STANDARDIZATION POSSIBILITIES OF PREPRESS WORKS AND FLEXOPRINTING BY A UNIVERSAL TESTCHART

Klaudia MAŇÚROVÁ[1], Edina JOÓBNÉ PREKLET[2], Csaba HORVÁTH[3], Viktor VETÉSI[4]

[1,2-4] University of Sopron, [3] Nyomda-Technika Kft.

Abstract: *This paper deals with the characterization and the standardization of flexo prepress works and printing process in general by a fingerprint test. According to our currently collected available information there doesn´t exist a broadly approved fingerprint test design, which would normalize and settle down the testing process of flexo printing. The scope of our research is to define parameters of a fingerprint design, which would help to build up a catalogue of elements for the print. We are defining the parameters characterizing the printing process and are suggesting elements, to research the specific field. We are in the first phase of our project, when the elements are almost ready and the test form design can be demonstrated. In the next phase we plan the realization of a survey to investigate the attitude of the Hungarian professional specialists. We plan to detect their overall rating of the elements and during the discussion we hope to discover further problems to be resolved, In the evaluation phase we will process the collected information and present a final fingerprinting form, which will be also produced and printed under real conditions. Our overall scope is to improve the available knowledge base for printing and prepress.*

Keywords: *fingerprint, flexo, prepress, testing*

INTRODUCTION

The virus crisis that is defining our days for the last almost two years does not spare any sector of the printing industry either, however the predictions about the recent and near future dominance of the flexographic printing between the printing processes have not changed. Many researchers and also the professionals in the printing industry agree that digital printing is evolving rapidly and gaining upon areas of use, but the dominance of traditional printing methods remains. Flexo printing is one of the most specific printing methods. There is a wide range of factors that affect the final print result. In the case of flexo technology no conclusions can be drawn about the expected quality or the operations required in prepress on the basis of one or two corresponding aspects, such as the same machine equipment manufacturer, the correspondence of the ink or ink transfer roller and the printing plates manufacturing technology, etc.

Figure 1: Two examples of a possible fingerprint test form compilation (Source: archives of Plastex Ltd.)

The printing conditions are different for each company, so each printing machine and substrate requires the creation of a unique printing and color profile. For creation of printing profiles a test print is required, which is called fingerprint (in English practice). Fingerprint is designed to assess the printing process and if we set our "questions" well, we will get a wide range of answers about the examined particular print. Thus, subsequent prepress and individual prints can be performed systematically and produce satisfactory results. To the best of our knowledge, there is currently no universally applicable fingerprint test form available in the European flexo sector. A huge number of test charts are circulating in practice, because the most technicians try to solve the fingerprints individually based on their own experience, information and tools. Test diagrams are given in cases where a special technology has to be set up, such as the test of surface structures for Esko Pixel + software technology for example. In this case, the software generates a test diagram for itself, as the goal is to set and optimize the production conditions. When, on the other hand, a general condition survey is required, participants in the printing process usually compile test diagrams based on their own imagination.

There is also the possibility that you can buy a license for a test chart from companies dealing with color management in general (f.e. GMG, EFI), but it is not certain that the test chart includes all the aspects to be assessed.

REPEATABILITY AND OPTIMIZATION IN FLEXOGRAPHIC PRINTING

What is optimization? Simply phrased, it is a printing test process that determines the printing parameters that result in the best print quality. Optimization is an extremely important basic requirement for print repeatability [2]. The goal of the optimization process is to identify the combination of the best print variables for the quality to be achieved in a given print process [1]. The test conditions must correspond to normal production conditions. The optimization process must be completed before creating the fingerprint. The process necessarily involves identifying the print variables from the perspective of the expected result. The U.S. literature distinguishes between two important groups of variables: press component variables and job-specific variables [1]. According to our experience the most flexo printing houses in Central Europe are looking for a generally suitable print setup. It occurs only infrequently that a high-volume job requires its own optimization and fingerprint process, normally it´s unprofitable for the printing house. When printing a general fingerprint, printers mostly rely on their printing experience to date.

Our research focuses on print and printing, so we do not deal with the optimization of printing conditions in this framework. We assume that the printing house has taken the appropriate steps to create the desired conditions, which is intended to assess the fingerprint, possibly correct it to some extent, and then evaluate it for standardization and repeatability.

RESULTS AND DISCUSSION

Just like the human fingerprint, each printing process is unique. Printing parameters such as speed, print pressure, dot distortion, etc. are different, however prints should be always accurate and consistent. Nowadays the primary focus in the printing industry is if the customer is satisfied with the print quality, price and other conditions, so printers cannot afford inconsistencies.

3.1 Fingerprint implementation

Optimization and standardization of the printing processes, saving time, cost and resources is a must. The base of this process is a printing form that helps to create a database of related parameters for each printing situation [3]. For each group of variables (printing machine, ink, substrate, etc.) we have to run a separate fingerprint,

preparing to determine the largest possible number of combinations and to be able to predict the results of any change. The primary purpose of a fingerprint is to measure and record the characteristics of a particular printing process with specific settings and raw materials. The specific settings and substrates to be printed are determined by the requirements of the printing customers and the printer itself (substrate, ink, graphic design) and the printer's experience or optimization experiments (best anilox for each color separation, optimized ink setting, best adhesive, etc.) [1]. The fingerprint must contain the colors used for printing - typically CMYK, but seven-color printing is also becoming more common in some printing houses, but then the fingerprint must contain all seven colors (CMYKOGV). One of the keys to a successful fingerprint is the meticulous documentation of each step. The most important step to an appropriate test form and creating a multi-category, alternative printing element database is to define the parameters to be measured. These parameters can be divided into two groups, these are the:

- process control parameters and a
- mechanical control parameters [1].

Process control parameters indicate the printing capability of a particular press considering the raw materials, settings, motifs, etc. to be printed. These test items map the quality capabilities of graphic design. The most commonly studied process control parameters are:

- tone colors,
- special / spot colors,
- grey balance,
- overprint and trap patches,
- raster scales,
- gradients,
- barcodes,
- line and text elements.

Mechanical control parameters include those variables that characterize the proper operation of the printing process from a technical point of view. These test items need to be placed in multiple places on the test form, as they are not necessarily balanced on every printing press at every single point. The most commonly studied mechanical control parameters are:

- impression and slur targets,
- registration targets,
- increase in tone value (dot gain / TVI).

It is also important to pay attention to a balanced design when arranging the fingerprint to avoid possible printing vibrations. In the following part we deal with each parameter in detail and present the graphical elements we believe are suitable for assessing the discussed parameters.

Testing possibilities of the process control parameters

The four basic colors of the printing process — cyan, magenta, yellow, and black — are called process colors [4]. Examining the tonal values of these four primary colors is extremely important, because they represent fundamental points for the subsequent color reproduction process. The measurement fields can be examined from densitometric (density) and spectral (L *, a *, b * ,, C *, h °, ΔE value) angle [1]. If the basic parameters of the four base colors are correct, it is likely that the overprinting raster values of the colors will also show a standard result. It is enough to test tonal colors simply, even with just a 7x5 mm rectangle for each color, as

this field is already sufficient to determine the density and spectral values for a photospectrometer. The visual of the graphic element is shown in Figure 2.

Figure 2: Graphic element for process tone values

If needed, the fingerprint may also contain spot colors. Using optimal print settings and ink, special spot colors can also be quantified by spectrophotometry (L *, a *, b *, C *, h °, ΔE) and visual evaluation. This type of test can be used to validate prints, create standards, and so on. Direct color should be tested in his tone values and raster scale too (see the Figure 3).

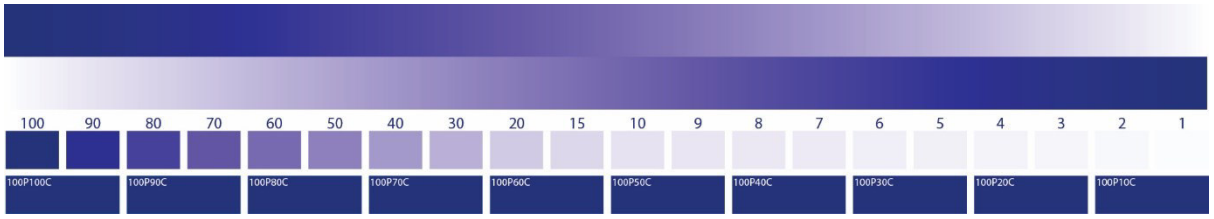

Figure 3: Graphic element for spot colors

Grey balance is one of the visual elements which are easy to evaluate. Grey balance is the appropriate combination of cyan, magenta, and yellow inks to produce a neutral grey when measured with a densitometer or spectrophotometer. You can also use a photo element to measure it, but a vector element like on the figure 4 is definitely useful.

Figure 4: Graphic element for grey balance

The quarter-, mid- and three-quarter tones of the grey balance are defined by the ISO Standard 12647-2, which always has the highest cyan values, with magenta and yellow at slightly lower percentages for the best grey balance. Grey balance is affected by process color hue, density, dot gain / TVI, or ink trap [1]. This is one of the most sensitive parameters and even the slightest change or inaccuracy can upset the color balance. Overprints and trapping are very important for prepress. Flexo technology may be characterized by the fact that the colors do not fit exactly at the meeting points of sharp contoured graphic elements due to printing inaccuracies. For this purpose, prepress operators use overprints to increase the size of the lighter element along its outlines to a certain extent, thus achieving a slight overlap between the two meeting colors during a multicolor printing. In this case, it is also easier for the printer to hold the register. Test elements for these purposes are shown on figures 5 and 6.

Figure 5: Graphic element for traps and overprinting 1.

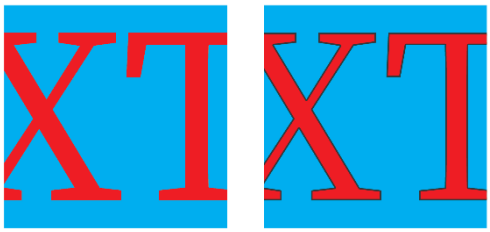

Figure 6: Graphic element for traps and overprinting 2.

In the printing process may the white underprinting cause similar problems than the other printing colors however in a slightly different way. It can happen because of printing inaccuracies, but also is true, that the behavior of the white ink is different from the other colors. When printing on a transparent substrate, without a smooth and covering white a good print quality cannot be achieved.

From this reason, printers sometimes use high volume anilox rollers for white underprints, or possibly even add a little extra pressure to get better white coverage. In this case, the white underprint may "flows out" from under the printed design. That´s why the white underprint must be withdrawn around the edges. A possible testing element for this topic is shown on the figure 7.

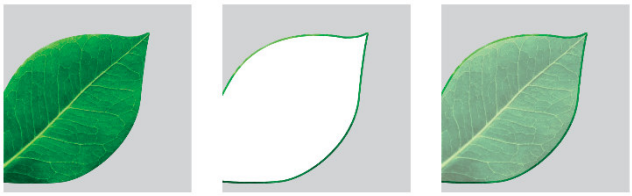

Figure 7: Graphic element for white underprint

Raster scales are composed from patches of different percentages of each color, usually ranging from 1% to 98%, as we need to examine the properties of these raster patches. The result can also be used to measure dot gain / TVI, print contrast and density. Amongst others the raster scales can help us to choose the correct screen type for plate production (AM, stochastic, hybrid, etc.). Figure 8 shows a detailed example of a raster scale.

Figure 8: Graphic element for CMYK raster scale

A gradient scale is actually a gradient that goes smoothly from the full tone of a color to the minimal dots, which can be held on a plate. These scaletypes suit well for the definition of the screentypes and screensets used on the printing plates. It is advisable to examine each color separately (see Figure 9), however, gradients of overlapping colors may also be interesting, especially for the highlight dots (see Figure 10).

Figure 9: Graphic element for CMYK gradient raster scale 1.

Figure 10: Graphic element for CMYK gradient raster scale 2.

It may be surprising, but in the recent practice barcode is one of the most important graphic elements on a product packaging. An active, easy-to-read barcode is an essential part of the product, nobody would accept long queues in store due to manual barcode entering. For this reason, is it important to know how a barcode behaves in the printing process, for what to have respect while planning new future packaging materials. It is a common practice in flexographic prepress to use Barcode Width Reduction, which means that the "sticks" of the barcodes are reduced by a few microns by the prepress operator so that they can then thicken back and take on their original size during printing. During the fingerprint, you need to determine how much this take-back should be. Barcode printing is also affected by the printing direction, so it is recommended to test in both directions in a similar format as shown on Figure 11.

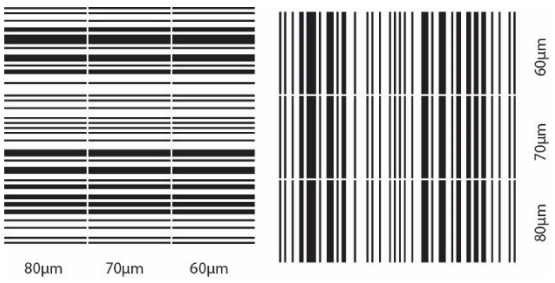

Figure 11: Graphic element for BWR

Line and text elements appear on every packaging. It is important to be focused on the dimensions of the texts and line thicknesses, the critical limit has to be found. It is worth to test the following points:

- Positive lines from one, two, possibly three colors
- Negative lines from one, two, possibly three colors
- Readability of positive text in one, two or even three colors
- Readability of negative text in one, two, possibly three colors

Figure 12 shows a possible way to test this.

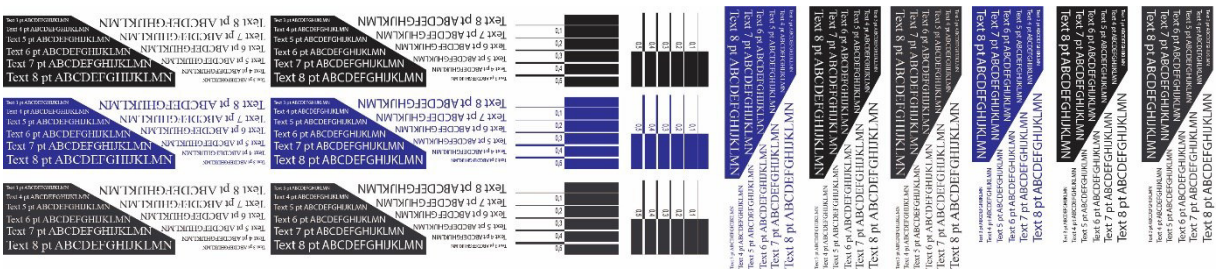

Figure 12: Graphic element for texts and lines

3.2 Testing possibilities of the process control parameters

As we mentioned before, mechanical control parameters include impression and slur, register accuracy, and dot gain (TVI). Examining the technical parameters characterizes the printing process, if everything is working as it should. It is advisable to place the test elements of the mechanical control parameters in several places within the test form, as the machine may not print evenly at all points.

The impression and slur test elements characterize the adequacy of the press force applied between the printing plate and the substrate and the anilox roller and the printing plate, as well as the transferred ink amount and it´s drying. Slur effects blurred prints and usually occurs when the printing plate is moving or rotating at a different speed than the substrate or the anilox. These parameters are usually tested with two types of test elements - a hexagonal thin line element and a star / flower element. The hexagonal test element is logically composed of hexagonal, thin, concentric shapes. If there is an “hourglass effect” on the hexagon, it means too much impression was applied between the printing plate and the substrate. If, on the other hand, a “bow tie effect” is seen on the test element, there is too much impression between the anilox roller and the printing plate. This item can also indicate ink balance and ink drying problems. The star / flower test element consists of triangular shapes starting from the mddle and thickening outwards. The element is mainly intended to characterize the pressure between the ink transfer roller and the printing plate. If the printing plate gets too much pressure, the center of the “flower / star” element will be filled up with ink. If, on the other hand, the impression is too low, the middle of the flower will remain empty. The test elements for impression and slur are shown on the figure 13.

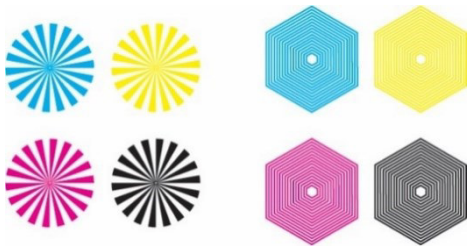

Figure 13: Graphic elements for impression and slur

To produce a high quality print is not possible without register accuracy, which is essential in all printing processes. By register accuracy we mean the exact matching of each printing color. There are several elements to assess registry accuracy, perhaps only limited by creativity. Classically used elements include the target cross used in Figure 14.

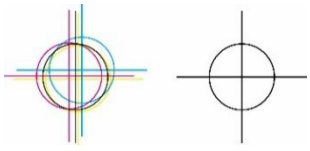

Figure 14: Graphic element fo register accuracy

The tone value incerase is a characteristic feature of flexographic printing. We use the terms “dot gain” and “TVI” (Tone Value Increase) in this topic. An accurate compensation curve can be generated from the values given by the fingerprint, it is essential for the accurate reproduction of the values set in the computer files. In fact, we can use raster scales with the same design as for process organization parameters, e.g. in figures 8 and 9.

Other elements on the fingerprint

In addition to the essential elements of a fingerprint belongs the testchart. They are designed to control the color management of the printing process. We are not dealing with this in more detail, as the development of test charts and their automatized evaluation, is handled by international software companies (such as GMG) who offer complex solutions for the whole color management process. However, it is also possible to compile a test chart manually and evaluate it manually, but this is an extremely time-consuming process. In an industrial environment, it is more appropriate to purchase a complete system that provides both - software and hardware, and the measurements can be partially or fully automated.

It’s important to mention that even the most professional printers will appreciate having something “eye-catching” on a test print. During the evaluation, it is very important to include elements in the fingerprint that are measurable, but in our experience, photographic parts are also needed. Photographic elements can serve different purposes: they can be included with the aim of showing the benefits of the technology - for example, if we want to convince the printing house about the advantages of a platemaking technology - it is not the test image that will enchant the printer. Or on the other side we can select pictures to show the limits of the technology.

Figure 15: Possible picture elements for a fingerprint (Source: Shutterstock)

CONCLUSION

The aim of our project is to develop a general test chart, which will be able to assess the conditions of a flexographic printing machine, the compatibility of the anilox rollers with the printing form, and the information necessary for the prepress. The research consists of the following phases.

1. Defining the specific properties of flexographic printing - specifying the phenomena to be assessed
2. Creation of the graphic elements of the printing form, digital execution of the printing form
3. Evaluation of the fingerprint design by professionals with the help of a questionnaire
4. Print tests
5. Evaluation protocol development to help interpret and document the results obtained.

Our research is currently in its second phase. Our plan is to further expand the range of applicable graphic elements and to continue the research between practical implementations. After the completion of the second phase, we plan to contact professional printers with a questionnaire. If the available resources will allow, we plan to print at least one fingerprint. As a final step, we plan to develop an evaluation protocol so that the results obtained can be interpreted and archived by all participants of the printing process.

Flexographic printing is a key technology in packaging production, our research is meant to help to meet the ever-increasing demands placed on packaging materials. Our goal is to facilitate, optimize and standardize the testing process. The results of the first phase of our research were presented at the TAGA 71st conference in Minneapolis, which was also published in the conference publication (Horváth, Palova, 2019).

ACKNOWLEDGEMENTS

The publication and research are supported by the Ministry for Innovation and Technology, by the National Resarch, Development and Innovation Office and the ÚNKP Programme.

INNOVÁCIÓS ÉS TECHNOLÓGIAI MINISZTÉRIUM

NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE HUNGARY

Új Nemzeti Kiválóság Program

REFERENCES

[1] Flexographic Technical Association, Inc., 2017. FIRST - Flexographic Image Reproduction Specifications & Tolerances. 6th ed. United States of America: Kindle Edition.
[2] Oetjen, S., 2017. An Introduction to the Importance of Press Optimization. [online] Packaging Impressions. Available at: <https://www.packagingimpressions.com/post/an-introduction-to-the-importance-of-press-optimization/> [Accessed 9 April 2021].
[3] Deamon, A., 2021. Best practices for press fingerprinting. [online] Carey Color Incorporated. Available at: <https://careyweb.com/press-fingerprinting-in-fta-oct-2013/> [Accessed 14 April 2021].
[4] Földvári, M., 2018. Színes nyomtatás. [online] Szinkommunikacio.hu. Available at: <http://www.szinkommunikacio.hu/13_12.htm> [Accessed 30 April 2021].
[5] GMG Color, 2021. GMG Open Color User Manual. [online] Sdla.webservice.gmgcolor.com. Available at: <https://sdla.webservice.gmgcolor.com/Knowledge%20Base/GMGOpenColor/GMG-OpenColor_Manual_en.pdf> [Accessed 1 May 2021].
[6] Horváth, Csaba ; Klaudia, Palova : Relationships Between the Surface Texture of Flexographic Printing Plates and Printability of Kraft Paper
[7] In: Proceedings of the 71th TAGA (Technical Association of the Graphic Arts) Annual International Technical Conference, March 17-20, 2019, Minneapolis, MN, United States (2019) pp. 176-188. , 13 p.

Corresponding author:

Klaudia MAŇÚROVÁ
Gy. Klapku 5, 94701 Hurbanovo, Slovak Republic
vach.klaudia@gmail.com
Jozsef Cziraki Doctoral School of Wood Sciences and Technologies
Simonyi Karoly Faculty of Engineering, Wood Sciences and Applied Arts University of Sopron
Bajcsy-Zsilinszky str. 4, 9400 Sopron