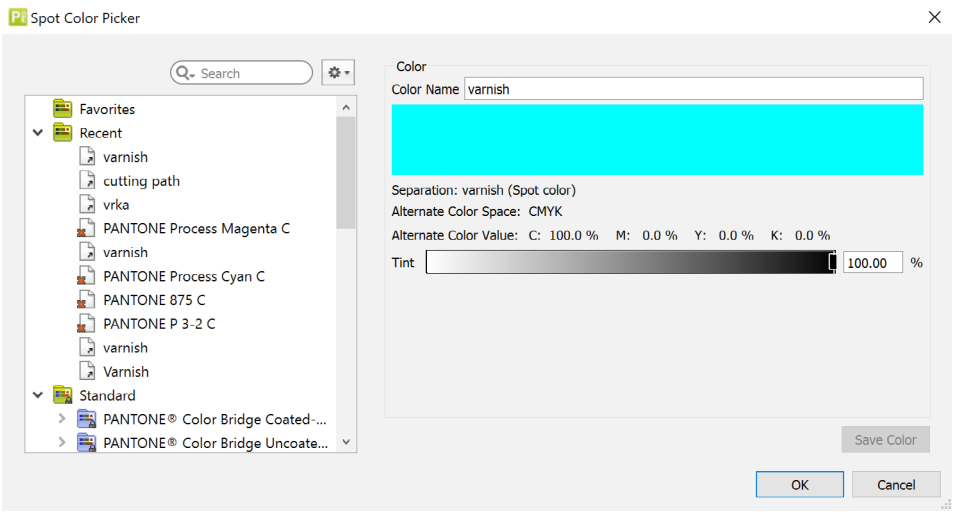


Fig. 120: Example of "Spot Color Picker" where the spot color can be selected or created in Enfocus PitStop Pro 2020 – in this case a new spot color named "varnish" was created

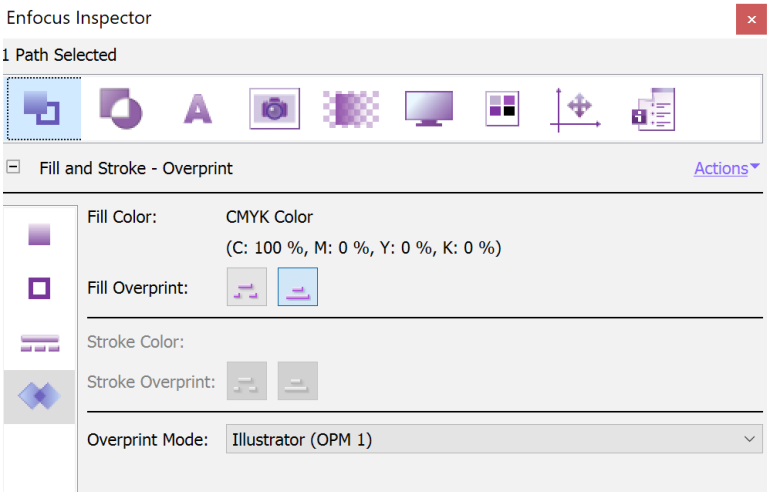


Fig. 121: Example of setting fill overprint to on in Enfocus Inspector, which was used within actions in Enfocus PitStop Pro 2020

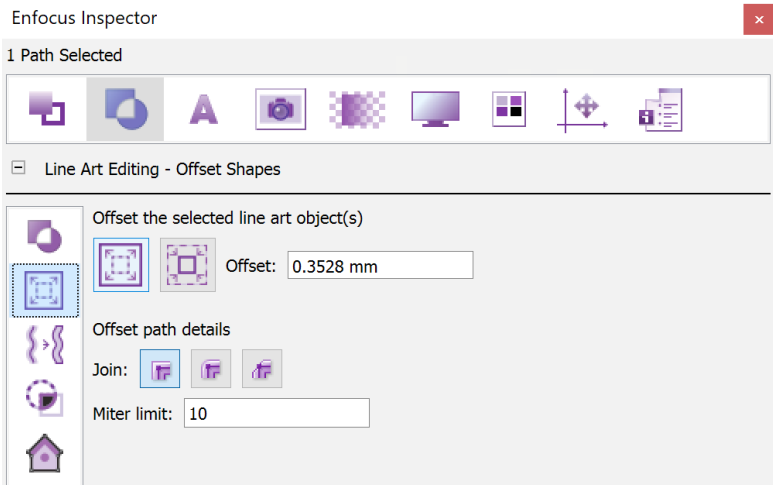
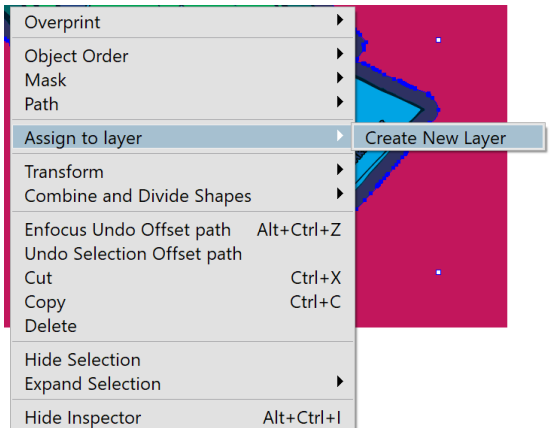


Fig. 122: Example of offsetting the path to increase the size of an object in "Line Art Editing – Offset Shapes" in Enfocus Inspector, which was used within actions in Enfocus PitStop Pro 2020

a)



b)

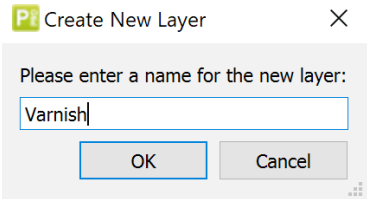


Fig. 123: Example of a) "Assign to layer – Create new layer" in the right-click menu, b) naming a newly created layer in Enfocus PitStop Pro 2020

This procedure to create an element for partial varnishing from vector images can be further modified to allow greater inaccuracy in selecting the complex objects (that are composed of many different objects) based on their size (approximately the same inaccuracy is allowed as in the case of Callas pdfToolbox – for this example job, the size between the size of the logo and the dark magenta background has to be chosen). The entire Action List is used twice; in the first case the "Select Size" selection is used, and in the second the "Select overlapping objects – objects that overlap any object from the current selection" is used, and the steps are repeated with a slight modifications only (e.g. no need to add offset path again, etc.). Here again, for the second "Unite line art" action, it is less important whether the "Create copy" or "Keep original objects" is selected. Again, it should be noted that for simpler objects, which are not composed of a large number of objects, this Action List also works flawlessly. This Action List is presented in Fig. 124.

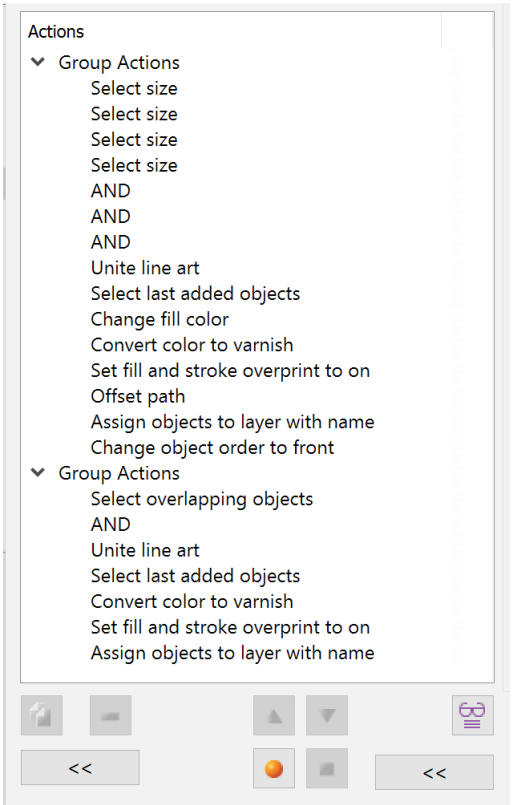


Fig. 124: Example of recorded, modified and simplified Action List that selects vector objects according to their size and creates varnished element, supplemented by the similar group of actions using "Select overlapping objects" in Enfocus PitStop Pro 2020

There are also other possibilities to make a selection to be further proccesed into the element for partial varnishing. One is to use "Select an objects inside region" action. Then it is needed to enter the values of X and Y coordinates, height, and width. However, the problem is that these values cannot be set to variable and, therefore, Smart Preflight cannot be created. However, it is possible to use the "Grab Offsets" function here. The action is shown in Fig. 125. Also, needed values can be easily determined using the Enfocus Inspector (Fig. 126). The

disadvantage, however, is that it is always necessary to change the Action List for each new printing data, which limits the possibilities of automation, for example, in workflow systems. When making the selection this way it is also necessary to pay attention to objects that may occur in the given region, except those which should be used to create an element for varnishing. In this case, it is a background in a shade of dark magenta. It is necessary to ensure that it will not be included in the selection. In this particular case of a continuous fill under the motif, this can be done by "Select color" action with setting the values to a variable (there is no need to create a new variable set, a set with color values already exists in the base), as can be seen in Fig. 127. In order not to select this color, the logical operator NOT is placed below the given action.

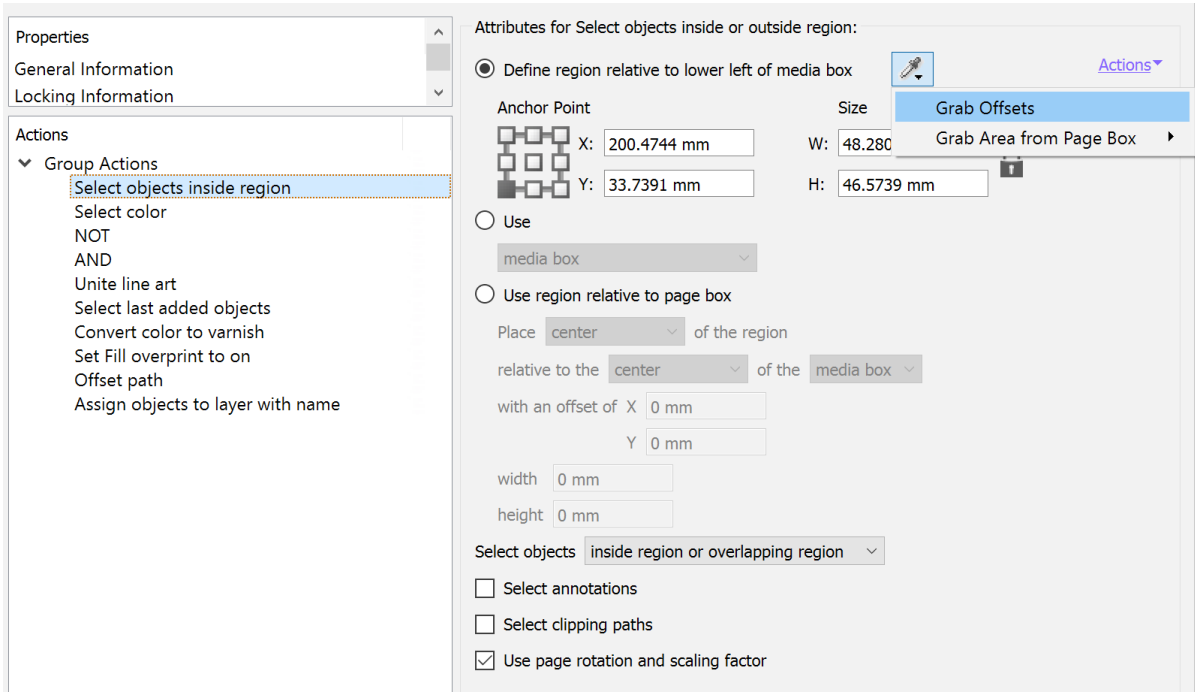


Fig. 125: Example of setting the Action List that creates varnishing element based on objects selected inside defined region in Enfocus PitStop Pro 2020

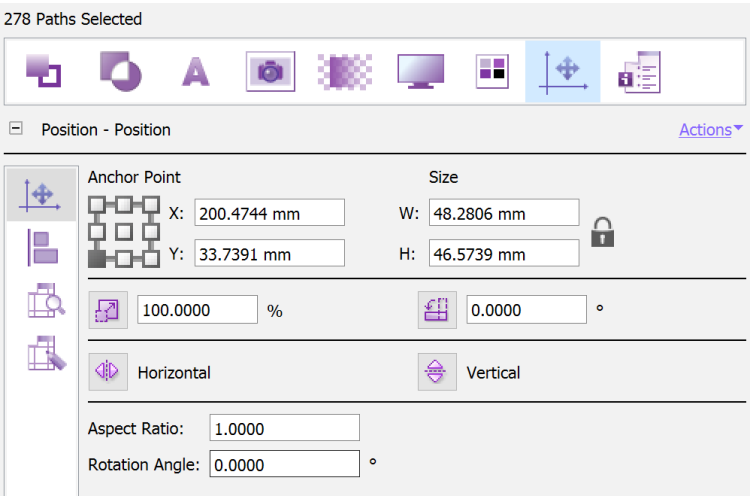


Fig. 126: Example of position and size of a selection in Enfocus Inspector in Enfocus PitStop Pro 2020

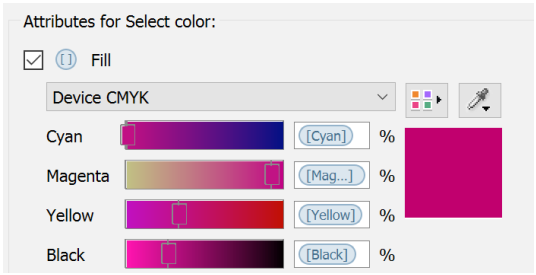


Fig. 127: Example of the action, which was set as a Smart Preflight using variables and selects the object with required DeviceCMYK color in Enfocus PitStop Pro 2020

Another way to select a given object is to use number of nodes (Fig. 128). The Action List setting is the same as in Fig. 125, except the object selection. This action can also be set as a variable, so a Smart Preflight can be created. However, it needs to create a new variable set. As with Callas pdfToolbox, the number of nodes in the path may not always be easy to estimate, so it is not so suitable option.

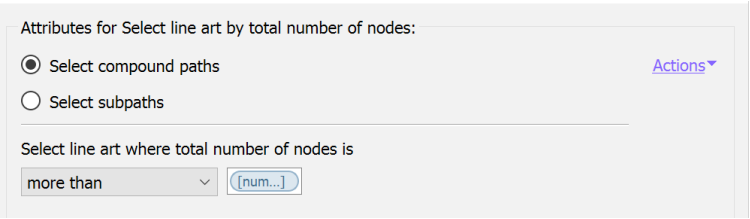


Fig. 128: Example of the action, that is set as a Smart Preflight using variables and selects line art by total number of nodes in Enfocus PitStop Pro 2020

Another similar option is to select an object using "Select objects in areas with dense graphic" (Fig. 129). However, this also does not work in all situations. For the minimum number of nodes in an area, the "Grab settings" button can be used when manually selecting the object. For "Size of the detection area (length of 1 side)", it is advisable to create a variable value and use Smart Preflight.

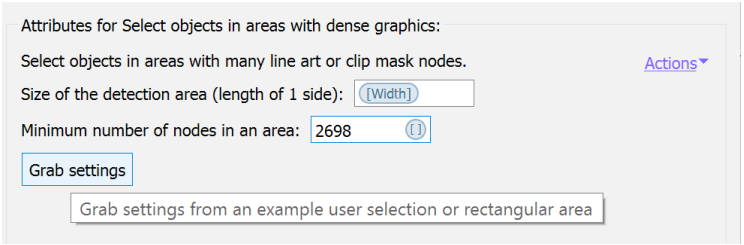


Fig. 129: Example of action that combines Smart Preflight using variables and "Grab settings" function, and selects objects in areas with dense graphics in Enfocus PitStop Pro 2020

The resulting printing data can be seen in Fig. 130 (the data is common to all listed Action Lists because they provide the same result).

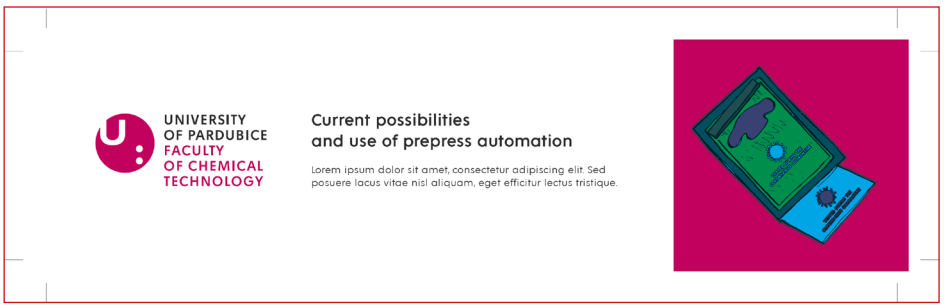


Fig. 130: A preview of the printing data fixed according to the assumed requirements (content with the bleed, trim marks and varnished element) using Enfocus PitStop Pro 2020 (scale 1 : 2), the CropBox marked with a red line

6.4.4 Creation of an element for partial varnishing from raster images

Since all of these actions are based on "Unite line art", they cannot be used for raster graphics. There is a certain limitation compared to Callas pdfToolbox, where only one fixup can be created for vector and raster graphics. On the other hand, a check used is usually based on selecting only a raster or vector object. Here, it is necessary to create different Action Lists. It is, therefore, necessary to select other actions instead of actions based on "Unite line art". Other actions remain the same as in the previous Action Lists. The element for partial varnishing created from the raster image was also set using the record function in the Action List, and the objects were edited manually. The first action that was used is "Trace the selected object(s)". If it is only neeeded to create the outline around the object, it is advisable to turn on "Ignore white holes". White threshold and curve optimization values were left at default. Other settings can be seen in Fig. 131. Then, fill is set to on (Fig. 132). Subsequently, the stroke must also be set to off (Fig. 133). All three actions can be found within the Enfocus Inspector. All other actions used are the same as for vector graphics.

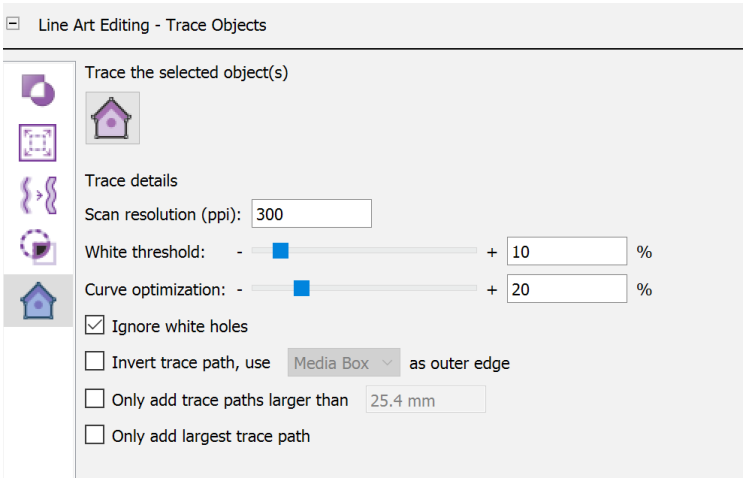


Fig. 131: Example of action to trace line art objects in Enfocus PitStop Pro 2020

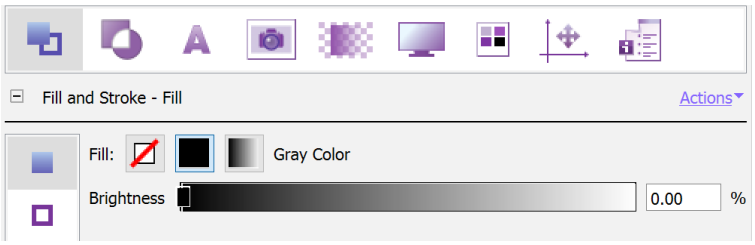


Fig. 132: Example of setting fill to on in Enfocus Inspector, which was used within actions in Enfocus PitStop Pro 2020

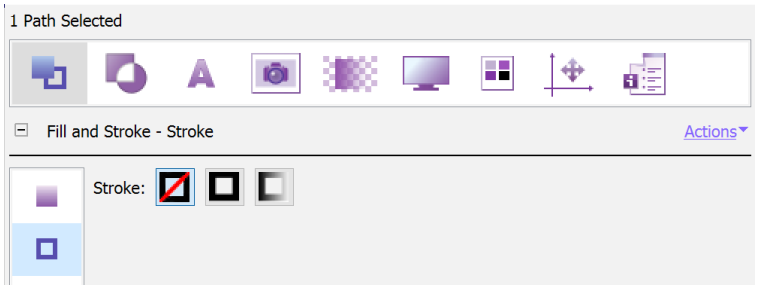


Fig. 133: Example of setting stroke to off, which was used within actions in Enfocus PitStop Pro 2020

The first option to select a raster object with this method is also using size, but in this case, using the "Select by image size" action. Values are entered in pixels, but they are easy to see in the Enfocus Inspector when the object is selected (Fig. 134). The action within the Action Lists is shown in Fig. 135. As can be seen, there is a parameter "Select if image width or height is". Therefore, unlike the previous selection using size, here it is advisable to create only two actions, one that contains "more than" and the second "less than". Alternatively, one action could be created with the parameter "equal to", and the exact value would be entered, but this was not used. As can be seen, a new variable set is created here as well, so it is a Smart Preflight. The entire set of actions within Action Lists is shown in Fig. 136 a. Already described action "Select object inside region" could be also used for selection even in this case. Again with consideration of the surroundings, in this case, the background in dark magenta color, where the color selection would be set with the help of the logical operator NOT. Created Action Lists is shown in Fig. 136 b. If in both cases no spot color should be created, it is possible to change the action "Convert color to varnish" to "Change fill color", for example, to Cyan (depends on the requirements of the workflow).

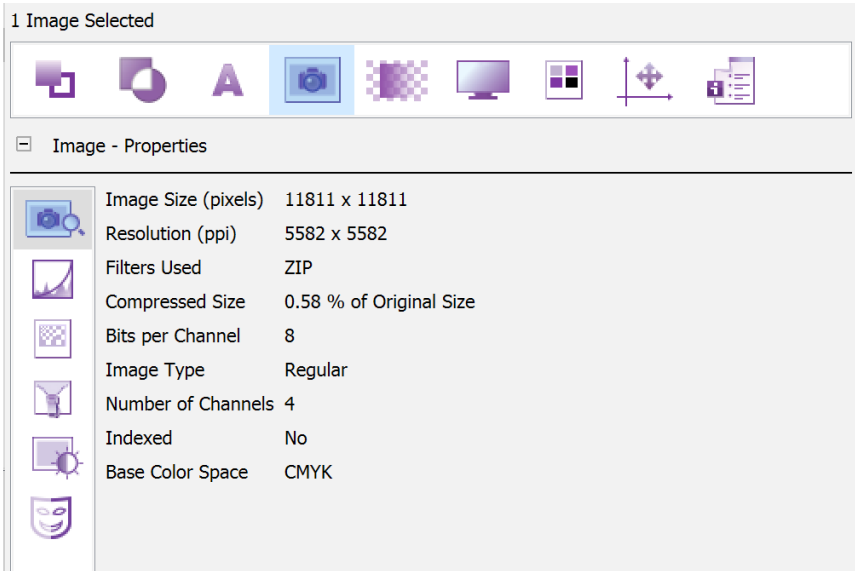
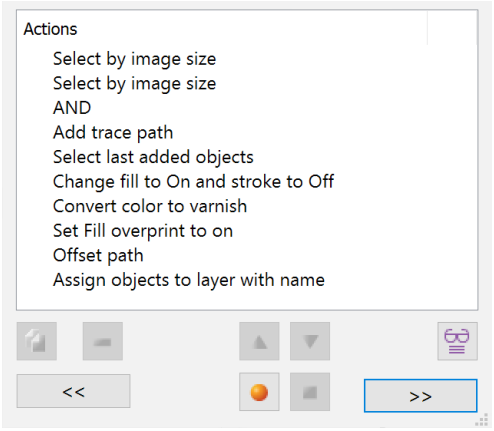


Fig. 134: Example of image properties including image size in pixels in Enfocus Inspector in Enfocus PitStop Pro 2020

Fig. 135: Example of action within Action List where attributes for selection by image size are set in Enfocus PitStop Pro 2020

a)



b)

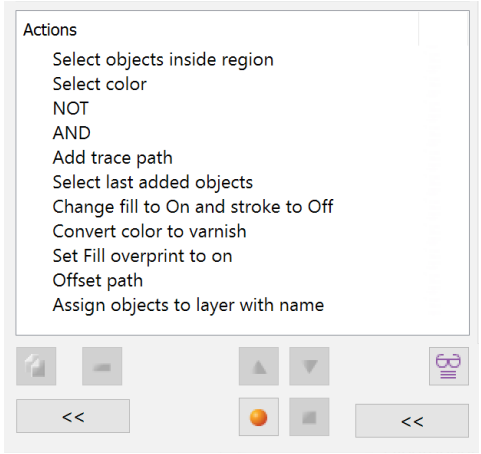


Fig. 136: Example of two modified and simplified recorded ActionLists within Action Lists that creates varnished element from raster image using a) select by image size, b) select objects inside region in Enfocus PitStop Pro 2020

6.4.5 Other options of creating element for varnishing

As with the Callas pdfToolbox, even there are other ways how to select a given object. Within the actions when creating Action Lists, it is possible to select, for example, “Select all” to select all objects. To select all raster images, it can be used “Select images” action. On the contrary,

to select vector images, it can be selected a “Select all” and “Select images” actions, while “Select images” action will include logical operator NOT. If are printing data delivered, for example, in layers, it can be used “Select layers” or “Select layers by name” actions. However, it should always be borne in mind that the procedure within Action Lists is different for vector and raster images. As with Callas pdftoollbox, it should be noted that once the transparency of the printing data is flattened, and the motif is not isolated on a white background, it is not possible to automatically create a varnished element for the desired motif.

6.4.6 Combination of multiple operations

As already mentioned, QuickRuns can be used to combine, for example, several Action Lists. If Action Lists are created only for use in the Enfocus PitStop Pro, it is a good idea to group them in this way. In this case, it is a grouping of Action Lists that correct the default printer marks and create an element for partial varnishing. The example is shown in Fig. 137. Compared to Callas pdfToolbox, a major disadvantage in Enfocus PitStop Pro is that it is not possible to process multiple files at once, for example, using batch processing.

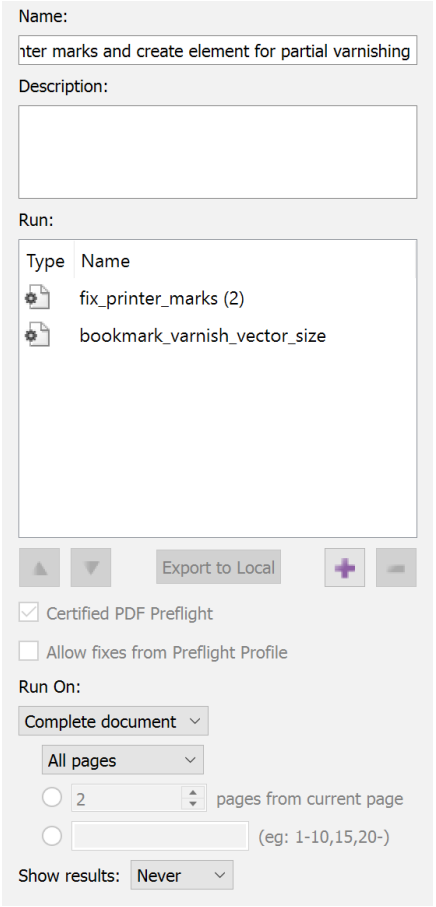


Fig. 137: Example of combined ActionLists within QuickRuns that correct default printer marks and create an element for partial varnishing on vector objects depending on the size in Enfocus PitStop Pro 2020

6.4.7 Creating a vector path for cutting

As with Callas pdfToolbox, another example is to create a vector path for cutting around the object that is isolated on a white background (again, a new layer, alternatively can be created a new spot color), in this case, the illustration of screen printing, see Fig. 36. Also for this method, different Action Lists must be created for raster and vector objects. The first case is the created cutting path around the vector object. This Action List is also based on “Unite Line Art” (see Fig. 117), however, it is used twice here. It is because the whole illustration has to be united, and that will not happen after the first use of this action (in this particular case). Therefore, if such complex illustrations are processed in the workflow, it is advisable to use it. However, this is not necessary for simpler illustrations or logos, and it is possible to use the “Unite Line Art” only once.

It is also important to follow the order in which these actions are used. It is, therefore, necessary to use the action before the “Change fill color” action, and after this action, as can be seen in the resulting Action List in Fig. 138. Unlike creation of partial varnish, here, the second application of “Unite Line Art” must no longer create new files but should edit the file. To do this, it is needed to simply do not check either “Keep original objects” if Action List is created by recording, or “Create Copy” if it is created within an “Action List”. Otherwise, the cutting path would be not only around the object, but also in many other places in the illustration.

To select an object, the selection of the object inside the region is used here, and “Use – BleedBox” is selected, see Fig. 125, only with different settings. Alternatively, the TrimBox could also be used. In this case, the entire Action List works by selecting all objects within the region, uniting them, changing the fill color to 100 % Cyan (see Fig. 118), uniting again, then change the fill to off and change the stroke to on, resizing the stroke (to 0.7056 mm), and changing its color to 100 % Cyan, as can be seen in Fig. 139 and Fig. 140. The miter limit is also set to 1 so that the resulting path does not contain the long ends of vector paths. A new layer with the created cutting path element is also created here, see Fig. 123, only with different settings. Again, it would be possible to create, for example, a spot color, it just depends on what the company prefers to process in its workflow. The resulting Action List is shown in Fig. 140.

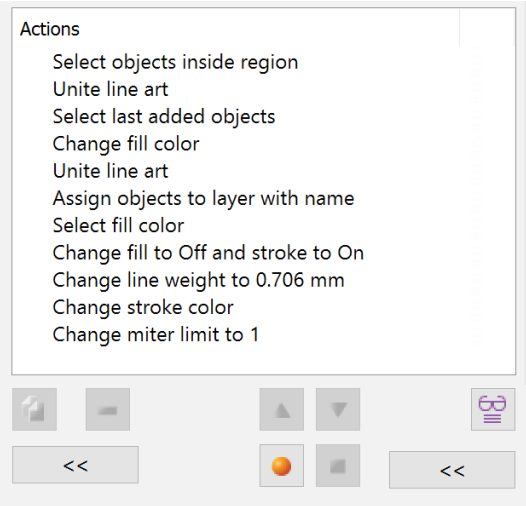


Fig. 138: Example of modified and simplified recorded Action List that creates cutting path from vector image in Enfocus PitStop Pro 2020

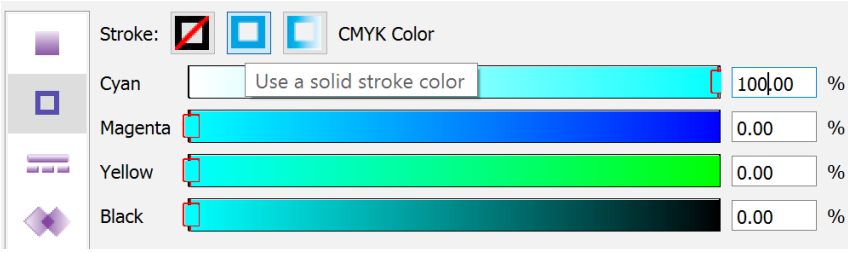


Fig. 139: Example of "Change stroke color" in Enfocus Inspector, which was used within Action List in Enfocus PitStop Pro 2020

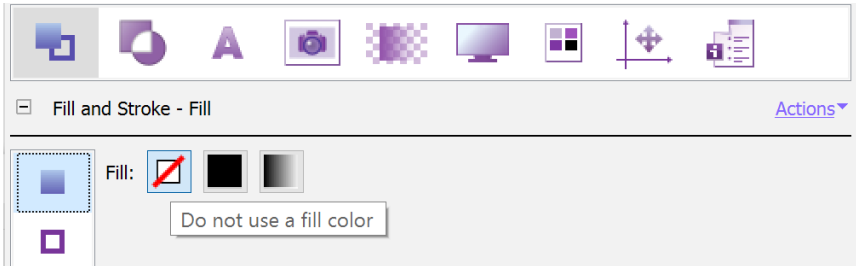


Fig. 140: Example of setting fill to off in Enfocus Inspector, which was used within actions in Enfocus PitStop Pro 2020

The second case is creating a cutting path around the raster object. Again, as in the case of the varnished element, it does not use the "Unite Line Art" action, but "Add trace path" action. All values of this action were used the same as in the case of the application of the varnish element, see Fig. 131. It is also necessary to resize the stroke (to 0.7056 mm) and convert color. Again, it is possible to choose between a spot color or only 100% Cyan (see Fig. 139). In this case, a spot color called "cutting path" is created as an example. In the last point, a new layer called "cutting path" is created. The entire Action List can be seen in Fig. 141.

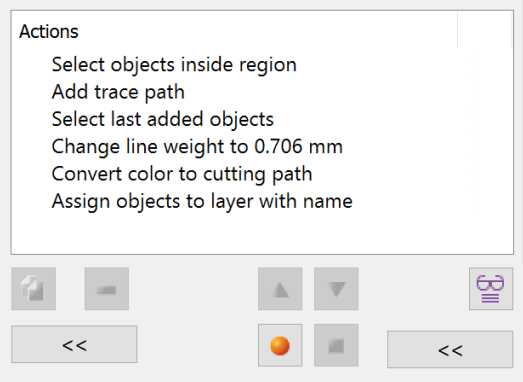


Fig. 141: Example of modified and simplified recorded Action List that creates cutting path from raster image in Enfocus PitStop Pro 2020

As for vector objects, there is another possibility of creating a cutting path, namely, rasterize selection and then adding a trace path. Basically, it is the same Action List as for the raster object, see Fig. 141, except for the rasterization that has to be above "Add trace path" action. Because a raster object is created, it can be a bit more speed consuming, but with "white threshold" and "curve optimization" adjustments, the path can be adjusted in a way that is not possible if the cutting path is created directly using the "Unite Line Art" function. The "Rasterize Selection" function used over the recording of the action can be found in PitStop Pro / Object / Rasterize Selection and can be seen in Fig. 142. It is also necessary to check the box, which keeps the original content and use other functions exactly in a demonstrated way in Fig. 143 so that the rasterized image is then deleted and does not remain in the graphics. The resulting printing and cutting data are not shown here, they are basically the same as in the case of Callas pdfToolbox Desktop 11, see Fig. 82 and Fig. 83.

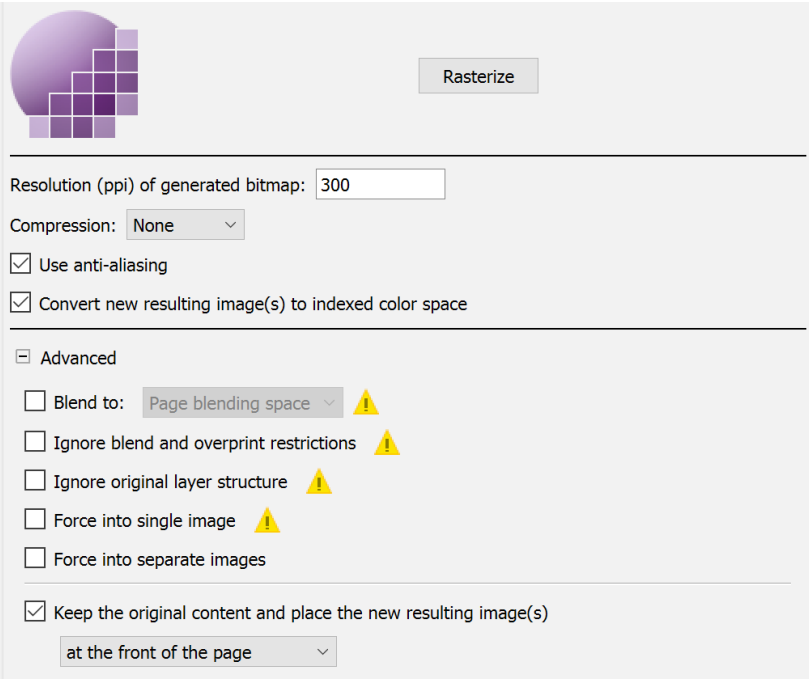


Fig. 142: Example of "Rasterize Selection" function, which can be found in PitStop Pro / Object / Rasterize Selection, which was used within the Action List in Enfocus PitStop Pro 2020

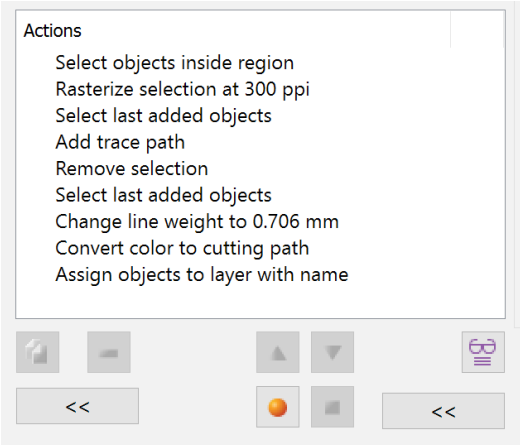


Fig. 143: Example of modified and simplified recorded Action List that creates cutting path from vector image using "Rasterize Selection" in Enfocus PitStop Pro 2020

6.5 Automation in Esko Automation Engine 18.1.0

The prepress workflow system that contains the most features of those that have been used for testing is Esko Automation Engine. Unlike Xerox FreeFlow Core, the Automation Engine includes built-in Enfocus PitStop technology. Besides other functions, Action Lists created within Enfocus PitStop Pro can be imported and used within the Automation Engine. Since the Automation Engine 18.1.0 used for testing still has a built-in Enfocus PitStop 2018, and the Actions Lists were prepared in version 2020, some major things missing (whether the Action List can be used can be found in the PitStop Profile Editor, which is a part of the Automation Engine). Below are created automated workflows that create a partial varnish and vector cutting path. Into the workflow was also incorporated modifying printer marks. The Automation Engine's interface is shown in Fig. 144. The right pane shows created workflows, saved as favorites. In the lower part, it can be seen the individual steps after starting the workflow, their progress, phases, state, etc. In the left pane, it can be seen various categories, for example, Files, WebCenter, Tasks, etc. Besides other things, it can be also created a hot folder here (hot folder was not created during the testing – testing was performed in a real printing company, and there was no space for that).

Individual workflows can be created on endless canvas, as shown in Fig. 145. In the left pane, next to the canvas, several tasks can be combined in various ways to create a given workflow.

SmartNames used in the Esko Automation Engine interface are another thing that can be used in the workflow. The fundamental concepts of SmartNames are explained in [445]. SmartNames are inserted into input fields. These are variables that refer to some value. Basic example is the SmartName [File] that refers to the name of the input file. However, it can also be used in the action used in the Action List, which enables Smart Preflight. If it is necessary to use some parameters in the workflow (in this case the size of the object to be varnished),

Workflow Parameters (Tools / Manage Workflow Parameters) described in [446] can be used. Here, workflow parameters can be added and edited. They can be then used in the form of Workflow Parameters SmartNames.

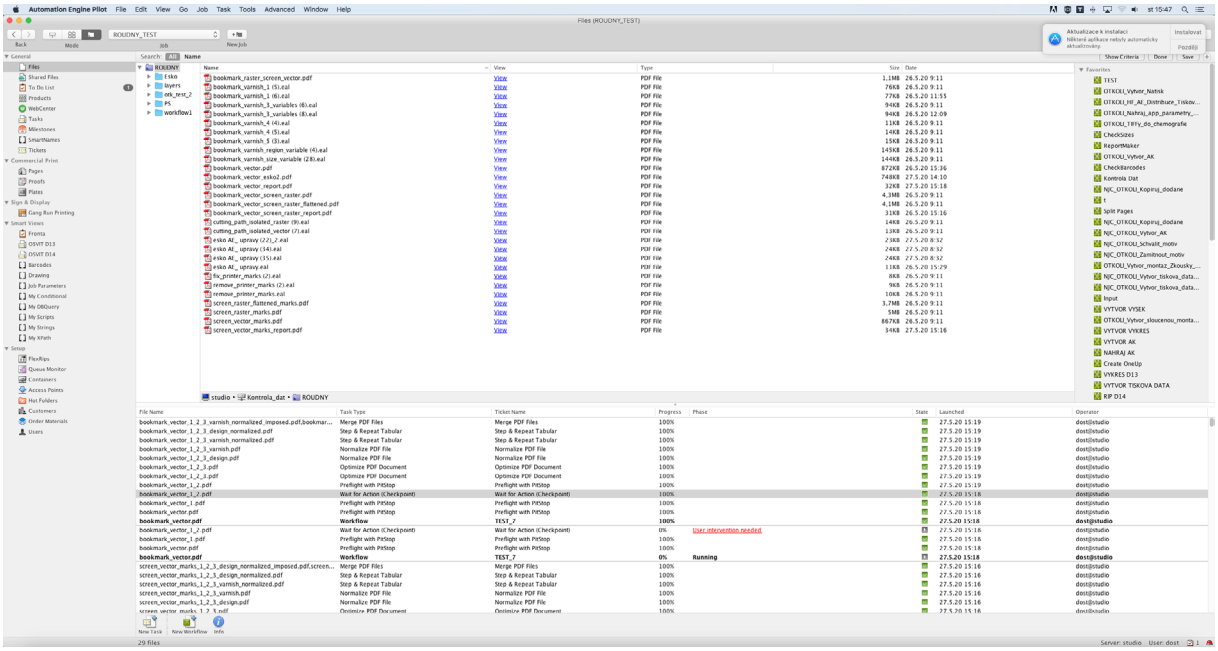


Fig. 144: Example of the interface in Esko Automation Engine 18.1.0

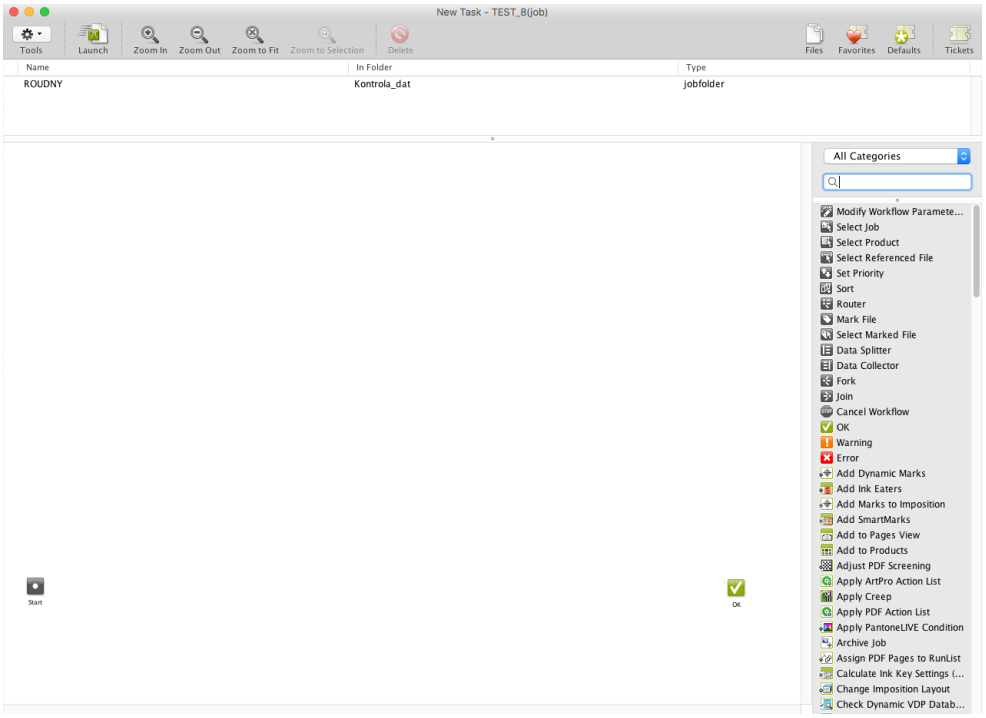


Fig. 145: Example of endless canvas where can be created any workflow, with the Automation Engine's tasks pane in Esko Automation Engine 18.1.0

As part of the testing, two workflows were created. The first to create a varnish on a given object according to the specified size of the varnished object, which is always entered as needed (Smart Preflight). For the first workflow, bookmark with the default printer marks and without

the data for partial varnishing was used, see Fig. 34. To select an object, it would also be possible to use the select objects inside or outside region, which unfortunately cannot be set as a variable (smart preflight) and would always have to be modified in PitStop Profile Editor. Selecting an object using number of nodes and areas with dense graphics would not be possible in this case. It is because the older Enfocus PitStop 2018 built into the Esko Automation Engine 18.1.0 does not include these options. The created workflow is shown in Fig. 146.

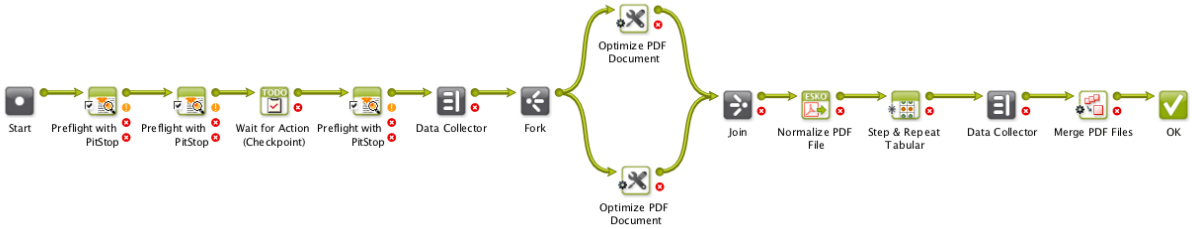


Fig. 146: Example of the first workflow created in Esko Automation Engine 18.1.0

In the first steps, Action Lists are used. The task where the Action List is selected is shown in Fig. 147. The first Action List removes default printer marks and replaces them only with crop marks, see Fig. 110. If adding a bleed should be included in the workflow, it could be, for example, in this step, instead of modifying printer marks. Before that, the preflight itself could be used to check whether the minimum distance between the TrimBox and the BleedBox is 3 mm, see Fig. 113. In the event of an error, the workflow could continue by adding a bleed, otherwise, the workflow would be moved to the next point. The second Action List creates a layer named "design" from all objects in the printing data, as can be seen in Fig. 148. The third Action List (see Fig. 116b) creates a varnish on the given object according to the specified size of the varnished object. In this case, a new layer named "Varnish" is created with the new partial varnished element. Since it is a Smart Preflight, there is a task "Wait for Action (Checkpoint)" before it. The workflow stops at this point with the message "User Intervention Needed", in the part where are individual steps after starting the workflow. The operator has to enter the required parameters, in this case, the maximum and minimum height and width of the object to be varnished. Ticket wait for action is in Fig. 149, window that appears when the workflow stops is in Fig. 150, and window that appears when someone clicks the edit button is in Fig. 151). If this procedure would be used more often, for example for companies that deal more with varnishing, it would be according to D. Štýbr (personal communication, May 27, 2020) possible to create a workflow where information about the dimensions of the varnished object would be entered, for example, within the information system to the order and then automatically transferred in the form of metadata using XML or CSV to the workflow. The operator would then not have to enter the size manually, but it would be filled in automatically based on the transmitted information.

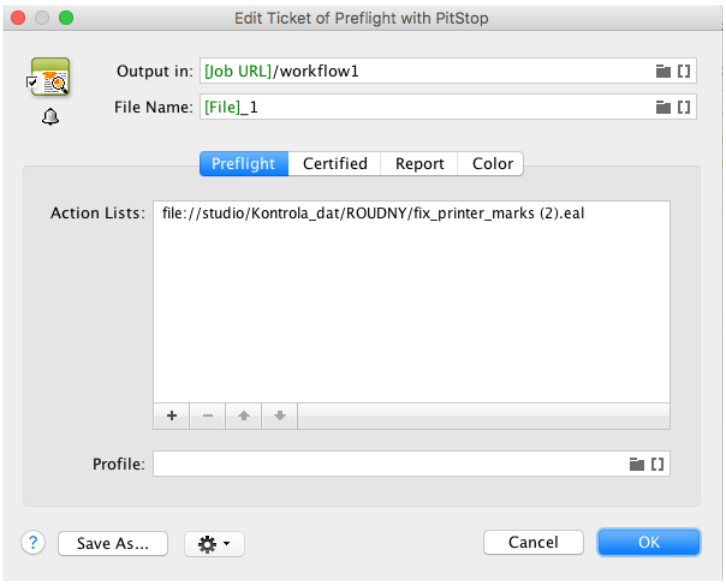


Fig. 147: Example of "Edit Ticket of Preflight with PitStop" in Esko Automation Engine 18.1.0

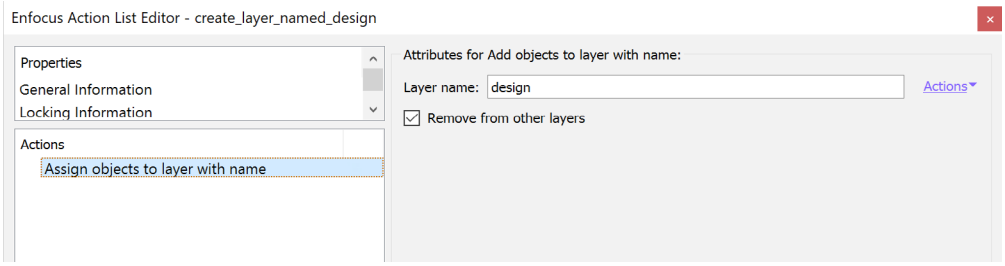


Fig. 148: Example of the Action Lists that assigns objects to layer with name "design" in Esko Automation Engine 18.1.0

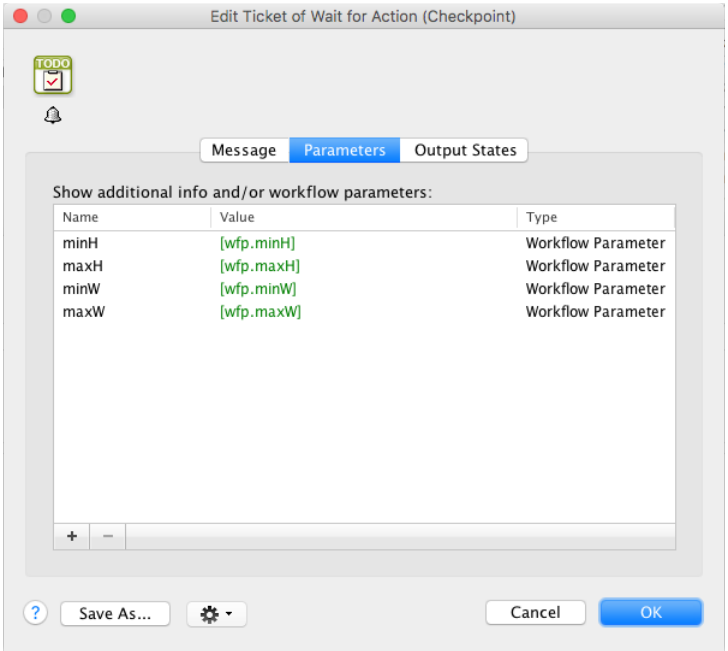


Fig. 149: Example of the ticket wait for action (checkpoint) with created Workflow Parameters for minimum and maximum width and height using SmartNames in Esko Automation Engine 18.1.0

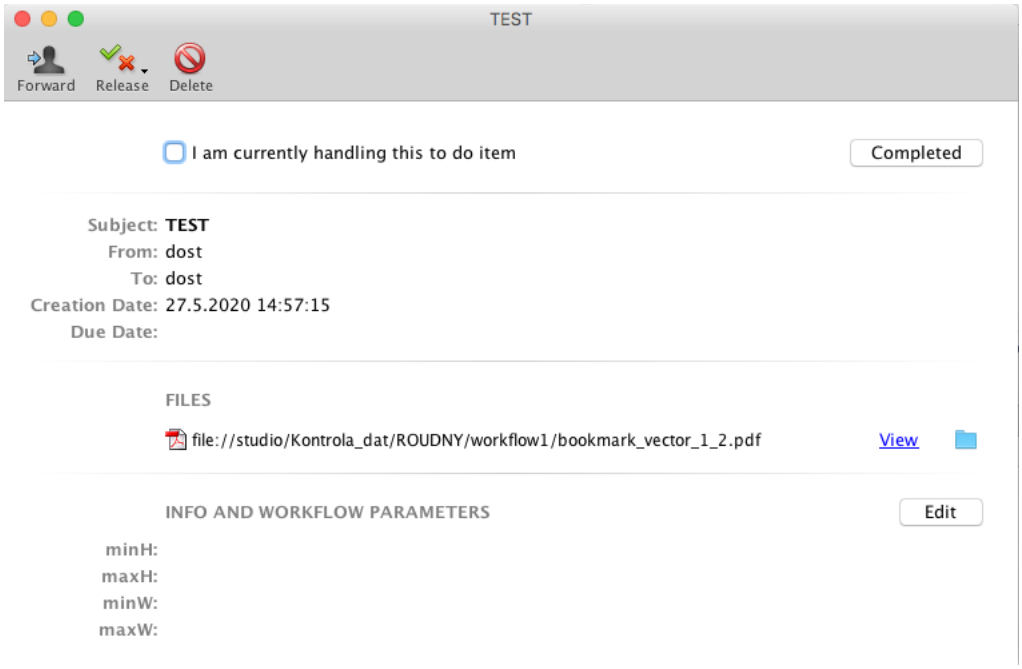


Fig. 150: Example of the window in Esko Automation Engine 18.1.0 that appears when the workflow stops; to enter the necessary information, it is necessary to click the edit button and after entering the information, it is necessary to click on the completed button

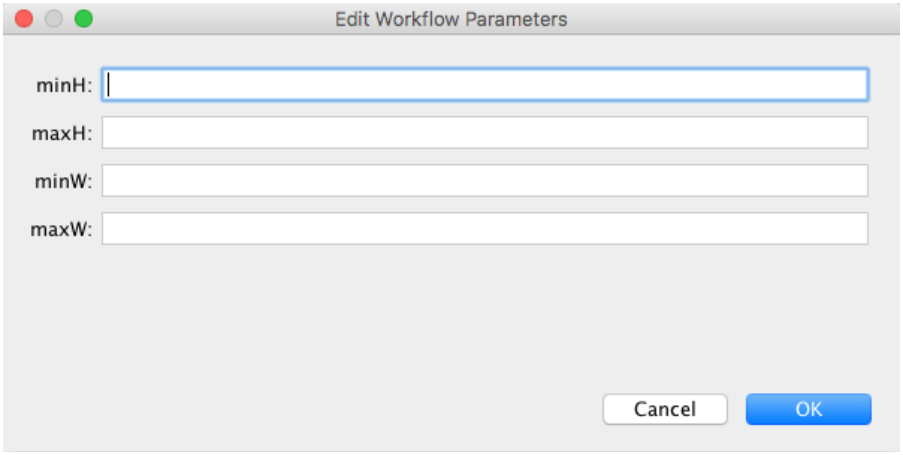


Fig. 151: Example of the window in Esko Automation Engine 18.1.0 that appears when the workflow stops and someone clicks the edit button; information is entered in points, which can be the only disadvantage – built-in PitStop in Esko Automation works with points, and it was not determined whether it is possible to switch to millimeters

Action Lists are followed by a Data Collector. The Data Collector only waits for all files before continuing the workflow. It is followed by the Fork task, which divides the workflow according to the selected criteria. These criteria are incorporated into two Optimize PDF Document tasks. As can be seen in Fig. 152, one deletes the layer named "design" and further processes only the layer named "Varnish". The second, on the contrary, deletes the layer named "Varnish" and processes only the layer named "design". It is followed by the Join task, which joins the workflow, however, there are already two PDF files at this stage, and the workflow will process both simultaneously.

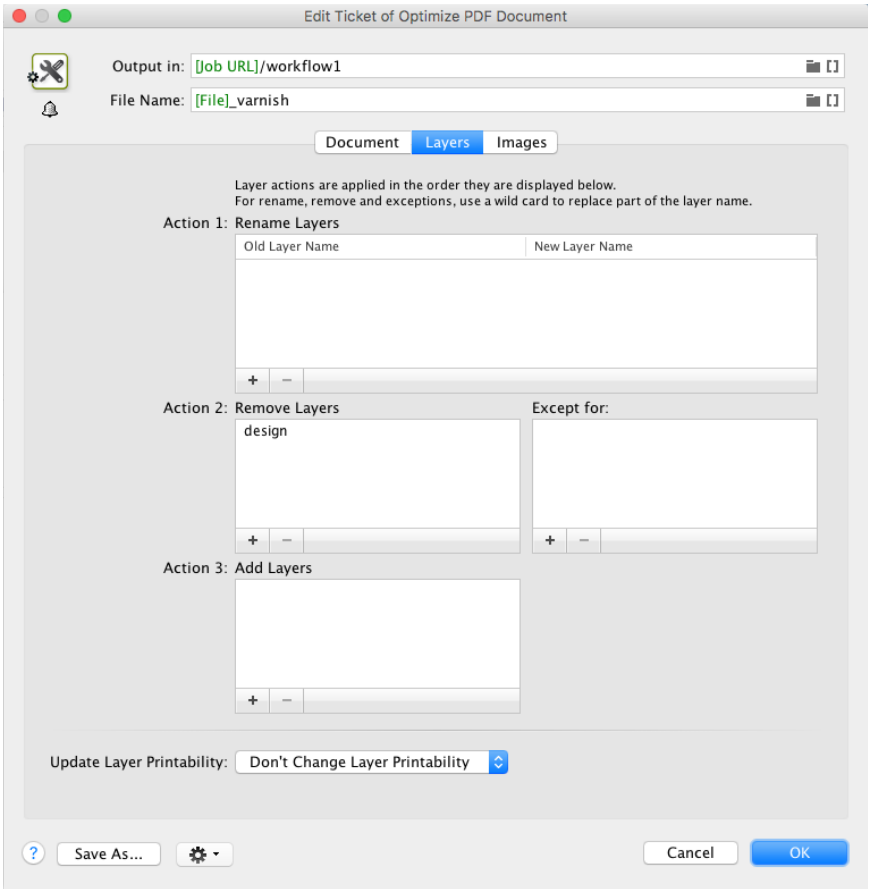


Fig. 152: Example of the Optimize PDF Document Ticket that removes layer named "design" in Esko Automation Engine 18.1.0

Within the Esko Automation Engine, it is always necessary to normalize the given file so that it can be processed correctly. It is, therefore, always necessary to use normalization, which is in the next step. All values were left in the default values (e.g. the CMYK profile was set to ISOcoated_V2_eci.icc, etc.). In the next step, the document was imposed on a sheet. A step & repeat tabular task was used for imposition. As a part of the testing, the imposition was made (three bookmarks were imposed below each other). Besides, default (already created) smart marks were used to add cutting marks defined within Action Lists to all imposed documents. If it would be necessary to add specifically defined printer marks for real orders, it is possible to use, for example, the Esko Plato application for their creation. However, it is not a common part of the Automation Engine and must be purchased separately. All other set parameters for imposition are apparent from Fig. 153 and Fig. 154. The step & repeat tabular is followed by the data collector that again waits for all files before continuing the workflow. The last step is the task "Merge PDF Files". It only combines two imposed documents – a document with imposed printing data and a document with an imposed element for varnishing into one, in this case, a two-page PDF. The output is a file named "Output" (Fig. 155). It is also possible to purchase a raster image processor Imaging Engine within the Automation Engine, and in the last stage of the workflow, data can be processed

directly (using the “Image to Screened Separations” task). If it would be necessary to create data for the varnish, e.g. for a logo instead of a screen illustration, it is necessary to enter only different dimensions. The resulting printing data and data for varnishing are shown in Fig. 156.

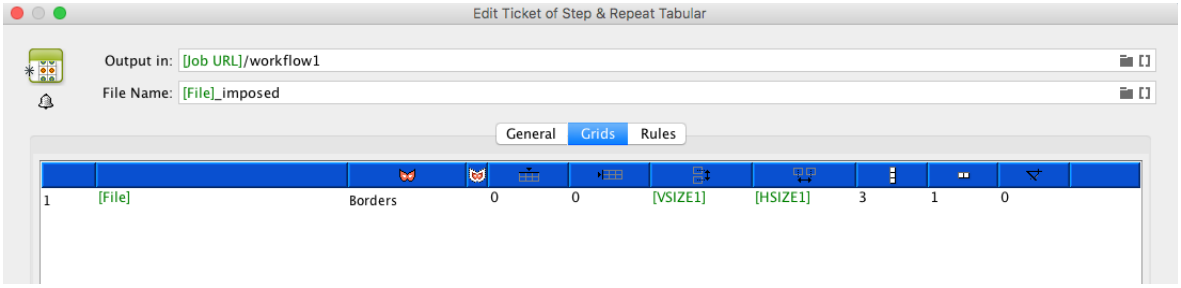


Fig. 153: Example of grids setting in Step & Repeat Tabular Ticket to impose three bookmarks below each other in Esko Automation Engine 18.1.0

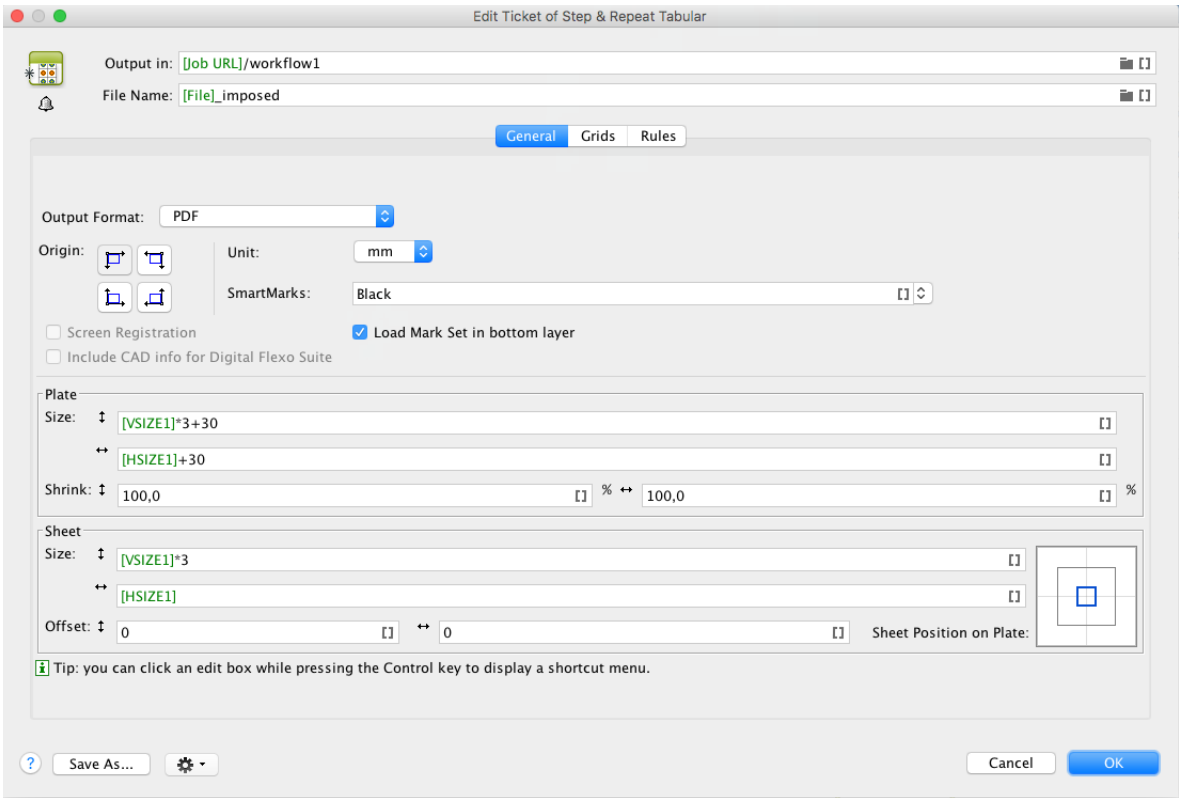


Fig. 154: Example of general setting in Step & Repeat Tabular Ticket that imposes three bookmarks below each other in Esko Automation Engine 18.1.0, adding “SmartMarks” and margins (30 mm) within the plate parameters

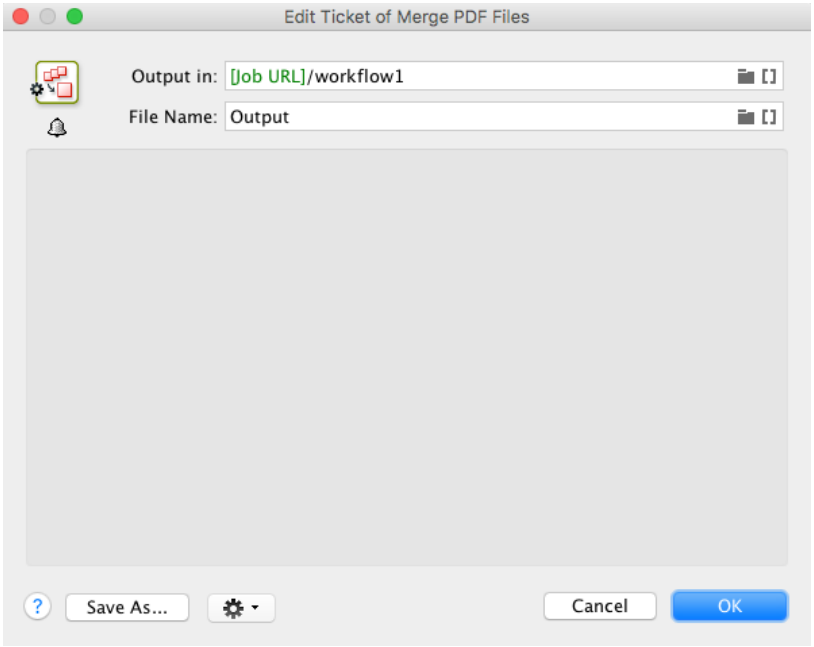


Fig. 155: Example of “Edit Ticket of Merge PDF Files” in Esko Automation Engine 18.1.0 that merges PDF files into one two-page PDF file

Fig. 156: Example of resulting a) printing data, b) data for varnishing (see Fig. 34) processed by the workflow presented in Fig. 146 in Esko Automation Engine 18.1.0 (scale 1 : 2)

The second created workflow shown in Fig. 157 concerns the cutting path around objects isolated on a white background, a screen printing illustration was used for testing, see Fig. 36. There is a major disadvantage in the version of PitStop 2018 used in Automation Engine 18.1.0, the "Add tracing path" action cannot be used. This feature is not available until Enfocus PitStop 2020. It can be used mainly for raster files, but also for vector files, where it is necessary to simplify the path. This workflow can, therefore, only be used for vector objects.

The workflow is practically the same as the workflow in Fig. 146, but Smart Preflight is not used here, so there is no “Wait for Action (Checkpoint)” task. Instead of the layer named “Varnish”, the layer named “cutting path” is processed, and the step and repeat imposition is changed to 2 × 3, compared to the previous 1 × 3. Cutting marks are also not added here. The imposition setting can be seen in Fig. 159 and Fig. 158.

Fig. 157: Example of of the second workflow created in Esko Automation Engine 18.1.0

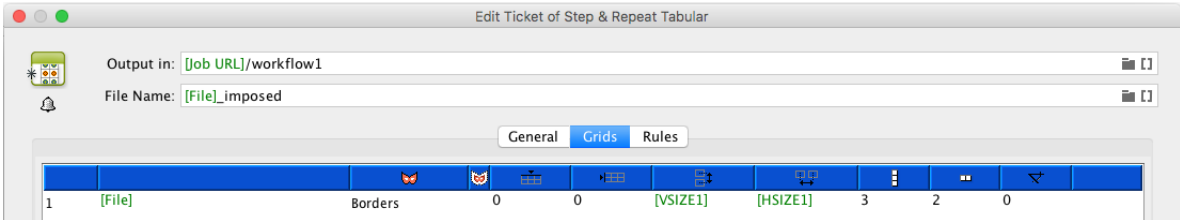


Fig. 158: Example of grids setting in Step & Repeat Tabular Ticket to impose six screen illustrations isolated on a white background in Esko Automation Engine 18.1.0

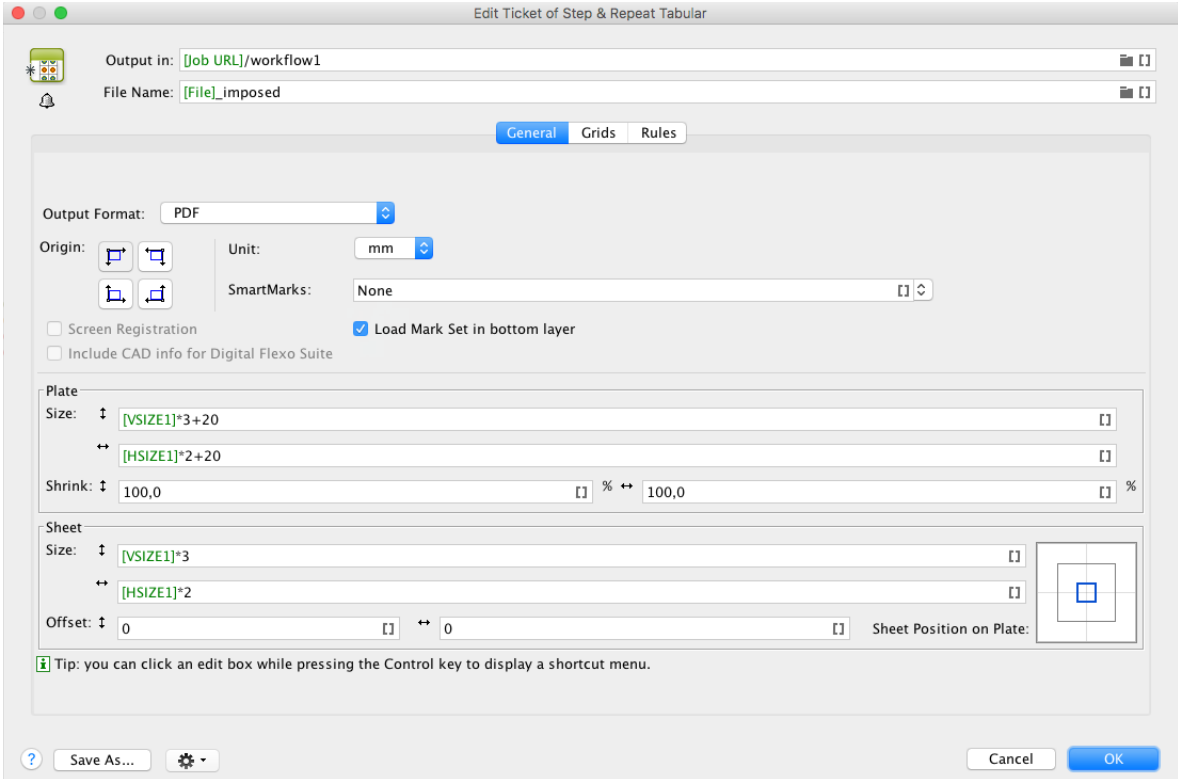


Fig. 159: Example of general setting in Step & Repeat Tabular Ticket that imposes six screen printing illustrations isolated on a white background in Esko Automation Engine 18.1.0, adding “SmartMarks” and margins (20 mm) within the plate parameters

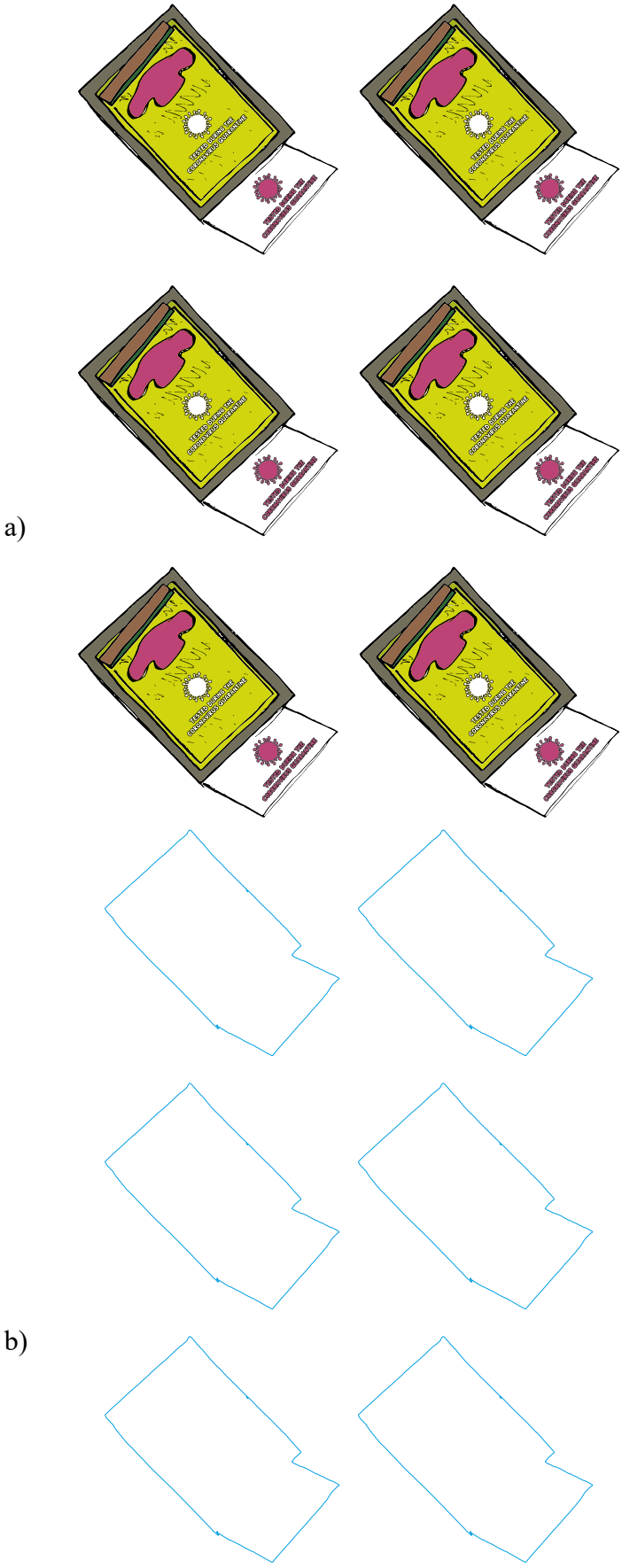


Fig. 160: Example of the resulting a) printing data, b) data for cutting (see Fig. 36) processed by the workflow presented in Fig. 157 in Esko Automation Engine 18.1.0 (scale 1 : 6)

6.6 Speed of performed operations

It is possible to look at the speed of performed operations from several points of view. In all tested cases, the time needed for automatic printing data processing was reduced to less than a minute (for one printing data), even with a combination of modifying printer marks (or adding bleed), creation of an element for partial varnishing (or creation of a cutting path), entering values of variable parameters and imposition. The individual operations are then processed within several seconds, which is especially evident in the processing of data only with simpler vector objects (including the screen printing illustration). It applies to both the raster and vector graphics used or their various combinations with a reasonable size of printing data (in this case 868 to 5 075 kilobytes). However, it is necessary to consider that the entered parameters must always be known or detected from the data (for example, within Enfocus PitStop Pro, which has suitable tools) and the detection itself can take some time, depending on the complexity and specifications of the element.

The demonstrated solutions of automated removing or replacing printer marks can help over 70 % of companies participating in the survey (from those who reported this problem) and currently solving this problem for more than one minute (see Chapter 4.7). The proposed solutions are applicable globally, in a few seconds.

Adding a bleed automatically can help almost 90 % of companies participating in the survey (from those who reported this problem) that solve this problem in more than a minute (see Chapter 4.7). This operation is very fast, again within seconds. There is also a higher percentage of participating companies that solve this problem for more than 10 minutes, which seems to be an unnecessary waste of time.

Procedures for creating technical elements can theoretically help almost 85 % of the participating companies (from those who reported this problem) that cannot solve this problem in less than a minute (see Chapter 4.7). However, if the detection of parameters should take a longer time (for example, for complicated illustrations) and the overall time needed would increase to 1–10 minutes, this solution would help less than 50 % of participating companies that reported this problem. Duration above 10 minutes is not expected.

For Adobe Acrobat and Callas pdfToolbox applications, there is a significant advantage of using batch processing compared to Enfocus PitStop Pro. For a larger number of files, the processing speed is several times higher. In Enfocus PitStop Pro, it is necessary to process each file separately, with the help of QuickRuns in the case of a combination of several Action Lists, or by running the Action Lists themselves. To efficiently process many files, Enfocus PitStop Server is needed, either separately or within one of the workflow systems, for example, Esko Automation Engine tested in this work. On the other hand, Enfocus PitStop Pro has tools for

a large number of manual adjustments or finding information about printing data, such as the number of pixels, object size, etc., which are not available in Callas pdfToolbox and Adobe Acrobat.

For companies processing more jobs than 1–10 per day, it is appropriate to choose the solution that supports batch processing and can process many files at once, thereby achieving the best degree of automation. From the tested issues, this applies especially for removal or replacement of default printer marks and for adding a bleed, as well as for missing data for processing steps in the cases when variable values are not needed or can be specified automatically. Nevertheless, the extent of features that can be checked or fixed is also highly important; there is no added value of batch processing when the issue as such cannot be solved automatically, for example, by adding an object defining varnishing or cutting in Adobe Acrobat.

An advantage is also that it is possible to apply the fixup or Action List after imposition. This can be used, for example, after nesting, when there are different counts of printing data for different jobs on a sheet to be used, for example, for printing and also cutting on a cutting plotter (logos, illustrations, images, etc., isolated on a white background). Batch processing can be used also for variable data, when the motif to be varnished is similar (although not the same) or when the motif is always different, but still the area to be varnished has some feature in common (raster image, size, layer, color, etc.).

Based on the results of the survey (see Chapters 4.3 and 4.11), the use of batch processing can be advantageous especially for companies that do not have or can not afford a suitable workflow system and are dealing mainly with commercial offset printing, among which there is a large group of companies processing 11–50 orders per day, or for companies dealing with label and/or packaging printing, which, on average, process the most orders per day. In contrast, for most respondents dealing with digital and/or large format printing, batch processing may not play such a role, as the largest group processes only 1–10 orders per day. However, also in this segment, the number of processed orders can be significantly higher in some companies and then the batch processing can be beneficial.

The testing has shown that when only single files are processed automatically, the differences between Adobe Acrobat, Callas pdfToolbox Desktop and Enfocus PitStop Pro are negligible in the case of removal or replacement of default printer marks; it similarly applies for creating bleed or adding data for processing steps in Callas pdfToolbox Desktop or Enfocus PitStop Pro. However, the disadvantage of Enfocus PitStop Pro may be that it is only a plugin for Adobe Acrobat. When Adobe Acrobat is highly utilized (for example, if a company has a workflow based on multiple plugins in Adobe Acrobat, for example, in addition to Enfocus PitStop Pro, it also uses an imposition program, such as Montax Imposer), processing speed may decrease.

It is also necessary to mention the different speeds when processing raster and vector images in Callas pdfToolbox Desktop and Enfocus PitStop Pro. One sample was processed 10 times,

the time was measured and the mean and the standard deviation were calculated. Fixups and Action Lists were set so that the procedure in both programs was as similar as possible. The printing data for the third example job were used for testing – illustration of screen printing with the printer marks and without the data for cutting (see Fig. 36). They were chosen because no parameters have to be entered, and the processing time is longer than when modifying printer marks, which is more suitable for comparison. The vector file size was 712 kilobytes and the raster file size was 4 191 kilobytes. The vector data contained 551 objects with 446 paths in total. The raster data contained embedded TIFF with a resolution of 1200 ppi. The size of MediaBox in both documents was 284.05 × 284.05 mm. Tab. 8 and Tab. 9 show that Callas pdfToolbox Desktop is generally faster when working with raster data, while Enfocus PitStop Pro is faster when working with vector data. Besides, Callas pdfToolbox Desktop is more consistent in speed. However, different speeds may be specific to these particular fixups and Action Lists and their optimization by given programs. Although the measured values are more or less negligible when processing a single document, they could be noticeable for processing larger amounts of printing data. For example, if the company is deciding between purchasing the Callas pdfToolbox Server and the Enfocus PitStop Server, similar tests can be used. Also, it should be noted that although the processing speed of vector data appears to be faster, it may be vice versa in case of very complex vector graphics.

Tab. 8: Speed of data processing when creating cutting path in Callas pdfToolbox Desktop 11 and Enfocus PitStop Pro 2020 – comparison of the applications; raster procedure means the use of "Raster selection" and "Add trace path" actions in Enfocus PitStop Pro and "Create shape from tracing page content" in fixup in Callas pdfToolbox Desktop when creating cutting path

Data type	Callas pdfToolbox Desktop	Enfocus PitStop Pro	Comparison
Vector data	1.7 ± 0.2 s	0.9 ± 0 s	Enfocus PitStop Pro is 1.8 times faster
Vector data, raster procedure of creating cutting path	1.5 ± 0.2 s	4.3 ± 0.2 s	Callas pdfToolbox Desktop is 3.0 times faster
Raster data	5.6 ± 0.1 s	24.6 ± 0.3 s	Callas pdfToolbox Desktop is 4.4 times faster

Tab. 9: Speed of data processing when creating cutting path in Callas pdfToolbox Desktop 11 and Enfocus PitStop Pro 2020 – comparison of cutting path creation methods; raster procedure means the use of "raster selection" and "Add trace path" actions in Enfocus PitStop Pro and "Create shape from tracing page content" in fixup in Callas pdfToolbox Desktop when creating cutting path

×	Vector data	Vector data, raster procedure of creating cutting path	Raster data
Callas pdfToolbox Desktop	1.7 ± 0.2 s	1.5 ± 0.2 s	5.6 ± 0.1 s
Time ratios – comparison	1.1	1	3.7
Enfocus PitStop Pro	0.9 ± 0 s	4.3 ± 0.2 s	24.6 ± 0.3 s
Time ratios – comparison	1	4.8	27.3

The processing speed of individual fixups and Action Lists is likely to be higher on a server than with a desktop versions, but since the entire workflow was compiled, and some operations could not be performed separately, the time of the individual steps was not compared.

For desktop applications such as Enfocus PitStop Pro and Callas pdfToolbox Desktop, the resulting speed also depends on the parameters and specifications of the computer. Time under a minute for one printing data was found during testing on a laptop with the following parameters: 16 GB RAM, 2 600 MHz, 4 processor cores, Intel Core i7. If the computer is to be used for automation, it is advisable to have only the required application running during these operations, but it is best to have a computer dedicated solely to these operations so that the necessary memory can be used for prepress and its automation.

For workflow systems, this testing was not performed, however, as the created workflows depended a lot on Action Lists created in Enfocus PitStop Pro and fixups created in Callas pdfToolbox Desktop, the information is usable here as well. With both used workflow systems, the processing speed can be even higher, thanks to the possibility of using hot folders and the server processing. The necessary data is only moved to the appropriate folder and further processed automatically. Since the Esko Automation Engine used in the testing had a built-in raster image processor, printing data can also be processed within the workflow and saved directly to the folder from which the data is taken by the relevant operator or system. As far as Xerox FreeFlow Core is concerned, raster image processor is not part of the workflow, however, via the external hot folder, the workflow can be connected to a raster image processor so that the output from the created workflow could be an input for raster image processor, where processing can be performed automatically again with appropriately selected software.

On the other hand, for the tested applications that can process files using batch processing, it is always necessary to run the batch. The modified files are then moved to another folder, but still only within one computer to which the license applies. Therefore, the processing time of the files also increases, as the data must be further transferred to the raster image processor folder and passed on to the appropriate operator or system.

The situation is more complicated with the tested workflow systems, Esko Automation Engine and Xerox FreeFlow Core. According to T. Nejedlík (email communication, January 20 to April 4, 2020), the speed of the Esko Automation Engine depends on the load of the processing channels. For example, if this system is delivered as a four-channel system, it means that four automatic tasks can run at the same time. Of course, if the load is higher, the speed decreases. Therefore, if possible, it may be appropriate to replace the tasks in the Automation Engine with corresponding steps in the built-in PitStop to increase speed. If, for example, one PitStop Action List can be made from four tasks in the Automation Engine (which can be composed of several actions, of course), in terms of channel utilization, processing in such a case is four times less demanding. It is also necessary to note that Action Lists should be applied only to input before

normalization. However, this should be solved rather at a high production load. Compared to Xerox FreeFlow Core, which has according to M. Šaněk (personal communication, June 12, 2020) only one processing channel (Xerox FreeFlow Core is based on FIFO logic – First In, First Out or Fly-In Fly-Out), Esko Automation Engine can be a more powerful solution, as it can run multiple independent workflows at once and process multiple tasks. In general, these aspects do not have to be considered for a low production load.

For the two tested workflow systems, the market segment is also important factor; Esko Automation Engine will be used mainly by companies specializing in label and/or packaging printing, while Xerox FreeFlow Core will be used mainly by companies specializing in digital and/or large format printing, or commercial offset printing. On average, the companies in the latter segments receive fewer orders per day according to the survey (see Fig. 20), so the performance of the workflow system is of less importance. However, as already mentioned, this is the case for the companies participating in the survey.

As for the parameters and specifications of servers in workflow systems, the performance should be optimal when meeting the recommended specifications, as the manufacturer always states the minimum or recommended system requirements for the server used. A minimum of 6 processor cores and 22 GB of RAM is required for 4 processing channels of Esko Automation Engine (this solution was used for testing). Different server specifications are required for a different number of processing channels, as can be seen in [447]. Minimum specifications for Xerox FreeFlow Core (on-premise version) are Intel Core i7, 3.3 GHz, 8 GB RAM, and recommended specifications are Intel Xeon Processor E5, 2.5 GHz, 4 processor cores, 16 GB RAM [77]. According to M. Šaněk (personal communication, June 12, 2020), if the company processes a lot of orders with many modifications, it is better to have a faster hardware, i.e. the recommended configuration (this applies to the one-premise variant).

Such a server must be dedicated only to the given workflow system, and no other application may be running on it [447]. The Cloud version can be also considered, which can be bought within Xerox FreeFlow Core [77].

6.7 Quality of performed operations

As with the speed of performed operations, also here it is possible to look at the quality of performed operations from several perspectives. Regarding the quality of the replacement of printer marks, the most possible configurations were found in Callas pdfToolbox Desktop. The main disadvantage of Enfocus PitStop Pro is that the offset of the new crop marks cannot be chosen; only the InDesign or QuarkXPress style can be chosen. It can be limiting, because InDesign crop marks interfere with BleedBox and QuarkXPress crop

marks are unnecessarily indented. An offset can be set in both Adobe Acrobat and Callas pdfToolbox Desktop, except when adding crop marks during imposition in Callas pdfToolbox Desktop – in this case, the problem with crop marks interfering with the BleedBox also occurs and cannot be fixed at the user level.

When comparing the addition of bleed, there is no noticeable difference when processing raster documents in the two applications supporting this functionality tested. But there are differences when vector graphics only is processed. The best demonstration of how bleed in inserted is to place an element, in this case a seamless pattern, to the edge of the printing data (Fig. 161) and compare how bleed is created using various methods. For Callas pdfToolbox, only the "Mirror page objects" method can be used when bleed is supposed to be in vector format (Fig. 162 a); if "Mirror as image" (Fig. 162 b) or "Repeat last pixel as image" (Fig. 162 c) options are used, a raster image will be created in the bleed as suggested by the name of these methods. There is no problem with the change of the type of graphics in Enfocus PitStop. If "Only add bleed by mirroring content" is selected (Fig. 163 a), adding a bleed works similarly to the "Mirror page objects" method in Callas pdfToolbox – the objects are mirrored. When this option is not checked, the objects at the edge of TrimBox are only extended to the bleed area (Fig. 163 b). Another option, to generate bleed by upscaling, is not presented here, because graphics at the edges is only enlarged. The advantage of Enfocus PitStop Pro is that the vector data remains vector and the raster data remains raster even in the bleed area.

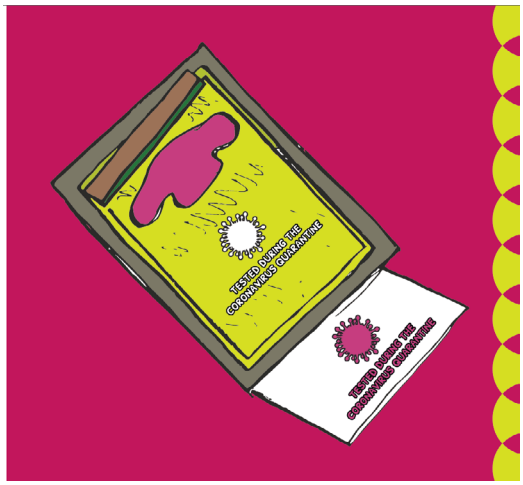


Fig. 161: Example of the modified printing data for a second example job (see Fig. 35) – with seamless pattern in the area from which the bleed will be created

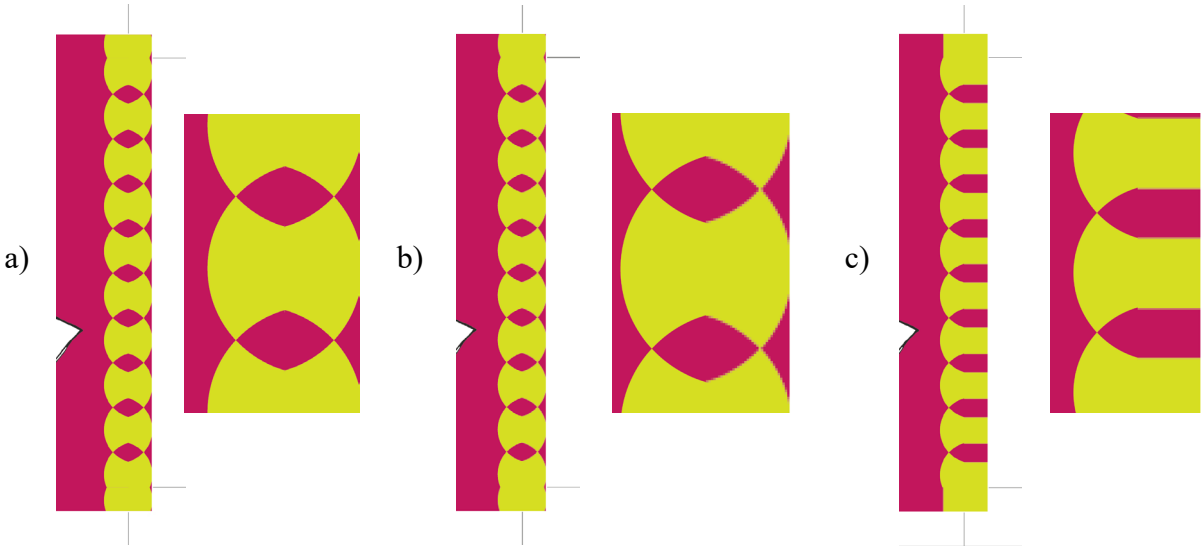


Fig. 162: Example of bleed created in Callas pdfToolbox Desktop 11 with zoomed details using a) "Mirror as image" b) "Repeat last pixel as image" c) "Mirror page objects" method

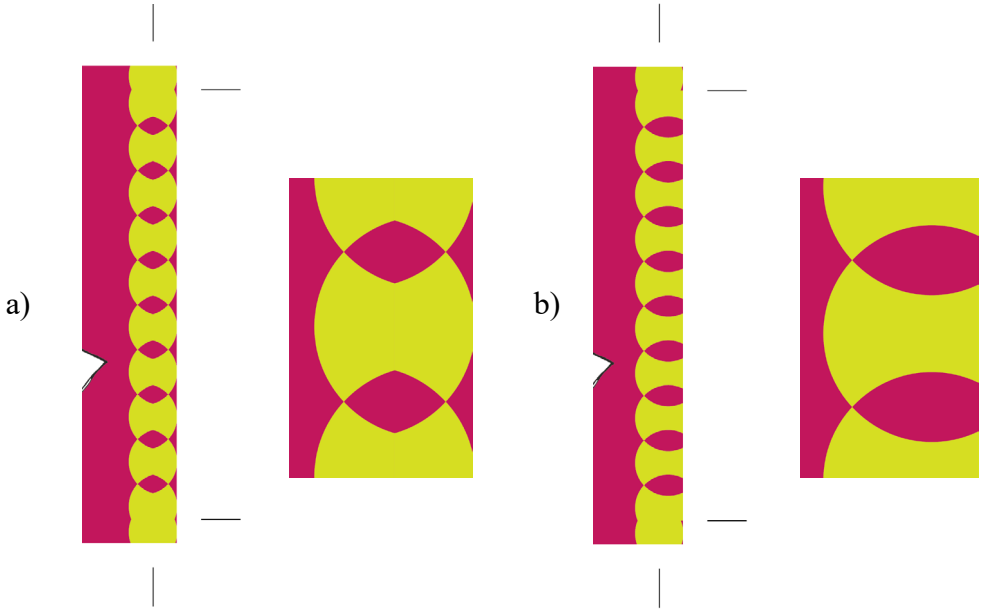


Fig. 163: Example of bleed created in Enfocus PitStop Pro 2020 with zoomed details a) with, b) without "Only add bleed by mirroring content" checked

Creating a cutting path can be better accomplished within Callas pdfToolbox. Fixup based on "Create and apply shapes" can be used for both raster and vector data if "Create shape from tracing page content" is used, while in Enfocus PitStop Pro it is necessary to create a separate Action List for raster data, based on "Add tracing path", and separately for vector data, based on "Unite Line Art" or "Raster selection" and "Add trace path". However, it should be noted that this only applies if it is not necessary to select specific objects on the page first, such as when creating an object for partial varnishing.

Regarding the partial varnishing, the best solution for selecting the object to be varnished is probably according to size, which is possible in both tested applications (both offer separate

check or selection of raster and vector data). In both programs, the complicated selection of hand-drawn complex illustrations, such as a screen printing illustration in this case, may be sometimes unpredictable. Both applications offer many other options (Enfocus PitStop Pro a bit more); however, some may not be fully usable in practice. Among the more generally aplicable ones, Enfocus PitStop Pro enables to “Select objects inside region”, and Callas pdfToolbox to select “Object on top of other object(s)”; the use of the latter across different designs is probably more limited than of the former.

Overall, the quality of creating elements for partial varnishing is not so crucial. The fixups or Action Lists are always set to create an offset path; therefore, all created objects are similar and should not cause any problem in production (making the application of varnish impossible). Another situation is when creating a cutting path. If the object is created directly from vector data, it is not possible to modify it in any way; however, in both applications, the miter limit can be set. When creating cutting path from raster data (the original data itself can be in vector format, only the respective element can be converted to raster data and then traced during processing as explained in Chapter 6.2 and 6.4), there are settings helping to achieve the optimal path. However, these features are still quite limited, when compared, for example, to Adobe Illustrator. The automatically created paths can cause problems when using the cutting plotter and especially when producing the cutting dies, which would be more likely used by label and/or packaging printing companies. Therefore, for more complex illustrations, it might be necessary to simplify the path as much as possible.

When comparing the cutting paths created using the six procedures tested, the resulting data are almost identical, except for the data created using the vector-based method “Unite Line Art” in Enfocus PitStop Pro. In this case, there was a small inaccuracy (Fig. 164a) compared to other options, which could not be avoided with any setting. Despite the higher speed of data processing with this method, it is worth considering whether it is not more appropriate to create a cutting path around vector data in the second demonstrated way to better comply with the requirements of the following production steps. Across all tested procedures, the problem could be caused mainly by the part of path shown in Fig. 164b, which was not possible to optimize in any of the applications. However, it is important to stress that not much data are to be cut on the basis of a complex hand-drawn illustration, and, in most cases, such problems would not occur.

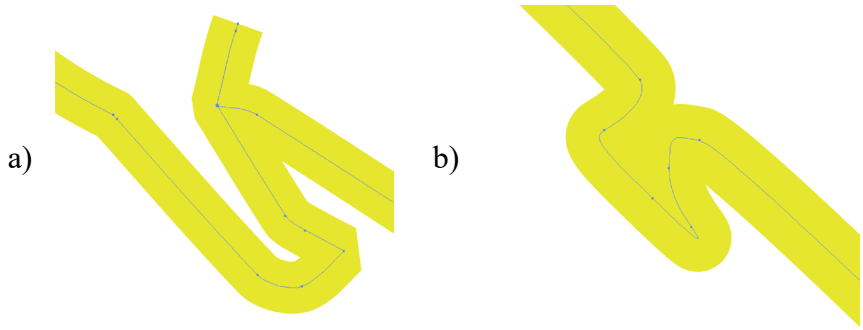


Fig. 164: Example of a) inaccuracy in creating a cutting path in the Enfocus PitStop Pro 2020 using the "Unite Line Art" method, b) non-simplified part of the cutting path, which is created by all demonstrated methods can cause problems in production

In workflow systems, the availability of different features and the quality of output is mainly limited due to older built-in versions of Callas pdfToolbox and Enfocus PitStop. The workflow systems always implement the new technology with some delay. Callas pdfToolbox 11 in Xerox FreeFlow Core and Enfocus PitStop 2020 in Esko Automation Engine can be expected at the turn of the year 2020/2021 with the release of an updated version of the entire workflow systems.

In this case, a significant limitation has been encountered during testing with the Esko Automation Engine 18.1.0, which includes PitStop 2018 built-in (there is also Esko Automation Engine 18.1.1 available, with built-in PitStop 2019). However, it is not possible to use the "Add trace path" in any of these two versions, so technical elements based on any raster objects cannot be created. Besides, it is not possible to select objects using "Select line art by total number of nodes" and "Select object in areas with dense graphic". Callas pdfToolbox 10.2 built-in in Xerox FreeFlow Core 5.4.1 includes all the necessary fixups and checks. However, it is necessary to follow the changes in general, because this segment is very dynamic and the options in Callas pdfToolbox and Enfocus PitStop are constantly improving. It is also important to mention that when an Action List created in a newer version of Enfocus PitStop is put into a workflow system that has built-in older PitStop technology, the unsupported actions are removed, but the Action List is imported and can be modified. However, this is not possible in a workflow system with built-in Callas pdfToolbox technology; checks, fixups, profiles, or process plans cannot be used in the older versions and an error message will pop up.

As another quality factor, the availability of Callas pdfToolbox and Enfocus PitStop in workflow systems can be considered. Built-in Enfocus PitStop technology in Esko Automation Engine includes Action Lists, which can be modified and created in any way, and there is no need to own the Enfocus PitStop Pro application. Built-in Callas pdfToolbox technology in Xerox FreeFlow Core, however, does not allow editing of individual fixups, checks, profiles, or process plans within workflow system, and it is necessary to create them in a separately purchased desktop application. This may be due to the integration of the CLI instead of the SDK; therefore, if the company is interested in editing within their workflow system, it is necessary to find

out the availability. On the other hand, Xerox FreeFlow Core includes a number of predefined fixups and profiles that are commonly used. They can also be exported from Adobe Acrobat.

6.8 Summary and other available options

Commonly available commercial products were selected for testing that can help automate prepress. Although Adobe Acrobat is the core software for a large number of companies in the graphic arts industry and many workflow systems implement Enfocus PitStop or Callas pdfToolbox technology, there are other solutions on the market, some of which are presented in Chapter 3.

An alternative solution for creation of an element for partial varnishing may be to purchase Prinect PDF Toolbox Coating Editor, a plugin for Adobe Acrobat. It offers a relatively simple solution for creating a spot color directly over the desired objects. Although it is not a fully automated solution, it is not necessary to redesign the printing data, and the editing can be finished very quickly, in a few minutes. Since the Prinect PDF Toolbox Coating Editor was not provided for testing, its capabilities are not shown here. However, its functions are presented in [448].

A good example of a workflow system that does not implement third-party solutions but creates its own is OneVision Software. In terms of the issues addressed in this chapter, it offers the Commercial Print Extension for Asura, which has features such as automated creation of varnish masks [251]. Besides, Asura itself can add missing bleed and printer marks [245].

Agfa offers within the Apogee Acrobat Pro Toolbar (including trap spotting, varnish and screening plug-in) [129], for which, however, no additional information was acquired.

Overall, the innovations in prepress software comes very quickly; only during the work on this thesis, several new products as well as new versions of existing software were released. Therefore, if the company wants to compete, it has to pay attention to the developments. One of the new applications is, for example, Enfocus BoardingPass for early detection of errors for customer service agents, which will be released in July 2020 [449].

Conclusion

The thesis provides a summary of prepress terms and processes along with possible solutions for its automation, and compares the coverage and affordability of selected workflow systems and individual applications that are used in prepress.

Based on this summary, a questionnaire was created, where the participating companies provided the information about their approach to prepress and its automation. The questions about the type of company, the number of its employees and the number of orders received per day were also included, so that the results could be better evaluated.

The results show that something could be at a better level, such as providing and sharing the necessary information concerning data preparation with customers or graphic designers, or automatically checking the printing data before it is received by the company. Many companies solve this only when a problem occurs, which causes delays. Interestingly, Adobe Acrobat and Enfocus PitStop Pro are widely used in the Czech Republic for preflight and changes, but Callas pdfToolbox is very rarely used among the survey participants although it can be a more powerful tool in some respects than the previous ones, such as for automation. It is probably because there is no official reseller of this software in the Czech Republic. Companies also significantly more use both Enfocus PitStop and Callas pdfToolbox desktop versions, but server versions can provide a higher degree of automation despite the higher cost. For routine prepress activities, the most participating companies use actions (such as Action Lists within Enfocus PitStop), followed by the use of hot folders. Compared to these options, JDF automation is still a little used. However, many companies do not automate routine activities in any way.

It is also interesting that almost half of the participating companies use a workflow system, which is the main means of automation, but according to the information obtained, many companies do not make full use of it or have not purchased adequate modules. For example, a large percentage of orders are still returned to the customer in order to fix them or they are fixed manually in the companies.

However, graphic designers who prepare printing data should also be better trained, as most respondents stated that every third order is poorly prepared. Therefore, as expected, the biggest problem is in the received printing data. The frequency of different issues and time needed for the corrections are discussed.

These findings were used to choose the issues for the demonstration of possibilites to automatically correct the improperly prepared printing data. Default inserted printer marks and a missing bleed were corrected, which belong to the most common problems. It was verified that these problems can be corrected very quickly. Furthermore, missing data for processing steps were selected for the demonstration, which do not occur as often, but the participating

companies spend more time with corrections. In Adobe Acrobat, the possibilities are very limited, so it is advisable to use this program rather as an environment for plugins, such as Enfocus PitStop Pro and others. Callas pdfToolbox and Enfocus PitStop Pro offer advanced options for printing data editing. Each of them has some advantages in terms of possibilities, quality, and speed of processing; therefore, their suitability must be evaluated in the context of particular requirements. While Callas pdfToolbox Desktop offers batch processing, process plans, and imposition and thus appears to be more powerful in terms of automation, Enfocus PitStop Pro offers the option of manual editing, which can also be recorded to Action Lists and which can be indispensable in some cases. In general, the range of functions in Callas pdfToolbox and Enfocus PitStop Pro is still being upgraded. Considering the processing of example jobs tested in this work, the selection of grouped objects would be an interesting function for complex motives since it would be sufficient only to group the necessary data to define the area to be varnished.

The greatest possibilities for automating the entire job processing are offered by workflow systems, which in most cases have built-in Enfocus PitStop or Callas pdfToolbox technology. However, it is necessary to take into account the older version, and, therefore, the limited options compared to the latest versions of the respective standalone applications. In this work, Xerox FreeFlow Core 5.4.1. and Esko Automation Engine 18.1.0 were used for testing. The workflow system should be always chosen according to the type and number of operations in order to achieve the highest degree of automation. Naturally, these factors differ across the individual market segments, depending also on the size of a company and the structure of its production, and can be also region-specific. As the workflow systems are rather expensive, the choice should be preceded by a thorough analysis of prepress in a given company, its current software coverage, and analysis of the goals that the workflow system should meet.

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Glossary

This section summarizes the terms that are used in the thesis.

AM
Amplitude-Modulated – type of screening that divides the image area into a regular grid of screen cells and the maximum halftone dot size depends on the size of the screen cell.

APPE
Adobe PDF Print Engine – a newer raster image processor technology that allows direct conversion of printing PDF to a raster without the need to convert to Postscript.

ASP
Active Server Pages – Microsoft's server-side scripting engine that produce dynamically-generated web sites.

Bit
The smallest basic unit of measurement used to measure computer data in the digital environment. One bit contains a single value either 0 or 1.

Bit depth
Defines the number of distinguishable luminance levels per color channel.

BPC
Black point compensation – technique that help maintain details in dark and light tones due to the different range between the white and black point of the source and target gamut.

Browser-based applications
Applications that run only with an active internet connection.

CAD
Computer-aided design – Computer technology for product designing and technical documentation. In the printing industry, it is used for packaging design.

CalGray, CalRGB, Lab and ICCBased color spaces
CIE-based color spaces that specify colors in a way that is independent of the characteristic of any particular output device.

CID codes
Character Identifier – codes used for fonts with a higher number of characters
(typically used for Chinese, Japanese, or Korean languages).

CLI
Command-line interface – its
function is to receive text commands and constructs them into functions, thus offering fast and easy integration of applications on a variety of platforms.

Cloud-based applications
Applications that work with the help of cloud data that can run in the offline mode, and their functioning does not depend on a web browser. These are considered as a combination of browser-based and desktop applications.

CMM
Color Management Module – engine that does all calculations of color conversion based on profile information.

CMYK
Cyan, Magenta, Yellow, Key or BlacK – standard, subtractive process colors.

Color depth
The sum of the bit depths of all the color channels.

CPSI
Configurable PostScript Interpreter – an older raster image processor technology with certain limits. When receiving printing data in PDF, it is needed to convert them to PostScript.

CSV
Comma Separated Values – it is a plain text file that contains a list of data and uses comma character (or semicolons) to separate data, used for data exchange between applications.

CTP
computer-to-plate – imaging technology where created printing data are output directly to a printing plate.

DeviceGray, DeviceRGB, DeviceCMYK
Color spaces that directly specify shades or colors of gray that the output device is to produce.

DeviceLink
It is a special kind of ICC profile used for CMYK to CMYK conversion that converts a color space of an input device directly into a color space of an output device.

DeviceN, Separation, Indexed and Pattern
Special color spaces that add features or properties to an underlying color space.

DTP
Desktop Publishing – it is usually used as a synonym for prepress.

EPS
Encapsulated PostScript – Document format used as a graphics file format for transmitting graphic data. It is no longer used in modern workflows

ERP
Enterprise Resource Planning – a system that managing business processes in a company like planning, sales, marketing, human resources, etc. It links different systems of a company together.

EXIF
Exchangeable Image File – metadata that carry information about the settings that author used, for example, during photographing.

FM
Frequency-modulated – type of screening where individual dots are randomly placed into the screen cell, based on an algorithm.

FOGRA
German-based Research Institute for the graphic arts involved in maintaining several ISO standards concerning color management and printing

FTP
File Transfer Protocol – a network protocol for transfer files between client and server.

Gamut
Range of reproduced colors.

GCR
Gray Component Replacement – it replaces chromatic CMY colors with a corresponding proportion of black in entire image.

GWG specifications
PDF specifications that are tailored for individual printing technologies or market segments.

Hard proofing
Proofing processes that working directly from digital data, where the color output of production printing is simulated.

HKS
Hostmann-Steinberg Druckfarben, Kast + Ehinger Druckfarben, and H. Schmincke & Co. It is one of the spot color systems.

Hot folder
Folder that allows the user to process files such as PDF and other file types without having to open them manually in an external program.

ICC profile
Data file that defines the relationship typically between RGB and CMYK values and their corresponding color coordinates from the independent PCS that describes the color appearance.

IPTC
International Press Telecommunications Council – metadata format used to incorporate, for example, title, description, keywords, photographer's information, copyright.

JavaScript
Scripting language for web pages, but many non-browser environments also use it, with regard to prepress, for example, Adobe Acrobat.

JDF
Job DEfinition Format – The communication standard based on XML. Its integration into the whole process from prepress to finishing are the part of automation in the printing industry that exceeds the PDF workflow.

JMF
Job Messaging Format – allows sending instructions and information about events such as start, error, status, results, etc.

JPEG
Joint Photographic Experts Group – Commonly used method of lossy compression for storing raster graphics images

JPEG2000
Joint Photographic Experts Group 2000 – newer image compression standard and coding system of JPEG with a wavelet-based technology with choice of lossless or lossy compression and support 16-bit depth.

LAN
Local Area Network – computer network that consists of computers connected over short distances.

MAM
Media Asset Management Systems – database for the management of digital assets in the form of various media.

MAXML
Multi-Channel Access XML – An XML-based dEfinition language designed for needs to deploy applications on many access channels simultaneously. It enables to create one application dEfinition and have it instantly accessible.

Metacode
Language defined by Xerox for variable data processing.

Metadata
Structured information about the job or file that are processing by a company.

MIME
Multipurpose Internet Mail Extensions – specification for the format of non-text e-mail attachments.

MIS
Management Information System – an information system at the level of support for the implementation of jobs and operational management.

On-premise software
Software installation where the company runs the software from its computer server.

OpenAPI
Application Programming Interface, which is publicly available to software developers.

OpenType
The newest standard for digital type fonts, developed by Adobe and Microsoft. It has some advantages over previous font formats, such as small caps, ligatures, using the Unicode standard, and the font is only a single file.

Output intent
Describes the final destination device that will be used to reproduce the color in the PDF, usually by choosing a suitable ICC profile

Pantone
One of the spot color systems.

PCS
Profile connection space – the central node used in an open color management system. It is presented by a device independent color space (CIELAB or CIEXYZ).

PDF
Portable Document Format – a format that makes it easy to view and edit documents, since it allows working independently with individual pages and with objects on a particular page.

PDF page boxes (boundary boxes)
Page boxes in PDF format that relate to the size of its pages. There can be up to 5 different dEfinitions: MediaBox, CropBox, TrimBox, BleedBox and ArtBox.

PDF/VT
International standard for variable data and transactional (VT) printing.

PDF/X
International standards that specify the requirements on a PDF document intended for the exchange of printing data.

PDFX-ready
The association that provides free information, settings, and preflight profiles based on GWG specifications in as simple and user-friendly form as possible.

PHP
Hypertext Preprocessor – A server scripting language that is suited for web development

PJTF
Portable Job Ticket Format – format whose functions have been built to the JDF.

PNG
Portable Network Graphics – widely used file format on the internet that supports lossless data compression for storing raster images.

PostScript
It is a interpretive programming page description language with graphics capabilities

PPF
Print Production Format – format for transferring production data from prepress to printing and finishing whose functions have been built to the JDF.

PPML
Personalized Print Markup Language – An XML-based standard printer language for variable data and transactional printing dEfined by PODi. It is device and manufacturer independent, but specific implementations may differ and may not be compatible.

Preflight
Checking of selected parameters of the printing data, specified in the preflight profile.

Proofing
Summary designation for all types of proofing – in the thesis for approval workflow, soft proofing and hard proofing.

Relational database
Database that keeps the necessary data in tables and allow manipulate them conveniently, usually using a special language, SQL.

Rendering intents
Methods of conversion from one color space to another.

RGB
Red, Green, Blue – additive color space.

Rich black
100 % K with an addition of 20–60 % of one or more process colors. It is used to increase opacity of the color or to increase the saturation.

Raster image processor
Technology that convert the PDF file to a raster image – bitmap with pattern of dots. There are three stages of raster image processing: interpretation, rendering and screening.

SaaS
Software as a Service – one of the software distribution models in which a provider makes applications available over the Internet.

SDK
Software Development Kit – interface that contains a collection of shared libraries, accompanying header files, developer documentation and samples for integration. SDK offers APIs for development and deployment environments.

Server
The central computer that provides specialized services, and the other computers serve as workstations.

Soft proofing
A true-to-color preview displayed on a monitor.

Spot colors
Inks with a given shade, to reproduce, for example, colors that lie outside the gamut and they can also be used when printing shades within narrow tolerances

SQL
Structured Query Language – special language used to manipulate with relational databases.

SWOP
Specifications for Web Offset Publications – specifications for standardization of printed materials used in the United States.

TIFF
Tagged Image File Format – file format commonly used for storing raster graphics images using lossless or lossy compression.

Trapping
Technique that is used to compensate for problems with the registration of the individual colors in printing.

TrueType
Standard for digital type fonts, developed by Apple Computer and licensed to Microsoft Corporation.

TVS, TDA, TAC
Tone value sum, total dot area and total area coverage, respectively the sum of all colors that shall not exceed 240–330 %, depending on the material and technology used.

Type 1
The worldwide standard for digital type fonts, developed by Adobe Systems for use in PostScript printers

UCR
Under Color Removal – it replaces chromatic CMY colors in neutral dark tones constituted by overprint with a corresponding proportion of black.

VIPP
Variable-Data Intelligent PostScript Printware – A PostScript-based language from Xerox. It allows storing pre-rasterized repeating objects into memory and then combines them with variable data.

VPS
Variable Print Specification – a PostScript-based format owned by Kodak. It works with nonreusable and reusable types of elements. Reusable elements are raster image processed and subsequently used with variable data

W2P
W*eb-to-print* – technology that offers a possibility for creating online print production using embedded templates on a website alongside a strategy that creates a new scope in the market and brings a new marketing potential.

XML
Extensible Markup Language – a markup language for the exchange of a wide variety of data with a simple and readable form of transmitted information.

XMP
Extensible Metadata Platform – metadata mainly used for storing information about page components or about the PDF document itself. Structure of XMP metadata is not suitable for dEfining a product and its parts

XSLT
Extensible Stylesheet Language (Transformation) – format for transformation XML documents or other formats into other XML documents.

Annex A

The questionnaire for the survey of problematic areas and the use of software tools and automation in prepress among printing companies in the Czech Republic translated to English

Questionnaire – prepress

The following questionnaire is used to identify problematic areas and the current use of software tools in prepress and is part of my diploma thesis. All data will be processed anonymously. Completing the questionnaire should not take more than 15 minutes. If you are interested in the results of the diploma thesis, you can let me know at st45503@student.upce.cz or petrroudny@gmail.com, and I will provide you finished diploma thesis. Thank you very much in advance for completing the questionnaire. Petr Roudný

* Required

Please provide the name of your company

(This only serves to eliminate multiple responses from the same company. All data will be processed anonymously and will not be provided to third parties. If you do not wish to provide your company name for any reason, you can skip this question.)

Your answer

What is the main production type of your company? *

- ◯ Commercial offset printing (possibly supplemented by digital or other printing)
- ◯ Digital and/or large format printing
- ◯ Label and/or packaging printing
- ◯ Textile printing and/or promotional products printing
- ◯ Magazine and/or newspaper printing
- ◯ Publishing
- ◯ Other:

How many employees work in your company? *

- ◯ 1–10
- ◯ 11–50
- ◯ 51–100
- ◯ 101 and more

On average, how many orders do you receive per day? *

- ◯ 10 and fewer
- ◯ 11–20
- ◯ 21–50
- ◯ 51–100
- ◯ 101 and more

Do you support graphic designers or customers in preparing printing data? *

(Můžete zaškrtnout i více odpovědí.)

- ☐ No
- ☐ Yes, we mention on the website how we require to prepare printing data (or we have information to download).
- ☐ Yes, we offer for free download of preflight profiles (own, GWG, PDFX-ready etc.), ICC profiles (own, Fogra, SWOP), droplets, etc.
- ☐ Yes, on request or when necessary to correct the printing data, we will explain how we require the printing data to be prepared.
- ☐ Yes, printing data are automatically checked before or during sending to the printing plant (Enfocus Connect, XMF Remote, Apogee WebApproval, InSite Prepress Portal, etc.).
- ☐ Other:

In which areas of prepress you encounter problems? *

(Check off even if it is an occasional problem.)

- [ ] There are no problems in prepress
- [ ] Poorly prepared printing data from clients / graphic designers
- [ ] Undelivered hard copy proof/sample
- [ ] Non-compliance of the received printing data or preview/proof with the job specification
- [ ] Transfer of printing data from clients / graphic designers to a company (unsuccessful attempt to send data, data does not arrive into the company due to ignorance of work with FTP server, corporate or public storage, e-mail attachment size exceeded, etc.)
- [ ] Transfer or sharing printing data within the company
- [ ] Color management (colors are not reproduced as expected, problems with converting spot colors to process colors, etc.)
- [ ] Quality inspection of printing data
- [ ] Data checking and approval by customers during job processing, or after raster image processing, concerning proofreading, approval (proofing)
- [ ] Raster image processing
- [ ] Other:

If you answered “Poorly prepared printing data from clients / graphic designers” in the previous question, please specify how often you encounter each type of problem.

	Never	Occasionally	Often
Printing data not complying with the required PDF/X standard	○	○	○
Bleed issues	○	○	○
Problems with printer marks (crop marks, registration marks, color bars, etc.)	○	○	○
Not embedded or corrupted fonts	○	○	○
Delivery of imposed printing data (complete imposition, double-sided, etc.)	○	○	○
Incorrect page format	○	○	○
Incorrect color space	○	○	○
Incorrect ICC profiles	○	○	○
Spot color issues	○	○	○
Trapping issues	○	○	○
Overprint issues	○	○	○
Total area coverage issues (total area coverage – TAC, total dot area – TDA, tone value sum)	○	○	○

Wrong resolution or format of raster images	○	○	○
Problems with transparency or its flattening	○	○	○
Missing data identifying processing steps (varnishing, cutting, embossing, etc.)	○	○	○
Problems with PDF files (cannot be opened, processed)	○	○	○
Mismatch of printing data with delivered proof	○	○	○

How long does it typically take you to solve the problems you sometimes encounter according to the previous question?

Answer by check off the time stamp for how long does it takes you to solve them: <1 minute = automated solution, 1–10 minutes, 11–59 minutes, 1–3 hours, 3–8 hours, 8–24 hours, >1 day.)

	<1 minute	1–10 minutes	11–59 minutes	1–3 hours	3–8 hours	8–24 hours	>1 day
Printing data not complying with the required PDF/X standard	○	○	○	○	○	○	○
Bleed issues	○	○	○	○	○	○	○
Problems with printer marks (crop marks, registration marks, color bars, etc.)	○	○	○	○	○	○	○
Not embedded or corrupted fonts	○	○	○	○	○	○	○
Delivery of imposed printing data (complete imposition, double-sided, etc.)	○	○	○	○	○	○	○
Incorrect page format	○	○	○	○	○	○	○
Incorrect color space	○	○	○	○	○	○	○
Incorrect ICC profiles	○	○	○	○	○	○	○
Spot color issues	○	○	○	○	○	○	○

Trapping issues	○	○	○	○	○	○	○
Overprint issues	○	○	○	○	○	○	○
Total area coverage issues (total area coverage – TAC, total dot area – TDA, tone value sum)	○	○	○	○	○	○	○
Wrong resolution or format of raster images	○	○	○	○	○	○	○
Problems with transparency or its flattening	○	○	○	○	○	○	○
Missing data identifying processing steps (varnishing, cutting, embossing, etc.)	○	○	○	○	○	○	○
Problems with PDF files (cannot be opened, processed)	○	○	○	○	○	○	○
Mismatch of printing data with delivered proof	○	○	○	○	○	○	○

Optional question: How do you solve the most common problems in prepress?

(Example: 1. Not set bleed: auto-fix in Enfocus PitStop Pro including crop marks; 2. The customer tried to impose printing data: contact customer, explain the problem and wait for delivery of corrected printing data; etc.)

Your answer

How much time does it approximately take you to check and processing a printing PDF, which is prepared correctly (count from its receiving up to processing in RIP)? *

- ◯ 1–10 minutes
- ◯ 11–59 minutes
- ◯ 1–3 hours
- ◯ 3–8 hours
- ◯ 8–24 hours
- ◯ more than 1 day
- ◯ Other:

How many orders are delivered with poorly prepared printing data? *

- ◯ All
- ◯ Vast majority (over 90 %)
- ◯ Approximately two-thirds
- ◯ Approximately one-half
- ◯ Approximately one-third
- ◯ Almost none (below 10 %)
- ◯ None

Which workflow system do you use in prepress? *

- ○ None, we use standalone programs, not communicaing with each other.
- ○ Own, tailored-programmed
- ○ We have combined different modules from different manufacturers.
- ○ Enfocus Switch
- ○ Esko Automation Engine
- ○ Kodak Prinergy
- ○ Heidelberg Prinect
- ○ Agfa Apogee (alt. Asanti or Arkitex)
- ○ Fujifilm XMF
- ○ Efi Fiery Workflow Suite
- ○ HP PrintOS
- ○ Ricoh TotalFlow
- ○ Océ Prisma
- ○ Dalim Twist/ES
- ○ OneVision Software solutions
- ○ Xerox FreeFlow Core
- ○ Helios (application of HELIOS Software GmbH)
- ○ Other:

How do you do preflight or fix printing data? *

- [ ] We do not preflight, nor we do fix data.
- [ ] Visual data check only (Adobe Acrobat or another PDF viewer)
- [ ] Adobe Acrobat
- [ ] Enfocus Pitstop Pro
- [ ] Enfocus Pitstop Server
- [ ] Callas pdfToolbox Desktop
- [ ] Callas pdfToolbox Server
- [ ] Markzware FlightCheck
- [ ] Built-in preflight in a workflow system (see previous question)
- [ ] Other:

Which other areas of prepress except for preflight do you have software covered? *

- [ ] None
- [ ] Mediated automatic preflight on the side of the client/customer (e.g. when sending data to a company)
- [ ] Data transfer from a customer to a company
- [ ] Information system
- [ ] Job management
- [ ] Job monitoring in production
- [ ] Color management
- [ ] Imposition (sheet assembly)
- [ ] Raster image processing
- [ ] Approval workflow or certified preview – soft proofing (online)
- [ ] Certified preview or certified print proof – soft proofing, hard copy proofing (in a company)
- [ ] Other:

Optional question: Which specific programs and modules do you use for the mentioned prepress areas?

Your answer

How do you simplify routine work in prepress? *

- [ ] Nowise
- [ ] I do not know, all automated tasks are done by a workflow system as set up since implementation.
- [ ] I do not know, all automated tasks are done by independent software as set up since installation.
- [ ] Using actions (Action Lists in Enfocus PitStop Pro, batch processing in Adobe Acrobat, etc.)
- [ ] Using hot folders
- [ ] Using JDF
- [ ] Other:

Which PDF standards and specifications are you familiar with? *

- [ ] PDF/X
- [ ] GWG specifications
- [ ] PDFX-ready specifications
- [ ] None
- [ ] Other:

Which PDF standards and specifications do you use in your workflow? *

- [ ] PDF/X-1a:2001
- [ ] PDF/X-4
- [ ] GWG 1v4 specifications
- [ ] GWG2012 specifications
- [ ] GWG2015 specifications
- [ ] PDFX-ready V1.3 specifications
- [ ] PDFX-ready V2 specifications
- [ ] Our settings based on standards/specifications.
- [ ] Our settings; we do not use standards/specifications.
- [ ] We do not edit received PDFs (we print what the customer sends).
- [ ] I do not know
- [ ] Other:

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