METHOD FOR PREPARATION AND SETTING OF A COLOR TONER-BASED PRINTER FOR COLOR MANAGED PRINT PRODUCTION COMPARABLE TO OFFSET TECHNOLOGY

СПОСОБ ПОДГОТОВКИ И НАСТРОЙКИ ЦВЕТНОГО ПРИНТЕРА ДЛЯ ЦВЕТНО-УПРАВЛЯЕМЫХ ПЕЧАТИ ПОЛИГРАФИЧЕСКОГО КАЧЕСТВА

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Abstract: *The paper presents some of the results, obtained during the research on scientific project at TU-Sofia № 171ПР0012-06 "Research on the influence of using raster image processors (RIP) on the quality of color printing of poligraphic digital proofing systems". The purpose of the parer is to present an optimized method for preparation of digital color toner based printer for color managed printing. The printer being researched uses specialized color server (RIP), that introduces many new functionalities, but at the same time introduces new difficulties related to setting the corrects settings in order to obtain predictable and repeatable quality prints. There are not many references in the literature to the correct way ot making these settings and the paper will be very usefull to those interested in the research of such printers as well as to practitioners in the field of digital printing, because it presents, in an organized way, the author's experience in the research of these printers and his practical experience in the field.*
KEYWORDS: *COLOR MANAGEMENT, COLOR PRINTER, PRINT QUALITY, COLOR GAMUT, ICC PRINTER PROFILES*

1. Introduction

Very often in the production practice in the area of digital printing, exists the practice of purchasing new digital printers, which are directly introduced in the production process without first being individually adjusted and calibrated to standard printing conditions. Without these settings the printer, regardless whether or not it uses raster image processor color server – RIP, will operate with its factory settings. It must be note that this is an acceptable option, but the print qualy will be at a basic level. It is important to have in mind that in many cases these factoy settings are oriented towards the American pre-press and print market. For example in many newly purchased RIPs and software packages for pre-press (Adobe CS etc.) the color simulation ICC profiles for offset by default are set to North-american speciffications (SWOP Coated v2 and newer versions). In Europe different print offset speciffications, based on Fogra series profiles (27, 29, 39 and newer) are used. Theese differences will lead to visible objections in the quality of the printed output. In addition, the factory settings in the printer driver and its RIP (if installed) are also not correctly characterizing the actual condition of the printer and one cannot expect perfect match between the displayed digital originals and their printed copies (as far as this is possible at all as is determined in an author's preceeding science research project [1]). In order to achive digital printing quality comparable to traditional press quality with color rendering identical in appearance to the digital original it is necessary to correctly set the hardware and software options of the printer – postscript driver and color server (if used).

2. Анализ на изследвания принтер

In the present study, a high-end middle class printer, is used based on toner digital printing: Konica Minolta Bizhub C350 with EFI Fiery X3e-22C-KM (IC-401) RIP processor. This printer is common in small-format digital printing studios, advertising agencies and prepress studios. Through the method of color adjustment and management described here, it is possible to realize a quality print based on standards and specifications and proven by instrumental measurements that customers require. Compared to another model of Konica Minolta - CF 9001 in another scientific project of the author [2], the printer design is based on a fundamentally different principle. Its internal mechanisms use the so-called. single-pass design ie. the four color images are stacked on top of each other and then the finished image is transferred once onto a sheet of paper. The intermediate carrier is the so-called transfer belt. Because of its properties it is flexible and this is a prerequisite for not so good registration of colors. The biggest difference with the CF9001 model is the fact that it is not actually a laser, but an LED printer with a resolution of 600x600 dots per inch. Although according to the specification, both the Konica Minolta models have the same resolution, the laser model has sixth-generation laser beam modulation technology called Limnos VI, which allows it to achieve up to 256 individual color gradations for each pixel (halftone dot) of the printed image, i.e., full color printing. The LED printer model does not have such technology and as a result its effective resolution is lower. This disadvantage is also apparent in visual comparisons of printed identical test pages from printers' color servers. The printer has an added color server - EFI Fiery X3e 22C-KM. The server is a newer generation and has advanced color management capabilities.

3. Preparation for color-managed printing

3.1. Hardware settings in the printer

The first step to bring the printer to color-controlled, standardized, predictable repeatable printing is to make hardware adjustments to the color gradations of the printer. For this class of printers, the settings are divided into two levels: printer level and subsequent color server level, the second level can not be implemented without correctly implementing the first level settings. The printer's service menu offer options for printing a gradation scale and its measurement by placing it in the scanner of the printer. The procedure is repeated three times. The results are shown in Figure 1. Once the gradation levels have been set, it is seen that the printed colors are more saturated than the originals. When compared to the standard Kodak Q13 offset scale, a much closer visual similarity in the colors appearance is achieved. The author's expectations are for a very good and accurate color rendition of the printer due to its good technical condition, despite the apparently lower gloss of the toner colors printed, which is determined by the properties of the dry ink used. A distinction should be made between setting the gradation leves and linearisation of the printer. The second process takes place in the color server and complements the adjustments made to the gradations. Figure 1 shows that a good balance of primary and secondary colors has been achieved. There is also a good balance of the composite black color, made up of the three basic colors. There is no early fading of color gradations, which is a direct manifestation of the good condition of the print drum and the printer's developers. Also, there is no uneven fading on the left and right part of the copy (no wear in the light-sensitive drums). Given the above-mentioned observations, if the printer is calibrated and profiled properly, it can be expected that it will be capable of quality print simulating and

exceeding the color range of offset printing! This is at present the main advantage of modern digital printers.

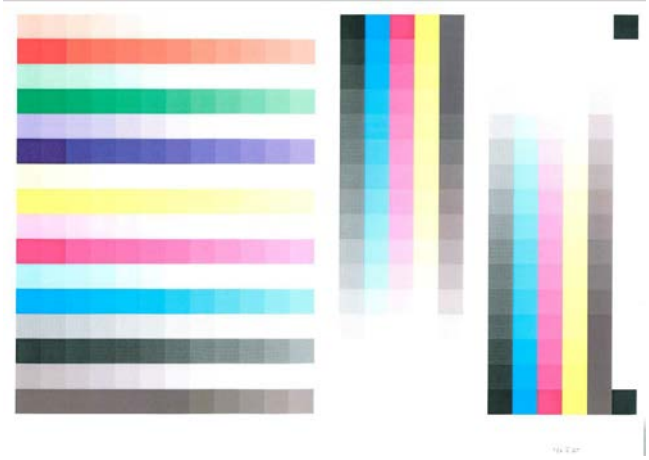

Figure 1 - Hardware setting for C350 printer gradations

3.2. Checking the color registration

After successfully adjusting the color gradations of the printer, it is necessary to check and adjust if necessary the registration of the colors. As stated in the previous paragraph, the print process of the printer uses a transfer belt. It is the main source of errors in color registration. A test page is printed on the printer (Figure 2).

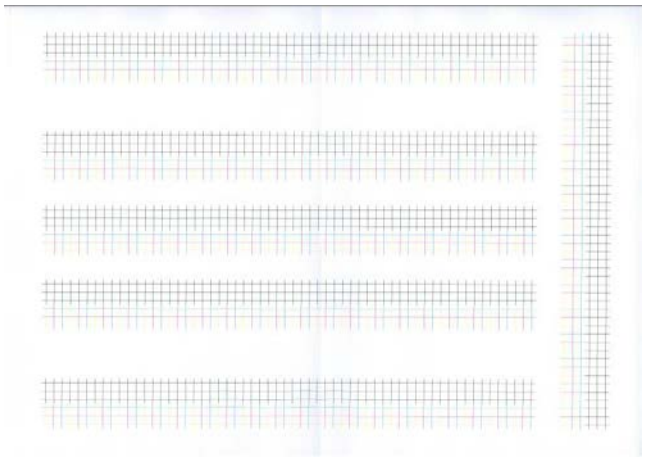

Fig.2 - Color registration page for Konica Minolta BizHub C350

It is folded in two and visually checked for the registration of the black color, and then the other three colors. Here the measuring tool is the human eye. After the check, it was found that the printer had registration errors in all four colors. After performing numeric adjustments to the LED control unit and to the transfer belt drive system, a test page was printed and analyzed. New registration errors were not found. Together with the color registration evaluation, a comparison of the printer resolution with the CF9001 model was made using a circular indicator printed on the standard test page of both color servers installed in the respective printers (Figure 3). The comparison clearly shows that despite the same resolution of 600 dots per inch, the laser printer is superior to the IED model on this benchmark. It is suggested that the printed images from the LED model will have less detail - the printer is obviously a "victim" of modern business practices on this indicator too.

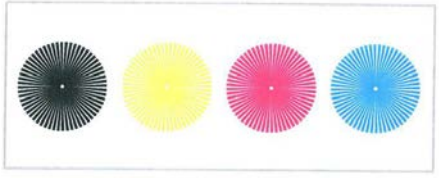

Figure 3 – Circular resolution test element printed on the Konica Minolta Bizhub C350

3.3. Color Linearisation (Calibration) of the color server

The last step before profiling the printer is to calibrate it at the color server level. This process builds on the alignment of the printer's gradations and results in an even distribution of the available gradation levels from 0 to 100% ink. Thus, the behavior of the printer is predictable and repeatable - preconditions for successful subsequent profiling. This setting can be done from the printer's color server integrated display, but more convenient and more feasible is the method using EFI Command Workstation's dedicated color management software. In this case the color adjustment module is used - fig.4. An expert level is selected from the module. Different calibration methods can also be seen from the drop-down menu depending on the usage of X-Rite DTP41 or 32 densitometers; spectrophotometer EFI ES-1000 (analog of X-Rite i1Pro); AutoCal or ColorCal methods.

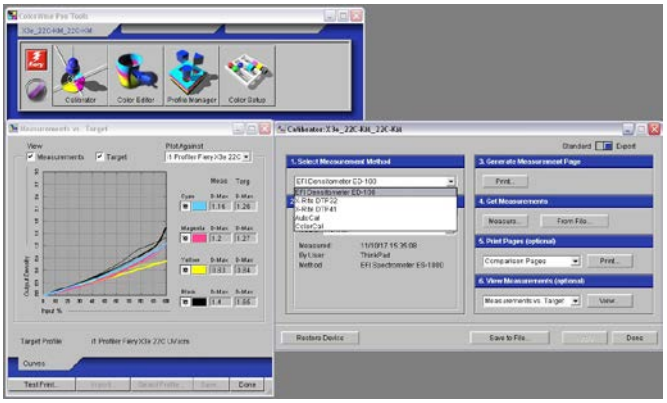

Fig.4 - Calibration menu for printer C350 (measured and set optical density at calibration)

Because the server is of a newer generation, it can be linearized with an i1Pro spectrophotometer. This is by far the most accurate method and it is used in the described method. The printed and measured test target is shown in figures 5 and 6. When printing the target, there are two types of structures of the color test elements: in sequence and random. The second option is preferred. The method used has the advantage that the values of the printed calibration colors are measured with a calibrated high-end color measuring instrument and the resulting calibration results in a noticeable improvement in the printed test images. It is also possible to apply the AutoCal procedure in the absence of measuring instruments. It consists of printing a color calibration scale and subsequent scanning from the printer along with a Kodak Q13 monochrome gradation scale attached to it at a special location. Such a calibration process relies on the precision of the optical system of the printer used and the possibilities for digitization of its scanner. In an attempt to improve this process, the researched printer has a built-in new ColorCal procedure. Another test page has been internally added by the manufacturer, containing color and gray elements with known values, used to calibrate the printer scanner, then the calibrated scanner is used to calibrate the printer (Figure 7). It is also important to note the "Calibration set" menu. In this case, it is possible to select only one calibration for all types of paper, which is a limitation based on the capabilities of the software at that time. In principle, each type of paper should have its own calibration to achieve optimum print quality. In current color servers, this is exactly the case. After the calibration, a comparrisson page is printed (Fig. 8). It can evaluate the achieved color rendering accuracy and gradient gradations in RGB printing and offset printing simulation with a specified profile in the CMYK data format. In both cases, the printer output profile is the default one, and is still the factory default because the customized profiling process has not yet been performed. The page shows that the color

gradations are true and even have the ability to print colors with a fill of less than 10%. Images after calibration are also of improved quality.

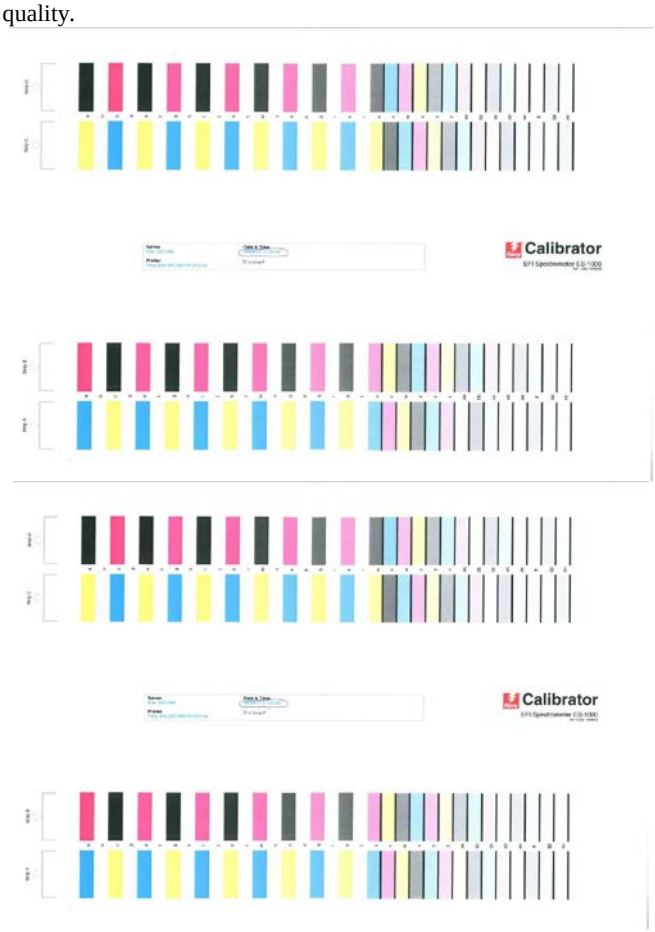

Fig.5 and 6 - Test page for calibration and linearisation of a C350 printer by a spectrophotometer with successive colors (top) and randomly arranged colors (bottom)

Once the settings have been saved, numerical information about the measured optical density of the colors can also be displayed in relation to the expected reference values. These values can be edited to obtain a special calibration used in private cases (Figure 4). The last step before profiling the printer is to print the general test page of the color server - fig.9. The test page shows that even at this stage of printer setup the color rendering quality is high. Color gradations are correct, and both test pictures on the page faithfully reflect the memory colors of real-world objects from everyday life.

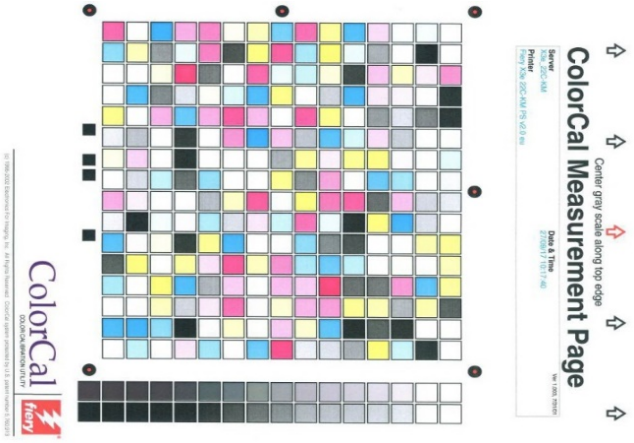

Fig.7 - ColorCal Test Page for calibrating the scanner and the printer itself

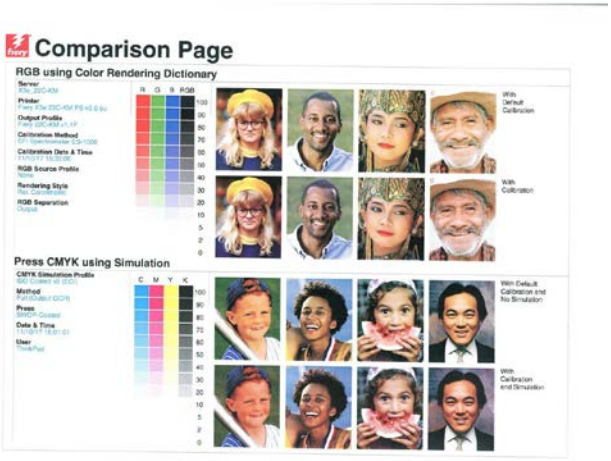

Figure 8 - Comparison page after calibration of the printer

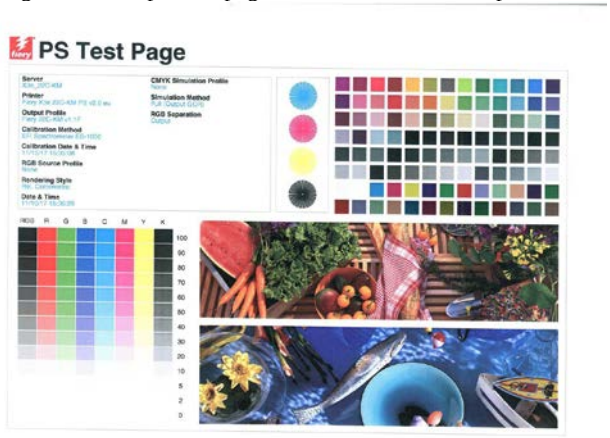

Figure 9 - Fiery X3e-22C-KM Color Server general Test Page After Calibration

3.4. Settings in the printer driver and on the color server before profiling

Prior to profiling the printer, it is necessary to set the correct settings to avoid unwanted duplicate color management, both on the driver and on the color server. The goal is to transmit the color values used to describe the behavior of the printer without distortion to the final print itself. The most important setting in the printer driver is to turn off color management there (Figure 10). The color server settings in the driver are desirable to be left as defaults, but only if they are properly set on the server itself (Figure 11). In Figure 11, color management for RGB data is set to "none," which implies using an incoming ICC color profile from the source file. The color setting in CMYK format is none, which implies using the incoming source color profile of the data, but if such is not embedded, the data will be printed raw without color management. This is also the purpose of profiling. It should be noted that advances in the development of color management in modern color servers have resulted in much clearer and more defined set-up rules for printing and profiling. Progress has also been made with specialized color server profiling software - the author has a Fiery Color Profiler Suite software package, specifically designed to address the problem of dual color management in profiling by skipping the current color output profile on the server. Using this package an ICC color profile was created describing the color server being researched.

4. Results and discussion

The method presented in the article describes in detail the correct way to set up and prepare a color digital printer for color-managed printing. This provides predictable and repeatable color printing with numerically verifiable values. After these steps, the printer is prepared for individualized profiling, which is the final stage of the

method. It is only after finishing this stage that the printer can be introduced into the production of printed output.

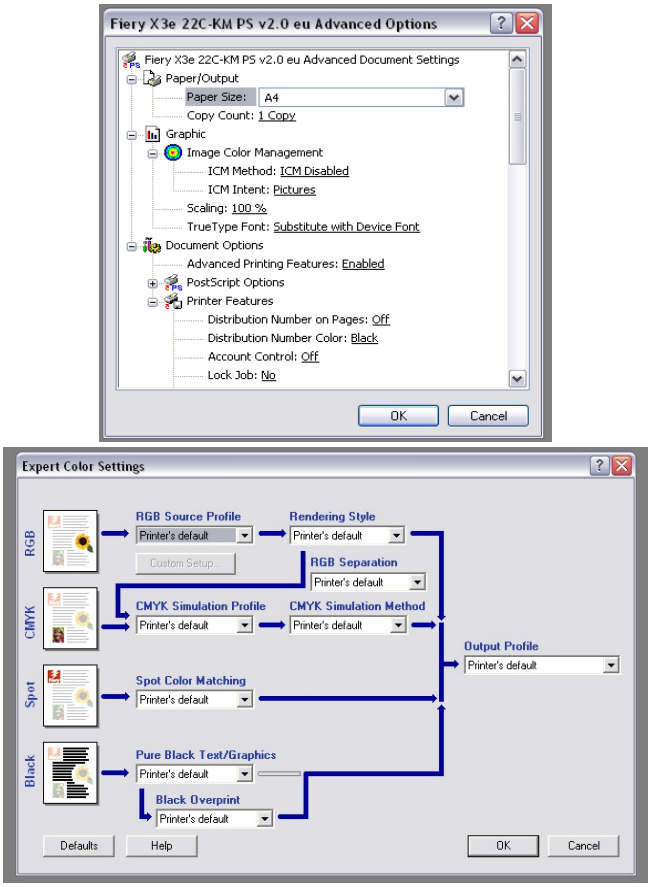

Figure 10 - Settings in the printer driver before profiling

Incorrect set-up and profiling of color servers for digital toner-based printers is a common problem at present. Until recently, it was considered that if the printer is only maintained with original inks and spare parts, it will retain its behavior (print quality) at a factory level. Therefore, the printers were also provided with a single factory color profile describing the behavior of an "averaged" model representative. No means for customized profiling of the current printer status is provided. Also, the type of paper used in these factory created generic profiles is very similar to traditional offset paper. At present, digital and even offset printing papers are highly bleached with fluorescent agents. This results in significant color shifting when printing with factory color profiles due to both fluorescence and used toner inks and spare parts. It is precisely toners and spare parts that are currently not necessarily to be OEM due to the availability of alternative suppliers, but this also leads to deviations in the color rendering. Another current issue is the generation of the spectrophotometer used for profiling. The device used in this study is i1Pro – the de facto standard instrument in the industry at present, but there is already a change in the normative documents in this field and it is necessary to use the new generation of devices - i1Pro 2, which has the great advantage of taking into account the effects of the fluorescence of the paper when profiling with it. This, however, undoubtedly leads to higher accuracy of individualized profiling of printers. The results of the profiling process of the properly set-up printer are described in a subsequent study by the author.

5. Conclusion

The application of the method described will ensure printing of printed output corresponding to the quality standards of traditional offset printing - final production or color proofs. What's more, a properly tuned, calibrated and profiled printer has a wider color range than offset printing, and it is possible to print output with more intense colors, which is the main advantage of this technology at the moment, attracting end-users. Due to the limited volume of the article, the profiling process and the subsequent print quality analysis of the printer are described in a further study by the author.

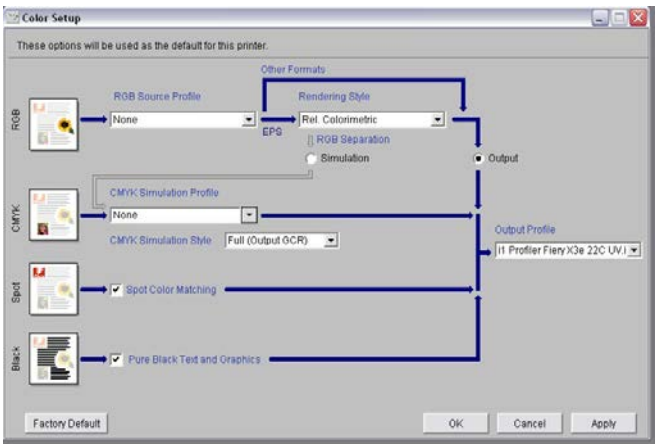

Fig.11 - Color settings on the color server before profiling

6. References

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2.“Изследване на влиянието на хардуерни растерови процесори (RIP) върху качеството на цветен печат на полиграфски цветопробни системи“, ТУ-София проект № 171ПР0012-06, 2017г.