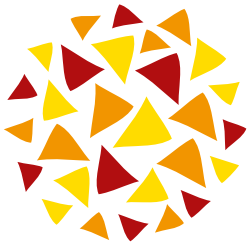
Proceedings

of the 43rd conference of the International Circle of Educational Institutes for Graphic Arts Technology and Management



IC 2011
NORRKÖPING
19 - 23 September

Dear reader,

In a few days, on 19 September 2011, the 43rd Annual Conference of the International Circle will be opened at Norrköping, Sweden. A very warm welcome to all of you who have taken the time to join this event. I am convinced that it will be an excellent convention as were the conferences before. I have seen how much work our Swedish colleagues have invested and how carefully they considered every detail to prepare for a great event.

What you now hold in your hands (or can see on the screen of your computer) are the abstracts of the contributions which have been accepted for presentation at the conference. These papers reflect the whole scope of the International Circle: a thoroughly international attitude, scientific excellence, and excellence in teaching as well. It may seem to be a bit old-fashioned in these days when education is also big business, but Wilhelm von Humboldt's idea of the unity of education and research in an international environment still prevails. And the International Circle stands for this.

Presenting a paper at conference, however, is only part of the process; generally speaking, there is only a slight difference between listening to a speaker and reading an article in a learned journal. The extra benefit of a conference like the IC Annual is the immediate discussion of the presentation. This not only helps to clarify what may have been self-evident to the writer, but not to the reader; it also provides the opportunity to add comments, to contribute own experiences, to point out weaknesses (if there are any) and to further develop the ideas which were presented, in short: to contribute to the advancement of knowledge and to come a bit closer to our common goal, the perfect education for our business.

These discussions may well continue during lunch or over a beer or two in the evening. At the last conference in Moscow, Russia, I awarded – with a smile – the prize for the most-disputed paper to our Swedish colleague, and chairman of this year's conference, Tommie Nyström. This was meant to be a great compliment; his paper perfectly served the purpose meetings take place for.

It must be admitted, however, that conference presentations are important, but that the breaks in between are as well. Talking to each other, starting collaborations, making new friends – all this is an unofficial, but not less important reason to visit our conferences.

I'm looking forward to another fruitful and enjoyable conference of the International Circle.

Wolfgang Faigle

President

Technical papers program: Schedule and contents

Tuesday September 20, 2011

Session 1. 09:30-10:50
Session chair: *Daniel Nyström*

Keynote:
The Future of the graphical industry from a paper supplier's point of view
Tommy Wiksand 1

Comparative Analysis of Papers Quality in Commercial Web Offset
Rossitza Sardjeva 3

Session 2. 11:20-12:30
Session chair: *Daniel Nyström*

Keynote:
Physical evaluation of the quality of color halftone
Li Yang 11

Evaluation of distinctness of image of enhanced printed samples
Igor Karlović, Ivana Tomić, Dragoljub Novaković and Ivana Rilovski 13

Session 3. 13:30-15:10
Session chair: *Tomas Törnqvist*

Bridging education and industry. Looking for new paradigms in Europe.
Luk Bouters 21

Infographics, a Visual Learning Methodology for Students with Autism: The Academic Landscape Revisited
Aydin Kintziger 23

Relationship of the old and new knowledge in printing technology education of today: the examples of retrospective analysis
Yuri V. Kuznetsov 27

International Activity and Graphical Students Education in Ukraine
Bohdan Durniak and Yaroslav Uhryn 31

Session 4. 15:40-17:20
Session chair: *Rajendrakumar Anayath*

Media consumption in a converging world and possible effects to publishing companies
Christof Seeger 33

Students for green printing:
Environmental BSc theses for the Finnish printing industry
Pentti Viluksela 43

Practical approach to manage the environmental issue
Csaba Horváth and István Patkó 51

A study on the Influence of calcium carbonate as a filler in bagasse based uncoated paper during perfecting in an offset printing machine and its impact in reducing carbon foot print
Rajendrakumar Anayath and Amrutharaj Harikrishnan 55

Wednesday September 21, 2011

Session 5. 09:00-10:20
Session chair: *Björn Kruse*

Keynote:
Printed Electronics – Introduction and Current Research
Isak Engquist 61

Screen printing into cavities of a thick insulating layer as a part of a fully printed thermoelectric generator
Andreas Willfahrt, Jochen Witte and Gunter Hübner 63

Session 6. 10:50-12:30
Session chair: *Björn Kruse*

Capabilities and the challenges of the use of special scanning technology for practical training and research - an abridged report
Michael Reiche and Thomas Schulze 73

Polynomial Color Reproduction Device Model Term Significance
Davor Donevski, Diana Milcic and Dubravko Banic 87

Typographic and colorimetric properties of non-impact prints on transfer foil
Blaž Rat, Igor Majnarić and Klementina Možina 83

Lines of Activities in the Field of Further Training
Alexander Tsyganenko 91

Session 7. 13:30-15:10
Session chair: *Yuri Kuznetsov*

Development of knowledge and press-test based Heatset training simulator
Peter Herman, Laurent Grimaldi and Gerd Carl 93

A Networked Workflow for a Fully Automated CtP Calibration System
Shahram Hauck and Sasan Gooran 95

Stability evaluation of printing
Anna Berdovshchikova 105

Characterization of the silver halide printing plate's surface properties
Tomislav Cigula, Sanja Mahovic Poljacek and Tamara Tomasegovic 111

Session 8. 15:40-17:50
Session chair: *Wolfgang Faigle*

Possibilities of the lasers use for plastic package production
Tetiana Kyrychok, Kateryna Diptan 119

The Advertising and Brands Protection by the New Printing Methods
Alexander Kondratov, Evgenia Anokhina and Konstantin Antipov 129

The Static Electricity Protection Method for Packing Materials
Evgenia Anokhina 135

Evaluation of Voids on a Shrink PVC Film by Varying Gravure Process Variables
Akshay V. Joshi 141

Keynote:

The Future of the graphical industry from a paper supplier's point of view

Tommy Wiksand

Holmen Paper AB
Sweden
tommy.wiksand@holmenpaper.com

Abstract

The subjects will be:

Market reality 2011, the future for publishing and how Holmen Paper is repositioning for this future.

Author biography

Tommy Wiksand, Sales & Development Director, Holmen Paper Marketing, has many years experience of marketing, sales and product development for an international business within the graphical paper industry.

Comparative Analysis of Papers Quality in Commercial Web Offset

Rossitza Sardjeva

sardjeva@mail.bg

Keywords: paper, LWC, MWC, SC, HSWO, quality, commercial web offset printing

Abstract

Paper affects productivity, quality and profitability, since paper makes up to 50-70% of printing costs.[1] Towards advertisings, inserts in newspapers, magazines, supplements, catalogues, leaflets, paper is the most important factor, which allows of these printing products to have a real chance at the global media market, improving first of all printing quality.

Commercial web offset printing technology is proactive to improve continuously printing quality using high quality papers and thus achieving a highest position in the graphic art industry. The success of this printing process is due to already launched different types of mechanical papers like LWC, SC, MWC, MFC and NP as well.

The purpose of this article is to summarize our experience in HSWO technology with different type of papers – LWC (Light Weight Coated), SC (Supercalandered), MWC (Medium Weight Coated), NP (Newsprint). For this has been used HSWO printing machine equipped with gas-dryer (Polyman, GOSS International M-600 A).

Heatset web offset printing process provokes reliable inks curing on the paper mainly due to the evaporation of high boiled mineral oils inside the gas dryer. [2]

We had numerous tests and observations of print performance on variable papers where the print quality was evaluated by densitometry and colorimetric methods, which together are the ideal regulation basis. Different papers have different levels of value of the solid ink density (SID), because of the surface quality and fiber composition as well. Visual effect of density and the adverse properties of ink weight on different papers and the purity of the single color tend to have direct correlation which depends first of all on type of papers.

Introduction

Developments in commercial web offset printing in recent years started with 32-page presses moving through 64 and 80, right to a 96-page printing system. This means more pages on the cylinders and high productivity (LITHOMAN - UWWO, new version of ROTOMAN Hi Print, Direct Drive). Through ongoing product evolution resulting in higher productivity with the same printing quality, commercial web offset printing definitely grew its market share.

An important factor in HSWO printing is low production costs in inserts, magazines and catalogs segments. Permanent cost reductions are enabled these printed products to have their position as an attractive and efficient communication medium for advertisers, publishers and industry in general.

In 2009 the volume in Europe had declined by ~15% and investments in HSWO presses had fallen to 1/3 of the annual values before crisis.[1] Also there were additional structural changes caused by shifting from print to online media. But afterwards, the situation has been changed. A look at the latest report shows the advertising has grown since first quarter of 2010 by around double digit percentages.[1] In 2010 paper consumption in Europe for the HSWO rose by 7% compared with 2009.

The trend of this printing segment shows the following: the central success factors of advertisings are clever regional distribution, creative product design and communication capability. Towards catalogues they are giving way to shorter run but more frequently orders. With magazines and other periodicals the variety trend continues above all with predominantly short runs. The dynamic growth of the corporate publishing products remains unabated. In general, due to tendency towards shorter runs and faster turnaround times, commercial web offset with its competing printing process, achieves due market share. Designed for the highest print quality and speed, proven HSWO technology helps printing companies all over the world to achieve the best quality – function optimized, standardized and cost optimized.

Hot air drying process in HSWO is realized by adapted gas dryer named “suspension” dryer: the web is conveyed at high speed through the dryer without contacting any elements surface. Sufficient curing is achieved if the paper web remains within 0,8-1 second in the drying area. For this if the paper web is conducted at an

average speed of 8 m/s, then the dryer needs to be at least 8 m long (our case). Passing through gas-dryer (~200°C) the solvents are forced to evaporate.

In these specific drying conditions printing inks have to contain a high proportion (20-40%) of high-boiling point mineral oils with long molecular structure. [2] Low boiling point mineral oils cannot be used here, because they can cause drying on the inking rollers.

The temperature of the dryer should be set according to the paper grade – the higher the paper grade the higher the temperature. Due to the eventual dehydration the paper web can become fragile and wavy, starting shrinking and causing difficulties in finishing processes. That is why moisturizing is recommended (rollers water and silicone section). The only restriction here is that the gas-dryer is taken place about 8 m.

Problem definition

Paper, ink system and ink setting are most important factors defined the print quality. In order to compare different types of papers in classical HSWO process have been used LWC, MWC, SC, NP papers and the methodology of optimal inking through measurement of SID combined with colorimetric control of color values according to ISO 12647-2. [3] In our case was used 16-page web offset printing press, horizontal configuration of 4 printing units, blanket-to-blanket system, equipped by gas-dryer (long 8 m) and multifunctional folder.

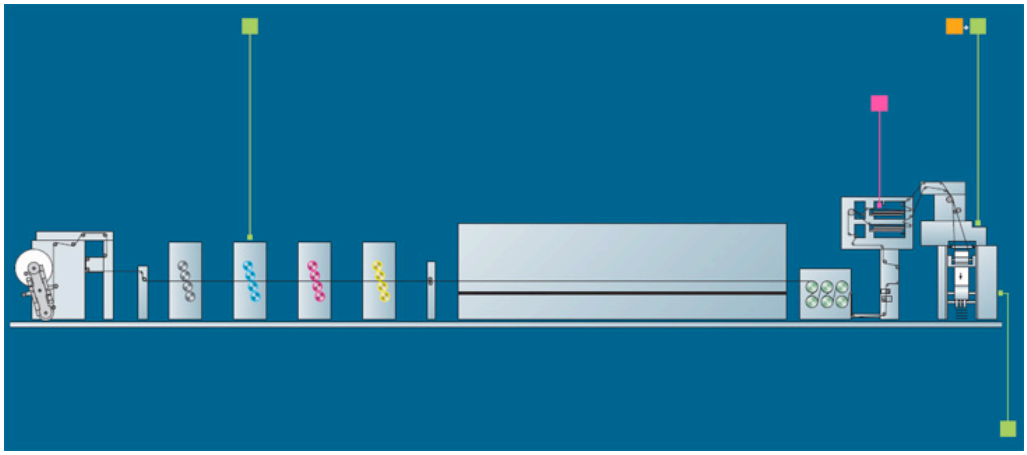


Figure1. Configuration of used web offset heatset printing machine

Has been used a modified test form consisted necessary control strips. The tests were carried out under normal operating conditions (t° ~ 24°C, RH ~ 50%) according to the following:

- Euro scale web inks Webking for HSWO, sequence for printing: black-cyan-magenta-yellow; CMYK – AM screening, 60 line/cm, UCR;

- alcohol damping solution: pH-4,8/5,2; t°- 10/12°C, 4-6% of IPA, complex Hydroweb additive for damping with 4% concentration ;

- offset blankets type Vulcan Alto ND-2, 1,96 mm thickness, and 0,14 mm underlines;

- temperature interval in the dryer -185°/115°C;

- optimal printing speed of 36-40 thousands rph (max speed 45 th. rph)

It is known that max printing speed in HSWO technology is up to 12-15 m/s. [4]

In above described conditions have been carried out numerous prints on the LWC, MWC, SC, NP of different brands and grades. Have been printed real printing products like magazines, inserts and weekly paper with average of 40 000 copies run. In this way the quality of papers has been proved by their behaviour in real printing process.

Drying effects of inks in this process is predominantly evaporation. But our former experience showed that inks setting on SC and NP causes drawbacks because they are uncoated papers.[5] So, in this case are used modified inks, consisted a small amount of low viscosity mineral oils to provoke their absorption in such papers.

Have been used following brands of papers: NP – 100% recycled content -45 gsm, LWC – 57 gsm, MWC – 70 gsm, SC – 57 gsm.

In the above mentioned conditions were printed series of samples with gradual smooth change of ink consumption (ink film thickness) – from slightly underinking to overinking in order to define optimal inking through SID of four process colours on control strips, printed on the used papers. Then the different samples with different inks densities (ink thickness) have been measured through spectral coordinates in CIELab system. Among all measurements have been chosen these where solid ink densities are optimal with the smallest possible colors deviations (ΔEab) which provide good visual perception.

For this has been used X-Rite spectrophotometer (SpectroEye) in the following conditions: D50 illuminant, 2° standard observer, measurement geometry 0°/45°, black backing (ISO 12 647 -2).

Ink setting is controlled visually and manually because there is no still reliable method for online control. [6] Our results have corresponded with high print quality without any visual drawbacks of ink setting.

Before these measurements, paper samples have been checked by their physical properties in lab conditions (tables 1,2,3).

All results are shown in five tables and four figures.

Table 1. Physical properties of used SC papers

Properties	SC			
Basis weight, [gsm] UPM SC	51,0	54,0	57,0	60,0
Bulk, ISO 534, [cm3/g]	0,9	0,9	0,9	0,9
Density, [g/m3]	1,11	1,11	1,11	1,11
Brightness D65, ISO 2470-2, [%]	70	72	72	72
CIE Whiteness, [%]	78	80	80	80
Opacity, ISO 2471, [%]	91	91,3	93	93
Gloss, Hunter ISO 8254-1, [%]	43	46	46	46
Roughness PPS-10, ISO 8791-4 [μm]	1,1	1,2	1,1	1,1
Humidity, [%]	5,4	5,6	6,0	6,0

Table 2. Physical properties of used LWC papers

LWC						
Basis weight, [gsm]	51	54	57	60	65	70
Brightness D65, ISO 2470, %]	71	73	75	75	78	80
CIE Whiteness, [%]	88	89	90	90	91	91
Opacity ISO 2471, [%]	89	91	92	93	93,5	94
Gloss Hunter, [%]	51	57	58	60	64	64
Bulk ISO 534, [cm^3/g]	0,9	0,8	0,91	0,9	0,9	0,9
Smoothness PPS-10, ISO 87-4, [μm]	1,4	1,2	1,2	1,2	1,2	1,2
Humidity, [%]	5,5	5,9	6,0	6,0	5,8	6,0

Table 3. Physical properties of used MWC papers

MWC						
Basis weight, [gsm]	65	70	75	80	90	100
Caliper, ISO 534, [μm]	56	58	62	66	75	82
Bulk, ISO 534, [cm^3/g]	0,86	0,83	0,83	0,83	0,83	0,82
Brightness D65, ISO 2470, [%]	88	90	94	95	96	98
CIE Whiteness [%]	94	96	98	100	102	104
Opacity, ISO 2471, [%]	91	92	93	93,5	94	95
Gloss ISO 8254-1, [%]	62	62	63	63	64	66
Smoothness, PPS-10, ISO 8791-4, [μm]	0,9	0,9	0,9	0,9	0,8	0,8

Table 4. Papers colors values

NP Sachsen	SC	LWC	MWC	CIELAB Values
45 gsm	57 gsm	57 gsm	70 gsm	
0,70	-1,76	2,20	0,3	a
3,77	-0,32	-2,77	-1,0	b

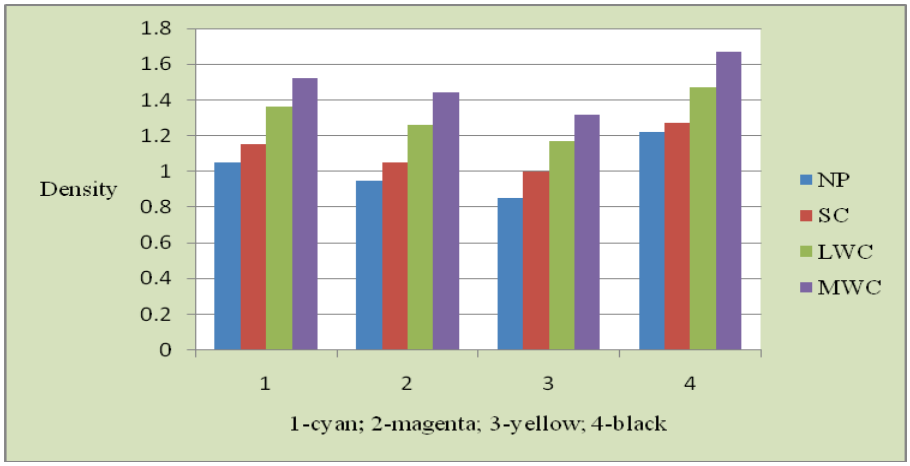


Figure 2. Solid Ink Densities of process inks, measured on different papers

Table 5. Optical densities and CIELAB values of printed samples

Process Inks	Solid D	L*	a*	b*	ΔE*ab
Newsprint , 45 gsm					
C	1,05	60,16	-31,66	-39,43	7,9
M	0,95	46,83	72,97	0,05	2,9
Y	0,85	84,60	-5,15	92,75	4,7
K	1,22	19,15	1,47	5,90	6,14
SC , 57 gsm					
C	1,15	60,08	-41,7	-45,06	4,3
M	1,05	53,74	70,98	1,96	6,5
Y	1,00	90,06	-3,17	91,93	2,4
K	1,27	22,75	1,65	5,06	5,9
LWC, 57 gsm					
C	1,36	49,21	-37,35	-43,40	8,7
M	1,26	50,09	70,92	-8,03	8,3
Y	1,17	86,96	-5,85	90,17	4,6
K	1,47	21,33	0,93	0,40	1,6
MWC , 70 gsm					
C	1,52	59,03	-35,2	-42,97	3,1
M	1,44	52,41	67,46	-5,05	9,5
Y	1,32	84,16	2,69	96,82	5,7
K	1,67	21,98	1,71	0,93	2,78

L*, a*, b* - D 50/2°, 0°/45°, black backing

Discussion

For commercial printing where dominate half-tone four-color process, optical density is the ideal regulation basis which is extremely proper parameter for measuring and regulating the inking accordingly [7]. In our study solid ink densities have been measured on control strips printed alongside the images. The values of measured SID varied depending on the physical properties of papers types as grade, brightness, smoothness, bulk, opacity (tabl.1, 2, 3) and on papers color characteristics shown in table 4 - these colors values are within the allowed limits according to ISO 12 647-2 [3] (except NP), what means that used brands of papers have diffusive reflection of the visual light.

The results show that solid inks densities on LWC and MWC are higher than these on SC and NP (fig. 2). The density values depend on the type of papers and the results have a direct relationship to the quality of papers surface which defines the ink consumption capacity. For instance, to achieve the same value of optical density on NP as on LWC, it is necessary almost twice amount of ink. The common rule is that the ink must be matched to the type of paper – paper physical characteristics define the optimal amount of ink.

All tests were carried out within the normal ink thickness range (~1 μm) and print quality was evaluated to ensure optimal densities. Since the optimal result is achieved, then is easy to keep it during the run and to match OK sheet. The advantage of this working method is stable printing process.

Controlling SID we are able to regulate CMY ink tonal values in order to achieve a proper gray balance. The great influence on the grey balance cause such important process factors like ink thickness, dot gain, trapping and color intensity, which are at a special attention. The tonal densities values measured on the tone prints (40%, 80%) of the fourth process colors CMYK represent good results with very acceptable dot gains, for example in case of used brand of LWC and MWC which can be explained by the coated paper surface. Dot gain essentially depends on the difference of paper surface treatment and its absorption capacity. Uncoated SC and NP present higher tonal values and dot gains due to their open surface, without of coating, which partially provides ink's penetration. So can be concluded, in the case of HSWO paper absorption is also of some importance, but it is not valid for all types of papers. Towards LWC and MWC papers the absorption is not important because these papers are coated and the whole amount of ink is forced to rest on the surface. This is one of the reasons for higher values of solid ink densities (even with the lower ink consumption) compared to the other types of papers which are without of coating. On the other hand uncoated low grades SC and NP papers are very cautious for ink consumption and this can cause different drawbacks (smearing, marking, etc.)

In addition, the definite role for higher SID is the higher brightness of coated LWC and MWC papers compared to SC an NP (tables 1, 2, 3). Therefore the most suitable for high quality commercial HSWO products are LWC and MWC – in our case these are: LWC 57 gsm and MWC 70 gsm.

The optical densities of SC and NP papers are almost identical which related to lack of coating and similarity of fibers composition. SC papers despite of their high surface quality like density, gloss, smoothness, have solid densities closed to NP which confirmed that coating and brightness are definitely more essential for density values (fig. 2, table 5). Toward NP can be said that this type of paper has to use rarely, only when are necessary to produce low cost high volume products where high print quality is not obligatory. In these two types of papers ink's setting is accomplished mainly by evaporation and partly by absorption, which is the reason to apply modified inks.

But on the other hand we know densities only are not responsible to represent visual color perception on prints. Ink density is not a suitable parameter for judging deviations in colors. The visual impression is function on the kind of papers and other process influencing factors. Depending on the nature of the used substrate (grade, thickness, opacity, brightness, absorption, color) the same inks with the same density can cause a different visual impression. And vice versa, the densities can be varied despite the colors are kept within the standard tolerances. The reason for this is primarily papers, also printing inks and other specific terms as well

Visual fluctuations during the run have been perceived so the colors are measured by their colorimetric parameters in order to evaluate what the human eye sees. The results shown in table 5 indicate the possible minimal color deviations within the received optimal solid densities. The color impression on the substrate related to the achieved ink density depends on the variety of papers. Sometimes it makes necessary to change achieved densities to match OK sheet. This is the case when ink/water balance or some other influenced factors have been changed.

Colors were measured by colors values in CIELab system with corresponding color differences as the deviations (ΔE^*ab) which correspond to the eye perception. In principle we have to choose permissible color variation in the tolerance range as the value ΔE. According to ISO 12647-2 the smaller the value ΔE, the smaller the distance between colors and nominal tolerances.[3]

Our colorimetric measurements and their comparison to reference values indicate different color location. Color measurement results shown in table 5 can be recognized colors out of tolerances - magenta almost for all type of papers except NP and cyan for NP and LWC. The same can be said for SC and NP papers but only toward black ink. The rest color values and corresponding color deviations are acceptable (<5) including yellow color deviation for all type of papers. All these results confirmed that it is essential to apply densitometric and colorimetric methods to achieve better results and also to apply compensation curves in prepress process for different grades of papers.

To sum up it can be noted that there is no ideal color system to evaluate color space, but the advantages of CIELAB system are well known at present.[6] In the same time we have ISO standards, GRACOL and SWOP specifications and may be others recommendations and rules, but there are not general applied norms.[8] So it will be good always to keep in mind that printing is a manufacturing process and multiple possible appearances are when staying within the rules.

In addition in this research has been found different color gamut depending on the used type of papers, but this is the subject of another part of article.

Also color register (circumferential and lateral) of the images was to at special attention during the run, with printed register marks positioned along the images which made controlling easier.

Towards physical behavior in the real printing process, different papers are described by their average breaking events – breaks as a function of type of paper (fig. 3). Web break frequency varies between different types of papers and we have found it is in the relative large limits – 3 to 8 % for all type of used papers. This web breaks range means that these breaks are occurred per 100 rolls. In our commercial webs typical web break range valid for LWC and MWC papers is 4-6%. As for SC can be said that in some cases this paper had better performance with 4-5 % of breaks which is due to its special surface quality (supercalandered).

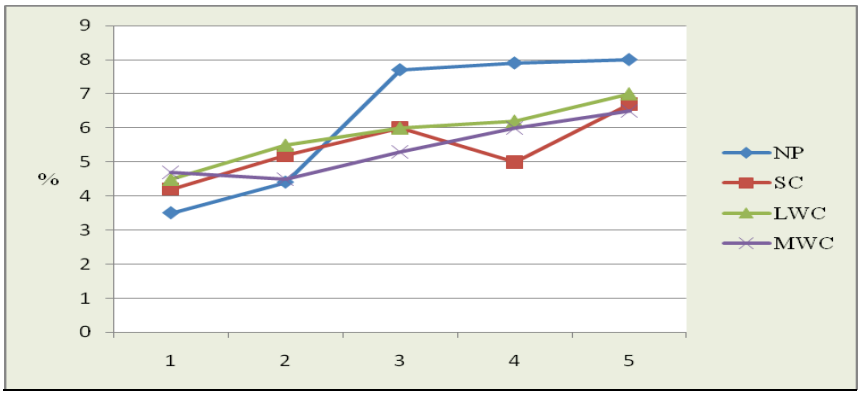


Figure3. Web breaks of different type of papers

More unstable performance shows NP where some times this range was better and sometimes was larger. Evidently all this makes necessary the target remains to achieve at least around 2% reduction to improve papers runability.

Web breaks usually occur when the tension is not proper and when there are local area weaknesses in the web or uneven web unwinding, web wander, web touching in the dryer or adhesion to the blanket. It is essential to have details of web breaks in order to check splice preparation and solve the problem with suppliers.

Conclusion

In commercial web offset printing there are many possibilities to apply different type of papers which can be used for different products. Flexibility of used papers has direct relation to the perceived product quality. Depending on our results could be made a quality range of used brands of paper types as a function of their printing quality (fig. 4).

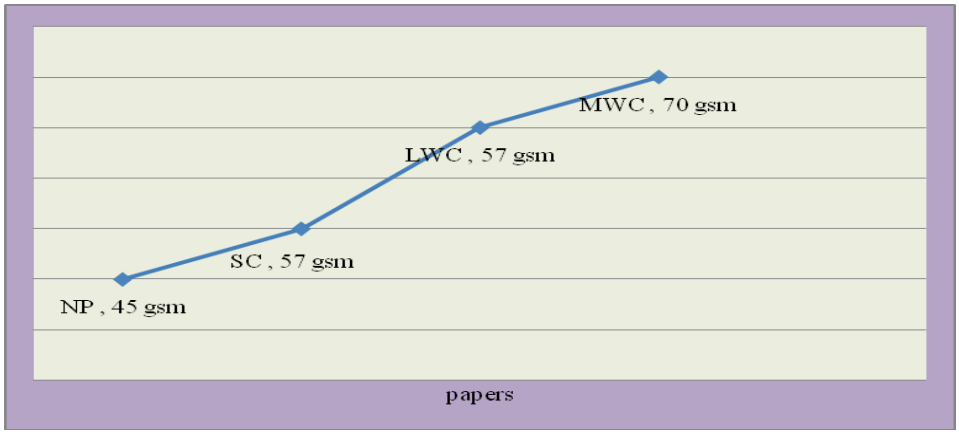


Figure4. Papers range according to the results of this research

Coated papers as LWC and MWC are most important papers resource for commercial web offset printing. These mechanical special coated papers with their superior physical properties are the reliable option for demanding printing job that combines the best quality and economy not experienced in other technologies. But when must be reached low cost paper products it is essential to apply uncoated mechanical type of papers like SC which offers sufficient brightness and opacity, high density and good process performance and altogether meets a good

print quality. Also when necessary to produce high volume and low economical products, can be printed on NP as well – better on NP made from 100% recycled content.

HSWO technology probably is the only in among of graphic arts industry where there is an endless combination of papers types and products quality. The higher the number of papers types the higher the quality product possibilities and therefore the higher the printing efficiency.

References

[1] www.worldofprint.com, High Volume: one recipe for success in commercial printing, manroland report, August 03, 2011

[2] Eldred Nelson R., What the Printer Should Know about Ink, 218-223, GATF Press, Pittsburgh, 2004

[3] ISO 12647-2:2004, Graphic Technology – Process control for the production of half-tone color separation,proof and production prints – Part 2: Offset lithographic processes

[4] VAPoN™ Resource Book, Webline Special Report, 3, 12-13, 2008

[5] Sardjeva R., Papers analysis for HSWO technology, Journal of the Technical University Sofia, br. Plovdiv, Fundamental Sciences and Applications, Vol. 16, 231-236, 2011, International Conference Engineering, Technologies and Systems TECHSYS, May, 2011

[6] Kipphan, Helmut, Handbook of Print Media, 1.4 Print Quality, 75, 100-105, Springer, 2001, Germany

[7] Colorimetry supplements, densitometric measuring and regulation, expressis technics, 18, 1-7, 2004, manroland corporate communications

[8] Gray-7, Improving Quality, Efficiency and Cost-Effectiveness, Technical Conference, Technology Forums and Labs, May 17-18, 2011, Rosemont, IL

Author biography

Dr. Rossitza Sardjeva is working for Technical University Sofia, br. Plovdiv as an associated professor of Print Media Specialty, where she teaches students for bachelor and master educational degrees. She has developed basis plans and programs for Graphic Arts technical specialty in TU, Bulgaria. Her scientific interests are in the field of printing technologies and printing materials as well, where she has a long experience. Also she is a lecturer for many years in Book Publishing Department of Journalism Faculty in Sofia State Kl. Ohridski University.

Keynote:

Physical evaluation of the quality of color halftone

Li Yang

Innventia, Drottning Kristinas väg 61, Stockholm
Sweden
li.yang@innventia.com

Abstract

This talk presents the fundamental aspects concerning quantitative quality evaluations of color halftone. It begins with the basic principles of ink-transfer and ink-setting of conventional and digital printing technologies and their potential influences on the print quality. Then it moves to studying the ink-setting processes. The effects of ink spreading and ink-penetration on color reproduction are specially addressed. Finally, methods for estimating physical dot gain, resulting from ink-transfer and ink–setting processes are presented.

Author biography

Dr Yang is a senior project manager of printability at Innventia, a research institute serving for papermaking and graphic industries. He also serves as the technical manager of the ISO authorized optical calibration laboratory. His expertise crosses ink-paper interaction, paper physics and paper optics. Prior to joining Innventia, he worked as project manager at Holmen Paper Development Center and even earlier associate professor at Department of Chemical Engineering at Karlstad University, Sweden.

He received a PhD degree in Physics at the Physics Institute, Academy of China, 1990. In 2003, he received his second doctoral degree: Doctor of Engineering at Linköping University, Sweden. He has been an active researcher in several research areas with over 50 peer reviewed publications in scientific journals and many conference reports. He has been particularly active in studying the effects of light-paper interaction on printing color reproduction, ink-paper interaction on printability and print quality with both conventional (offset, gravure and flexography) and digital printing technologies. He has been the instructor to tutorials on these topics and invited speakers at international conferences.

Evaluation of distinctness of image of enhanced printed samples

Igor Karlović, Ivana Tomić, Dragoljub Novaković, Ivana Rilovski

Faculty of Technical Sciences, Department for Graphic Engineering and Design – Novi Sad, Serbia
karlovic@uns.ac.rs, tomic@uns.ac.rs, novakd@uns.ac.rs, rilovska@gmail.com

Keywords: distinctness of image, print enhancement, modulation transfer function, subjective quality factor

Abstract

Image quality is often quantified through parameters like colour reproduction fidelity, image noisiness, sharpness, contrast etc. The evaluation of enhanced samples is more complicated due to the geometrical attributes of gloss which is highly influenced by measuring and viewing angle. The gloss values are often used to quantify the print surface and the spatial characteristics of the samples, since surface roughness and smoothness determines the type and amount of the reflection. Gloss is usually determined through the measurement of the specular part of the light reflection. Besides measuring specular reflection, spread of the light reflected at the specular angle is also very important since it indicates how sharp the image reflected by an object surface is likely to be. Quantification of this scattering is called distinctness of image (DOI) and is very important in indentifying effect of gloss, haze, polishing marks and orange peel on a coating. DOI is often regarded as better indicator of surface quality then the classic gloss values and can be evaluated with a combined gloss/haze/DOI meters. Recently, new digital techniques using image sensors are introduced into the market. In this paper we evaluated the DOI on print enhanced samples through the use of modulation transfer function, subjective quality factor and other calculated values. Method incorporated into new instruments for DOI measurement is used, where sharp edge is projected on samples and recorded with CCD or CMOS sensor. For image detection we use CMOS sensor USB microscope and analyze recorded image with appropriate software packages. In order to evaluate how well this measurement method correlates with perceived DOI, visual assessment has been performed where 10 observers evaluated images projected onto print enhanced samples. The results indicate usability of measurement method for predicting DOI of enhanced print samples and hence samples quality.

Introduction

When evaluating printed samples there are two groups of attributes which can be taken into account – chromatic and geometric. In order to define perception of printed material properly, both class of attributes have to be defined. Perception of geometric attributes does not have the tridimensional limitation as colour perception [1], hence geometric scales are not easy to formulate. Formulation involves measuring distribution of light from a sample under different angular conditions and optimizing the measurement to correlate better with visual rankings. The most important geometric attribute, which to some extent influence even colour perception, is gloss. This term is mostly used to describe specular gloss, being one of the types of gloss defined by Hunter [1]. Specular gloss describes amount of light reflected in the specular direction and is good indicator of surface roughness. However, if it is to be defined how well surface reflect image being projected on it, specular gloss failed to predict or correlate with visual rankings [2].

Another type of gloss, distinctness of image (abbreviation: DOI) defines the deviation of the spread of light reflected at the specular angle. DOI is sensitive to even subtle scattering effects; the more light is being scattered out of the regular direction, the more the initially well defined image is being blurred. Two surfaces may have the same gloss values but differentiate in ability to distort image being reflected. Hence, DOI values would give a better insight in product surface quality then gloss values [3].

The aim of this study was to test whether the method for measuring DOI, based on analyzing image reflected from the surface, can be used to predict distinctness of image for offset printed samples enhanced with different types and amounts of coating. Since the coating change surface structure of the paper, it is logical to assume that DOI will be improved if the paper is enhanced with glossy, and decreased if it is coated with matte coatings. The degree of DOI decreasing or increasing is inspected both objectively and subjectively in order to define whether the suggested metrics can describe human perception properly.

Theoretical background

ASTM D5767-95(1999) describes test methods for instrumental measurement of DOI of coating surfaces. At first method gloss reflectance factor measurements are made on the specimen at the specular viewing angle and at an angle slightly off the specular viewing angle. Figure 1. shows how DOI is measured when evaluating

metallic surfaces following this method and according to ASTM E 430-11. Here DOI value is obtained as follows:

$$Rs=Rs_{sam}/Rs_{std} \quad (1)$$

$$DOI= 100\ (Rs-R_{0.3}) / Rs \quad (2)$$

Where: Rs is amount of light reflected at the specular angle,
Rs_{sam} – amount of specular light reflected from a sample,
Rs_{std} is the Rs value for black glass when measuring non-metals and a mirror when measuring metals,
and $R_{0.3}$ is the light reflected 0.3 "off" the specular angle.

The DOI value of a surface is number between zero and one hundred; a surface that exhibits a perfect undistorted image returns a value of 100, as the values decrease and as the image becomes less discernable.

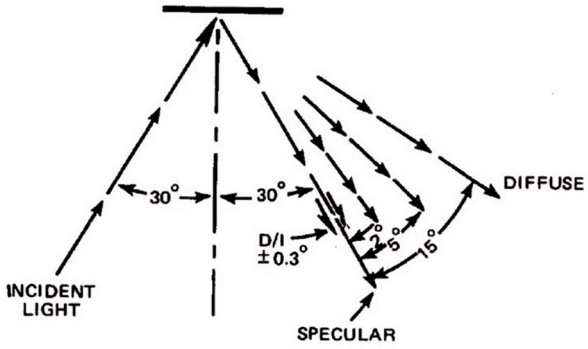


Figure 1. Position of light source and receptor when measuring appearance of metals

Second method for DOI measurement implies projecting the light through a small slit on the specimen surface and measuring its reflected image intensity through a sliding combed shutter in order to provide a value of image clarity. At third method the light through a pattern is projected on the specimen surface and its reflected image intensity is measured directly to provide a value of image clarity. This method has been incorporated in measuring device called DIAS developed by Tse et al. at 2005. [4] and in its improved version presented at 2009. [2].

Basic principle behind this measurement technique involves projecting a sharp edge onto a surface, as shown on Figure 2, and capturing the reflected image using a solid state area or line sensor, e.g. CCD or CMOS [4]. From the digitized image a reflectance profile (or the Edge Spread Function, ESF) is obtained. The corresponding line spread function (LSF) is obtained by taking the first derivative of the ESF (and using appropriate smoothing) [5], and as a DOI metrics the peak and 50% width (blurriness) are defined. Due to the poor reproducibility and repeatability for lower DOI materials, these metrics are improved by moving from spatial to frequency domain.

A Fourier transform is applied to the LSF in order to obtain Modulation Transfer Function (MTF) – a function that describes a relative contrast at a given spatial frequency (output contrast/input contrast). For the best indicator of image sharpness spatial frequencies where the MTF is 50% of its low frequency value (MTF50) or its peak value (MTF50P) are often used [6]. Frequencies can be measured in cycles or line pairs per distance (typically millimetres, but may also be inches, pixels or image height).

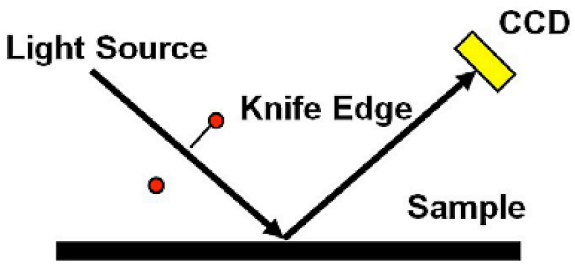


Figure 2. Principle behind measuring reflected image in DIAS design

Tse et al. noticed that the highest amount of noise in DOI measurement occurs at the frequencies which are higher than human perceptual capabilities, so in order to filter out the noise they computed metrics in the limited frequency range that is relevant to human perception [2]. Here, human sensitivity is described by visual contrast sensitivity function (CSF). Area under the convolution of the CSF and MTF curves, when the spatial frequency is plotted on a logarithmic scale, is defined as DOI metrics. This value is also known as subjective quality factor (SQF) and is widely used to describe perceived sharpness. Higher the SQF value, higher the perceived sharpness. Tse et al. [5] reported high correlation of obtained MTF and SQF values with subjective rankings, where evaluation were performed over 10 ink-jet (unprinted) photo papers.

When evaluating DOI for printed and unprinted samples, it was reported that ink-jet printing diminishes DOI except for the very low DOI papers [4]. Testing was conducted for ink-jet printer using pigment inks and very micro-porous papers. In the same paper [4] it was stated that the extent of the decrease is lower for the CMY inks than the black ink, and also that DOI decreases at higher tonal values.

Methods and materials

Samples used in this study were printed with conventional and hybrid inks and coated with UV, aqueous glossy and matte coatings. UV coating are chosen since it provides high amount of specular gloss, and are used together with hybrid inks. Test image is printed on KBA Rapida 105 four colour offset printing machine which was equipped with an additional coating tower with closed chamber doctor blade system. As a substrate we use glossy 130g/m^2 paper, defined as Type 1 in ISO 12647-2:2004. Inks used for printing were from Sun Chemical – conventional from World Series (complying with the ISO 2846-1:2006) and hybrid from HyBrite series. Printing was performed using the inking values defined in Lab colour space within ISO 12647-2:2004.

After printing, the conventional ink prints were coated with aqueous glossy Prestofix Hochglanzlack H6055/55 and aqueous matte coating Prestofix Mattlack H260/55 in two quantities regulated with two anilox rollers (60 l/cm and 90 l/cm). The quantities were calculated through the weight measurement of the 10 x 10 cm samples taken on 6 positions on the sheets and were defined in g/m^2 which is standard industry specification for calculating coating transfer and coverage. For the drying process we used the machines IR drying system which was at system settings specified by the press manufacturer. The hybrid ink prints were also coated using the two anilox rollers with and UV glossy coating VP 10532 from VEGRA and was dryed by the UV lamps installed on the machine (with factory settings). After drying we have used random sampling method to acquire the printed sheets from the OK sheets which conform to the inking standard to minimize the influence of ink film thickness.

Test image chosen for this study was a simple 10x20 cm rectangle printed with 100% black. In order to obtain objective metrics we followed principle incorporated into DIAS measuring device. Sharp edge was projected onto the samples with the help of USB lamp, positioned at 30° from perpendicular, and reflected image were detected with CMOS sensor USB microscope, Veho VMS-001, positioned also at 30° (setting the same as the one presented on Figure 2). Angle of 30° was chosen for this purpose since the samples we used mostly had a high specular gloss values (values were obtained with Glossmaster three angle glossmeter), so we decided to use the angle near the 20° following ASTM D5767-95.

Both lamp and the microscope were positioned at 15 cm from the sample. Experiment was performed in dark room and microscope operated without LED lamps, so that detected light was just the one reflected from the surface. Recorded images (1024x768 px, with the resolution of 300 dpi) were imported into Imatest 3.1 software, and analyzed with the help of SFR module. The procedure of obtaining MTF and SQF values inside Imatest is exactly the same as the one explained in [2]. Region of interest was defined as 300x500 pixels and was manually adjusted for each image in order to enclose the detected edge more precise. Figure 3. shows region of interest for images detected from print enhanced with matte, glossy and UV coatings (all with 60 l/cm) respectively.

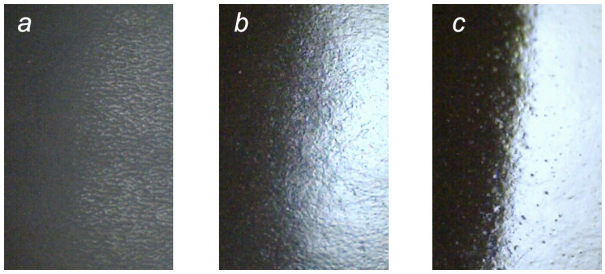


Figure 3. Region of interest for images detected from: (a) matte, (b) glossy, (c) UV coating

Reflectance profile and corresponding line spread function for each print are obtained from this sample. MTF is calculated from LSF by applying the Fourier transform (following ISO 12233). For this calculation detected edge has to be slightly slanted in order to reduce artefacts from imager and to increase effective spatial resolution [5]. An advantage of the slanted edge test is that the camera to target distance isn't critical. It doesn't enter into the equation that converts the image into MTF response [6]. Each image detected from the samples we used were slightly tilted (as can be seen from Figure 3) and since Imatest can calculate MTF from edges of any angle except 90° and 45° we did not need to transform images making the test less accurate. Figure 4. shows reflectance profile (or edge profile), line spread function and modulation transfer function for image detected from sample enhanced with matte coating (region of interest shown on Figure 3a).

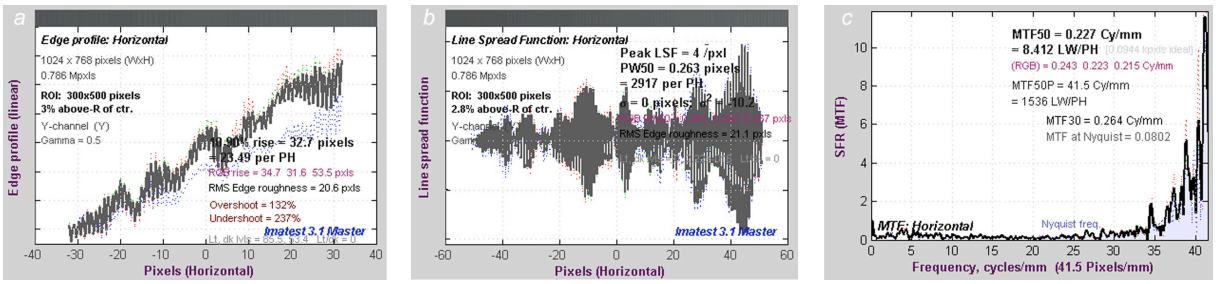


Figure 4. (a) Reflectance profile, (b) LSF and (c) MTF for image detected from matte coated sample

Characteristic points from MTF curve for each sample are recorded – the spatial frequency at response of 50% and 30% (noted as MTF50 and MTF30). It was stated [6] that the spatial frequencies where MTF is 50% of its low frequency value are the best indicators of image sharpness and MTF30 is also shown to correlate well with perceptual rankings [2].

MTF is a measure of device or system sharpness, only indirectly related to the sharpness perceived by an average observer. To get metrics more related with human perception information about viewing distance and the human visual system must be included. The SQF factor takes into account both system sharpness (defined by MTF) and human visual system (defined by contrast sensitivity function - CSF), calculating the degree of perceived sharpness for selected viewing distance. First step of the calculation involves relating spatial frequency in cycles/pixel (which is calculated by the software) to spatial frequency in cycles/degree (which is used for the eye's response). Here, viewing distance is crucial since calculation is performed as follows [6]:

$$f\ (\text{cycles/degree}) = f\ (\text{cycles/pixel})\ (\pi\ n_{PH}\ d\ )\ /\ (180\ PH\ ) \qquad (3)$$

where: f is spatial frequency,
n_{PH} is the number of vertical pixels (along the Picture Height, assuming landscape orientation),
d is the viewing distance,
PH is the picture height in units of distance.

When spatial frequency is transformed in cycles/degree CSF value for every angular frequency is obtained as:

$$CSF(f) = 0.114\ f \exp(0.1254\ f) \qquad (4)$$

Finally, SQF is calculated as follows:

$$SQF = K \int CSF(f)\ MTF(f)\ d(\log f) = K \int (CSF(f)\ MTF\ (f)\ /\ f)\ df \qquad (5)$$

where: K is the normalization constant.

In order to obtain visual rankings and parameters for calculating SQF for each sample, perceptual test was conducted. Ten observers, with normal to corrected vision, evaluated images projected onto print enhanced samples. We followed the procedure described in [4] where laptop computer is used for projecting the test images onto the sample resting on a laptop keyboard. The same angles as the one used when images are gathered for digital analysis are used for projecting and viewing – laptop screen was tilted for 60° allowing the light to fall onto the samples at the 30° from perpendicular. Samples were placed onto keyboard at the position which enables the reflected light to reach observers eyes at 30° (as shown on Figure 5). Observers were instructed to place their head near the top of the tilted screen, so the position of each observer during assessment was approximately the same with the viewing distance of 15 cm. In order to make it easier for the observers to focus at the appropriate position, samples were cut to 3x10 cm and placed onto keyboard with longer side parallel to the longer side of the keyboard.

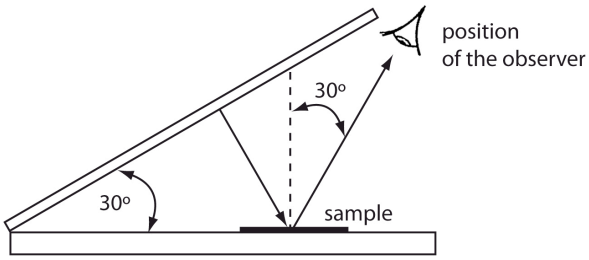


Figure 5. Position of the sample and the observer for perceptual evaluation

Assessing was performed in dark room, where only light was the one from the laptop screen. Images projected on samples were black/white vertical lines with 50% duty cycle and various line spacing ranging from 4-40 px (10 images altogether). Assessor uses the arrow keys on the laptop keyboard to cycle through the available line spacing (only one image with single line spacing is projected at a time). All instructions are given verbally and assessor was directed to note the minimum line spacing for which the reflection contains resolvable lines. If the lines with spacing of 4 px are perceived, sample was defined as high DOI and rated with 10, and if only lines with spacing of 40 px are noted, sample was ranked as low DOI (rated with 1). Other ranks are obtained accordingly. Intermediate values were allowed, but were rarely used. Assessors evaluated two samples of each type of uncoated and coated prints, where the samples were presented to them in random order – different for each assessor. Results of perceptual rankings, together with the obtained MTF and SQF values are given as follows.

Results and discussion

MTF and SQF values for all samples used, together with the subjective rankings are given in Table 1 (for prints where conventional inks are used) and Table 2 (for samples printed with hybrid inks).

Table 1. Objective values and subjective rankings for samples printed with conventional inks

Type and amount of the coating	MTF30 (cycles/mm)	MTF50 (cycles/mm)	SQF	Subjective ranking
None	0.242	0.304	6.57	8.25
Aqueous matte (60 l/cm)	0.227	0.264	9.26	6
Aqueous matte (90 l/cm)	0.282	0.457	8.77	7.3
Aqueous glossy (60 l/cm)	0.294	0.348	11.95	9.6
Aqueous glossy (90 l/cm)	0.205	0.327	9.86	9.25

Table 2. Objective values and subjective rankings for samples printed with hybrid inks

Type and amount of the coating	MTF30 (cycles/mm)	MTF50 (cycles/mm)	SQF	Subjective ranking
None	0.14	0.229	7.74	5.8
UV (60 l/cm)	0.563	0.734	16.22	10
UV (90 l/cm)	0.686	0.882	11.34	10

Subjective rankings presented in Table 1. indicate that matte coating applied to conventional prints decrease DOI, while glossy has an opposite effect. If the amount of a coating is higher for matte samples, DOI is improved. For glossy samples, higher the amount – lower the subjective DOI. This can be explained with the fact that if more glossy coating is applied to the surface, coating layer becomes thicker allowing more incident light to refract in contact with the medium. UV coating applied to hybrid prints improved DOI significantly. There were no differences in perceived DOI if the amount of coating is changed - every observer reported the same values.

Comparing MTF30 and MFT50 values and subjective rankings for samples printed with conventional inks no correlation was found (r=0.163 and 0.135, respectively). For hybrid inks results were quite different – high correlation is obtained both with MTF30 and MTF50 values (r=0.977 and 0.976, respectively). Observing the results from Table 1. it was concluded that MTF values for samples with matte coatings fail to describe visual rankings. If these values are removed from evaluation, high correlation is obtained (r=0.97 for MTF50).

High correlation between MTF values and subjective rankings exists for prints where hybrid inks and UV coating were used (r=0.977 for MTF30 and 0.976 for MTF50). If all samples were taken into account correlation for MTF30 were only 0.693 (Figure 6a) and 0.675 for MTF50 samples (Figure 6b). It was not improved even if results for matte samples were omitted.

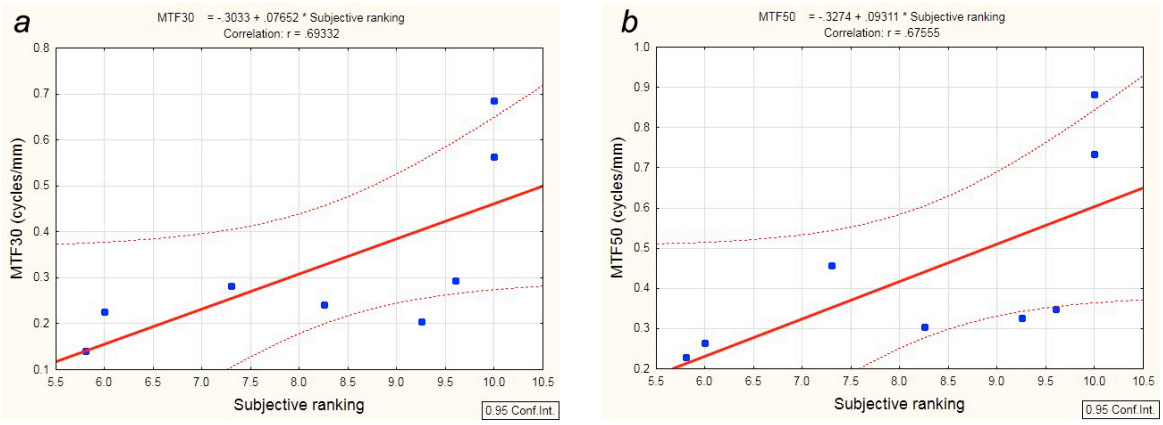


Figure 6. Correlation between (a) MTF30 and (b)MTF50 values and subjective rankings for all samples

When SQF values are evaluated with regard to perceptual ratings, for samples printed with conventional inks correlation was weak (r=0.413). If results for matte samples are omitted, correlation is highly improved (r=0.989). For hybrid inks correlation were moderate (r=0.819). If all samples were taking into account correlation between SQF values and subjective rankings was low (r=0.663, as seen on Figure 7).

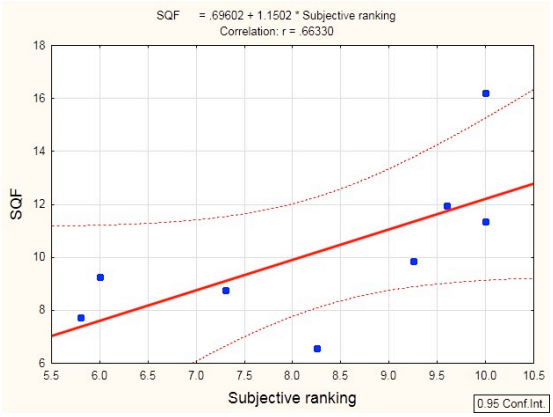


Figure 7. Correlation between SQF values and subjective rankings for all samples

High correlation between DOI metrics and perceptual rankings are obtained if evaluation is performed for samples printed with the same type of inks and only when they are enhanced with glossy coatings. We believe that DOI values for matte samples obtained by measurement would be improved if the measurements were performed at the wider angle that the one we used. ASTM D523 and ISO 2813 standards suggest using angles of 60° and 85° for measuring specular gloss for medium and low glossy samples, respectively. One angle measurement, as the one we tested, certainly cannot be used if samples with different specular gloss values are to be evaluated.

Conclusion

Distinctness of image is very important attribute that describes surface structure of a sample and its ability to reflect projected image. By evaluating DOI incorrect particle size/distribution in printing and enhancing can be

detected as long as many other problems: incorrect coating flow, inappropriate cure time or temperature, application problems etc. Symptoms of poor DOI can be visually perceived as brush marks, orange peel, waviness or other structures visible on the surface.

Since the human eye has a much higher resolving power than any sensor, but also many limitations, defining DOI metrics that will correlate well with perceived DOI is quite a demanding task. In this paper we evaluate metrics obtained from analyzing image reflected from the prints enhanced with both glossy and matte coatings. Amount of coatings are also changed for each sample. Although very simple devices and procedures are used, high degree of correlation was obtained for samples enhanced with glossy coating. Low overall correlation can be explained with the limitation of a sensor used for detecting and using only one measuring angle. Since these metrics are quite dependent from the type of the sensor used, it is reasonable to assume that better sampling would be achieved with more precise sensor and changing the angles of measurement with regard to the type of the sample.

Acknowledgment

This work was supported by the Serbian Ministry of Science and Technological Development, Grant No.:35027 "The development of software model for improvement of knowledge and production in graphic arts industry".

References

[1] Hunter, R., Harold, R. “The measurement of appearance”. Second Edition. New York: John Wiley and Sons. pp. 75-89. (1987)

[2] Tse, M.K., Forrest, D., Hong, E. “An Improved Method for Distinctness of Image (DOI) Measurements”. ISJ Imaging Conference JAPAN, June 10-12, 2009, Tokyo, Japan. (2009)

[3] HunterLab. “Distinctness of Reflected Image (DOI)”. Application note, Vol. 9, No. 10. (2008)

[4] Tse, M.K., Briggs, J.C., Graczyk, T. “Distinctness of Image (DOI) of Inkjet Photo Papers,” IS&T NIP21: International Conference on Digital Printing Technologies, Sept. 18-23, 2005, Baltimore, Maryland. (2005)

[5] Tse, M.K., Forrest, D., Hong, E. “A Second-Generation Portable Instrument for DOI (Distinctness of Image) Measurement,” IS&T: The 25th International Congress on Digital Printing Technologies and Digital Fabrication, Sept. 20-25, 2009, Louisville, Kentucky. (2009)

[6] Koren, N. “Imatest Documentation”. Technical documentation for Imatest 3.1 Master software. (2009)

Author biography

Igor Karlović was born in 1978. in Novi Sad, Serbia. He received his PhD degree at Faculty of Technical Sciences, department for Graphic Engineering and Design in 2010. Currently he is working at the same department as an Associate Professor. His fields of interest are measurement technology, reproduction technique and colour management. Igor is member of Union of Hungarian Printing Industry and Union of Graphic Engineers and Technicians of Serbia.

Bridging education and industry.

Looking for new paradigms in Europe.

Luk Bouters

Artevelde University College Ghent - Belgium
Luk.Bouters@arteveldehs.be

Abstract

Recently the EU authorized, often in close collaboration with Intergraf, a number of studies to diagnose the European printing industry, especially its competitiveness and prospects to respond to its recent structural and technological challenges.

In this presentation the author highlights the main findings of two recent reports commissioned by the European Commission.

The first one, Investing in the Future of Jobs and Skills (2009), was initiated to ensure a better match between the supply of skills and the demand of the labour market for qualified manpower. It provides a methodology to improve the capacity of the EU Member States to assess and anticipate future skills need of employers and employees in the print media industry.

The second report, New Skills for New Jobs: Action Now (2010) presents and expands on a set of recommendations of an expert group to build stronger bridges between the world of education and training and the world of industry. It outlines and recommends a set of actions to ensure that workers acquire the skills required.

Particular attention in the presentation is paid to the major findings and their implications for higher education specialized in media production and management as these reports contain a great number of 'mind squeezers' and pose many challenges to all parties involved in the training of tomorrow's media professionals.

Author biography

Luk Bouters is dean of the Department of Graphical and digital media at the Artevelde University College Ghent – Belgium.

Infographics, a Visual Learning Methodology for Students with Autism
The Academic Landscape Revisited

Aydin Kintziger

Artevelde University College Ghent, Belgium

Keywords: infographics, autism, education

Abstract

Always having had a vested interest in alternative ways of learning and teaching, Aydin Kintziger decided to question the current teaching model and to rethink the way courses and study books aim at conveying study contents to students nowadays. In his work he focuses on students with autism and the way they get to deal with study material in class. He does so by shining the spotlight onto the use of infographics: a way of channeling data and presenting it visually.

While anticipating having triggered a wave of similar initiatives with his work, he hopes to have created a sense of urgency for them at the same time. Because he believes that, given the current climate we find ourselves in, it would be foolish not to explore different ways of teaching.

Autism

What is autism?

Autism is a pervasive developmental disorder characterised by impairment in social interaction, personal flexibility, communication skills and by repetitive patterns in one's behaviour. About 60 out of 10,000 people are considered to fall somewhere along the autism spectrum. This is a number that's probably even higher than we currently anticipate. So far, scientists haven't been able to come up with a conclusive reason as to why.

Autism isn't considered a disorder that affects intelligence. If an autistic person's IQ is greater than 80, he or she is called a high functioning person with autism. However, in some cases he or she may be considered being someone with a delayed - essentially another - development.

The disorder is not to be ranked in just a single category, but incorporates several levels of autism. That's why it's often referred to as autism spectrum disorders (ASD). It's a name for a spectrum of psychological conditions characterised by widespread abnormalities.

Aside from being a developmental disorder, autism is also an information processing disorder at the same time. That's why people who have been diagnosed with autism often have a deviating vision and interpretation of the world around them. They often don't have the ability to give proper meaning to their observations and they sometimes have trouble making (the right) connections between people, objects and events.

What are the consequences of autism?

At home, at work and even at school, autism can easily lead to integration difficulties and sometimes even sensory integration dysfunction (SID). Most people develop the ability to become somewhat independent, when they arrive at a certain age. But parents of children who have been diagnosed with autism, often have to guide their offspring intensively for a longer period of time, and sometimes even permanently.

In general, this can be a very debilitating task for family and friends. They sometimes (have to) opt for professional guidance in designated facilities. There, the people with autism can get individual sessions with a psychologist and/or psychiatrist. The latter not only for guidance but also for medication for the treatment of additional problems. The origin of these secondary problems, like anxiety disorders and specific phobias, are often associated with autism. They're sometimes due to the interplay between the disorder itself and the (miss)perception of the society by people with autism.

Is any medical treatment available?

Autism spectrum disorders aren't curable (yet), but people who have it can be guided through life. As with many other incurable illnesses and disorders, the first step in order to deal with it, is acceptance. The extent to which

people accept their diagnosis, strongly differs from person to person (and thus from student to student). Also, and this gets overlooked more than often, the degree to which the people around them accept the disorder and are open to learn how to deal with it, may differ.

How can we help?

There are a lot of students with autism who attend class on a regular basis. But this isn't always the case. It can be a real struggle for them to organise their notes and courses; they can't sometimes do it on their own. But having trouble getting your things in order is one thing, learning how to ask for help is another. (Even for people without autism!)

Enter the teachers

It's important for our educators to know how to handle certain situations and how to deal with students who have an autism spectrum disorder. Let's list a few items that can be very helpful when dealing with such students.

Teachers have to realise that people with autism don't always respond to a situation according to age. This is because their developmental age isn't always in correspondence with their real age.

During a game like soccer practice, it's very important to clearly state all the rules. People with autism sometimes have trouble grasping certain 'obvious' rules.

Other students can act relentless towards others, who are or act differently. For this reason, people with autism often get picked on, which only feeds their sense of insecurity and uncertainty. That's why teachers should be open about the differences, and the fact that a person with autism might need a helping hand now and again.

When someone with autism starts acting problematic, this can be assigned to fear and stress. As a teacher, be aware of the fact that it's very important to firstly let the student settle, before concentrating on the cause of the problem.

During trips or other days with special activities, make sure that there's sufficient structure. It's advisable to give students with autism an extensive schedule of the entire day.

Although a bunch of teachers are already putting a lot of effort into making the classroom a healthy and rich environment for any type of students, monitoring students and giving them special attention when most needed just isn't enough.

"Personalised learning (...) is recognising that we all have different strengths and weaknesses, different interest and different ways of learning. [It's] finding the best ways to engage with different people with different interests, passions and ways of thinking." ~ Sir Ken Robinson [1]

I believe this statement being true. So in an attempt to find a new way to help students with autism, I investigated the usefulness of infographics. Because multiple studies have indicated that people who have an autism spectrum disorder, often are in fact visual thinkers.

Infographics

What is an infographic?

Infographics are a way to channel information and data visually. It's often referred to as information visualisation. This is mainly done by combining graphs and simple (sometimes instructive) illustrations with text and colour coding. It's designed to make big chunks of information easily accessible and understandable.

Information gets presented very succinctly, yet in a visually attractive form. This allows the user to perceive and comprehend a lot of data at a single glance. This way, knowledge gets conveyed rapidly and efficiently.

How can infographics help?

As stated earlier, some people with an autism spectrum disorder do think in pictures. This means that the use of visual aids can actually benefit their learning process substantially. Visual reminders are a perfect example of this and are widely used.

If you want to create an infographic for a person with autism, it's key to hold in mind some important points. Unlike a lot of the mainstream infographics that you find after doing a quick Google search, it's crucial not to overdo it with graphical elements and numerous kinds of colour codings. It's often advisable to just use simple black-and-white illustrations and just a few and clear colour codings. Restrain yourself from cluttering the design with pretty but in essence quite useless elements.

Every single illustration should have proper value and a guided purpose. Each image has to have a clear meaning and should actively contribute to the comprehensiveness of the infographic as a whole. Infographics should be concise, well-organised and verifiable all at the same time.

What did my study show?

For my research, I worked closely together with Dominique Anné, a 19-year-old student with autism. He was diagnosed with the disorder when he was 4 years old. At both the MOS and Reynell test he scored under his age, but at the same time showed tremendous puzzling skills. He has an IQ of 87 and thus a normal intelligence.

Together we scrolled through all of his courses. After consideration we decided to focus on one particular course: horticulture. I studied the material myself (which is essential in order to create efficient infographics) and consulted with Dominique's counsellor and a few of his teachers, with the intent of getting a better understanding of his habits and learning pattern.

After obtaining a comprehensive understanding of the curriculum, I took all my new knowledge to the drawing board and drew up some sketches, reforming the material to what would become a personalised infographic. After that I designed and printed out a couple of rough prototypes and consulted a professor in graphic arts, which in turn lead to the production of a refined and final infographic.

In order to get measurable feedback and meaningful results, I obtained advice from one of my college professors and created a document with various specific questions about different aspects of the infographic, and asked Dominique to answer them honestly. Meanwhile, one of his teachers in school gave a written test about the subject that I had made an infographic of, in order to also asses the effect and usefulness of the reformed curriculum.

His answers to the numerous questions pointed out that he did find the infographic a very useful tool during his study activities. The results of the written test only confirmed this and clearly established that on average he scored about 15% higher than before. An important element to factor in is, and I can't stress enough how crucial this is, the fact that Dominique was in a very hospitable environment while studying and digesting the subject. This is especially important for people with autism, who can be very prone to external stimuli.

Conclusion

The isolated result of the test and the positive feedback given by Dominique, are a good indication of what infographics can mean for people with autism. It would be premature however to extrapolate these findings and to give them unwarranted, generalised meaning. It's overly clear that more research needs be done in order to obtain more significant results and to draw further purposeful conclusions.

One might also argue that infographics can benefit not only students with autism, but any other student. This is totally true. But regardless of how many research anyone can ever do in regard to this topic, and no matter how specific infographics become towards people with autism, to some extend they will always be applicable to a much wider audience.

Making any type of infographics takes a lot of time and demands effort. Not only the designing in itself, but to a large extent also the preparation that's needed beforehand. In my opinion, it's more than worth it when designing for people with disorders like autism, as the attention they may require often goes unattended.

Much research is yet to be realised and completed. I hope that my work will be a stepping-stone for other people and I expect them to improve upon it in any way they can.

References

[1] Janet Steffenhagen, "Sir Ken Robinson urges schools to adopt personalized learning", The Vancouver Sun, (2011)

Author biography

Wanting to meet people and learn new things, is of the same importance as the need to inspire other people with his own experiences and ideas. Having gained numerous invaluable experiences, covering countries like South Africa and Finland, proves his willingness to challenge old ways of thinking and to constantly question his own view on the world.

Aydin graduated majoring in graphic design and management. He recently started working at EskoArtwork, a graphic arts company headquartered in Ghent (Belgium).

Relationship of the old and new knowledge in printing technology education of today: the examples of retrospective analysis

Yuri V. Kuznetsov

North-West Institute of Printing of the St. Petersburg State University of Technology and Design, Russia
yurivk@mail.ru

Keywords: graphic technology, education, knowledge, specialization

Abstract

The approach to solving the "universal" training paradigm with providing the optimal balance of the old and new knowledge as well as the other dialectic issues of graphic technology education are discussed with an accent on informative nature of a print product and with examples taken from the teaching experiences of the author over the last three decades.

Introduction

Unlike other information technologies which have appeared at the time of modern "precise knowledge", the printing industry accumulates graphic data processing skills and experiences generated over the centuries, i.e. much earlier than the term IT has itself come in use. For many years, the printing technology was mostly considered as the specialized material processing routine leaning, in general, upon the various sections of chemistry and physics. The coming IT era once again accentuates the informational nature of "raw material" of printing and that of its final product. Nevertheless, the physicochemical and mechanical component can't be completely omitted or even reduced because, unlike in the other ITies, the output data are materialized here in the form of a hard copy on a very different kind of print stock with the use of steadily growing variety of processes and equipment.

On the other hand, the mentioned above informational component of printing should motivate the graphic technology training to take into account that the print product in general appeals to cognitive and aesthetic perception of a customer. The whole multistage printing technology can be considered in this respect as the communication channel. The prepress phase is, in its turn, the optimal data encoding providing the conformity of a data share transmitted to a print with the visual properties and preferences of such a product's end user. The press, especially "digital", can also be, to certain extent, related to specialized peripheral computer or network equipment.

Along with the optimal combination of the physicochemical and informative issues, the other challenge of graphic education consist in its having to embrace the whole spectra of printing technology applications since the average company's headcount in our industry doesn't exceed 20 and there is hardly room for more than one specialist with higher education. This presents an obstacle to specialized training which would focus on a certain printing method or print product, as well as on pre-press, press or post-press.

On the background of the growing variety of printing methods and facilities for their computerized control a lot of dilettantish misconceptions have appeared mostly as result of incorrect these achievements interpretation in advertising periodicals. Helping the trainee to adequately appreciate, for example, the "color myths", Giorgianni and Madden placed in their book [1] the whole paragraph of such misconceptions analysis by the myth/reality withstanding. Similar attempt in relation of the "screening myths" was also done by the author in [2].

Some dialectic issues of the technology development

The prepress started in the Middle Ages as the combination of letters and pictures engraving procedures performed at print form for a given page by a single person. Following the invention of typesetting the page making has been for over three centuries divided into two parallel text and image processing crafts, each of them involving the essentially different specific skills, tools and, during its latest period, rather sophisticated electronic equipment. About three decades ago it has once again converged into an entity due to the computer desktop facilities used by the same operator.

It's important to remind to the trainees the reasons for both of these processes' initial separation and their recent convergence [3]. The first of them is comprised of the principle difference between these two basic kinds of input graphic information. Even if relatively conditional, the image is, to the most part, a replica of visually

perceived world. Text is the initially ciphered data with its letters or hieroglyphs acting as graphic codes of sounds or ideas. Nowadays, the computer technique has made it possible to bring such, by its nature different, data to the same form of the eight digits combination. In a text file, one of the 256 meanings of a byte can indicate a target font, while in an image file it points out a pixel tone value (halftone dot area, ink coverage). Shortly after such unified presentation becomes available in the late 70ties for the volume of data sufficient for a whole page, the first electronic layout system HDP (Helio Data Processing) was created by Dr. Ing. R. Hell company [4].

Earlier, there was often clear knowledge of what had to be done but a lack of means to realize the task. Today we face quite a contrary situation disposing of adequate resources but lacking in knowledge [5]. Thirty years ago, there was a number of scientifically approved recommendations on, for example, the direction and degree of tone and color values correction for print quality improvement. However, even at the time of color electronic scanners, there was a lack of means for the proper control in providing the desired variations. Side by side with the basic parameters of color scanners it was used to indicate, for example, the 70% or 75% of UCR as the upper black ink volume limit provided by given equipment for replacing the three color achromatic component. The digital image processing of today allows for the practically unlimited variation of such parameters in any direction with the discretion of just, for example, 100 square microns of ink coverage (according to 2500 dpi of a film- or a platesetter resolution). Nevertheless, some professionals currently point out the need of additional research and training which could substantiate the recommendations and performing methods for effective use of the recently appeared precise control facilities. In this relation E. Enoksson [6] notes, for example, that just in about 25% of Swedish print houses the people have ever heard about UCR/GCR functions of Photoshop.

Moving forces and trade offs within the step-to-step technology evolution

The certain kind of an academic problem arises periodically with the progressive implementation and partial or sometimes complete mutual displacement of engraving, photochemistry, electronics, laser, computer and networking techniques in our industry. In this respect the following stages of data processing for printing can be distinguished after the times of manual engraving:

- photomechanical processes starting from 1880ies;
- electronic reproduction
  - analogue signals as of 1950;
  - digital signals as of 1970;
- computer processing systems
  - closed (CEPS) as of 1980;
  - open (PostScript based) as of 1990.

Each time, over more than the last hundred years, it had had a serious effect on the graphic engineering teaching content. At every following technical period, the educator had to “trim” the “old” knowledge with providing the optimal conformity of the rest of it with the “new” one within the course credits limits. In this respect, it is important to do a retrospective analysis of the basic reasons for moving to a novel technology level along with disclosing the trade offs usually inherent in this move. So, it’s not out of place to give some examples of such issues for above listed stages.

Photomechanical process

The most essential for the first stage was the introduction of the projection halftone screen. The invention of autotypy has greatly increased the illustrative component in print product excluding the need in artistic services of engraver for photographs reproduction. However, some shortcomings inherent in this technique haven’t been overcome until now. One of them is comprised of the print dots of any kind of halftone (periodic or “stochastic”) destroying the fine detail of a print image. That continues to keep the definition of the latter about ten times lower of the printing process resolution. The locally adaptive halftoning techniques which artificially copy the engraver skills of representing, for example, the fishing rod by a solid line, to the contrary of the scattered dots of a halftone, are currently still in development [7].

Electronic reproduction

The basic reason for coming from photomechanical reproduction to electronic one was comprised in the intermediate presentation of an image data by the electric signal. In spite of relative complicatedness of the process, as compared to the previous, camera using one, it has allowed for the flexible tone and color correction demanded to replace the material wastage masking techniques and costly manual retouching. Nevertheless, even the latest color electronic scanners couldn’t provide such correction selectively, for the given image area, while the scanning procedure has also destroyed the continuous input data onto, at least, discrete lines.

Within the electronic reproduction period one can find the intensive inventory work and patents competition for providing this technology with the functionalities which, being inherent in former camera equipment, were initially sacrificed on behalf of the color correction facilities.

For the scanners operating on analogue signals it was very problematic, for example, to vary the image size on a drum in its circumferential direction. The problem was solved when it became possible to convert in digital form and to place in a buffer memory the image data of, at least, one scan line. In John Crosfield memoirs [8] one can find the keen story of his Magnascan color scanner launched in the market by agreement with his "friend", as well as competitor and patent holder, R. Hell [9]. The interesting technical solution bypassing this patent was used by Dainippon Screen in Scanagraph 701 [10]. According to this solution the latter became, perhaps, the first sample of this type of equipment having its drums for original and exposed film not fixed on the same shaft and thereby comprising, to the contrary to the previous "color scanner" concept, the modern separate image input and output units.

Previous to introducing the first digital screening with "rational tangents" of Dr. U. Gast in Chromograph DC300 [11], the halftoning was mostly performed by placing the contact screen over the recorded photoplate. The use of the photomechanical screening effect made, in its turn, the resulting halftone dot area on the transparency (tone value) very dependent on the film exposure and chemical processing stability. It is worthwhile to mention this position, because a similar problem is currently being met in electrophotographic printing where the halftone dot exposure profiles on the OPC drums have the bell, Gaussian shape. That results in insufficiently ridged connection between the tone value signal and these dots areas in toner based development.

The first attempt of creating the "soft proof" using TV techniques was performed by Toppan Printing in its CP 525 system as the auxiliary equipment for photomechanical reproduction. However, this kind of color adjustments visualization became especially urgent with introducing the electronic scanners. To the contrary to manual retouching on an image carrying transparency, the scanner operator has blindly dealt there just with multiple potentiometers setting the masking coefficients for an each of four process inks. The low resolution image memory operating at TV frame frequency wasn't available at that time. That's why the first soft proofing systems had to use the pick-up TV camera and to provide the precise modeling of the all color transformations stages: from the scanner image capturing up to the printing.

Computerized print data processing

This period has started with digital techniques able to store and process the image data volumes for the whole page at resolution fitting the color print quality level. There were two basic advantages in introducing computer between the image capturing and output. The first of them was comprised in providing the, so called, sophisticated, local color retouching, seamless combining the images and other artistic effects. The other and, may be, more principle advantage was in the above mentioned facility of text and illustrative data layout on a page and in the following pagination such data for the whole press sheet.

The merger of the text and the image processing equipment producers was remarkable for that time. On the cover of Linotype-Hell advertizing pamphlets one could meet the slogan "Strong together" (although both were soon after incorporated by the Heidelberg).

In discussing this step, it is important to remember that the complete presentation of an image by the set of discrete digital samples inherent in rather computationally busy interpolative calculations for the image sizing or rotation. On the contrary, providing such functions through the smooth lens zoom or film/original turning in cameras was no problem 60 years ago.

The latest step of transition from the closed Color Electronic Prepress Systems (CEPS) to the open, Postscript based graphic processing environment has provided the flexible remote exchange with text, image, layout, color proofing and other data. These new facilities turn out to be in high demand by the numerous players in the printing business. That's why transition to the novel way of publishing data communication took place in the beginning of the 90ies during a rather short period of time. That resulted, in turn, in a remarkable deterioration of print quality due to the discrepancy of color values interpretation at the different production stages and locations. Thus, this problem had then to be urgently solved by the ICC development of Color Management Standards.

As one of the final evolution steps there should be also noted the convergence of the earlier separated graphic transformation and other processes control data into a single file according to CIP3, CIP4 concepts.

Conclusions

The knowledge of technology evolution is important for the appropriate understanding of its current state and further development potential.

Such knowledge can be effectively mastered when it's based on the retrospective analysis of principle reasons and compromises of moving to each next technology generation.

The digital technologies of today allow for the unprecedentedly precise and flexible control of graphic print data parameters. However, contrary to former times, that involves more intensive research and training for the adequate use of these facilities' potential.

References

[1] E. Giorgianni, T. Madden. "Digital Color Management: Encoding Solutions", Addison-Wesley, Reading, Mass. (1997)

[2] Y.V. Kuznetsov, "High definition halftone printing – HDHP: background, current status and challenges of the adaptive screening developments", IARIGAI 35, pp. 323-331 (2008)

[3] Y.V. Kuznetsov, "Pre-press image processing. Screening", handbook, Mir Knigi, Moscow, 1998 (Russ.)

[4] "Premiere of Helio Data Processing at Hell's", EPI, N5, p. 29 (1978)

[5] Y.V. Kuznetsov, "Does some philosophy still exist for the halftone frequency selection?", Proc. of IS&T's Int. Conf. on Digital Printing Technologies, Orlando (USA), Oct.17-22, pp. 362-365 (1999)

[6] E. Enoksson, "Image reproduction practices", TAGA Proceedings, pp.318-331 (2004)

[7] Y.V. Kuznetsov, "Adaptive Screening Developments at the Graphic Technology Department", Papers of the 42th Conf. of Int. Circle, 19-20 Oct. 2010, Moscow, pp. 69-74

[8] J.F. Crosfield, "Recollection of Crosfield Electronics. 1947 – 1975"

[9] R. Koll, F.-O. Zeyen, DE patent 1193534

[10] F. Hatayama, T. Tanaka, patents DE 3431482, GB 21455896

[11] U. Gast, "Method and apparatus for recording rastered continuous-tone pictures in printed graphics", US patent 3725574

Author biography

Professor Yuri V. Kuznetsov has a Ph.D from the Leningrad Bonch-Bruevich Institute of Electric Communication. Until 1982 he worked there as a team leader in the Graphic Arts Laboratory on the development of electronic reproduction systems. His Dr. Sc. degree in Printing Machinery and Technology was received from the Moscow State University of Printing. Currently he is the Chairperson of the Graphic Technology Department of the North-West Institute of Printing at the St. Petersburg State University of Technology and Design where he teaches courses and conducts research in Pre-press Image Processing, Print Quality and Color Management. He holds over 20 patents, has written over 30 papers on topics related to imaging in printing and has authored three books. The last of them, "Image Processing Technology in Printing," was published in 2002. The basic results of his scientific research are implemented in the High Definition Halftone Printing (HDHP) technology using the patented algorithms of the locally adaptive print image encoding.

International Activity and Graphical Students Education in Ukraine

Bohdan Durniak [1] and Yaroslav Uhryn [2]

[1] *Prof. Dr.Sc., Rector of Ukrainian Academy of Printing*
[2] *PhD, Vice-rector of Ukrainian Academy of Printing*

Abstract

The investigation of the Ukrainian educational legislation performed by the European experts proves that Ukraine is one of the most active participants of the European integration in this field. Higher educational establishments play a leading role in promotion of European ethical and cultural values in Ukraine and it helps them to train highly competent leaders for the future. Nowadays we can state that the international cooperation is one of the top priorities for Ukrainian high schools.

Recently many steps have been made in the direction of implementation of European standards in our education process.

- considerable changes have been made in the legislation about education;
- two-level system of students training have been implemented which allowed Ukrainian students to follow their studies at the European universities. Currently this work is focused on the development of PhD programs;
- Ukrainian scientists and teachers have possibilities to exchange the experience, and perform the investigations in European countries;
- participation in the international projects allows Ukrainian universities to implement European approaches and methodology in the process of students training.

For a moment several international programs are running in Ukraine : Tempus, Erasmus Mundus, Erasmus Mundus External Cooperation Window, Jean Monnet, DAAD, and Fulbright. Participation of the Ukrainian universities in these international programs financed by the European Union and other bodies allows:

- to enhance the international cooperation capacity of Ukrainian universities
- to facilitate the transfer of know-how and good practices in the field of student and academic staff mobility;
- to develop highly-qualified, open-minded and internationally experienced professionals and leaders;
- to improve the transparency and recognition of studies and qualifications,
- to disseminate European Union social and democratic values;
- to contribute towards improvement of quality and pertinence, to university research, to changes in system governance and to innovation of higher education.
- to build the capacity of the administration and public and private sector by participation of their staff in higher education mobility activities;

The international activity of the Ukrainian Academy of Printing is focused on the improvement of training process through the constant update of methodology and content of study curricula, students and staffs exchange. The Academy aims to enlarge scientific cooperation with advanced research institutions and leading companies and to engage foreign students and scientists to study and fulfill the researches at the Academy.

Basic fields of international activity of the Academy involve:

- training of Ukrainian students and teachers at foreign educational institutions;
- training of specialists for abroad countries at the UAP;
- training of Bachelor and Master students for foreign countries;
- participation in international grants and projects;
- participation in international conferences and exhibitions;
- scientific researches in the fields of printing engineering and technologies on demand of foreign companies;
- cooperation with foreign companies focused on the organization of students work placement and providing the Academy with modern printing equipment and materials.

Every year the Ukrainian Academy of Printing extends its international relations. Nowadays we closely cooperate with about 30 higher educational institutions and printing companies from Belgium, Check Republic, China, Hungary, Germany, Great Britain, Lithuania, Netherlands, Poland, Russia, Slovakia, Turkmenistan, Uzbekistan.

The cooperation with the world-known printing companies “Kolbus”, “ Heidelberg ”, “KBA”, “Man-Roland”, helps us to provide our students and teaching staff with up-to-date knowledge, to equip our research laboratories and training centers with modern printing equipment, technologies and materials.

The main aim of the international activity of the Ukrainian Academy of Printing is its further integration in European and world educational community through the development of educational and cross-cultural relations with partner institutions all over the world.

Media consumption in a converging world and possible effects to publishing companies

Prof. Christof Seeger

University of applied science Stuttgart, Germany
(Hochschule der Medien - HdM)
seeger@hdm-stuttgart.de

Keywords: media consumption, publishing, press, converging media, social media

Abstract

The digital age presents traditional newspaper publishing with a series of new challenges. The cycles of change are very dynamic and the effects on the traditional newspaper business are tremendous. One could even state that the changes are comparable to Johannes Gutenberg's discovery of modern printing 400 years ago. In 2011, publishers have to develop applications, or "apps," for mobile devices, they face decreasing ad-markets and a new orientation of the younger generations media consumption. The publishing managers are in a trial and error process as they try to answer the important question of how they can position their media brand in the ever-changing digital world.

Due to the many advantages of digitalised media channels and the existence of permanent internet access, media consumption itself and the requirements of the different types of mass media have changed. The cost of content distribution has reduced to almost nothing, which requires the publisher to be continually updating the content and implement interactive features for the users.

These facts lead to a new evaluation of media marketing. Former newspaper/magazine publishers are in the process of converting into media publishers; overseeing a multimedia content company that offers services in all media channels. One of the key tasks for the future is to satisfy the existing readers' expectation of the media brand and their specific media channel. On the other hand, the brand needs to be extended to reach new audiences: particularly, the important younger generation, who can be reached in digital worlds. Two main questions must be researched; how are these groups equipped and what content are they interested in? Many publishers are afraid of losing too many readers of their printed issue and, with the introduction of digitalised media channels without a business model, accordingly destroy their core product.

Introduction

Navigating knowledge, information and news is a fundamental component of societal discourse and cultural history. Together with the development of written script came a new intellectual dimension in which communication between speakers and thinkers was separated. Knowledge removed itself from the privileged and could be preserved and utilised by all. As is well known, knowledge was usually reserved for a privileged section of society, which resulted in stagnated societal development. Finally, with the discovery of printing with moveable letters, this societal condition was able to be overcome. This was the beginning of communication to the masses. At this period of time no one could have suspected the effects that book publishing would have on world history. The best example of this is Martin Luther, who, with his translation and duplication of the Bible, entirely and sustainably changed the existing ideas of the world. A quote from the German physicist and author Georg von Lichtenberg from the 18th Century summarises this impressively: "Lead has changed the world more than gold. And rather than lead in the shotgun, lead in type case."

Publishing houses as legitimate institutions was an early development and the meaning as well as the social acceptance of newspapers and magazines has been undisputed for almost 400 years. The topical challenges of this branch are enormous and, at present, have an open ending exit. The business models, which functioned so well in the past, are meeting more and more pressure. The development cycles of media technology are so fast, that the media companies have almost no time to insert their media channels in to the context of well thought out strategies. In closing, the receiver's media consumption is also changing, in particular within younger age cohorts.

Development and use of mass media

The development of mass media is described best with Merryl/Lowenstein´s 3 Level Model of Mass Communication [1]. (Note: a communication science classification is not the subject here, and relevant

specialists will be referenced where necessary.) In the 3 Level Model of Mass Communication, the first level is said to be "Elite Media." Only a small circle of people, who are intellectually and financially capable, can afford to and do use this. This level was reached long ago in Europe. Nevertheless, we are experiencing an increased and rapidly growing demand for Newspaper titles in developing countries which are on the verge of industrialisation, and with which wide spread illiteracy may be overcome.

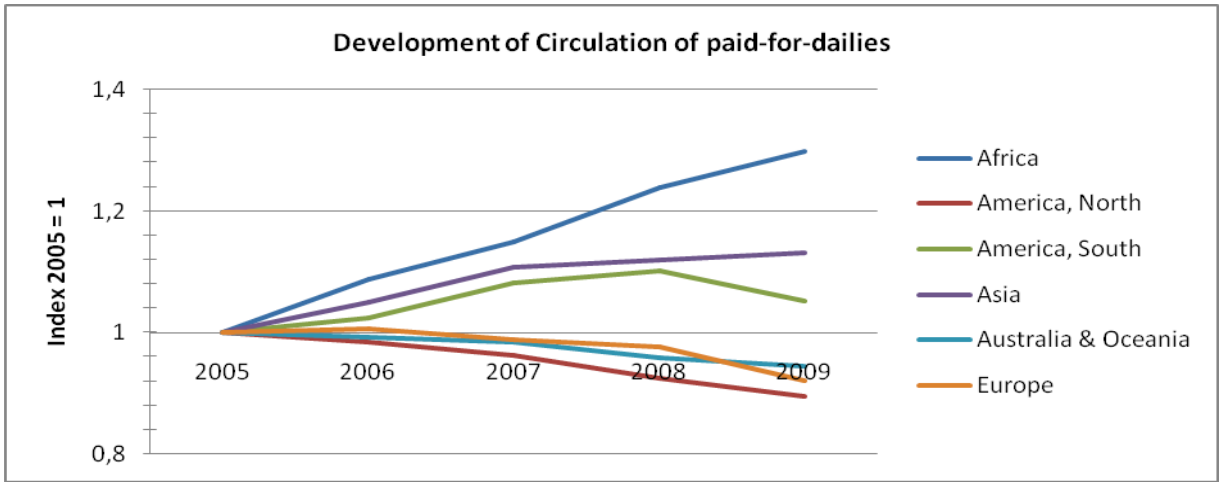


Figure 1. Worldwide Development of Newspaper edition (own portrayal according to: [2])

With the introduction and widespread dispersal of electronic Media begins the 2nd phase of Mass Communication: The popularisation phase. "Popular Media" [1] penetrate all the social levels and are, therefore, not only reserved for the elite. The content portrayal of such media is becoming increasingly available for conversation. Electronic media, television and the radio fulfil a differing purpose to the user. They are often used as motives, such as escapism or para-socialism. That is, these media are being used in order to escape daily life and oppose emotions, not because the user wishes to be alone. Many modern television formats fulfil such motivational needs along with the need to converse.

Print media, on the other hand, is strongly associated with the expectation of believable information. From printed media such as newspapers, the reader expects information, orientation in everyday life and food for thought. From the internet the reader expects predominantly fun and conversational interaction, but also information.

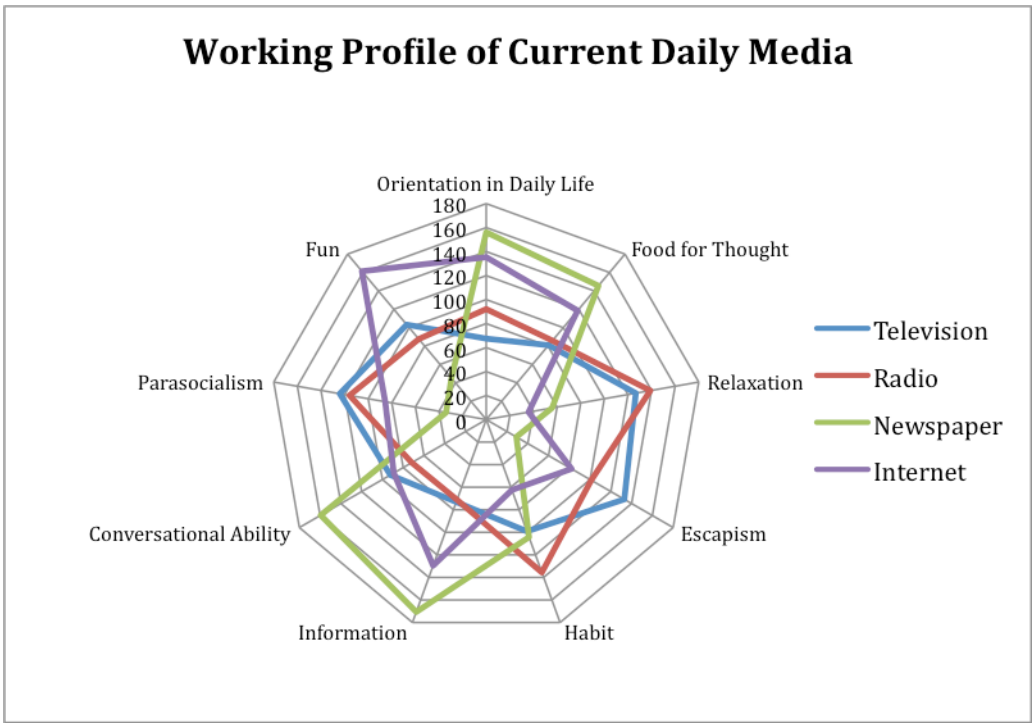


Figure 2. Expectations of classic media (own portrayal according to: [3])

These complementary medial changes of roles functioned very well and at a stable level in the 90´s at the end of the last century. Through the digitalisation of content, and the therefore fundamentally simple method of dispersal, together with the permanent access to the internet, arises a new dimension. This dimension is one which does not just cast the question of how the media company may profit from the content, but it also lastingly changes the consumption of media. This 3th stage is his phase of "Specialised Media" [1], which actually contains a paradox. The needs of the individual in a society overflowing with information are becoming more and more personalised. Digitalised content can satisfy this need for information according to the "Long Tail" principle. This means that someone exists who is interested in exactly this information or even expected other information. Parallel to this, the term mass media is becoming obsolete to everyone in the target group. And even worse than this, the business-models no longer work.

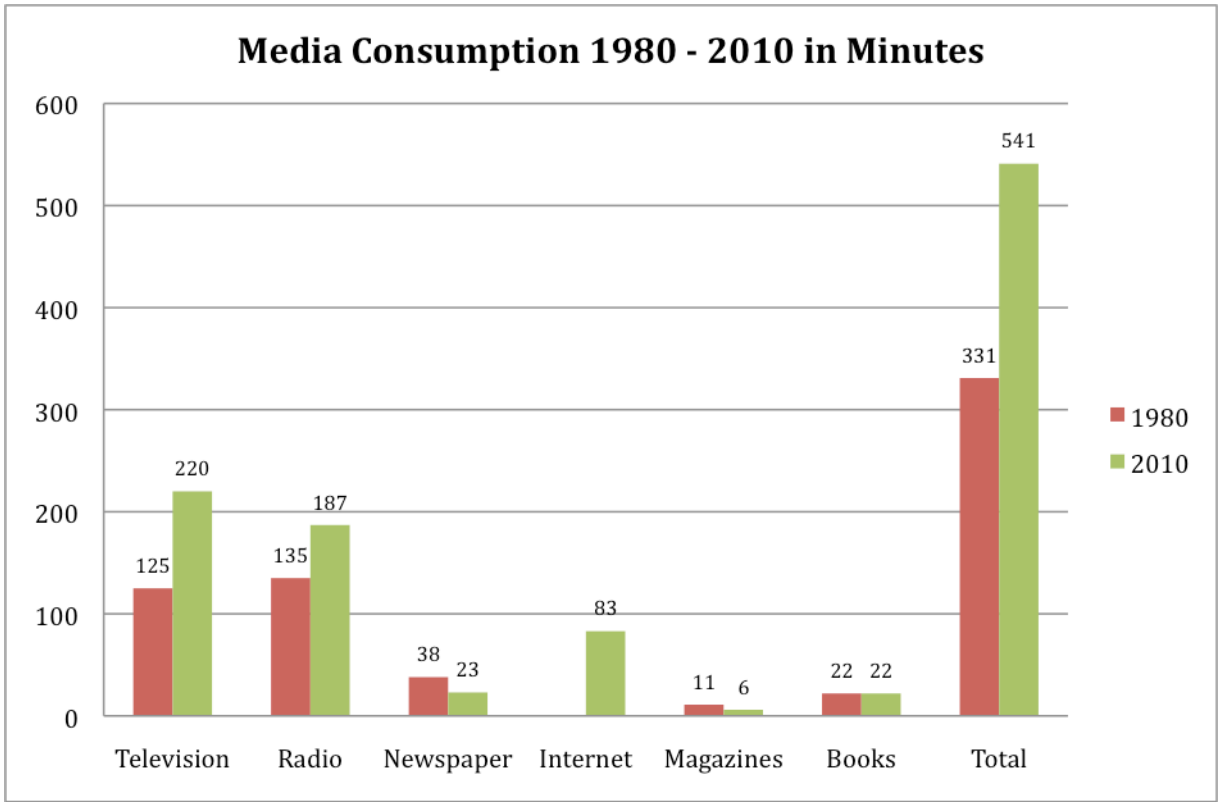


Figure 3. Time budget of Media consumption 1980-2010 (own portrayal according to: [4])

The wide range of media content, accompanied with the corresponding technological provisions, leads to a growing use of media. Although in 1980 research demanded that a quantitative limit of 4-5 hours of media usage be introduced, this value has risen to roughly 10 hours, which is somewhat due to passive use of differing sources of media.

Today, the large challenge lies in holding the users' attention. This means that users have many differing media options, all of which they alone simply cannot utilise and, therefore, must carry out a personal examination of cost per use.

Winning the users' attention is the main requirement for success. This is also true for publishers, who more frequently find themselves in a, until now unknown, competition for the user's time. Their competitors are other publishers and service providers, who are, in part, new to the industry. In the process, attention is not only defined as passive willingness to receive information, but it also assumes a conscious and separate intellectual identity, which expresses itself in the usage time of a particular media. It therefore falls upon the publisher, in their function as conveyers of information, to reach and catch the attention of the user and to maximise usage time, in order to successfully ensure journalistic and advertising messages.

If we look at the relevant statistics of media usage, it soon becomes clear that attention to the most traditional media channel, the newspaper, has been declining for years. For this point it should be noted that not only the range of the daily newspaper is decreasing but also the intensity of use, a fact notable in the length of daily use. The original borders have merged with the internet and the internet is recording the largest increase in use.

Social networks in particular are changing the classic models of communication. One no longer has to wait for the Gate Keeper, who, in the past, was an institutionalised media group, in order to receive information. Of

course, there is also a lot of content existing in social networks which is neither journalistic nor demands editorial quality. However, there are now "Journalists' 2.0", who have are required to deliver well researched articles. This is, under certain conditions, no longer necessary for media groups to publish content.

The Classic Gate Keeping Model

A Gate Keeper is that arbitration which, similar to a relay, has the task of either forwarding or rejecting information in the process of mass communication. The concept of the Gate Keeper was used for the first time by the German American psychologist Kurt Lewin in 1947 [5] and since then is a large concern for communications researchers, who ask questions such as: according to which criteria is information selected? How large is the influence of the editor? How large is the influence of the media company?

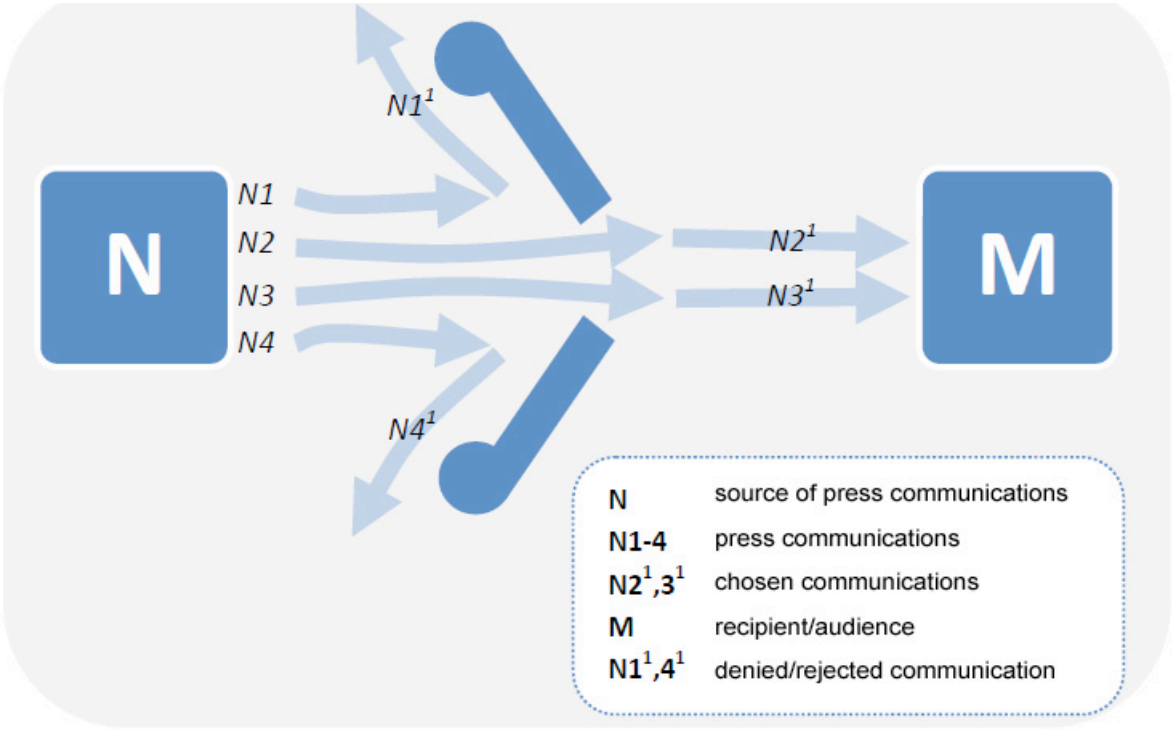


Figure 4. Expanded Gatekeeper-Model according to David Manning White [6]

These models have been continually developed. In the mean time, many reviewed factors arise which affect the passing on of information. These factors work parallel to the subjective influence of the editor and the restrictions in the technical course of news production (such as time, space to be filled or organisational guidelines.)

Modern Gate Keeping Research

The problem, in a modern understanding of gate keeping models, is multilateral. Pamela J. Shoemaker defines 3 main channels [7]:

Source Channel

People act in this channel that have experienced or witnessed an event, and/or possess particular knowledge about this occurrence.

Media Channel

This channel carries the gate keeping decisions of media professionals, such as journalists. This occurs as a rule after an event occurs and information arrives from different sources. The particular Gatekeeper chooses at that moment if and how he processes the information.

Audience Channel

In contrast to journalists, people from the wider public receive their news and information mostly from the journalists' media channel, rather than the source channel. The information from this channel can not only be consumed by individuals, but also be passed on to others through E-Mail or social news.

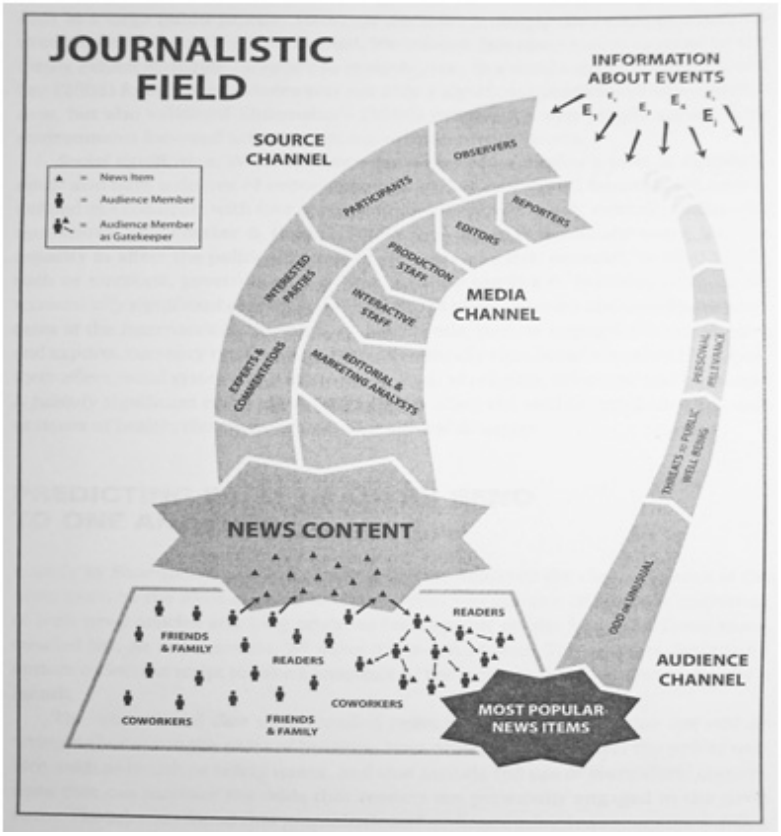


Figure 5. Different channels and key words influence which news we consume and which news are most Popular [7]

A central discovery to come out of this theory is that the recipient can not only passively consume content but can also mutually converse, exchange views and inform others. Admittedly, people have been sharing media content and information long before the introduction of the internet. However, this has become much easier, more direct and faster through social media. Through the function of social media software, the initial recipient, described as the public, can carry out the function of the Gate Keeper themselves.

We decide through our own media consumption who carries out the Gate Keeper function for us and accordingly about the relevance of the chosen media channel. Information portals can be immediately interlinked with us individually, independent of whether this concerns a classic mass medium, such as the newspaper, or whether the internet site of a telephone company, such as Telekom, is our number 1 news portal.

Until now the reach of institutionalised mass media was a lot larger than the influence of individual portals. It is generally true that the individual does not have an address book containing many thousand entries at their disposal, which they can access in an instant. At the same time these restrictions appear to dissolve in to differing possibilities with the help of the internet and social media.

The American actor Ashton Kutcher dared the media group CNN, that he could exceed the limit of one million twitter followers. In April of 2009 he achieved this, wanting to prove that a single person has a voice. An individual person can, theoretically and with the help of the internet and social media, reach more people than an entire media group.

Changing Communication through Social Media / Spherical Model of Communication

The depicted spherical model of communication was developed at the University of Media in Stuttgart, and attempted to demonstrate the complex and diverse possibilities that arise when two people want to communicate. The term ecosystem is introduced for the purpose of this model as a functional interaction of living creatures in their environments.

The model may be examined with the help of the example of Facebook. One could also analyse any other communication platform instead of Facebook. However, roughly half a billion people worldwide use this particular social network, and in Germany this number is approximately 18 Million.

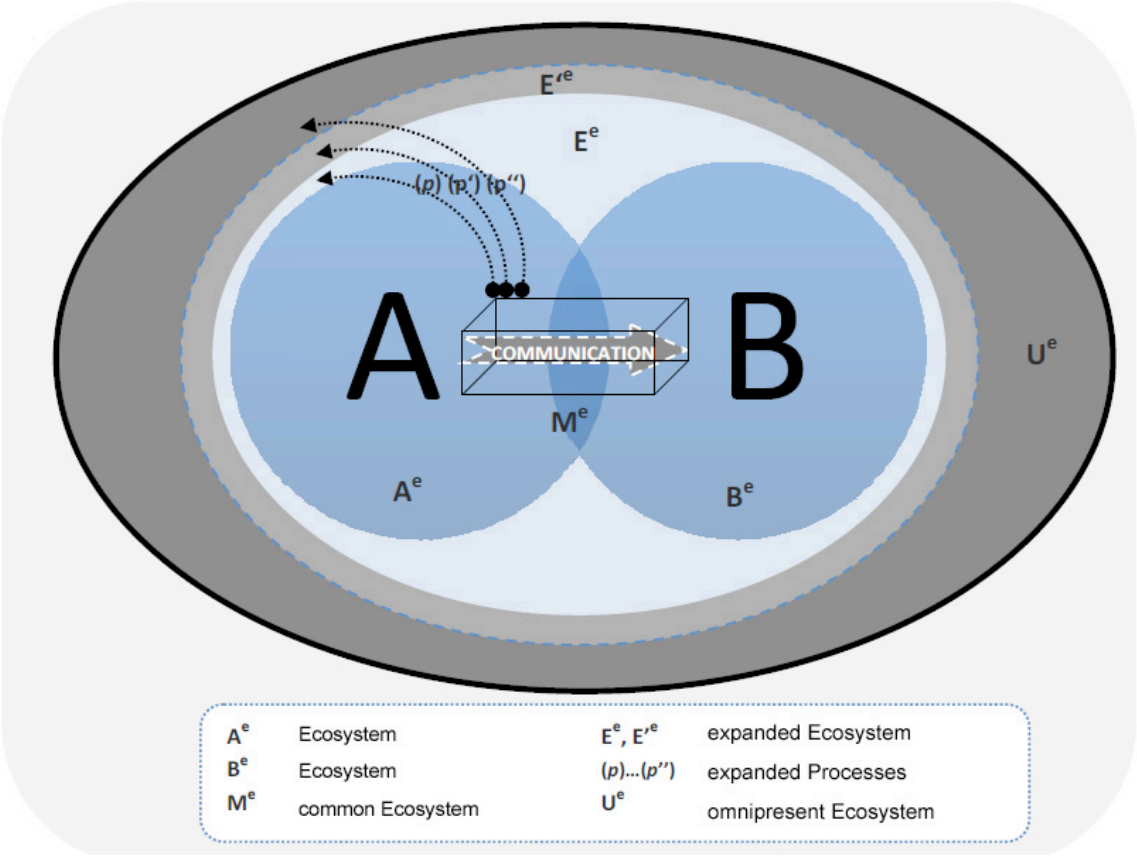


Figure 6. Spherical model of communication

The following cases shall be empirically examined:

- A contacts B directly and communicates through a personal message. Most internet platforms offer possibilities for one-to-one communication. E-mail, telephone or a simple face-to-face conversation are examples of this type of communication. This is, therefore, a form of communication which has always existed and forms the basis for the observation of human relations, which assumes a mutual understanding of syntactic and semantic plains without the effect of pragmatic plains.
- A contacts B in a mutually communal system (A>Me>B). A "group," of which both A and B and their contacts are members, is an example of this. This is possible through many platforms in which non-members can also read the particular messages through the help of developed processes and functions (such as a search engine). This variation shows the already extensive dimensions and the wide scattering of communication within networks. This is similar to when you are in a public place, such as the train, and can listen in on another´s conversation. Most people are, however, uninterested in such conversations.
- Although with the example of Facebook we are dealing with a closed system, it is also possible through the help of particular settings for "non friends" or even "non-members" to view another´s profile, photos, videos and wall postings (A>Ee>B).
- A or B communicate with one another in their own personal ecosystems (A>Ae>B or A>Be>B). In these cases A and B´s contacts, in our case Facebook friends, can also take part in the conversation. This is possible through a public platform within the system (in our case profiles or so called "walls") of either A or B. Accordingly all of A or B´s contacts can theoretically read every message.

This is an entirely new concept for which offline examples do not exist. A comparison with e-mail can only theoretically explain this revolutionary form of communication: A would, in this circumstance, have to include B as a recipient (as "CC" (copy)) of every e-mail. As a rule, this would never happen.

But it happens exactly here, within social media, where mass media communication takes place. A third party observes messages through their shared ecological system, which was actually not targeted to them. The third person then publishes that message again in his own ecological system.

The conclusion or inference must therefore be found in social media, in particular through an ecosystem which is as large as possible or has a large and influential reach to third parties.

Changing Communications Model

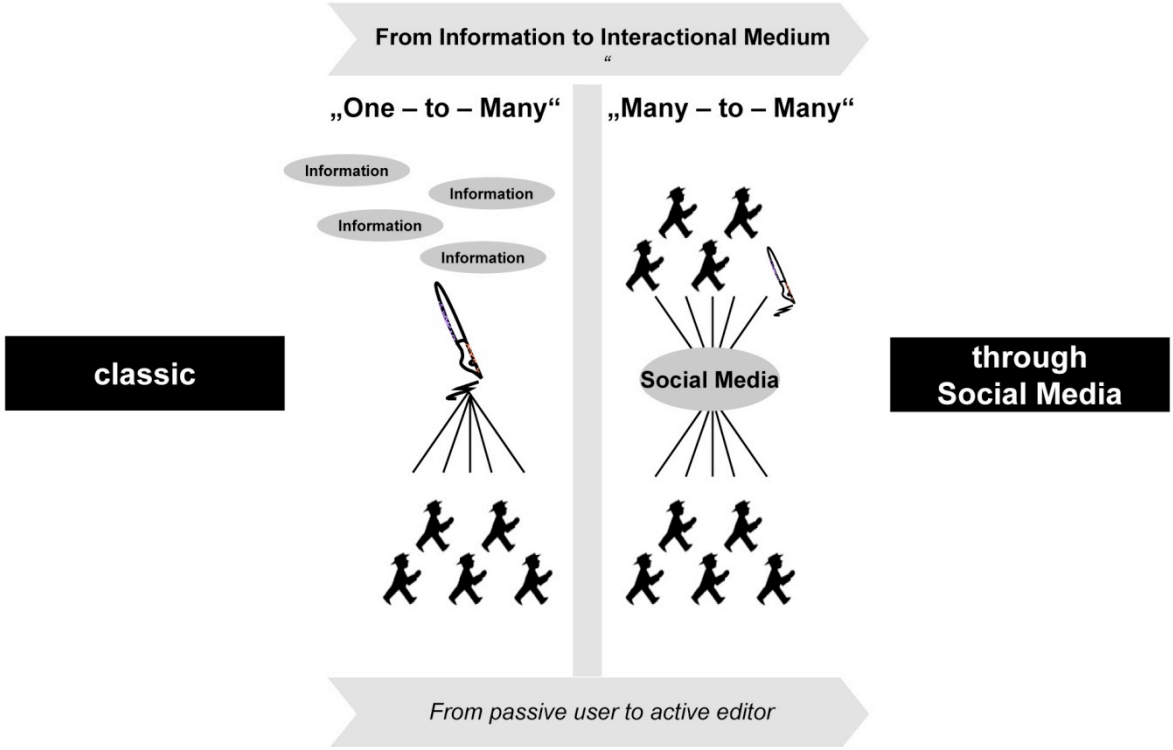


Figure 7. Changing Models of Communication

The changes are clear through this diagram. While in the classic examination the medium was *the* authority to publish content, in the new examination it is only *an* authority to publish content.

Social science has occupied itself for a long time with the phenomenon of group building and why people come together to form groups. The term “social network” was first defined in studies in 1954. The short answer as to why people come together in social networks is explained through societal changes and the strong independence of the individual.

There are two theoretical approaches to this definition:

The representatives of the “loss theory” substantiate that, due to the fact that traditional relationships, such as families or neighbours are strongly losing their meaning, social networks serve more or less as replacements for relationships. The individual searches for such replacements within their social networks.

If these theories are correct, there is an immediate and negative consequence on local and regional media markets.

The representatives of the “liberalisation theory” see reasoning in digitalisation and the coupling of spatial dimensions. That is to say, one can use new forms of relationships and communications, through which emerges a new social capital for the individual. And in order to bring attention to themselves, the individual has to share content in a simple and moving way, independent of the question of relevance and how good the content is. The average user makes roughly 90 content units (UGC) per month available. Frequent motives are:

- relationship building / networking
- self profiling
- attracting attention for something
- community/community feeling
- desire for feedback
- conversation

A few of the mentioned points are of an intrinsic nature, defined from the user for themselves. There are, however, initial business models in social networks which specially focus on exterior motives. Recently founded local based social networks, such as Gowalla and Foursquare, work together with reward mechanisms. Through sharing ones current location, with the help of a "check in" function, one can collect markings, and frequent users can also become virtual mayors of their favourite locations. At the same time, this beckons rewards in real life; vouchers and coupons from particular businesses, at which one can check in, are sent out in to the neighbourhood.

This means that the traditional filter beginnings become more blurred and professional messages begin to appear on the monitor next to suggestions from friendship circles.

This, in closing, leads to 4 theories, which can always be put forward in combination with communication:

- The behavioural communication of the consumer has significantly changed.
- The social media principle of "sharing" is shaped mainly due to social motives.
- The relationship to the sender of a suggestion through social media is the largest deciding factor in the retrieval of the suggested content.
- Information sharing in the current era is influenced by various filter function and Gate Keepers.

Consequences of Changing Media Consumption

Out of changing media consumption in a converging world arise a few central arguments affecting the classic media group, in particular, press publishers, which are incredibly significant for the further development of said media groups.

The widely discussed substitution theories, according to which media markets are going to disappear, are not truly lasting. News, in particular regional and local news, belongs to the 5 most important usage aspects in the internet. On the contrary, publishers are changing throughout; from the former newspaper maker to the publisher of today and the media publisher of tomorrow; publishers are changing in to a multimedia house. Press publishers will also take in a central role in this area in the future, as well as in the internet and in mobile media.

3 fundamental points play a central role in these changes:

Degree of Multimedia

Similar to the performance spectrum explanation of digital media, the internet is a multi media medium, in which the classic examples of media; print, radio and television, merge in to one another. Along with the widespread development of broadband in every household comes the steady growth of multi medial content. In the last few years, press publishers have also increasingly integrated moving image content in to their web portals. The user growingly demands and prefers this type of marketing. For the traditional print publisher, this step is not so simple. Publishers are, in effect, entering uncharted territory and have to build up new qualifications, beginning with multi medial narrative competence in editing, including cutting and editing videos for online clips.

User Participation

The term Web 2.0 is a synonym for web-based participation. Through user participation, publishers are confronted with new demands and challenges. The once passive consumption of content is giving way to an active style, in which the receiver becomes a "Prosumer," that is, both a producer and consumer. The central question in this context is, on the one hand, which role journalism is going to play as the Gate Keeper and on the other hand, how the reader ship within the community can be expanded.

Individualisation

The previous model of communication is based upon the idea that a communicator sends his message to a diverse public. Because of content digitalisation, there now exists widened possibilities to appeal to the user using of various media forms such as text, picture and sound. This enables a certain Meta relationship between the user and the media market which is to be developed.

In order to ensure the individual contact of the recipient, multimedia houses must have the competence to develop multimedia content for different media channels. In the process, the classic characteristics and qualities of journalistic work may not be allowed to be forgotten. These characteristics are excellent quality and seriousness.

Strategic Management of Media Brands

A further central point is the strategic positioning and development of separate media brands. Users are increasingly searching for a reduction of complexity within an abundance of information, and are allowing themselves to be strongly leaded by media brands. Therefore, publishers, with their strong brand core for printing brands, posses the necessary and fundamental requirements to stretch the brand in further media channels, and to similarly be accepted by the user as a trusted and orientated institution. This demand for a stretching of the brand sounds, theoretically, relatively simple: in actuality, one only has to transfer the anchored brand acquaintance and brand image on to a new product. However, practice shows how complicated it truly is to stretch a media brand in such a form, so that it is possible to appeal to new target groups, as well enjoy advertising presence in differing media channels. Nevertheless, the expansion of existing media brands is afflicted with less risk and less cost than creating a completely new brand for the internet.

It is therefore obvious that the positive side effects from marketing can be used to synergise already established and known markets and minimise risk within them. In order to fulfil this purpose, brand transfer must be differentiated in to two central areas: line extension and brand extension. The classic line extension is, theoretically, associated with only a slight risk, because a large brand fit already exists between new products and their mother brands. The line extension shows that brand development occurs in other genres of media. This means that a certain basic competence is expected of the media house. In the case of brand extension, the transfer of media markets occurs on to non media products. This would be recognisable, for example, should a regional newspapers offer energy rates. The risk of over stretching the media brand is relatively high and respectively carries high marketing costs.

Newspaper publishers have the best prerequisites to develop from a classic publisher in to a multimedia house. Dependant on the genre of the paper, publishers have nationally or regionally strongly anchored markets which enjoy a high degree of credibility and are generally very well known.

Purchasing and using press products is a powerful ritual. This is seen, for instance, both in subscribers, who expect their paper in their letter box every day, but also those that regularly purchase press products at a newspaper or magazine stand. These rituals can also be traced back to the high familiarity and credibility of such media brands.

Most decision criteria for whether or not content is used lie within the relationship of the reader to the sender of the information. Trust and reputation are the primary characteristics important to the user. The personal interest of the subject or the content of the recommendation is only secondary. In summary, it can be said that trust in the sender and their reputation carries more influence on the consumption of said content rather than the content itself!

Senders of information or suggestions can also be media houses, to whose social media we can subscribe to. For that reason, trusted brands are playing an increasingly important role in a jungle of information, and are also participating in social media with every individual.

Conclusion

The summarised conclusion of this paper will be presented together with practical suggestions for the press branch which must be put toward solving the challenges of changing media consumption in a convergent world. These suggestions are independent of the particular nation's market conditions and are applicable to all media types which happen to find themselves in the phase of "specialised media."

Practical Suggestion 1:

Individual media brand strengthening and a clear positioning within the market, as well as an anchoring and positioning within the social networks of the recipients (extension of ecosystems).

For this to occur, journalists must have the freedom to research the history of their reports away from the pressure of creating headlines and making deadlines. They must also be able to illuminate backdrops and draw credible conclusions. In order to hold a strong position within the media market, high quality journalism is required.

Practical Suggestion 2:

Focus on lasting quality criteria in journalism.

In the future, journalists will have different tasks then those of today. Convergent media is advancing inexorably. Only those than are able to adapt to new situations will be able to prove themselves in the future. At the same

time, publishers must have qualified staff within their editorial department who can receive and take on further training and who are also ready to change permanently. Journalism will develop and partly reinvent itself. The qualifications of journalists and their readiness to be innovative will decide whether or not integrative journalism is possible.

Practical Suggestion 3:

Reflect upon the changing role of journalism.

It is not to assume that journalism will more or less merge in to social networks. Because of the participative nature of social media there is a potential to build and strengthen relationships to the readership. This will be possible if the journalists are ready to become an integrated aspect of social networks and will lead to the journalist becoming the manager of the community.

The split of the institutionalised anchoring of public media from the participation of the user is indeed large. Therefore, the question in the future will be less and less regarding "whether or not" but increasingly regarding "which aspects belong where."

Practical Suggestions 4:

In the future, publishers must discuss topics in greater depth which relate to the further development and use of products. This is a new field which the media company never demanded of the printed newspapers and magazines. A print product can be used identically in every country in the world.

The demands and challenges in the area of mobile appliances are many and diverse. One muss address questions of ease of use, lay out and typography, as well as questions centred on and around publishing.

References

[1] Merrill, John Calhoun und Lowenstein, Ralph Lynn (1979): Media, messages and men. 2. ed, New York u.a., (1979)

[2] WAN-IFRA/ZenithOptimedia, World Press Trends 2010, (2010)

[3] Oehmichen, Ekkehardt und Ridder, Christa-Maria: Die MedienNutzerTypologie 2.0. Aktualisierung und Weiterentwicklung des Analyseinstruments. 1. Aufl, Baden-Baden, Nomos-Verl.-Ges., (2010)

[4] Reitze, Helmut: Massenkommunikation. Eine Langzeitstudie zur Mediennutzung und Medienbewertung. 1. Aufl, Baden-Baden, Nomos-Verl.-Ges., (2010)

[5] Lewin, Kurt: Frontiers in Group Dynamics In: Human relations, Vol. 1, (1947)

[6] White, David Manning: The ‚Gatekeeper': A Case Study in the Selection on News, In: Journalism Quaterly, 27, (1950)

[7] Shoemaker, Pamela J. & Vos, Tim P: Media Gatekeeping, In: Stacks/Salwen (2009)

Author biography

Christof Seeger is a Professor at the Stuttgart Media University, Dean of the Masters course "Print & Publishing" and a member of the Bachelor course "Media Publishing". His experience is in the publishing sector of magazines and newspapers. His research work is focused on changes in media consumption in digitalised environments and the effects to editorial organisations; the way that the media has to be designed, as well as changes to the business models. He is co-founder of the Convergent Media Centre, a student driven newsroom-project at the Stuttgart Media University which was awarded with the "European Newspaper Award". His newest project is an institute for development and design for mobile applications (ADEC).

Students for green printing: Environmental BSc theses for the Finnish printing industry

Pentti Viluksela

Helsinki Metropolia University of Applied Sciences, Finland
pentti.viluksela@metropolia.fi

Keywords: Environmental management, environmental tools, printing industry, university students.

Abstract

Attention to environmental issues in the Finnish printing industry has increased over the past five years. As a result, altogether 22 environmentally related BSc (Eng) theses have been completed or are underway at the Media Technology programme of Helsinki Metropolia University of Applied Sciences. Typical thesis projects have dealt with the introduction of an environmental tool (e.g. the Swan label, ISO 14001 environmental management system, carbon footprint calculator), collection of eco-balance data from the printing processes for LCAs (lifecycle assessments), or environmental surveys among printing companies or materials and equipment suppliers. There have two primary client groups of the environmental thesis projects: printing companies and a research institution. Other clients include consulting companies, public or industry organisations and the university itself. During their thesis projects, most of the students have gained a versatile insight into the workings of a printing company. The clients have so far been satisfied with the students' input, despite their somewhat limited experience. From the university point of view, the environmental thesis projects have enabled Metropolia to collect considerable data and knowhow on the topic. Environmental projects have often had a wider scope than normal, company-specific theses, and the results may benefit the whole industry.

Introduction

In Finland, the printing industry has not been in the forefront of environmental action. Up till 2007, few publishers and other print buyers demanded environmentally friendly materials or production processes. Environmental organisations, such as Greenpeace, have been interested in sustainable forestry and chlorine-free bleaching, but not in green printing. Thus, especially small and medium sized printing companies have been slow to taken any steps towards greener alternatives. [1]

In the EU regulatory context, the main environmental impact of printing is the emission of organic solvents (e.g. the Solvents emission directive (SED), [3]). Printing is included in the BAT (Best Available Techniques) reference document for surface treatment using organic solvents [4] along with other surface treatment techniques such as painting cars and aeroplanes, making mirrors and coating electrical wire. The BAT is, however, only applicable to heatset offset, flexography and rotogravure, and the environmental permit system specified in the Integrated Pollution Prevention and Control (IPPC) directive covers only large printing companies, which use more than 10 tonnes of solvents annually. [2], [3], [4]

In the recent years, however, the environmental awareness of businesses and the general public has increased. Swan labels and ISO 14001 certificates are steadily increasing [6]. Carbon footprint has become an interesting topic [7] [8] and the number of FSC and PEFC chain-of-custody certifications is increasing in the printing industry and its paper suppliers [9] [10]. The Federation of the Finnish Media Industry introduced its sustainability guidelines for the printing and publishing industry, entitled "On the way towards more sustainable", in 2010 [11].

The same green trend shows in the BSc theses of the Media Technology programme of Helsinki Metropolia University of Applied Sciences. The number of environmental topics has increased in the past years. As Metropolia is the only university of applied sciences in Finland that teaches printing technology, the situation at Metropolia probably reflects quite well the situation in the Finnish printing industry.

Topics and clients of the BSc theses

During the period 2007–2011, Metropolia students have completed 17 BSc (Eng) theses on environmental issues of the printing technology/industry, and five more are underway, hopefully to be completed by the end of 2011. The theses are presented in

Table 1 [14]...[35]. Out of the 22 thesis authors, 13 are female and nine male.

Table 1. Environmental BSc theses of Metropolia, 2007–2011.

Author	Title	Year
Hulkkonen M.	Ecolabels of the printing industry and the Swan Label application to the printing house	2007
Keinänen J.	Nordic eco-label for a printing house	2007
Kähkönen H.	The Nordic eco-labelling of a printing company	2008
Peltonen K.	Environmental aspects of digital printing	2008
Perasto J.	Sheet-fed printing from the point of view of sustainable development	2008
Aurassalo A.	Chain of custody system certification of a printing house	2009
Häyry P.	Environmental survey for a flexo printing house	2009
Kauhanen P.	The changes in material and energy flow in heatset offset printing	2009
Haanpää P.	Energy measurements in digital press	2010
Hopponen J.	Electrophotography and the environmental effects of digital printing	2010
Lämsä A.	Environmental databank for printing and publishing houses	2010
Mattinen J.	Environmental load of graphic industry and applying Nordic eco-label for offset printing house	2010
Nuuttila I.	Environmental demands of a printing house	2010
Seppänen K.	Databank on environmental responsibility for the Finnish printing industry and publishers	2010
Juselius J.	ISO 14001 for digital printing press	2011
Sippola A.	Environmental responsibility of material and equipment suppliers	2011
Varvio H.	Introduction of carbon footprint calculator to Finnish printing houses	2011
Kalliomäki S.	Environmental management system for small printing companies	2011e
Pakarinen P.	The importance of eco-labels for print companies	2011e
Pietarinen R.	Environmentally conscious packaging design	2011e
Rantala M	Green procurement of printing equipment and materials	2011e
Wondimu E.	Environmentally efficient graphic design	2011e

The annual number of environmentally related theses has grown considerably in the past five years, which supports the greening trend in the Finnish printing industry. Figure 1 shows a classification of theses according to the year and the topic.

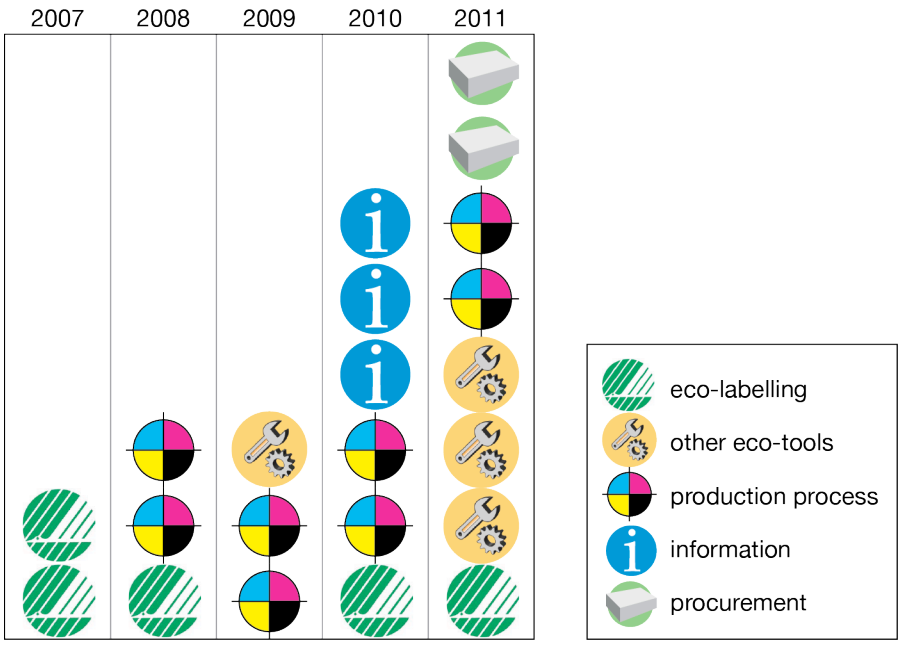


Figure 1. Environmental BSc theses of Metropolia presented according to the year and topic.

Eco-labelling has been a popular thesis topic, and exemplifies the need of a printing company to engage student resources: The company wants to obtain the eco-label, mostly because of customer pressure, but it does not have the available human resources for the application process. The application of the Nordic Swan label requires detailed information on the various materials – especially chemicals – consumed by the printing company, but also on subcontracting, waste handling and management issues. The student has to collect data both from the company processes and books, as well as from materials suppliers and service providers. At the same time, procedures are developed to continue the data collection for the annual reporting required by eco-labelling. Thus, after the initial work of the thesis student, the company can continue to fulfil the eco-label requirements with their own resources.

The first six theses related to print production processes concentrated on a specific printing process, and entailed the collection of detailed eco-balance data from real-life printing operations. Five of these theses were done as part of the Leader project, a major research initiative carried out by the VTT Technical Research Centre of Finland and other organisations [5]. The two recent process theses deal with the environmental aspects of packaging design and graphic design.

Apart from the Nordic eco-label, some theses have dealt with other environmental management tools: ISO 14001, Ekokompassi (a light environmental management system for small companies), chain of custody certification (FSC or PEFC) and carbon footprint. In the information-related theses, the students searched, analysed and presented information from various sources to provide the printing company or the industry with specific or general reference data on environmental issues.

In Figure 2, the clients of the theses are presented. Individual printing companies are the largest single client group. Thesis projects for printing companies usually fulfil a specific need, e.g. a study on chemical legislation, an application for the Swan label, or an evaluation of Chain of custody certification. Theses carried out for a research institute (VTT in this case), have had a wider scope: to provide representative data for the whole printing industry. It can be noted that in many cases, there are two or more clients: for example, in the case of the Leader project, VTT was the main client, but the practical work took place in one or more printing companies. This kind of co-operation between various members of the printing industry is encouraging. The Federation of the Finnish Media Industry has also been a partner in some joint thesis projects.

Normally, the initiative for a BSc thesis project comes from printing companies or other external sources. In 2011, Metropolia initiated three theses on its own. One is connected to the purchase of new digital printing equipment, and the others to environmental aspects in the design process of printed products. The external clients are preferred, because they provide a real-life, industrial or business environment for the student – and

usually also a small financial compensation. However, the school-initiated projects can also be acceptable, depending on the motivation of the student and the situation at the school.

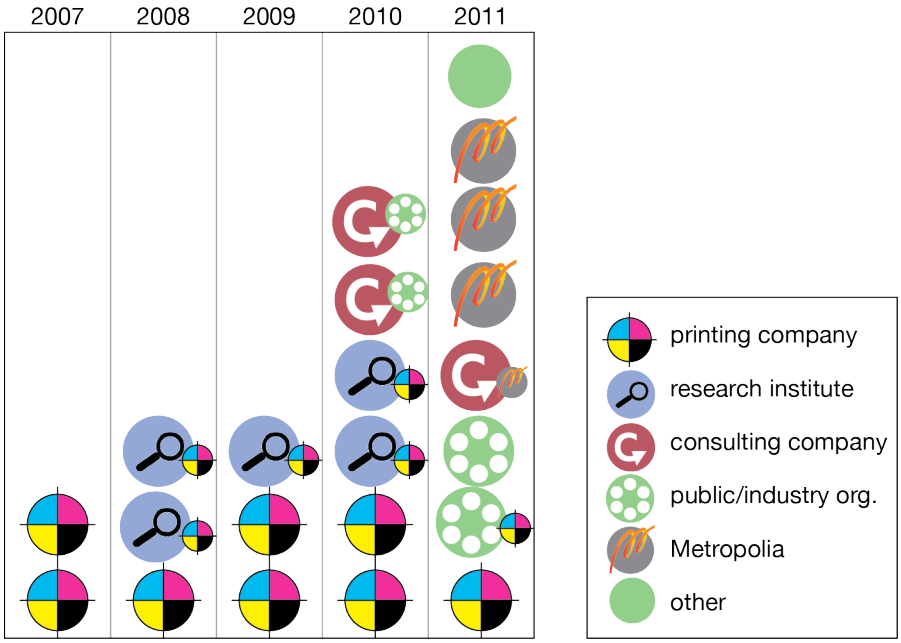


Figure 2. Environmental BSc theses of Metropolia presented according to the year and client.

Experiences

The environmentally oriented theses are in many respects similar to other theses of the Media Technology programme. The students show the usual variation of initiative, resourcefulness and adherence to timetables. Adequate guidance and support, both from the client and from the university, is required to get the project completed. However, due to the increasing media coverage and the rise of environmental concerns, the students that choose environmental topics may have an added dose of motivation and interest.

There is not much information available in Finnish on the environmental issues of printing. Good skills in English are essential, and skills in Swedish are a bonus. In some cases, knowledge of chemistry is required – an issue that has received some consideration in the curriculum as well.

Since environmental activities often cover the whole production process, the students tend to get a fairly comprehensive view on the operation of a printing company – from materials purchasing to waste handling, from marketing to production, and from energy consumption to delivery vehicle emissions. This versatile exposure may enhance the student's understanding of the printing process.

More than half of the primary clients of the environmental theses are other than printing companies. This shows that many players are interested in environmental issues, and that printing industry players are working together towards a more sustainable industry. Environmental performance can nowadays be a competitive factor between printing companies, but it is also a common concern. This concern is shown in the recent international initiatives to brighten the environmental image of the printing industry, for example the TwoSides project [12].

Conclusions and recommendations

The increase of environmental theses follows the current green trend in the printing industry, and there has been a clear need for this additional student resource in the Finnish printing sector. According to anecdotal evidence, printing industry experiences green waves in 8 to 10 year cycles. It remains to be seen if the environmental trend is here to stay this time. In any case, the social dimension of sustainability is getting more and more attention also in the media sector. For example, Global Reporting Initiative, the organisation behind the sustainability reporting guidelines, is planning to publish its Media Sector Supplement, a set of specific guidelines for the sustainability reporting of media companies [13]. The social issues are becoming important in the printing industry as well.

The BSc students have proven to be a competent and flexible human resource for the assignments. The clients of the theses have so far been satisfied with the students' input. In some cases, active guidance and support, either from the client or from the University, has been required to compensate the students' limited experience and initiative.

Most of the other "regular" thesis topics at Metropolia are company-specific, and the benefits from the project are limited to that company. In contrast, many environmental thesis projects have had a wider scope, and the potential benefits may extend to the whole industry. In the best cases, there are several winners: the student, one or more printing/consulting/research companies, the printing industry as a whole, and the university.

From the university point of view, the environmental thesis projects have been interesting and rewarding, and they have enabled Metropolia to collect considerable data and knowhow on the topic. However, dissemination of this information is at present not well organised. There is a clear need to find ways of informing the Finnish printing industry and other audiences of the theses and their findings. There would also be a need to exchange information and results in an international context. Perhaps the International Circle could be a suitable forum for the exchange of environmental findings, trends and practices.

References

[1] Viluksela P., "Environmental sustainability in the Finnish printing and publishing industry", Licentiate thesis, Helsinki University of Technology, Espoo, Finland (2007)

[2] EU, "Reference Document on Best Available Techniques on Surface Treatment using Organic Solvents", European Integrated Pollution Prevention and Control Bureau (EIPPCB), Seville (2007)

[3] EU, "Council directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control", OJ L 257, 10.10.1996.

[4] EU, "Council directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations", OJ L 85, 29.3.1999.

[5] VTT, " Lean development with renewable resources (LEADER)", Www document, available at http://www.vtt.fi/sites/leader/index.jsp?lang=en (accessed 9.8.2011)

[6] Antikainen H., "GT-ympäristöraportti", GT-Raportti no. 4, September 2009, VTT:n mediatekniikan asiantuntijapalvelu (2009) [In Finnish]

[7] Verdigris Project, "Colour me Carbon", Www document, available at http://verdigrisproject.com/articles/colour-me-carbon (10.8.2011)

[8] Intergraf, "Carbon footprint", Www document, available at http://www.intergraf.eu/AM/Template.cfm?Section=Carbon_footprint (11.08.2011)

[9] Forest Stewardship Council, "FSC Certificate Database", Www document, available at http://info.fsc.org/ (11.08.2011)

[10] PEFC, "PEFC Council Information Register, Www document, available at http://pefcregs.info/search1.asp (11.08.2011)

[11] Finnmedia (The Federation of the Finnish Media Industry), "Viestintäalan ympäristölinjaukset 2015 – Matkalla kestävämpään", Pdf document, available at http://www.vkl.fi/files/1125/vkl_ymparistolinjaukset_web.pdf

[12] Two Sides, "Two Sides", Www document, available at http://www.twosides.info/ (11.08.2011)

[13] Global Reporting Initiative, "Media", Www document, available at http://www.globalreporting.org/ReportingFramework/SectorSupplements/Media/ (12.08.2011)

[14] Hulkkonen M., "Ecolabels of the printing industry and the Swan Label application to the printing house", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2007) [in Finnish]

[15] Keinänen J., "Nordic eco-label for a printing house", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2007) [in Finnish]

[16] Kähkönen H., "The Nordic eco-labelling of a printing company", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2008) [in Finnish]

[17] Peltonen K., "Environmental aspects of digital printing", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2008) [in Finnish]

[18] Perasto J., "Sheet-fed printing from the point of view of sustainable development", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2008) [in Finnish]

[19] Aurassalo A., "Chain of custody system certification of a printing house", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2009) [in Finnish]

[20] Häyry P., " Environmental survey for a flexo printing house", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2009) [in Finnish]

[21] Kauhanen P., "The changes in material and energy flow in heatset offset printing", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2009) [in Finnish]

[22] Haanpää P., "Energy measurements in digital press", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2010) [in Finnish]

[23] Hopponen J., "Electrophotography and the environmental effects of digital printing", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2010) [in Finnish]

[24] Lämsä A., "Environmental databank for printing and publishing houses", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2010) [in Finnish]

[25] Mattinen J., "Environmental load of graphic industry and applying Nordic eco-label for offset printing house", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2010) [in Finnish]

[26] Nuuttila I., "Environmental demands of a printing house", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2010) [in Finnish]

[27] Seppänen K., "Databank on environmental responsibility for the Finnish printing industry and publishers", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2010) [in Finnish]

[28] Juselius J., "ISO 14001 for digital printing press", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2011) [in Finnish]

[29] Sippola A., "Environmental responsibility of material and equipment suppliers", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2011) [in Finnish]

[30] Varvio H., "Introduction of carbon footprint calculator to Finnish printing houses", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (2011) [in Finnish]

[31] Kalliomäki S., "Environmental management system for small printing companies", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (in preparation) [in Finnish]

[32] Pakarinen P., "Benefits and disadvantages of eco-labels for print companies", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (in preparation) [in Finnish]

[33] Pietarinen R., " Environmentally conscious packaging design", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (in preparation) [in Finnish]

[34] Rantala M., "Green procurement of printing equipment and materials", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (in preparation) [in Finnish]

[35] Wondemu E., " Environmentally efficient graphic design", B.Sc. (Eng) thesis, Metropolia University of Applied Sciences, Espoo, Finland (in preparation)

Author biography

Pentti Viluksela has an MSc (Tech) degree in printing technology and a LicSc (Tech) degree in environmental technology and management, both from Helsinki University of Technology (now Aalto University). Before embarking on a teaching career at Metropolia (previously EVTEK), he has worked in the paper and printing industry and in development co-operation projects.

Practical approach to manage the environmental issue

Csaba Horváth[1], István Patkó[2]

[1] *Óbuda University, Institute of Media Technology, Hungary*
[2] *Óbuda University, Institute of Environmental Protection Engineering,Hungary*
horvath.csaba@rkk.uni-obuda.hu
patko@uni-obuda.hu

Keywords: environmentally friendly printing, certification system, EFP mark

Abstract

The authors have demonstrated in the article what principles can serve as the basis of the development of a system of criteria that would qualify, offer references and examples for the environmentally conscious operation of printing companies. Such a system of qualification and title would be an important marketing tool and element of persuasion towards evidencing the sustainable development of graphic communication.

Scope of research

If you really care about the environment, turn off your server tonite
Paper is a completely renewable resource!
(Michael Makin, President & CEO, Printing Industries of America)

In the struggle between graphic and electronic communication taking place in our evolving information society, this latter type of communications seems to have a more positive image in society. Such judgment must have emerged as a result of opinions that have been formulated in relation to the erroneously interpreted and assumed environmentally-damaging impacts of printed products and technologies.

One of the most important responsibilities of the profession is to turn this negative judgment of the public opinion into a positive evaluation by highlighting the unaltered efficiency, importance and enhanced environmental friendliness of printed products.

The authors have demonstrated in the article what principles can serve as the basis of the development of a system of criteria that would qualify, offer references and examples for the environmentally conscious operation of printing companies. Such a system of qualification and title would be an important marketing tool and element of persuasion towards evidencing the sustainable development of graphic communication.

And how can a printing company be environmentally friendly? Obviously as a result of its commitment to environmental protection and consciousness. The printed products of such a printing company considerably reduce environmental loading, and support sustainable development. In addition to the environment-sparing technologies, environmental aspects also determine the internal operation of the printing company, and are taken into consideration to an utmost extent.

Commonly used labels and certification systems

Printers' environmental programmes are either independent company initiatives or, more commonly, voluntary regional schemes like those Scandinavian Nordic Swan or France's Imprim' vert (Green Printer). The latter is an initiative launched by the French Printing Federation FICG) in association with Chambers of Craft and Commerce. Participating printers are given assistance to define their environmental priorities. A network of over 60 engineers has been created to visit this these printers to assist them in implementing their policies. At the same time FICG helps promote companies that have obtained the Imprim'vert classification by using the logo as a value added brand to print buyers, administrators and insurance companies [1]. Printing Industries of America has introduced a Sustainable Green Printer Partnership, the Japanise Federation of Printing Industry manages the Green standard and GP certification system [2,3].

Proposal for an eco-friendly printing standard and EFP certification system in Hungary

On the basis of this approach, such a set of criteria can be defined that seems to be sufficient for appropriate evaluation, still does not make qualification superfluously complicated. Under the commission of the Hungarian Federation of Printers and Papermakers, the authors have made a proposal for such a solution.

Primarily, they have set forth requirements whose fulfillment can be properly documented, controlled.

Factors of standard to be environmentally friendly:

- reduction of pollutant,
- prevention of global warming (carbon footprint)
- material circulation (sustainable resource use; long term use; reuse, recycle; easy processing and disposal),
- easiness to continue and improve the task.

Besides environmental sustainability, the system of standards for evaluation also considers activities performed for economic and social sustainability.

The proposed system would award the title on the basis of applications. By submitting their applications, the actors wishing to use the title should complete a self-assessing checklist that serves as a stage of pre-selection. Thereafter, an appointed body accredited by the founder and professional forums would verify the authenticity of the self-assessments. Then, the founder decides on the awarding of the title for a definite term.

The authors have already tested the proposed system of criteria at seven Hungarian printing companies, checking whether the system can be used realistically. The responses and results show that the criteria that they have elaborated and recommended can be fulfilled, and are motivating. Nevertheless, until acceptance they still should be subjected to and shaped in several filters and consultations.

The authors are also proposing the creation of a trademark in association with the “eco-friendly printing” title.

Figure 1. Proposal for trademark “eco-friendly printing” title (English and Hungarian).

Conclusion

“Eco-friendly printing and sustainability are more than using recycled paper and soy inks … it is a holistic approach to running a business.” (Gary Jones, director of PIA) [3]. The Hungarian printers should operate on eco-friendly way to demonstrate their business is a sustainable medium.

References

[1] Nigel Wells: Sustainability, Energy & Environment; Frequently asked question … and some answers, Printcity GmbH Co.KG, 2008, Paris, 23 p.

[2] Nsenga Thompson: Big impact, Green strategies for smaller printers, American Printer, April, 2010 18-20 p.

[3] Kunio Ishibashi: Green Standard and GP certification system, World Print and Communication Forum, London, March 25, 2010

Author biography

Professional CV of Csaba HORVATH

Born and live:	*1953, Budapest, Hungary*
Qualifications:	*Mechanical Engineer (M.Eng) – Technical University of Budapest, 1977*
	Electrical Engineer (M.Eng.) – Technical University of Budapest, 1987
Academic degree:	*PhD – Pannon University, 2006*
	Dr. (univ) – University of Veszprem, 1994
Workplaces:	*Óbuda University, Budapest, Associate Professor, 2007 –*
and professions:	*Director of Media Technology Institute, 2010 –*
Others:	*President of the Federation of Hungarian Printers and Papermakers, 2008 –*
	Member of the Board of INTERGRAF, 2010 -
Main fields of research:	*Printing technologies and machines, Production and Maintenance Management, Environmental Engineering*

A study on the Influence of calcium carbonate as a filler in bagasse based uncoated paper during perfecting in an offset printing machine and its impact in reducing carbon foot print

Prof. Dr. Rajendrakumar Anayath[1] & Amrutharaj Harikrishnan[2]

[1]Head, Print Media Academy, Heidelberg (I) Pvt. Ltd, Chennai – 44, INDIA.
[2]Print Application Specialist, PMA, Heidelberg (I) Pvt. Ltd, Chennai – 44, INDIA.
rkanayath@yahoo.com, amrutharajhk@yahoo.com

Keywords: Top Wire Side, Offset printing, Perfecting, Alkaline paper, ISO 12467 – 2 standards.

Abstract

This paper presents a method to check the drying property of substrate used in offset printing there by printer can save energy, consumables and substrate. This will also help us to know the CO_2 (Carbon-di-oxide) generated and means to reduce the carbon foot print. A press system encompasses the printing press plus all of the materials that are used to print, such as paper, ink, fountain solution, plates and blankets. The two phase experiment sequence for checking the ink drying on uncoated paper includes the following stages. In the 1st phase Printing on Back Wire (Smooth Side), Printing on Top Wire (Rough Side) with ISO 12467 – 2 standard and study the print. Recommend the paper manufacturer to improve the product's surface structure based on the evaluation made. In the 2nd phase Printing on Back Wire (Smooth Side), Printing on Top Wire (Rough Side) and vice versa. All press setting should be with ISO 12467 – 2 standard and study the print.

Offset printing technology constitutes 53% of complete printing industry in the Indian peninsula, but very few in the printing community is aware of the Environmental aspects. This study will help to find out solutions to make Indian print industry green, rather a new concept "CO_2 NEUTRALISED PRINT".

Objective

Study the ink drying behavior of uncoated paper at optimized printing condition. This will also help us to know the Carbon dioxide generated through energy consumed, consumables used, through substrate wasted as well as means to reduce the carbon foot print.

Need of the study

It is important for us all to think in terms of first reducing our emissions of CO_2. As one begins this process, it soon becomes evident that there is no way we can currently reduce our emissions of green house gases to zero. Every single aspect of our economy from manufacturing to transportation, and agriculture to health care is dependent on fossil fuel derived energy and resources. As we seek and develop alternative sources of energy, and as we begin to think and live in more efficient ways, we are still left with the undeniable reality that considerable CO_2 emissions from economic activity of the industrial world will continue and perhaps escalate for the foreseeable future. The only current way to address this issue head on is to offset the emissions we cannot yet eliminate.

Majority of the present day jobs demand double sided printing sometimes single colour on both sides or two colour or can be four colour or more on both sides. In India there are very few presses with 8 unit perfecting facilities to finish multi colour printing on both sides in one stretch. So many times the one sided printed pile undergo a waiting time before the reversal printing. This study will help us to understand how to reduce the carbon foot print and the time delay influences in back trapping or smearing on to the impression cylinder of ink.

Methodology

Heidelberg SM-74 -4+P, press is used to conduct this experiment. Papers used in this study are uncoated paper. In order to ascertain that finding under standard printing conditions, a lot of 30 reams of 80 gsm Super Printing Maplitho grade used for the test printing. The maximum image size was taken so that any variation in all the four corners as well as the center can be measured for different parameters. The test form selected was of solid image where by there will be maximum coverage of ink and the reaction can be easily detected. Saphira Thermo Plate with process calibrated curve was used so as to have recommended dot gain specified by ISO 12647 – 2 standards. The temperature and humidity has a great influence on the Runnability of paper. During the

experiment the shop floor temperature is 22.8 degree centigrade with Rh of 55. For testing the paper used is uncoated paper, hence the variation in the Rh can easily affect the stiffness paper ultimately affecting Runnability. The moisture content in paper is also checked and temperature maintained at 23 degree centigrade with Rh of 60.6. Since the machine has to be set for the thickness of paper for smooth travel and proper impression, the paper thickness is measured and loaded as 0.07 mm. for 80 gsm uncoated paper.

Ink and fountain chemistry balance is very critical in offset printing. This process is called emulsification. The emulsification differs from ink to ink and fountain to fountain. The fountain solution is prepared with 10% iso propyl alcohol with 2% fount in 88% water with the hardness of 8 dH. The conductivity of the base solution is 1058 micro semen when the temperature is maintained at 10.9 degree centigrade. Variation in this chemistry proportion can bring down pH to acidic nature there by affecting the life of dots on plate. This can also can affect the drying of ink as well as ink density on paper. Saphira HEI Edition low tack ink - ideal for uncoated papers were used throughout the experiment. Targeted ink density was Y – 1.39, C – 1.52, M – 1.64, B – 1.94. The ink sweep and dampening sweep which is responsible for the amount of ink supply on the inking rollers and moisture to plate is kept 30% and 35% respectively.

Often it was found that during printing of uncoated papers the ink from the first side printing (BW) is transferred on to the impression cylinder seriously affecting the image printed on the first side.

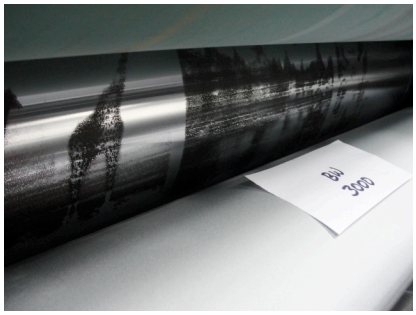


Figure 1. Photograph showing impression cylinder at 3000th copy.

This phenomenon is visible even at 1500 – 3000 impressions. As a results frequent cleaning of the impression cylinder is essential thus resulting in down time of the machine which results in more energy loss and reduction in productivity. This experiment has been carried out under these circumstances.

Normally all the printers print the smooth side (BW) of the paper as the side faces the roof when the paper bundle is opened. Once the BW printing is completed the job is taken up for the rough side printing (TW). While printing in this sequence it was recommended to print the rough side (TW) first instead of the normal practice of printing the smooth side (BW) first.

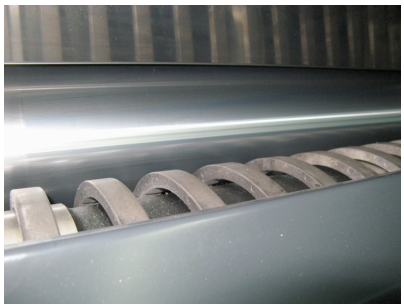


Figure 2. Photograph showing the ink deposition on the impression cylinder before printing.

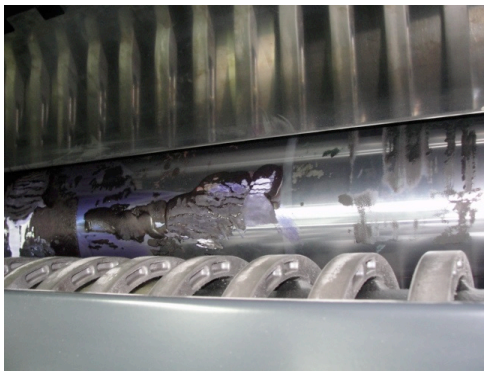


Figure 3. Photograph showing the ink deposition on the impression cylinder after printing

Carbon footprint

The term "carbon footprint" refers to the amount of carbon (CO_2) we emit individually in any one-year period. CO_2 is produced from many sources and is the primary gas responsible for Global warming and the resulting alarming changes in our climate. Nearly everything we do in our modern society requires energy. This energy is generated primarily by burning fossil fuels. From all sources, the average American is responsible for approximately 19.00 – 21.00 tons of carbon emissions annually, where as an Indian citizen is responsible for 1.00 – 1.50 tons of carbon emission annually. The US as a whole is responsible for emitting approximately 25% of all global green house gas emissions every year while they are only 5% of the world's population.

Observations & Inference Experiment 1

1.	Energy consumption for 51 x 74 format	= 36kw
	Average CO_2 factor for electricity per kWh	= 0.514 kg CO_2
	CO_2 for 36 kW for 8 hours	= 148 kg CO_2
2.	CO_2 in kg/kg material	= 3.8
	IPA used	= 6.4 kg
	CO_2 for 6.4 kg	= 24.32 kg
3.	CO_2 factor for blanket	= 6.5 kg/m2
	For blanket size .772 m x .627 m	= 3.146 kg CO_2
	For 4 printing blankets	= 12.6 kg CO_2
4.	CO_2 in kg/kg Wash-up solvent	= 2.3
	Wash-up solvent used	= 2.5 kg
	CO_2 for 2.5 kg	= 5.7 kg
5.	CO_2 factor for plate	= 7.88kg/m2
	For plate size .745 m x .605 m	=3.551 kg CO_2
	For 4 printing plates	= 14.2 kg CO_2
6.	CO_2 in kg/kg fount	= 2.0
	Fount used	= 1.28 kg
	CO_2 for 1.28 kg	= 2.56 kg
7.	CO_2 in kg/kg Ink	= 2.5
	Ink used	= 2.0 kg
	CO_2 for 2.0 kg	= 5.0 kg
8.	CO_2 in kg/kg Substrate	= 1.27
	Paper used = 30 reams x 21.3/kg	= 639 kg
	CO_2 for 639 kg	= 825 kg

Table 1. Carbon foot print calculation of the first experiment

Total CO_2 release during this exercise is 1037.38 kg.

The following advantages were observed while printing of the rough side of the paper first. 1.) Higher surface strength - since the ink pick up is reduced on to the impression cylinder, 2.) Lower filler orientation

- usually the filler is applied to the (BW) side which will smoothen the paper surface, where as the TW side has lesser filler which results in higher bonding of ink and thus reduced ink transfer. 3.) Since the ink absorbed on the TW is of less thickness the drying is fast as the oil is less absorbed. 4.) As the TW side is wavy (peaks & valleys) due to the fiber orientation, there by blanket contact area is less allowing less ink transfer. During the experiment it was observed that, the runnability is improved.

Use of hi-tack / hi-pigmented inks certainly prevent emulsification up to an extent. When paper is at delivery pile keep a low pile so that there will be space between the sheets. Increasing the porosity and increase the wood pulp% can improve surface finish of paper. Maintain slightly more temperature ie. +2 degree centigrade than the existing operating temperature in the shop floor. We suggest 24 degree centigrade for India. Paper humidity should not be less than 45 % in any case ,otherwise it may lead to static electricity formation on the paper which leads to more printing problems. Ash content on paper can be increased up 12% for enhanced oil absorption. Use as minimum fountain chemistry % possible.

Based on the recommendation and inference 80 gsm Super Printing Maplitho grade paper was improved for its filler content, porosity, wood pulp% where by surface finish of paper was improved and keeping the printing variables constant the experiment was repeated for the second time under the same conditions.

Observations & Inference Experiment 2

Below is the preliminary observation recorded during 2nd experiment. Extent of Ink Transfer into the impression cylinder:

	Smooth side 1st ptd.	Rough side 1st ptd
After 2000 reversal impressions:	very less	Nil
After 4000 reversal impressions:	Nil	Nil

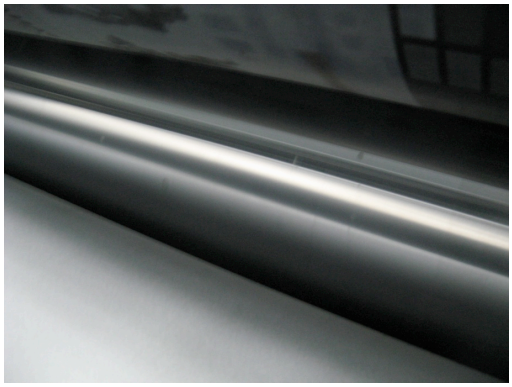


Figure 4. Photograph showing impression cylinder at 4000th copy.

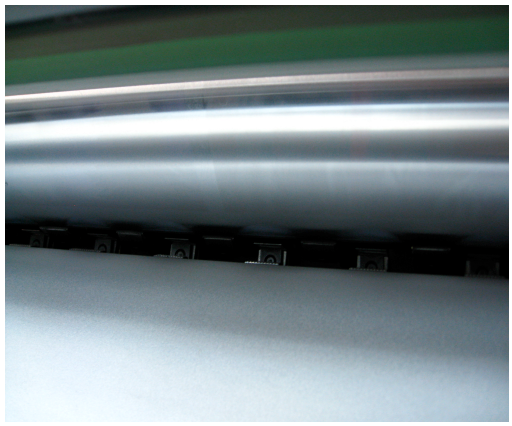


Figure 5. Photograph showing impression cylinder at 2000th copy.

1.	Energy consumption for 51 x 74 format	= 36kw
	Average CO_2 factor for electricity per kWh	= 0.514 kg CO_2
	CO_2 for 36 kW for 3 hours	= 55.5 kg CO_2
2.	CO_2 in kg/kg material	= 3.8
	IPA used	= 6.4 kg
	CO_2 for 6.4 kg	= 24.32 kg
3.	CO_2 factor for blanket	= 6.5 kg/m2
	For blanket size .772 m x .627 m	= 3.146 kg CO_2
	For 4 printing blankets	= 12.6 kg CO_2
4.	CO_2 in kg/kg Wash-up solvent	= 2.3
	Wash-up solvent used	= 1.5 kg
	CO_2 for 1.5 kg	= 3.45 kg
5.	CO_2 factor for plate	= 7.88kg/m2
	For plate size .745 m x .605 m	=3.551 kg CO_2
	For 4 printing plates	= 14.2 kg CO_2
6.	CO_2 in kg/kg fount	= 2.0
	Fount used	= 1.28 kg
	CO_2 for 1.28 kg	= 2.56 kg
7.	CO_2 in kg/kg Ink	= 2.5
	Ink used	= 1.00kg
	CO_2 for 1.00kg	= 2.50kg
8.	CO_2 in kg/kg Substrate	= 1.27
	Paper used = 5 reams x 21.3/kg	= 106.5 kg
	CO_2 for 106.5 kg	= 135.2 kg

Table 2. Carbon foot print calculation of the second experiment

Total CO_2 release during this exercise is 246.35 kg.

CO_2 saving after the paper is improved = 791.03 kg. (1037.38 kg. - 246.35 kg.)

This saving of 791.03 kg. is achieved due to the following:

1. As there was no ink deposition on the impression cylinder the printing machine run for less hours, because cleaning of impression cylinder was not required.
2. Use of wash up solvents to remove ink deposition on the impression cylinder reduced
3. Ink consumption was also reduced as the paper surface is better, targeted density could be achieved faster.
4. These factors resulted in 70% reduction in the use of paper where by CO_2 was substantially reduced.

Conclusion

Paper, Ink, Printing plates, Cleaning agents and Energy has diverse impact on environment. There are multiple approaches for reducing or even eliminating these impacts. It is the paper that provides by far the biggest opportunity for shrinking a print job's carbon foot print. Depending on its properties and how it is made, paper accounts for between 60% to 80% of the total CO_2 emissions. Therefore printer has to be very meticulous in selecting an appropriate stock.

References

[1] Kipphan, Helmet, "Handbook of print media technologies and production methods," (Illustrated ed.), Springer, p.354, ISBN 3540673261, 2001.

[2] Ryberg, Robert, "A guide to graphic print production (second ed.)," Wiley, p. 353. ISBN 0471761389, 2007.

[3] Rainey, “A study into the permeability and compressibility properties of bagasse pulp,” PhD thesis, Queensland University of Technology, 2009.

[4] Goodward, Jenna, Kelly, Alexia, “Bottom line on offsets,”, World Resources institute, 2010.

[5] Gillenwater, Michael, Derik Broekhoff, Mark Trexler, Jasmine Hyman, Rob Fowler, "Policing the voluntary carbon market". Nature Reports Climate Change 6 (0711): 85–87, 2007.

[6] Albert, Richard J., Worldwide Survey: State-of-the-Art TCF Bleaching, Int’l Non-Chlorine Bleaching Conference Proceedings, Florida, Alliance for Environmental Technology (AET), 1995

[7] Beck, H., et. al, , Occurrence of PCDD and PCDF in different kinds of paper, Chemosphere, 17(1): 51-57. 1988

[8] Saunamäki, Reijo, , Finish Pulp and Paper Research Institute (KCL), Treatability of wastewater from totally chlorine-free bleaching. Tappi Journal, 78(8):185-192. Aug. 1995

Keynote:

Printed Electronics – Introduction and Current Research

Isak Engquist

Linköping University, Deptartment of Science and Technology
Sweden
isak.engquist@liu.se

Abstract

What is printed electronics, what can it do for us today and what will the future bring? Norrköping has established itself as a strong environment in the area of printed electronics, with world class research at LiU, demonstrators and prototypes at Acreo AB, and production facilities at PEA-Manufacturing. In this keynote, an introduction to the area will be given, followed by a description of current research in Norrköping and a look at the possible future development.

Author biography

Isak Engquist is an associate professor in the Organic Electronics research group at LiU, Campus Norrköping. He moved to LiU in 2007, after working with optical sensors at the Swedish defence research agency (FOI) and with organic memories at Thin Film Electronics AB. His current research interests include printed transistors, diodes, and sensors.

Screen printing into cavities of a thick insulating layer as a part of a fully printed thermoelectric generator

Dipl.-Ing. (FH) Andreas Willfahrt, Dipl.-Ing. (FH) Jochen Witte, Prof. Dr.-Ing. Gunter Hübner

Stuttgart Media University– Hochschule der Medien (HdM)
Nobelstrasse 10, 70565 Stuttgart, Germany

Keywords: Seebeck effect, thermoelectric generator, waste energy harvesting, screen printing

Abstract

Thermoelectric generators (TEG) convert thermal energy into electricity, directly [1]. The sophisticated and therefore expensive ways of producing such TEGs presently prevent the technology to enter new markets other than space missions or the combustion systems of cars [2]. A promising approach to reduce the costs per Watt is to print the TEG structures on flexible substrates to be able to affix the flexible TEG directly on the heat source or sink. This report describes the process of assembling a fully printed TEG especially the issues that arise when printing the intermediate insulating layers in a so called vertical layout of a TEG. As the layer thicknesses all are rather thick screen and stencil printing were used. When the cavities in the insulating layer are subsequently filled with the thermoelectric leg materials the electrical contact between the top and the bottom conductors of the TEG are established. However, the cavities must be filled properly to ensure a good electrical contact. For this reason, the flow behaviour of the thermoelectric materials must be optimized for printing.

Introduction

The so-called Seebeck effect was found in 1821. Seebeck noticed a thermoelectric potential when a temperature difference between the contact point of a couple of dissimilar conductive materials and the open ends of the thermocouple exists, illustrated in Figure 1, single thermocouple [1]. The voltage generated by a single thermocouple is quite small, usually in the range of some μV. Since the Seebeck coefficient is a material constant, it is important to use materials with a high Seebeck coefficient to maximize the generated thermoelectricity. Thermal diffusion of the major charge carriers in the conductor (Figure 1) determines, whether the Seebeck coefficient is positive or negative compared to a reference material, e.g. Pt or Cu. Combining a highly positive and a highly negative leg achieves the best performance of a thermocouple. Thermocouples are also used for temperature measurement because the generated thermoelectric voltage is characteristic for a material combination.

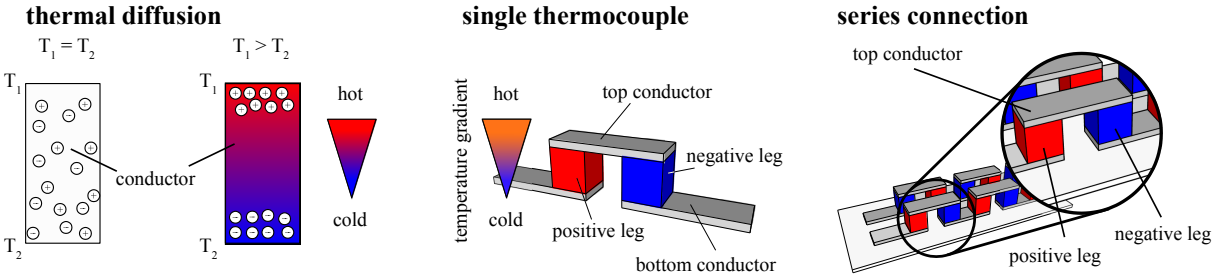


Figure 1. A thermocouple consists of two dissimilar materials electrically connected. Several to many of these thermocouples connected electrically in series and thermally parallel form a thermoelectric device, e.g. a thermoelectric generator. In reverse it is also possible to apply voltage to the thermocouples in order to generate a cooling effect which is known as a Peltier element

Thermoelectric generators consist of more than one couple since the generated voltage is proportional to the number of single thermocouples. The best performing material in room temperature range is Bi_2Te_3 n- and p-type doped. Previous work was done in formulating a printable Bi-ink but oxidation during ink preparation and subsequent application of the ink in screen printing is supposed to inhibit electrical conduction. In this report the authors work with nickel as the n-leg material and with PEDOT:PSS as the p-leg [3] and the focus is on the optimization of the n-leg nickel ink. Although nickel has not an optimum Seebeck coefficient it can be used as a model ink to study the printing technique and assembly of the TEGs. During this work the nickel ink has been improved especially with respect to printability and the levelling behaviour after the snap-off of the screen. Once

printable materials with higher Seebeck coefficients are available the knowledge gained here can easily be adapted.

Printed Thermoelectric Generators

As shown in Figure 2, the fully printed thermoelectric generator (TEG) comprises of five functional layers. The first layer is a silver conductor on the substrate. The second layer is an insulating material with apertures into which the thermoelectric materials are printed subsequently. The last layer is a second silver conductor on top.

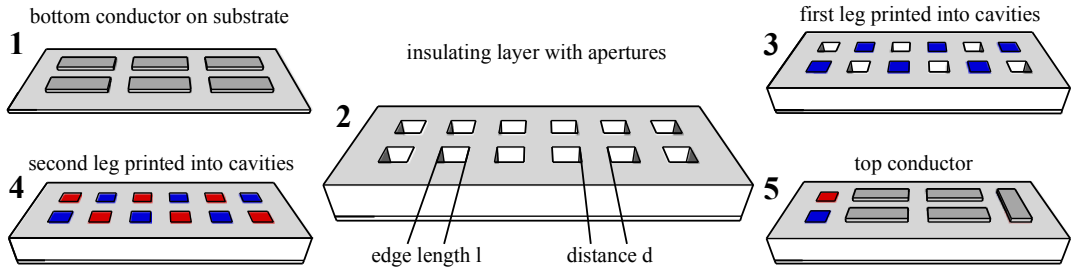


Figure 2. Fully printed thermoelectric generator in a five layer vertical setup. 1) bottom conductor 2) insulating layer with apertures (cavities) 3&4) thermoelectric materials printed in cavities 5) top conductor.

The insulating layer is needed to achieve a reasonable overall height in order to maintain the temperature gradient between the hot and cold side, i.e. the insulating layer provides very high thermal as well as electrical resistance [4].

Materials and Parameters

Two promising candidates for the insulating materials with good processability and ink layer deposition were found in a previous investigation. Their properties are summarized in Table 1. The fundamental difference of the materials is the way of curing. If multilayer printing is necessary to achieve a reasonable ink layer thickness, the UV ink (CFSN 6052) is to prefer over the plastisol ink (Texiplast 5000) due to the time advantage of the curing process. The measurement of the surface roughness shows different tendencies for both materials. The Rz-Value of the UV ink decreases with successively printed layers (-18%) but the plastisol ink's surface roughness (Rz-Value) increases with multiple print runs (+13%), see Figure 3.

Table 1. Insulating materials, printed with a 54-64 (meshcount in threads/cm – thread diameter in µm) screen

Material	Ink Layer Thickness (single print stroke)	Surface Tension	Rz-Value
SunChemical CFSN 6052	20 μm	25 mN/cm	1.44
Manoukian Argon TEXIPLAST 5000	30 μm	34 mN/cm	1.35

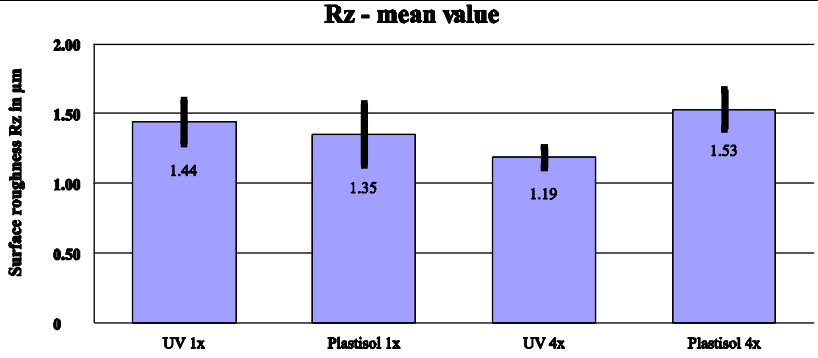


Figure 3. Surface roughness of the printed insulating layers. Both materials were printed in one (single stroke 1x) and four print runs (4x, multilayer with intermediate drying process).

With several subsequently printed layers the ink layer deposition is almost equal with both insulating materials. For instance, the ink layer thickness of five subsequently printed layers is in both cases around 100 μm. The Plastisol-ink was chosen for the print trials because of the smoother surface.

The self-made Ni-inks were prepared using different particles, additives and solvents (see Table 2). The nickel particles differ in size (Alfa Aesar nickel powder, average particle size 3-7 μm; Vale T255™ nickel powder, average particle size 2-3 μm). Dispersing additives were chosen for their known property to reduce dispersion viscosity and stabilization of pigments against settling. The solvents chosen for blending with Cyclohexanone as the main solvent show a higher evaporation number than Cyclohexanone which should provide better levelling and therefore surfaces with less roughness (Cyclohexanone = 40 [5], Butyl glycol acetate = 190 [6], 2-Ethylhexyl acetate = 320 [7], evaporation number reference is Diethyl ether = 1). The binder used for all inks was ethyl cellulose N 200 (Ashland Aqualon). An ink consisting of 70 wt % of Alfa Aesar Ni powder and a butanol-cellulose blend was used as reference material (Ni70).

Table 2. Investigation of different ink constituent parts.

Parameter / Factor	Variables / Level		
Ni particles	Alfa Aesar Ni powder	Vale T255™ Ni powder	Alfa Aesar : Vale T255™ (1:1)
Particle size	3-7μm	2-3μm	blend (2-7μm)
solvent	Cyclohexanone	Cyclohexanone : Butyl glycol acetate (2.6:1)	Cyclohexanone : 2-Ethylhexyl acetate (2.6:1)
additive	no additive	DISPERBYK® 180	DISPERBYK® 2155

A full factorial design of experiments (DoE) with 3 factors and k = 3 levels (3^k = 27 inks) was setup comprising of all variations listed in Table 3. The 27 inks were prepared with a high-speed dissolver (VMA Getzmann LC30, tooth disc 40 mm diameter, 10 min 800-1000/min) in a beaker of 7 cm diameter.

Table 3. Ink codification.

	Vale T255™ nickel powder			Mixture of Alfa Aesar : Vale T255™			Alfa Aesar nickel powder		
	no add.	BYK 180	BYK 2155	no add.	BYK 180	BYK 2155	no add.	BYK 180	BYK 2155
Cyclohexanone	P01	P02	P03	P10	P11	P12	P19	P20	P21
Cyclohexanone + Butyl glycol acetate	P04	P05	P06	P13	P14	P15	P25	P26	P27
Cyclohexanone + Ethylhexyl acetate	P07	P08	P09	P16	P17	P18	P22	P23	P24

The ink formulation (Table 4) is calculated to give 50% solids on mass (disregarding the additive) and a pigment volume concentration (PVC) of 80%. The PVC is critical for the resistance of the dried ink systems as the counterpart (20% in this case) is the binder, which is intrinsically isolating. The binder settles between the particles and increases the contact resistance between them or even isolates them totally from each other.

Normally inks are tuned to the desired viscosity by adding solvent. In this study the amount of solvents is fixed in order to be able to study the influence of the dispersing additives on the viscosity outcome.

Table 4. Composition, proportion of constituent parts.

Ingredient	Weight
nickel particles	48.22g
solvent	35.84g + 13.54g
additive	0.00g or 1.20g
binder	1.20g

The found results and properties for the newly formulated inks are compared with the standard ink Ni70 (Table 5).

Table 5. Ink formulation Ni70.

Ingredient	Weight
Alfa Aesar Ni powder	70.00g
solvent n-Butanol	45.00g
binder EC N 200	2.00g

The formulation for Ni70 gives a PVC of 82% and a total solids content of 60% on mass.

Issue: Filling of Cavities

The cavities must be filled properly with the thermoelectric materials in subsequent print runs. As an optimum the exact height of the insulating layer must be achieved. If the ink is not able to fill the cavities completely or if the material deposition is higher than what fits into the cavities, problems with printing the silver conductor on top will occur. Figure 5 illustrates the issue resulting from the low solid content of the PEDOT:PSS ink (p-leg) leading to only partially filled cavities. The dotted line represents the ideal height that should be achieved by both thermoelectric inks. On the other hand the nickel ink exceeds this height. In order to optimize the nickel deposit the full factorial trials were carried out.

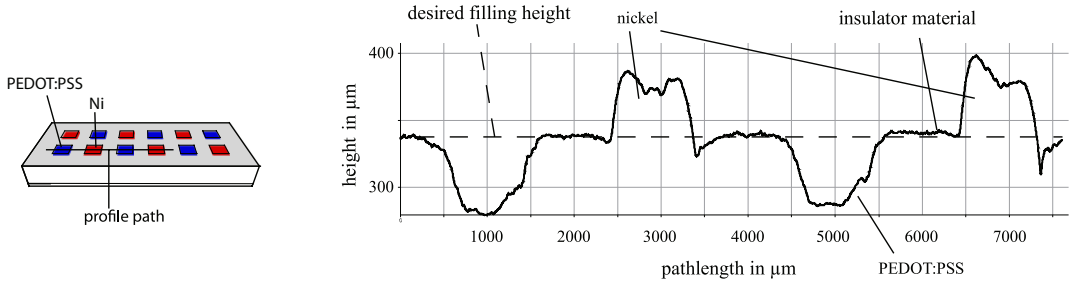


Figure 5. Crosscut through a printed TEG. The layer thickness measured along the profile path. The cavities are alternately filled with PEDOT:PSS and nickel ink (Ni70). The dashed line marks the ideal level of filling.

Methods and Hardware

Before printing rheological measurements of each ink were performed with an Anton Paar MCR 300 rheometer with cone plate geometry of 25 mm diameter and 1° angle. The measurements allow for a detailed examination of the interesting parameters and good understanding of the impact of these parameters on the inks properties.

For the print trials two test forms including different structures were employed. A rectangle with 2 cm by 7 cm is used for resistance measurements (test form “rectangle”, 54-64 screen mesh). The ability to fill the cavities properly is examined with the second print form comprising of squares in different distances to each other (0.5 mm, 1.0mm and 1.5 mm, test form “squares”, 77-48 screen mesh, see Figure 6). Table 6 shows the parameters of the screen preparation. The filling of the cavities is examined by assessing the thickness along the crosscuts (as shown in fig.5) measured with the confocal microscope Alicona Infinite Focus.

Table 6 shows the parameters of the printing forms. Both screens were coated using an automatic screen coater, 2 coatings on the print side, 1 coating on the squeegee side. Figure 6 illustrates the printing form “squares”. The 54-64 screen mesh coating achieved a smaller standard deviation (SD) than the 77-48 screen mesh.

Table 6. Printing form parameters.

	emulsion over mesh	screen tension	Stencil surface roughness Rz
54-64, “rectangle”	20.6 μm, SD = 1.4 μm	24 N/cm	5.2 μm
77-48, “squares”	68.1 μm, SD = 3.2 μm	25 N/cm	2.8 μm

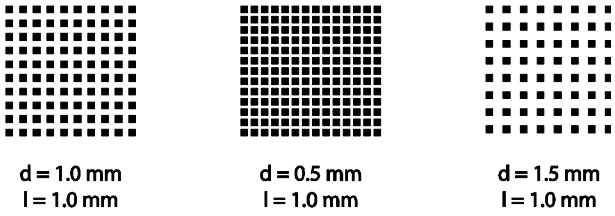


Figure 6. Printing form "squares".

Results

All 27 ink variations were printed with test form "rectangle" on PET substrate (Melinex, 175 μm thickness, tempered before printing). Afterward the resistivity of the printed test element was measured with a Keithley 173 A Digital Multimeter. Since the print results were differing in terms of the wetting behaviour and the resulting ink film homogeneity, a test setup (Figure 7) was chosen instead of using a four-probe setup. A preliminary test showed that using contact probes destroyed the ink layer. The resistivity test setup was prepared by gluing two pieces of copper plated epoxy boards (as in standard PCBs) on a polystyrene basis for a defined measuring distance. The test samples were put on the copper plated side of the boards. A weight of 250 grams was used for a consistent pressure on the copper plate. The test leads were soldered to the copper plates.

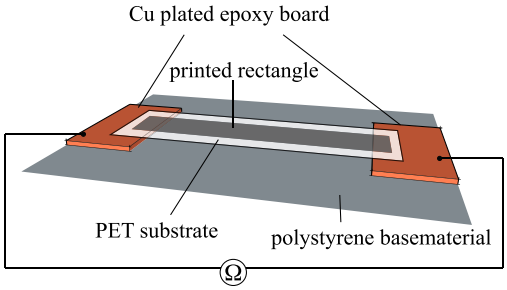


Figure 7. The test setup for the resistance measurements of the printed rectangles. Test leads were soldered onto the copper plated boards on each side.

Already the subjective impression of printability during the print trials gave a good indication for the ink performance, since the flow behaviours and the print results are very different. The results of the resistance measurements correspond very well to the impressions during the print trials. The inks P10 to P18 showed very different flow behaviour than the other inks. According to Figure 8, P11 to P15 show no conductivity, at all. The inks P01 to P09 show in general a better conductivity than the inks P19 to P27. The inks P01, P04 and P07 even indicate a lower electrical resistance than the reference ink Ni70.

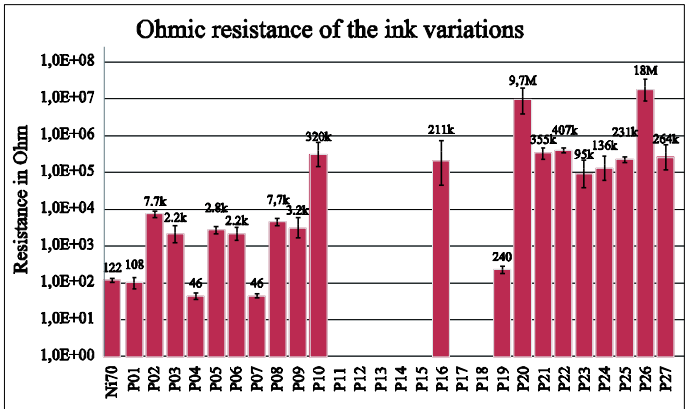


Figure 8. Resistance measurements of all 27 ink variations.

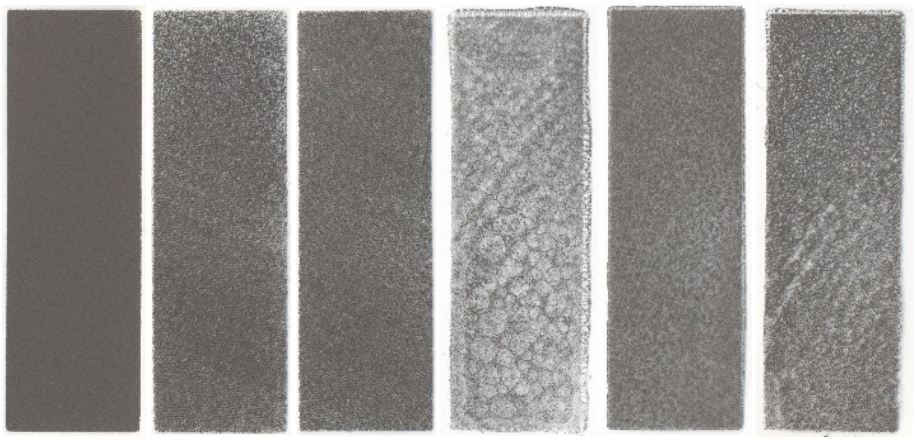


Figure 9. Print samples with different ink variations. The reference ink Ni70 shows the best opacity (indicator for even particle distribution). All 27 test inks were more or less translucent (indicating uneven particle distribution). The inks P10 to P18 were only partially conductive.

The visual assessment of the printed samples yields huge differences in the opacity, thus in the distribution of the Ni particles. While the inks P01 to P09 were stable and provided quite a good homogeneity of the particle distribution, the inks P10 to P18 were severely worse. As shown in Figure 9, P14 had the worst appearance in terms of the particle distribution and the opacity of the ink film. The Ni70 reference ink showed only little defects in the ink layer compared to the other specimens. For the subsequent trials only the first nine inks (P01 to P09) were taken into account, since the other inks didn't show the needed performance regarding the printability and conductivity.

Filling results

The filling behaviour of the inks was tested with the print form "squares". Printing the inks P01 to P09 into the cavities of the plastisol insulating layer resulted in only partially filling. Since the inks P01 to P10 as well as P16 didn't achieve satisfying print results in terms of properly printed "squares", this test procedure was discarded. It was assumed that the mesh properties interacted with the high EOM leading to a disturbed ink release and thus an incomplete printed image. Instead of the screen a copper stencil was tried. For the stencil preparation apertures were etched into a 300 μm thick copper plate. The apertures formed a trapezoidal geometry providing a wider opening on top of the stencil.

Table 7. Visually assessed quality of ink transfer.

Evaluation Matrix									
Ink variation	P01	P02	P03	P04	P05	P06	P07	P08	P09
d = 0.50 mm	+	--	--	++	+	0	-	--	--
d = 1.00 mm	+	-	++	+	-	0	-	--	--
d = 1.5 mm	+	-	0	+	-	-	--	0	--
overall ranking	+	-	0	++	-	0	--	-	--

The stencil printed samples were assessed visually. This assessment included completeness of the image and the filling of the cavities. The visual inspection of the samples allowed a revision of the inks behaviour during the stencil printing process. The best result was achieved with the inks P04 and P01. Both inks showed better electrical conductivity than the reference ink Ni70. However, the ink P07 – which also showed low ohmic resistance – was rated poor. Visually assessed, the ink variations P03 also showed a reasonable result, but the ohmic resistance is about 20 times higher than resistance of the reference ink.

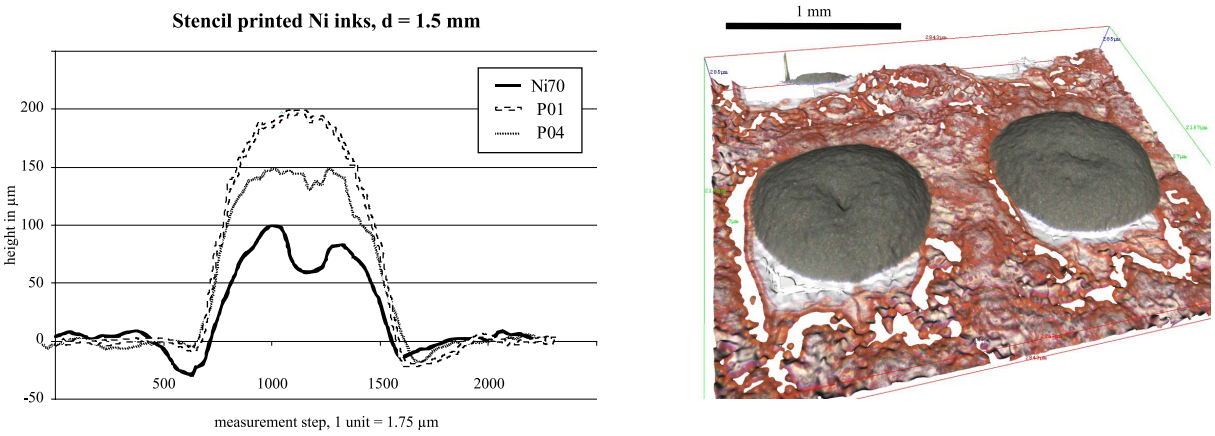


Figure 10. The reference ink Ni70 and the P01, P04 inks differ in the shape of the profile. The Ni70 ink sinks in the center, leading to a sort of "doughnut effect" which is not displayed by the profile of the inks P01 and P04.

In Figure 10 the comparison between the stencil printed profiles of the best performing inks P01, P04 and Ni70 is shown. The stencil apertures provided squares with rounded corners due to the etching process. Thus, the printed structures are similar to printed dots (Figure 10, right). P01 and P04 differ substantially from the reference ink Ni70 in the absence of the "doughnut effect", which is shown in microscope image on the right hand side. The highest ink layer was achieved with the ink variation P01, which is also one of the best performing inks regarding the ohmic resistance. Further insight was found by conducting rheological measurements of the insulating materials

In order to understand why surface roughness increases for the plastisol with additional printing runs and decreases for the UV ink in the rheometer the structure recovery (T = 23°C, γ = 1%, ω = 10rad/s, Figure 11 left) after shear and the behaviour while curing (simulated through a temperature ramp T = 23°C-118°C-23°C; ΔT = 2K/min, γ = 1%, ω = 10rad/s, Figure 11 right) were assessed.

The recovery after shear differs profoundly between the two inks. While the UV ink (SunChemical) is still able to level as the loss modulus G'' is much higher than the storage modulus G', the plastisol ink (Manoukian Argon) shows from the first data point G' over G'' meaning that it cannot level at all. This leads to the conclusion that the surface roughness increase for the plastisol ink is caused by mesh marking while the decrease for the UV ink is caused by levelling after printing (Figure 11 left).

On cure the plastisol ink shows storage modulus G' constantly over loss modulus G'' and can therefore not level in the cure stage (Figure 11 right). Cure for the UV ink is happening nearly instantly as the UV-hardening reaction commences when exposed to UV-light.

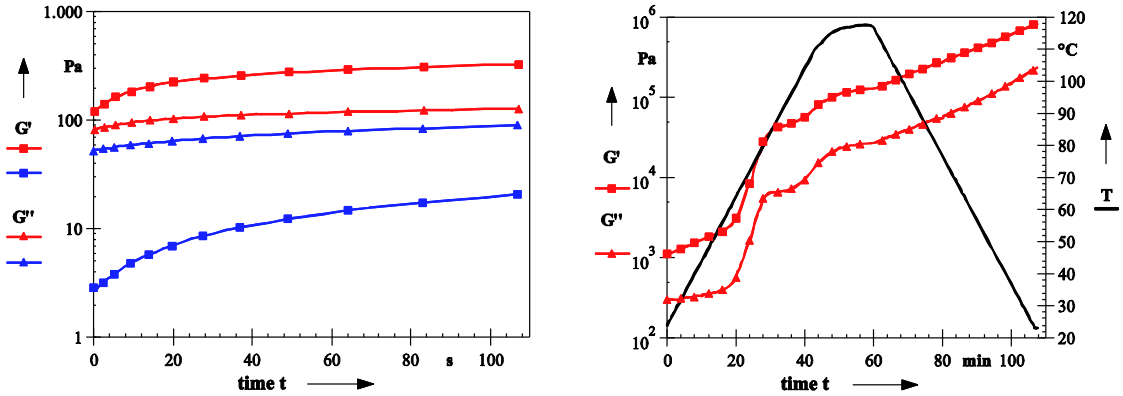


Figure 11. left: Structure recovery after shear, right: Structure on cure (red: Manoukian Argon Plastisol, blue: SunChemical UV-ink).

Rheology of the Ni-inks

All inks from Table 3 were assessed for their flow behaviour with the rheometer in oscillatory mode (T=23°C, γ=100%, ω=1-100rad/s) due to their known shear thickening (dilatant) behaviour. The increase in oscillation

frequency simulates increasing shear and allows assessing the flow behaviour even of materials showing dilatancy.

The structure of the nickel inks differ widely. While the inks made from Alfa Aesar nickel and the mixture of Alfa Aesar and Vale nickel show quite low internal structure the inks made from Vale nickel alone show consequently higher structure (Figure 12 left). The high viscosity for the Vale nickel pigments as well as the lower viscosity for the Alfa Aesar grade was expected as the total particle amount increases with decreasing particle size, thus increasing viscosity with higher surface area. Unexpectedly the mixture of both grades provides the lowest viscosity systems with hardest settling cake. The reason remains unclear.

All inks display dilatant flow behaviour which can be seen by the crossover of G' and G'' around an angular frequency of 10rad/s. Nickel pigments can be found in two varieties – spherical or dendritic i.e. branched. Both grades used in this publication are of dendritic nature. Accordingly both grades showed dilatancy indicating that the dendritic pigments tend to clog together on flow. Spherical pigments are expected to overcome this but on the other hand are expected to give worse conductivity.

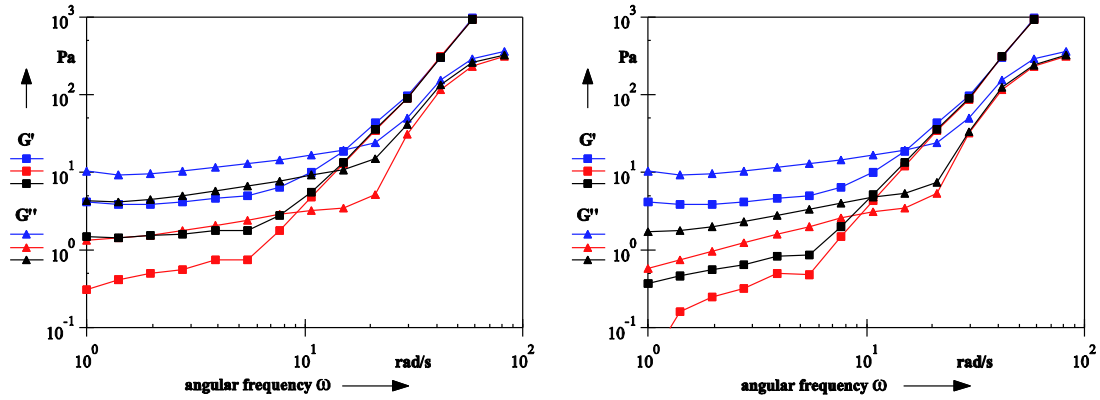


Figure 12. left: Structure of P01 (blue), P10 (red), P19 (black), right: Structure of P01 (blue), P02 (red), P03 (black).

The influence of the dispersing additives is clearly visible; the rheological properties vary with the kind of dispersing additive (Figure 12, right). Settling of pigments is fast for all inks indicating that the suspending properties of the additives are not sufficient to keep the pigments in suspension. Without any additive (P01 in Figure 12 right) the viscosity is highest, settled pigments form a medium hard cake and resuspension is feasible. DISPERBYK 180 additive (P02 in Figure 12 right) gives the lowest viscosity, hard caking and bad resuspension properties indicating negative interaction with nickel pigments. DISPERBYK 2155 (P03 in Figure 12 right) gives medium low viscosity, yet the softest cake allowing for easy resuspension indicating positive interaction with the nickel pigments surface. Cosolvent variation showed no observable effect on viscosity (Figure 13 left).

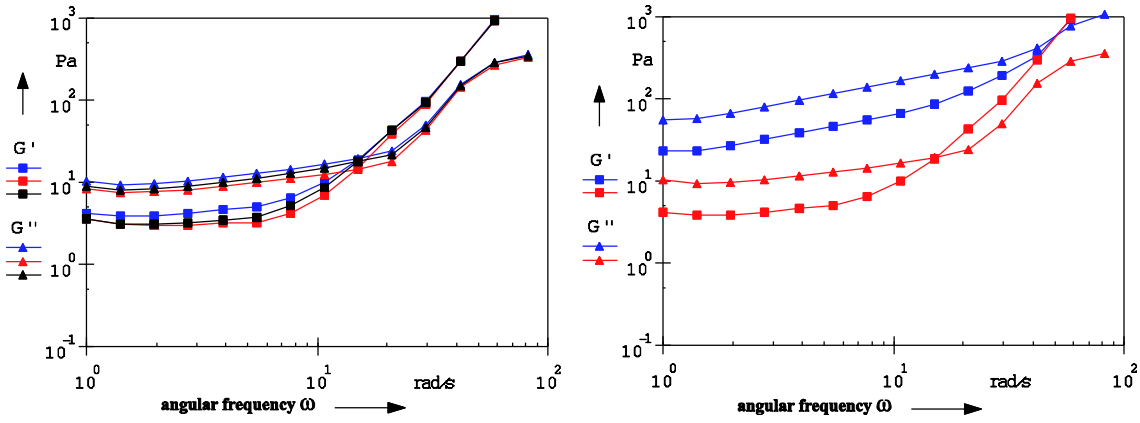


Figure 13. left: Structure of P1 (blue), P4 (red), P7 black) right: Structure of P1 (blue), Ni70 (red).

In comparison with the standardly used Ni70 ink the ink formulations tested in this publication show earlier G'/G'' crossover in all cases (Figure 13 right). It is unclear whether this can be attributed to solvent type or solids content.

Conclusion

The Vale T255™ Ni powder provided better results regarding the ohmic resistance and the filling of the cavities than the Alfa Aesar powder, but all results achieved within this examination are not satisfying yet. The wetting behaviour of all ink variations is insufficient. Even the reference ink Ni70 shows defects in the ink layer, albeit the defects are negligible compared to the test inks P01 to P27. While the results of the screen printed samples are poor, stencil printing seems to be an alternative. The inks P01 and P04 have been perceived as an improvement in terms of the drying behaviour, since the reference ink Ni70 tends to clog the screen mesh quickly. The incompatibility of both Ni particles illustrated by the results of the inks P10 to P18 was an unexpected result. The authors assumed a better percolation and therefore an improvement of the electrical conductivity. Since the inks with the particle blend did not show any conductivity – beside two exceptions – the different surfaces of the particles are supposed to interact negatively with the solvents and binders respectively.

Regarding the conductivity and the shape of the profile the best result was achieved with P01. This ink didn't show any "doughnut effect" and also showed a superior conductivity than the reference ink Ni70.

An alternative to screen printing was found in stencil printing, since the first trials in stencil printing led to better results than printing with a screen. The profiles of the printed samples are promising and the amount of transferred ink is – due to the thickness of the stencil – quite high. Subsequent trials have to focus on the optimization of the inks in terms of a suitable viscosity for screen printing and the improvement of the uniformity of the apertures in the stencil to provide equal ink volumes for filling the apertures.

Acknowledgements

The authors would like to thank the following industrial partners for their assistance in providing materials and technical advice in the creation of this work: Kiwo, Sefar, SunChemical and Byk as well as EKRA for providing the printing press and Anton Paar for providing the rheometer. The authors also like to thank Tim Paulsen B.Eng. for the support during the print trials.

References

[1] ROWE, D. M. (2006). Thermoelectrics handbook: macro to nano-structured materials. Boca Raton, FL, Taylor&Francis.

[2] JÄNSCH, D. (2009). Thermoelektrik: eine Chance für die Automobilindustrie. Renningen, expert-Verl.

[3] DUBEY, N. AND LECLERC, M. (2011). Conducting polymers: Efficient thermoelectric materials. Journal of Polymer Science Part B: Polymer Physics, 49: 467–475. doi: 10.1002/polb.22206

[4] WILLFAHRT, A. AND HÜBNER, G. (2011). Screen Printed Thermocouples in a Five Layer Setup. Proceedings of Large-Area. Organic and Polymer Electronics Convention 2011 (LOPE-C 11), Frankfurt/M., page 196-200. Organic Electronics Association (OE-A), ISBN 978-3-00-034957-7

[5] Evaporation rates of solvents, Technical Data Sheet Siegwerk, April 2008

[6] Technical Bulletin Butylglykolacetat, BASF, April 2008

[7] Technical Bulletin 2-Ethylhexylacetat, BASF, March 2008

Author biography

Andreas Willfahrt received his Engineer degree in October 2006 at Stuttgart Media University (HdM). Since January 2007 he is employed at the Institute for Applied Research at HdM in the department Innovative Applications of Printing Technologies. Andreas was involved in the research project "transprolabel", dealing with printed RFID-antennas. Since June 2009 Andreas participates in the research project "printed thermoelements", which is fostered by German Federal Ministry of Education and Research. In November 2009 Andreas was enrolled as PhD-Student at Linköping University, Sweden.

Capabilities and the challenges of the use of special scanning technology for practical training and research - an abridged report

Prof. Dr.-Ing. Michael Reiche[1], Thomas Schulze[2]

[1]*Prof. Dr.-Ing. Michael Reiche, Faculty of Media, Leipzig University of Applied Science, Germany*
[2]*Thomas Schulze, Faculty of Media, Leipzig University of Applied Science, Germany*
[1]*reiche@fbm.htwk-leipzig.de*
[2]*thomas.schulze@fbm.htwk-leipzig.de*

During the last decades the media industry, especially the prepress departments, was characterised by two far-reaching changes. First, the increasing of the degree of automation and the growing importance of process control and process management led the branch from the graphic arts to the graphic industry, both in terminology and, more important, in thinking. Both production environment and prepress technology has been completely changed. Most of the environment, used for the traditional analogue prepress workflows has been migrated to software, like imposition using reproduction film, has been minimized like reproduction cameras or has been nearly complete vanished like reproduction film developing. This implicated that some of the traditional job outlines like type setter, reproduction photograph, retoucher, all of them specialists in using a special prepress environment, has been vanished too or has been metamorphosed to new job outlines which embrace all the traditional skills. On the other hand, because of the fact that many processing steps can be performed using software on an average computer system, this processing steps done in the past by specialists are now often performed by non-specialists like journalists. In other words: typical prepress processes, like type setting, has been migrated from the prepress stage to the pre-media stage. That means that the operating volume has been lost. In the consequence many of the type-setting studios, reproduction photography labs and prepress departments which in the past belonged to fully integrated printing houses has been closed or scaled down. Although the prepress stage has lost some of the traditional work items, it didn't become superfluous. The appearing of digital reading devices in the most diverse developments and its fast spreading provides the prepress stage new fields of application. Prepress became a service provider for digital media production.

Photographic reproduction of historical books for the purpose to manufacture facsimile copies or reprints has been a traditional work item. The new reading devices provide a new kind of facsimile or reprints: the value added digital facsimile.

Figure 3: Student using the Wolfenbuettel Book Reflector

Rare and sensitive books are kept well closed and protected from direct sunlight, moisture and other environmental influences in libraries, guarded by librarians. Interested readers have to accept the efforts of travelling to these libraries and safety measures while reading the books or doing the scientific research. Many of these books are held worth to be made available to a wider audience. For many of the use cases the reader would accept to hold in the hand not the original but a facsimile or a reprint, provided that the digital facsimile reproduction contains all the attributes of the original, e.g. font characteristics, formats, colours and all the meta information that the reader needs for his work with the book. Most of the physical properties of a book, like page

format, paper colour, contrast, resolution etc. can be reproduced digitally, some of them, like weight and smell, cannot be reproduced using the contemporary reading devices. A few of the properties can be simulated, like haptic properties. Modern reproduction processes have to regard the capabilities of digital modern digital reading devices and have to deliver respective tailor-made data. The first step in the technical reproduction process to achieve most of the mentioned properties is the scanning process. Digitalisation of sensitive books needs a special environment. One approach for books that tend to be affected by opening over a determined angle is the Wolfenbuettel Book Reflector, developed by Herzog August Library of Wolfenbüttel (www.hab.de) and Kaiser Fototechnik (www.kaiser-fototechnik.de). This solution is widely used by the German libraries both for safeguarding and archiving of sensitive documents as well as for providing its digital representation for interested personnel via World Wide Web solutions. HTWK owns a Book Reflector with an opening angle of 45°. This enables the digitalisation of books without immoderately strain and negative affecting of bindings during the reproduction process. The Wolfenbuettel Book Reflector is a well-established und effectively functioning system for the digitalisation problems mentioned above. The result of the process are digital copies of the single pages of the book. But the Wolfenbuettel Book Reflector is just one tool that supports one specific working step. Depending on the properties to be achieved, a certain number of further working steps have to be performed. Following the definition that a workflow has to be developed for a single product or a product group in a workshop structure, each of the different forms of value added digital facsimile requires its own workflow. Therefore the first task in developing a workflow is the definition of the properties of the end product, in our case, the value-added facsimile. Some of the properties was already mentioned. If the desired properties of the end product are defined they have to be mapped to the technical processes. For example, the digitisation of a analogue artwork required a scanning process. The desired end format of the digital book determines the magnification factor as a set-up parameter of the scanning process. If the digital book should provide the value-adding functionality of a full-text search, an OCR process has to be performed. In this case, the resolution of the scanning process is determined by the requirements of the process. Other functionalities, like animated turning of the pages, the insertion of bookmarks etc. causes the corresponding processes and their set-up parameters. In this way the workflow for the desired digital book is set up. At the moment, most of the value-adding functionalities are developed to a great extend by individual programming work. In the view of the fact, that new electronic devices for reading digital contents appears on market in ever-decreasing intervals, it is necessary to automate the workflows to the most possible extent. A manufacturing-like development of value-added digital books is not suitable for a functional business model. In this field a great need for research can be identified.

Figure 4: digitising a sensitive book

How the Wolfenbuettel Book Reflector can be used for teaching the students? Primarily, the abilities and skills in reproduction processes can be developed. The students learn how to prepare the scanning process, that means, to classify the book, to calculate the scanning resolution depending on the desired output resolution and to set up the system. While processing the book the students get a feeling for the efforts and the time consumption of the scanning process. They learn to repeat the operations with a continuous accuracy and become therefore patient and constant in working. Of course a great importance is attached to the monitoring of the quality of the digitised content. Students have to check whether the desired resolution has been achieved and that the image has been reproduced completely and in the right angle. If they detect a quality problem, they have to decide about a fitting solution strategy. In the end the students have to hand-over the digitised content as a semi-finished product to the next working step. The students have to control their own work and act autonomously to the greatest possible extent, but have to respect that they perform a single working step that is embedded into a complex working

chain. This leads to the second field of application, the education in workflow design. The students learn to look beyond the borders of the single processes. They learn to describe processes in a formal way. Based on their hands-on experience with the process,the students develop an abstract definition of the term “process”. In doing so they dispute the typology of processes (core processes, administration processes and support processes), discuss whether a process can be classified as a specific process or a company-typical process, examine the character (time invariance, stochastic behaviour, continuity, stability), specify the properties (e.g. structuredness and variability) and define a suitable process view (transformational, data-related, process-related etc.). If the students have understood the cybernetic approach of the process definition, they learn the basics in designing workflows. They become acquainted with different options of the modelling, like the fundamental Black-Box-Model, Petri-Nets and the architecture of integrated information systems (ARIS). They recognise the capabilities and limits of the different models and are able to choose the appropriately model for different use cases. And here the cycle comes full circle. The students have aquired abilities and skills in different working steps, like scanning by using the Wolfenbuettel Book Reflector. It may be assumed that they have understood the processes that they have performed. In the next step the students should be enabled to describe the learned processes in a formal way. With this knowledge, the students will be competent in analysis of existing workflows as well as in designing new workflows.

Figure 5: Japanese xylographic art

Some few words to our current research activities using the Wolfenbuettel Book Reflector: Together with the famous Grassi museum of applied arts (www.grassimuseum.de) Japanese xylographic books from the 18th and 19th century was processed. The images are very impressive and may appear unusual to our eyes. This is due to the high amount of areas of colour in exceptional colour spaces. This and the relatively low amount of textual content impose special requirements concerning the processing of the books. Because the books are bind in the traditional Japanese way, some additional difficulties arose. First, the unusual opening behaviour has to be respected. The turning of the pages must be done very carefully. This leads to an increased effort. On the other hand it had to be taken in consideration that the Book Reflector was constructed to support the digitisation of modern standard shaped books. The open book consists of two type areas separated by the gutter, the inside margin. The V-shaped Book Reflector was lowered to the binding edge and because of technical reasons it was impossible to scan small areas of the gutter. Therefore books, consisting content, text as well as images, placed in the area of the gutter, are difficult to be processed with Book Reflector. In the case of the Japanese xylographic books very often additional effort has to be made to capture the contents in the gutter. As a side project a working time recording of the working steps took place.

On the output side of the process value-added digital books are planned. These books are intended to be used both by scientists and readers interested in this extraordinarily beautiful xylographic art. The development of the workflow for these digital books is still ongoing.

At the moment the workflow is characterised by a high amount of manually performed working steps. Because of the unusual binding and the exceptional colour spaces, increased efforts in both processing and postprocessing of the images has to be respected. There are great potentials for further research activities with the goals to streamline the processes and to increase of the degree of automation of the whole workflow.

The Wolfenbuettel Book Reflector constitutes one core element of the workflow for the production of value added digital facsimiles. It is not only utilised for production purposes, but also for the developing of different skills and abilities of the students. Therefore it is a good means to an end, both for practical training and research.

Author biography

Prof. Dr.-Ing. Michael Reiche is responsible for the training in prepress/digital media production at the Leipzig University of Applied Science (HTWK). He is a qualified type setter, mechanical engineer and worked for several years both a technical

engineer for logistic environment and as a SAP consultant. Also he was scientific staff at the Institute for Print and Media Technology at the Chemnitz University of Technology.

Polynomial Color Reproduction Device Model Term Significance

Davor Donevski, Diana Milcic, Dubravko Banic

Faculty of Graphic Arts, University of Zagreb, Croatia
davor.donevski@grf.hr, diana.milcic@grf.hr, dubravko.banic@grf.hr

Keywords: polynomial model, model terms, term significance

Abstract

The least squares fitting is a commonly used method of output colour device characterization. For this purpose, polynomial models are fitted to the data obtained by measuring the device responses to inputs. As it implies the model form, i.e. the polynomial terms to be chosen prior to fitting the model, this choice affects the model prediction power. Terms of a given order in higher order models can be formed in a large number of ways by combining different powers over the variables in cross-product terms, all resulting in the same order. In this research, optimal models for the eight processes were determined by performing backward elimination on their maximum models. The backward elimination is the procedure of eliminating terms or blocks of terms from the maximum model, one at a time, and comparing each reduced model to the maximum model in terms of sum of squared differences. The evaluation was performed on the same independent test used to determine maximum models. Partial F test was used to compare performances of different models. The maximum and optimized models were, in addition to statistical evaluation, also evaluated psychophysically by transforming an image and evaluating it visually. The evaluation showed that the reduced model performed better than the maximum model. This paper is a part of a larger study which has the aim to investigate whether the significance of model terms can be related to some statistic calculated from the characterization data. This would allow choosing the appropriate terms and building models adapted to particular devices.

Introduction

Polynomial models are commonly used for characterizing output devices. Polynomial order and terms are chosen prior to fitting the model to the data. It is generally known that increasing the model order results in better fitting to the training data, but may also result in overfitting thus reducing the model prediction power. The reason for this are variations in the data, [1]. Many studies have shown that the choice of model terms affects both the quality of fit and model prediction power, [2, 3]. One of the important findings of those earlier studies is that including the intercept significantly improves the model precision, especially in lower order models with smaller number of terms, [4]. However, there was no systematic analysis of which data characteristics relate to the significance of model terms. If we consider the model terms as predictors, it is easily recognizable that some terms model the particular process better, while others are less significant. Some of the device's channels are more, and some are less linear. In addition to that, the interaction between a pair (or more) channels is more complex than the interaction between some other channels. This is the reason why the choice of powers over channels in interaction terms affects the term significance. This research aimed at finding the criteria in the characterization data for the selection of optimal model terms. In order to do that, a systematic determination of model term significance had to be carried out on a number of different output devices. It was expected that some regularity in terms' significance would appear. Although such regularity was not found due to the suppressor effects, the study has shown that some terms significantly reduce the model accuracy and that models can be improved by eliminating those terms. The most important finding is that high order polynomials which overfitted that data and caused artefacts in the transformed images performed well after elimination of insignificant terms, even though the reduced models were of the same order as the initial models.

Methodology

The study was carried out on three ink jet printers (two thermal and one piezoelectric) and one laser printer. All of the devices used RGB drivers. Two types of substrates were used with each of the four printers, plain 80 g/m^2 and satinated 120 g/m^2 paper. This resulted in eight different processes. The characterization data was obtained using a standard 918 patch chart supplied with commercial ICC profiling software. As it is known that model evaluation should be performed on the independent data set, such set, also consisting of 918 values was created. The values predicted by the models were compared to the values of the independent data set measured with a spectrophotometer (D50 illumination, 2° observer and 45°/0° measuring geometry).

The model terms' significances were evaluated by the partial F-test and the insignificant terms were eliminated using the backward elimination procedure. This procedure consists of taking the maximum model, i.e. the model of the maximum order including all possible terms up to that order and reduced models which are actually the maximum model with one term excluded. Evaluating the maximum and a given reduced model (with particular term excluded) by means of sum of squared errors (values predicted by the model vs. the empirical data) gives the results of their prediction powers. In order to decide whether the difference between the models' performances has occurred by chance or should be considered significant, the partial F-test is performed and the decision is made by comparing the calculated probability with a chosen significance level (usually 5% or 10%). In this study, 10% level was used. In a series of reduced models (compared to the maximum), the least significant term is excluded and that model is taken as the new base model and the procedure is repeated. This process is carried out until there are no more insignificant terms to eliminate. The procedure was carried out on individual model terms and on the blocks of terms. This paper will show results for blocks of terms which were grouped by orders and number of channels contained within them. Figure 1 shows the backward elimination procedure. Although there exist several methods, the backward elimination was chosen for its property to reduce the suppressor effect, [5, 6].

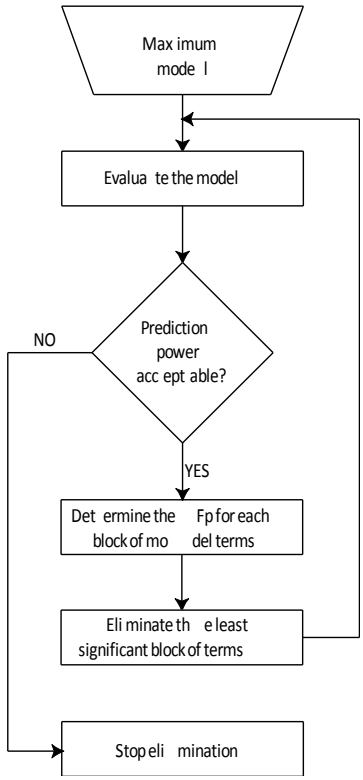


Figure 1, Backward elimination flowchart

Results and discussion

The results of one of the eight processes are shown in this paper. They relate to the laser printer and satinated paper. The maximum model was of 6th order. Figure 2 shows the changing of the partial F values throughout the elimination steps for the three blocks of terms which had the highest significance in the beginning of the elimination procedure. Step 1 relates to the partial F test results for the initial, maximum model. Further steps relate to the reduced models with eliminated blocks of terms, as shown in Table 1. It can be noted that there is no obvious regularity in the eliminated blocks of terms as there are individual channels, pairs of channels, and all three channels and they are of lower and higher orders. It can also be noted that the elimination of some blocks of terms reduced, while the elimination of others increased the significance of the three observed blocks to a higher or lower extent. Figure 3 further illustrates this as it can be noted that two of the three most significant terms from the beginning remained most significant at the end, but one block of terms ($C^2M^2Y^2$) did not. As these interdependencies are too complex, no regularity could be found and related to the device data characteristics.

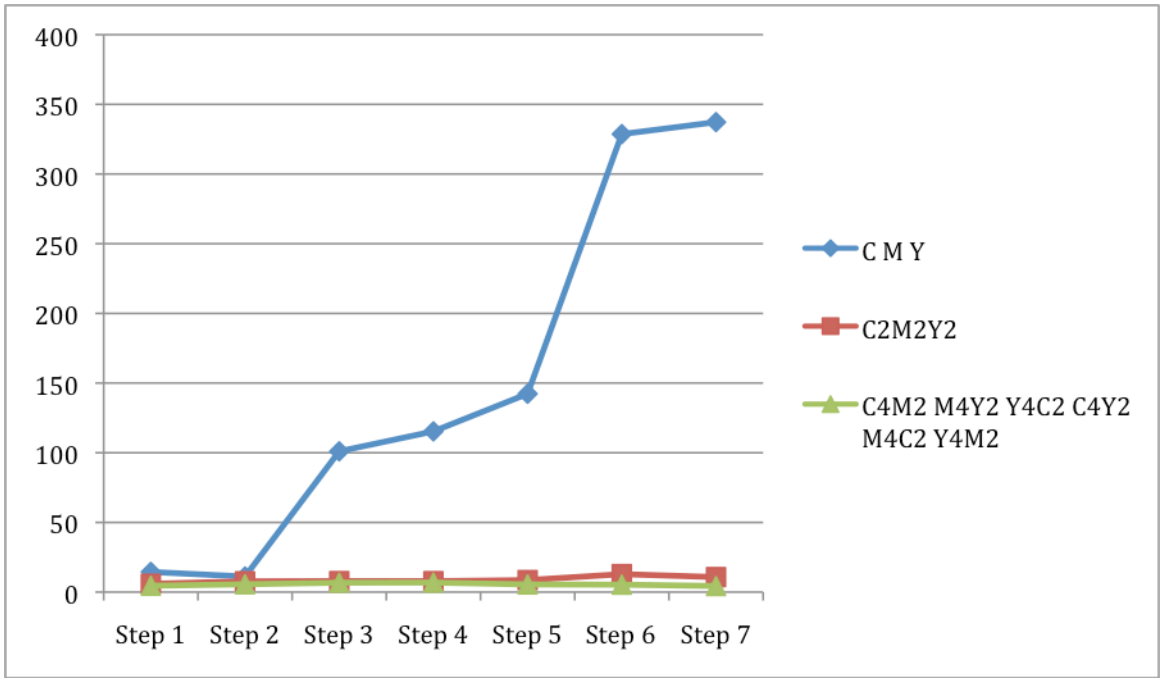


Figure 2, F values for the three blocks with highest significance on the beginning of eliminiation process

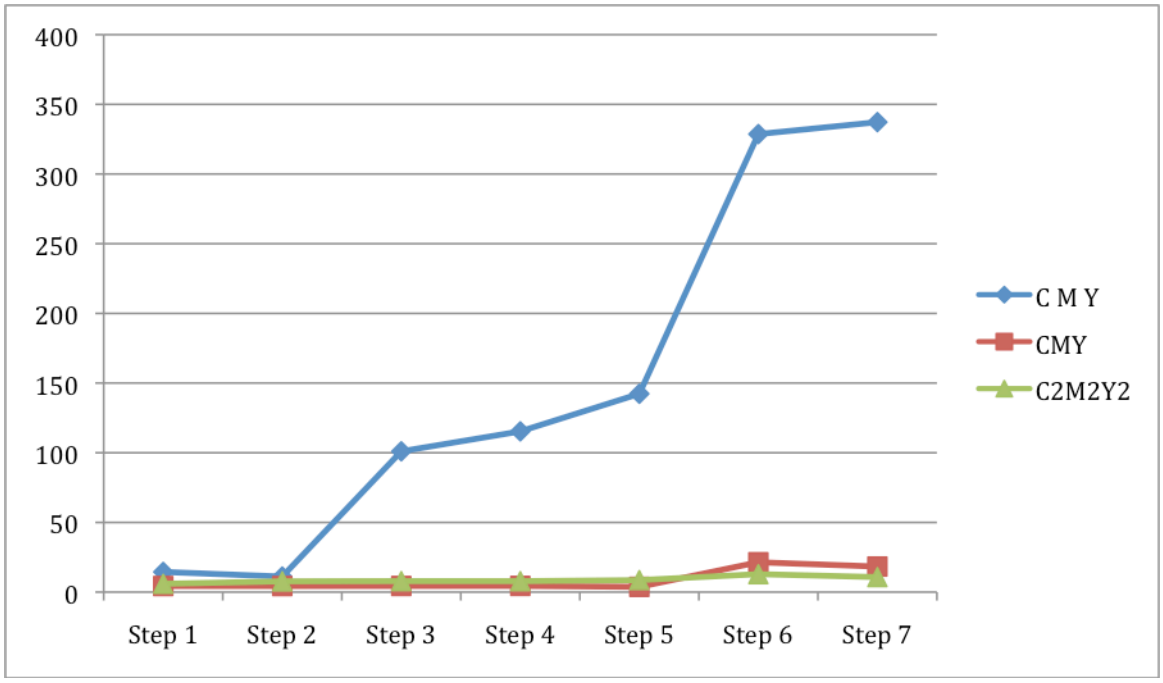


Figure 3, F values for the three blocks with highest significance at the end of eliminiation process

Table 1, Blocks of terms eliminated throughout the elimination steps

Elimination step	Block of terms eliminated
2	$C^4\ M^4\ Y^4$
3	$C^2\ M^2\ Y^2$
4	$C^3M^3\ M^3Y^3\ C^3Y^3$
5	$C^4M\ M^4Y\ Y^4C\ C^4Y\ M^4C\ Y^4M$
6	$CM\ MY\ CY$
7	$C^4MY\ CM^4Y\ CMY^4$
8	$C^3M^2Y\ C^3MY^2\ C^2M^3Y\ CM^3Y^2\ C^2MY^3\ CM^2Y^3$

Table 2 shows the results of the numerical evaluation of the maximum and reduced models' performances. It can be seen that the reduced model had poorer performance in the central tendency measures, but had slightly better performance in the maximum error. It is important to stipulate that these results pertain to reduced model obtained at 10% significance level. This means that some of the eliminated blocks of terms would be retained at some lower level and in that case the numerical evaluation would show better results for the reduced model. However, it is generally known that model performances cannot be assessed through numerical evaluation alone as it is possible for it to show good results, and yet artefacts appear in the transformed images. This is shown in Figure 4. Even at the 10% level, and poorer numerical evaluation results for the reduced model, the images show that artefacts which appeared using the maximum model were significantly reduced using the reduced model. It is also important to notice that the reduced model was of the same order as the maximum, so it was not the model order itself that caused these artefacts, as often stipulated in previous research, but the choice of the predictive terms appropriate for the particular device.

Table 2, Evaluation results for the maximum and the reduced model

	N – no. patches	dEab	Min	Median	Max	C.I. 95%
Maximum	918	2,45	0,21	1,96	11,58	0,21
Reduded	918	2,50	0,21	2,12	11,23	0,21

Figure 4, a) Maximum model performance ***b) Reduced model performance***

Conclusion

The aim of this research was to find the criteria in the device data for choosing optimal device models. In order to do that, optimal models had to be determined for a number of processes. Backward elimination procedure was chosen as it is known to reduce suppressor effects. As these effects were still present, regularity in eliminated blocks of terms could not be found. It can be said that the models obtained by backward elimination are not optimal, but improved with respect to the initial maximum models. However, it was shown how important the choice of model terms is, and that high order polynomials can be used and perform well (without noise fitting) if the terms appropriate for a particular device are selected. It was also shown that some terms significantly reduce the model prediction power, and it can be seen not only on the transformed images, but also in the results of the partial F-test.

References

[1] Green, P., „Overview of characterization methods“, Colour Enginnering, Chichester : John Wiley & Sons, 127-141, (2002)

[2] Cheung, T. L. V, Westland, S., „A comparative study of the characterization of colour cameras by means of neural networks and polynomial transforms“, Journal of Coloration Technology, 2004.

[3] Yilmaz, Y, et. al., „*Color calibration of scanners using polynomial transformation“,* ISPRS Congress Proceedings, 890-895, (2004)

[4] Hong, G. W, Luo, M. R, Rhodes, P. A., „A study of digital camera colorimetric characterization based on polynomial modeling“, Color Research and Application, 76-84, (2001)

[5] Field, A., „Discovering Statistics Using SPSS: Third Edition“, London : Sage Publications, (2009)

[6] Kleinbaum, G. D., „Applied Regression Analysis and Other Multivariable Methods“, Belmont : Duxbury, (2008)

Typographic and colorimetric properties of non-impact prints on transfer foil

Blaž Rat[1], Igor Majnarić[2] and Klementina Možina[1]

[1]*University of Ljubljana, Faculty of Natural Sciences and Engineering, Snežniška 5, SI-1000 Ljubljana, Slovenia*

[2] *University of Zagreb, Faculty of Graphic Arts, Getaldićeva 2, 10000 Zagreb, Croatia*

blaz.rat@ntf.uni-lj.si

majnaric@grf.hr

klementina.mozina@ntf.uni-lj.si

Keywords: inkjet, electrophotography, thermal transfer foil, typography, CIEDE2000

Abstract

The research focused on the study of typographic and colorimetric properties of prints on transfer foils made with the non-impact printing technology, using two different printers – electrophotography- and inkjet-based, their cartridges and two thermal transfer materials which were transferred onto a cotton fabric. Four-colour prints and typography defined with three different typefaces (one sans-serif, one transitional and one modern) were made. The typefaces were tested in four sizes (6, 8, 10 and 12 pt). The prints were exposed to a different number of washing and drying cycles, the differences in colour and typographic tonal density being measured before and after the cycles. The colour differences of 100% and 50% intensity fields (CMYK100 and CYK50) were measured spectrophotometrically, whereas the difference in typographic tonal density was measured by means of image analysis.

The differences in colour ΔE_{00}, lightness ΔL_{00}, chromaticity ΔC_{00} and hue ΔH_{00} for the substrate and prints (CMYK) after a different number of washes were calculated with the obtained spectrophotometric measurements. The changes in the colour of the substrate alone had to be taken into account as well, as these results demonstrate that the hue of the transferred layer of the transfer foil also influences the indirect transfer printing. While inkjet printers apply a thicker layer of ink, more precise printing of smaller graphic elements is achieved with electrophotography. The most substantial difference in typographic tonal density after a different number of washes was measured at smaller type sizes (6 in 8 pt). Due to its design features, the tested sans-serif typeface displayed higher typographic tonal density than the other two tested typefaces. After a different number of washes, the highest difference in typographic tonal density was measured at the sans-serif typeface.

Introduction

Various technologies and an array of applied materials connected with them substantially influence our everyday lives. One of such fields is the non-impact printing technology, which has become widely spread also due to its quality improvements and the possibility of using different substrates, e.g. paper, plastics, glass or metal. Non-impact printing technologies generally give higher print quality, faster printing speed and are more commonly used in the consumer than in the professional field [1]. The basic advantage lies in the print head which does not come into a direct physical contact with the substrate. Modern digital printing technologies, e.g. piezo inkjet, electrophotography [2], are also used for the information transfer onto textile materials by means of various transfer foils. Nevertheless, the question of the quality and long-term print fastness arises, especially after the washing of textiles.

In the research, we wanted to establish which modern digital printing technology for printing onto textiles, e.g. by means of a transfer foil used in textile fabrication, enables the best quality and long-term fastness. Moreover, we wanted to find out what typeface in relation to its size contributes to better legibility and its recognition. Several factors need to be taken into consideration, e.g. material composition, printing technology, amount of applied ink (ink layer thickness), and the size of printed graphic and typographic elements, to draw conclusions or even make recommendations.

We focused on three different typefaces and their sizes. The smallest sizes were of uttermost importance, as we wanted to make recommendations on an appropriate use for displaying brand logos printed on textiles through transfer foils, usually placed discretely on a small area of a T-Shirt or other piece of clothes. When a brand name is printed next to a logo, its size is usually smaller, e.g. between 6 and 8 pt. The exact type size depends on the x-height of a typeface – typefaces with larger yet moderate x-heights are generally more legible at smaller sizes [3–5]. In addition, several other typographic characteristics need to be taken into consideration to make the name

more legible, i.e. distinctive character features (counter shape), ascenders, descenders, serifs, contrast (stroke width), set width, type size, leading (i.e. space between lines) etc [6].

For the research purpose, we analysed typographic tonal density (or typographic tonality), which refers to the relative blackness or shades of grey of type on a page and plays a significant role in the visualization of information. Typographic tonal density can be expressed as the relative amount of ink per square centimetre, pica or inch [7]. Its variation depends on the changes in various type features [3, 6, 7], e.g. larger counters trap a larger amount of white space in the enclosed spaces of letters, and a thicker stroke width creates more ink per area [7–9]. Typographic tonal density and colorimetric properties, as well as the demand to ensure suitable visibility even after several washes depend on the ink and its layer thickness made with a transfer printing technique [10]. These factors are extremely important and were also evaluated in the research.

Experimental

The research focused on the study of typographic and colorimetric properties of prints on transfer foils made with the non-impact printing (NIP) technology, using two different printers, their cartridges and two thermal transfer foils. The prints were transferred onto a natural material – 100% plain weave (P1/1) cotton. The colorimetric properties of cotton were measured with a spectrophotometer DataColor, Spectra Flash 600 Plus-CT (aperture size 6.6 mm) where the measured whiteness value was 74.48 and the measured hue value was 98.21.

The two printers used in the research were:

– printer P1: HP Indigo S5500; electrophotography with liquid ElectroInk; indirect printing (transfer foil: Forever Digi-Print WT), and
– printer P2: Roland LEC-300; piezo inkjet technology with Roland ECO-UV ink; indirect printing (transfer foil: Poli-flex Printable 4016).

Typography defined with three different typefaces, i.e. one sans-serif (Arial) [11, 12], one transitional (Times) [11, 12] and one modern (Blaznic) [11, 12] typeface, was analysed. The typefaces were tested in four different sizes (i.e. 6, 8, 10 and 12 pt). Furthermore, four-colour prints with 100% (CMYK100) and 50% (CMYK50) intensity fields of dimensions 10 × 10 mm were printed. The test form was designed with the program Adobe InDesign CS5 and was used as a PDF file, which ensured a unified appearance of the form on various computers and operation systems, and in consequence, on the print.

The transfer foils printed with printers were transferred onto textile by means of the heat press PN-45: foil Forever Digi-Print WT at pressure 32 kPa, temperature 168 °C in 20 seconds and foil Poli-flex Printable 4016 at pressure 32 kPa, temperature 175 °C in 15 seconds.

The prints were exposed to a different number of washing and drying cycles, defined in accordance with the standard on textile washing and drying procedures, ISO 6330 [13]. With the washing machine Gorenje WA 1341S (at temperature 40 °C), five washes were performed, whereas for drying, the tumble dryer Mathis HVF 69905 (at temperature 110 °C) was used. Print fastness was measured after each of the five cycles of washing and tumble drying.

The differences in typographic tonal density and colour were measured before and after the cycles. The differences in typographic tonal density of the unwashed and washed samples of typefaces were measured by means of image analysis (ImageJ) [14]. This software gives the opportunity to measure, analyse and provide output values, e.g. area, number of particles and percentage of coverage [15, 16].

The colour differences (CIE L*a*b* parameters) of 100% and 50% intensity fields (CMYK100 and CYK50) were measured with the spectrophotometer DataColor, Spectra Flash 600 Plus-CT (aperture size 6.6 mm) in accordance with the ISO 105-J01 [17] standard using the D65 standard illumination, 10° standard observer and instrument geometry 45/0. The colour difference (ΔE) between the unwashed and washed samples was calculated according to the CIEΔE2000 L*a*b* equation for colour differences [18, 19].

Results and discussion

Typographic properties of prints

The typographic tonal density (TTD) of typefaces, each in different size, was measured before and after each of the five washes. The TTD of tested typefaces according to the used type sizes, printed with different printers is presented in Table 1.

The differences in TTD of prints after the fifth wash are presented in Figure 1. The differences in TTD of printed typefaces in size 6 pt and 8 pt after each wash are presented in Figures 2 and 3. In Figure 4, the average differences in TTD after the first, third and fifth wash are given.

The results show an expectedly higher TTD at the sans-serif typeface (cf. Table 1), due to the differences in the letter stroke width being smaller. The lowest TTD was observed at the transitional typeface Times. Times has its thick stroke thinner than the typeface Blaznic. The best smoothness of letters was printed with printer P1, while the highest values of TTD were given by printer P2, which is a consequence of a thicker ink layer. It is also evident that the smallest values in TTD were given by printer P1.

After a different number of washes, the smallest difference in TTD was observed on the prints printed with printer P1. The most noticeable average difference in TTD occurred at the Arial (sans-serif) typeface (cf. Figure 1).

The obtained results show the biggest differences at the typefaces used in sizes 6 and 8 pt (cf. Figures 2 and 3). TTD at smaller type sizes is usually higher due to a smaller counter size of letters and leading. Furthermore, the differences were more evident after the washing, especially on the prints printed with printer P2. The typefaces with differences in stroke width (i.e. Times and Blaznic) were more influenced by the poor printing quality. At very small type sizes, uppercase letters are more legible than lowercase letters. While comparing the influence of a different number of washes (cf. Figure 4), it can be seen that the differences in TTD on the prints printed with both tested printers (P1 and P2) became similar after the third wash.

Table 1. TTD of tested typefaces printed in different sizes with printer P1 and P2

	TTD (%)							
	P1				**P2**			
Typeface	**6 pt**	**8 pt**	**10 pt**	**12 pt**	**6 pt**	**8 pt**	**10 pt**	**12 pt**
Times	19.69	18.52	20.40	19.47	39.31	33.74	30.44	28.73
Arial	28.91	26.08	24.63	23.53	42.97	38.24	34.24	32.28
Blaznic	22.22	21.66	21.24	22.85	42.75	37.48	34.95	32.12

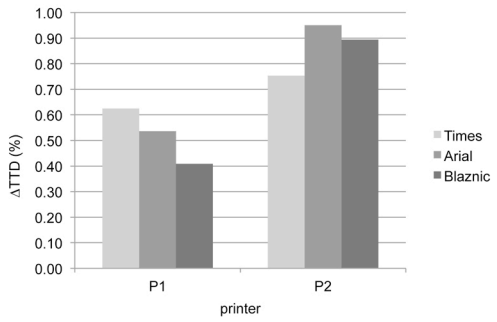


Figure 1. Average difference in TTD of tested typefaces printed with different printers (P1, P2)

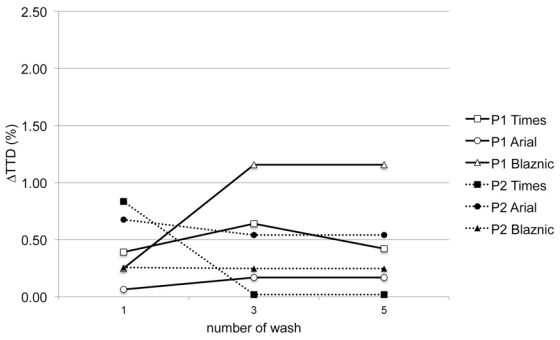


Figure 2. Differences in TTD of printed typefaces in size 6 pt after first, third and fifth wash

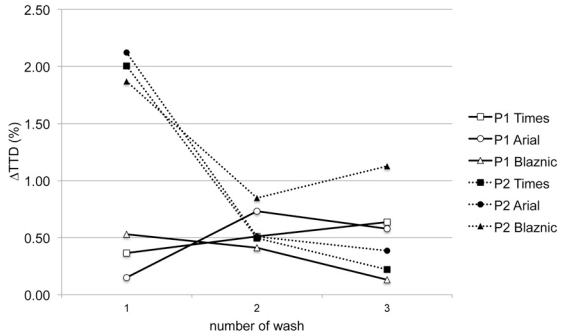


Figure 3. Differences in TTD of printed typefaces in size 8 pt after first, third and fifth wash

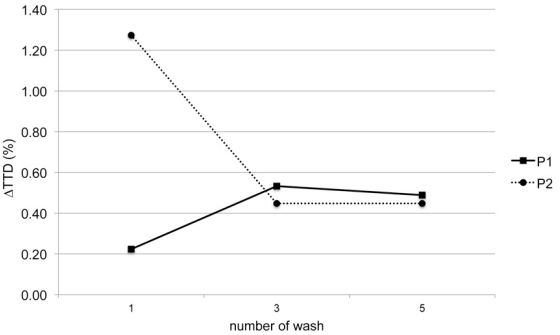


Figure 4. Average differences in TTD of printed typefaces in all sizes after first, third and fifth wash printed with two printers (P1, P2)

Colorimetric properties of prints

An analysis of colorimetric properties of CMYK prints (100% and 50% intensity field) was made. Figure 5 shows the CIE L*a*b* values of spectrophotometric measurements of prints before and after a different number of washes. In Tables 2 and 3, the differences in colour ΔE_{00}, lightness ΔL_{00}, chromaticity ΔC_{00} and hue ΔH_{00} are given for the substrate and prints (CMYK100, CMYK50) after a different number of washes.

The used cotton fabric printed with different NIP technologies using different transfer foils (substrate) showed colour differences, where all the prints became slightly darker after the first wash. After the first wash, the non-printed parts of the substrate also had the highest colour difference (cf. Table 2), which means that indirect transfer foils respond to warm water and extra heating (drying). The agitation in warm water leads to the transfer layer degradation and a better view of the original fabric structure (hue of the substrate becomes grey-bluish). The transfer foil used on printer P2 is much more stable.

Table 2. Colorimetric differences in substrate with corresponding foils after first, third and fifth wash

		ΔE_{00}	ΔL_{00}	ΔC_{00}	ΔH_{00}
P1 on substrate	S 0 wash–S 1 wash	2.06	1.25	1.62	0.24
	S 0 wash–S 3 wash	3.40	0.22	1.77	2.90
	S 0 wash–S 5 wash	3.65	1.12	1.42	3.16
P2 on substrate	S 0 wash–S 1 wash	0.55	–0.27	0.30	–0.37
	S 0 wash–S 3 wash	0.79	–0.31	0.63	–0.36
	S 0 wash–S 5 wash	0.74	–0.30	0.65	–0.18

In comparison with other process colours (cf. Table 3 and Figure 5), the prints made with cyan displayed the highest colour differences. The 100% intensity fields made with both NIP technologies changed after the first wash so much that the differences could be seen with a naked eye. After the third wash, the prints stabilized. The 50% intensity fields prints made with printer P2 demonstrated the same behaviour. On the other hand, the 50% intensity fields made with printer P1 worsened after each wash and the colour values were far from those printed on the transfer foil at the beginning. The reason for the changes is the pigment particles based on phthalocyanine in the cyan ink. The phthalocyanine molecules are extremely large, which contributes to poor mutual binding. After the first wash, a relatively large part of pigments was released and lost. The printer P2 ink layer being thicker than the one made with printer P1, the colour differences on the prints made with printer P2 were more substantial. Afterwards, the layer left stabilised and the colour differences were almost not noticeable.

The magenta prints made with printer P1 faced more substantial changes than those made with printer P2. The magenta prints with the 100% intensity field applied with printer P1 hence showed the maximum difference, which diminished after each wash. This was not the case with the 50% intensity field, the colour differences increasing after each wash. At the magenta prints made with printer P2, regardless of whether they were of 100% or 50% intensity fields, very small colour differences appeared. This means that the UV airing contributed to the fixation of magenta pigments (quinacridone) on the substrate.

The yellow colour uses azo pigments as its base. The molecules of azo pigments are of smaller size structure; such prints thus displayed the smallest colour differences. The prints made with printer P1 had much higher colour differences than those made with printer P2.

After the first wash, the black prints of 100% intensity fields printed with printer P2 did not change very much colorimetrically, while during further washes, the colour differences became very significant. A possible reason could be found in the fact that the black ink absorbs more UV brightness, which activates a higher number of photoiniciators, creating a more stable top layer. This corresponds to the pigment particles composed of pure carbon, the low molecular structure binding of which is good. Nevertheless, a longer temperature and mechanical exposure degraded such prints, which was demonstrated in significant colour differences. The black prints of both intensities (K100, K50) made with printer P1 were distinguished by smaller colour differences.

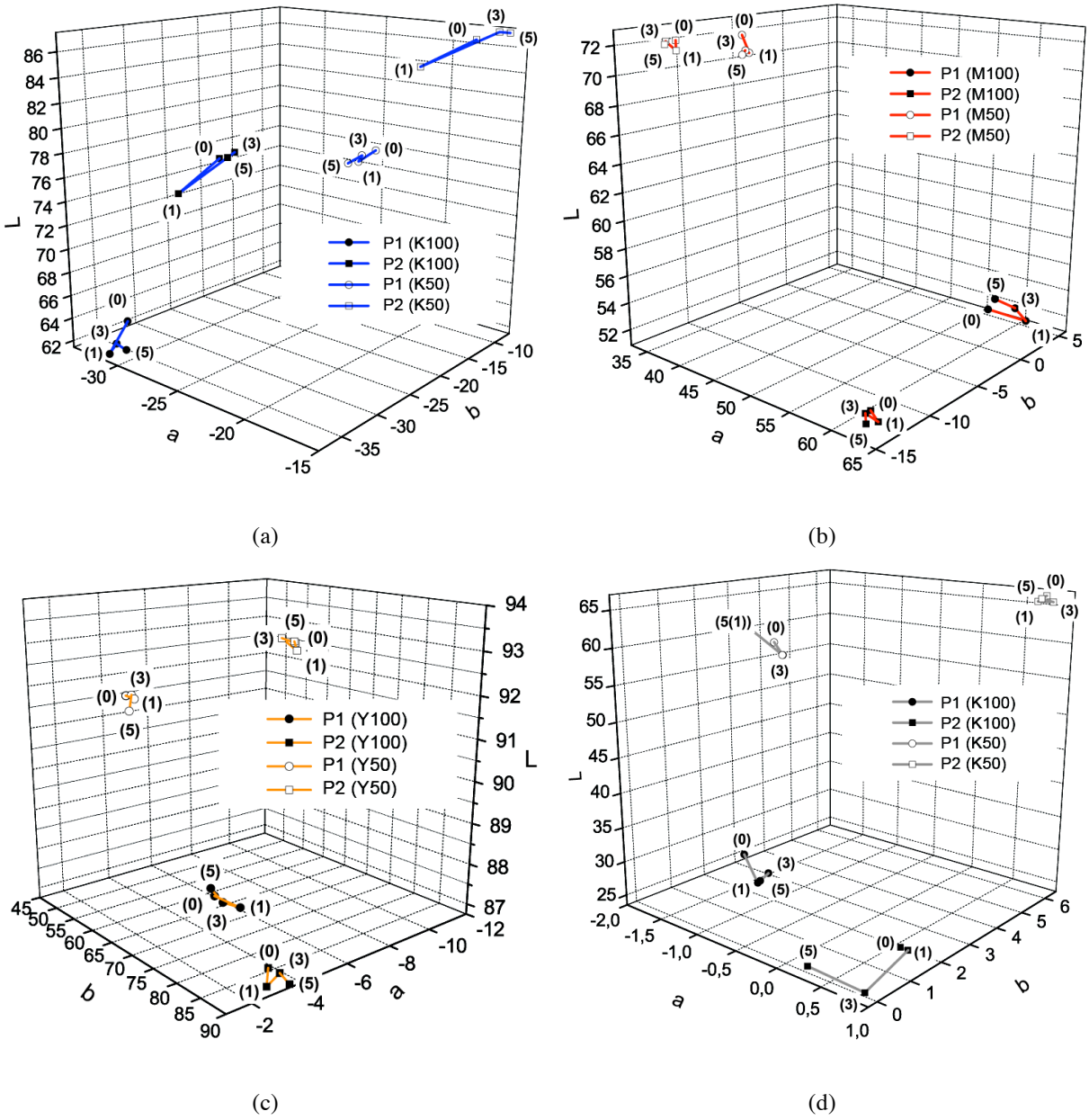


*Figure 5. CIE L*a*b* values of textile substrate (with used transfer foils) of 100% and 50% intensity field prints (P1, P2) before washing (0) and after different number of washes (1, 3 and 5) for cyan (a), magenta (b), yellow (c) and black (d)*

Table 3. Colorimetric differences in CMYK100 and CMYK50 prints (P1, P2) after first, third and fifth wash

		ΔE_{00}	ΔL_{00}	ΔC_{00}	ΔH_{00}		ΔE_{00}	ΔL_{00}	ΔC_{00}	ΔH_{00}
C 0 wash–C 1 wash	**P1 (C100)**	2.11	1.85	–0.62	–0.81	**P1 (C50)**	0.99	0.52	–0.63	–0.56
C 0 wash–C 3 wash		1.39	1.00	–0.45	–0.86		1.20	0.04	–0.64	–1.01
C 0 wash–C 5 wash		1.71	1.15	–0.29	–1.23		1.63	0.47	–1.08	–1.13
C 0 wash–C 1 wash	**P2 (C100)**	3.20	1.81	–1.22	–2.35	**P2 (C50)**	2.94	1.42	–1.92	–1.72
C 0 wash–C 3 wash		0.98	–0.68	0.43	–0.55		1.06	–0.50	0.89	–0.31
C 0 wash–C 5 wash		1.01	–0.40	0.22	–0.90		1.48	–0.49	1.32	–0.48
M 0 wash–M 1 wash	**P1 (M100)**	2.29	1.68	–0.53	–1.46	**P1 (M50)**	1.10	0.88	–0.66	0.09
M 0 wash–M 3 wash		1.48	0.69	–0.24	–1.29		1.17	0.66	–0.87	0.41
M 0 wash–M 5 wash		0.84	–0.13	0.19	–0.81		1.44	0.84	–0.99	0.63
M 0 wash–M 1 wash	**P2 (M100)**	0.56	0.50	–0.24	–0.05	**P2 (M50)**	0.63	0.39	–0.48	0.13
M 0 wash–M 3 wash		0.18	0.07	0.01	0.16		0.38	0.02	0.05	0.38
M 0 wash–M 5 wash		0.57	0.49	–0.14	0.26		0.50	0.11	–0.14	0.47
Y 0 wash–Y 1 wash	**P1 (Y100)**	1.10	–0.03	–1.10	0.10	**P1 (Y50)**	0.34	0.04	–0.33	–0.07
Y 0 wash–Y 3 wash		0.59	–0.02	–0.57	0.15		0.23	–0.02	–0.23	–0.05
Y 0 wash–Y 5 wash		0.15	–0.12	–0.01	0.09		0.31	0.23	–0.21	0.02
Y 0 wash–Y 1 wash	**P2 (Y100)**	0.41	0.15	–0.30	0.23	**P2 (Y50)**	0.33	0.13	–0.26	0.15
Y 0 wash–Y 3 wash		0.32	0.03	–0.32	–0.04		0.56	–0.04	0.55	–0.09
Y 0 wash–Y 5 wash		0.57	0.17	–0.54	–0.11		0.30	0.05	0.19	–0.23
K 0 wash–K 1 wash	**P1 (K100)**	1.54	1.39	0.65	–0.10	**P1 (K50)**	1.05	1.00	0.32	0.12
K 0 wash–K 3 wash		0.86	0.63	0.56	0.19		0.92	0.29	0.87	0.10
K 0 wash–K 5 wash		1.45	1.33	0.59	–0.01		1.80	–1.66	–0.54	–0.43
K 0 wash–K 1 wash	**P2 (K100)**	0.56	0.53	–0.12	–0.11	**P2 (K50)**	0.51	0.44	0.26	0.05
K 0 wash–K 3 wash		2.81	2.65	0.36	0.88		0.54	0.50	0.10	0.19
K 0 wash–K 5 wash		2.55	2.17	1.22	0.55		0.42	–0.01	0.37	0.20

Conclusions

Print fastness is influenced by the application of ink and the type of the non-impact printing technology. The application of thicker ink layer is more suitable for printing onto larger surfaces and provides better fastness. On the other hand, this is not appropriate when details or elements in smaller sizes are being printed, e.g. letters in smaller sizes. Electrophotography enables precise printing of smaller graphic elements, e.g. thin strokes and serifs at smaller sizes of letters. The biggest difference in the fastness of prints after a different number of washes was measured at smaller type sizes (6 and 8 pt). Despite the most substantial difference in typographic tonal density being measured at the sans-serif typeface, this did not affect its legibility, as the typographic tonal density is higher at this typeface due to its design features than at other typefaces with different stroke widths. The use of sans-serif typefaces and uppercase letters instead of lowercase letters is recommended for smaller type sizes.

In general, the UV drying inkjet ink is more stable during the substrate changes; furthermore, smaller colour differences can be measured. While larger molecular parts of pigments (cyan) easily separated from the substrate, smaller molecular parts of pigments (yellow) remained almost unchanged.

To achieve suitable visibility of smaller graphic elements, e.g. of letters printed with the non-impact printing technology, special attention has to be paid to the choice of typographic characteristics of typefaces and their sizes, with regard to the used type of printer.

A further research needs to be performed to analyse a more substantial degradation of the printed layer, subsequently leading to a more suitable method for a long-term use of textile products.

Acknowledgements

The authors would like to gratefully acknowledge the financial support for the PhD grant from the Slovenian Research Agency for the PhD student Blaž Rat.

References

[1] Kiatkamjornwong, S., Putthimai, P., Noguchi, H., “Comparison of textile print quality between inkjet and screen printings”, Surface Coatings International Part B: Coatings Transactions 88, 25–34, (2005)

[2] Kipphan, H., “Handbook of Print Media”, Springer-Verlag, Berlin, 60–67, 135, 140–142, (2001)

[3] Možina, K., “Barva in tipografija”, in: Interdisciplinarnost barve, 1st part, Društvo koloristov Slovenije, Maribor, 341–364, (2001)

[4] Gaultney, V., “Balancing Typeface Legibility and Economy: Practical Techniques for the Type Designer”, research essay, University of Reading, Reading, 1–9, (2001)

[5] Tracy, W., “Letters of Credit: A View of Type Design”, David R. Godine, Boston, 30–32, (2003)

[6] Reynolds, L., “Legibility of Type”, Baseline, International Typographic Journal 10, 26–29, (1988)

[7] Keyes, E., “Typography, color, and information structure”, Technical Communication 4, 638–654, (1993)

[8] Možina, K., Černič, M., Demšar, A., “Non-destructive methods for chemical, optical, colorimetric and typographic characterisation of a reprint”, Journal of Cultural Heritage 8, 339–349, (2007)

[9] Možina K., Medved, T., Rat, B., Bračko, S., “Influence of Light on Typographic and Colorimetric Properties of Ink jet Prints”, Journal of Imaging Science and Technology 54, 060403-1–060403-8, (2010)

[10] Majnarić I., Bolanča, S., Golubović, K., “Neke karekteristike transfernih folija načinjenih tehnikom mlaza tinte te njihov utjecaj na kvalitetu otisaka na pamučnoj tkanini”, Tekstil 59, 10, 456–462, (2010)

[11] Možina, K., “Knjižna tipografija”, University of Ljubljana, Ljubljana, 160–179, 184–191, (2003)

[12] Bringhurst, R., “The Elements of Typographic Style”, Hartley & Marks, Point Roberts, 127–132, (2002)

[13] ISO 6330, "Textiles – Domestic washing and drying procedures for textile testing" (ISO, Geneva), www.iso.org, (1996)

[14] "National Institutes of Health, Research Services Branch", http://rsb.info.nih.gov/ij/, accessed May 2011

[15] Igathinathane, C., "Shape Identification and particle Size Distribution from Basic Shape Parameters using ImageJ", Computers and Electronics Agriculture 63, 168–182, (2008)

[16] Tse, M.-K., "A Predictive Model for Text Quality Analysis: Case Study", Proceeding IS&T's NIP23: International Conference on Digital Printing Technologies, Anchorage, Alaska, USA, 16–21 September, 419–423, (2007)

[17] ISO 105–J01, "Textiles – Tests for colour fastness – Part J01: General principles for measurement of surface colour" (ISO, Geneva), www.iso.org, (1999)

[18] Luo, M.R., Cui, G., Rigg, B., "The Development of the CIE 2000 Colour – Difference Formula: CIEDE2000", Color research and application 26, 5, 340–349, (2001)

[19] "Colorimetry", 3rd edition, Commission Internationale de l'Eclairage, CIE Publication 15, 20–22, (2004)

Author biography

Blaž Rat was born on 6 September 1982. After he finished Gymnasium Velenje in 2002, he enrolled at the Faculty of Natural Sciences and Engineering, Department of Textiles, University of Ljubljana, study programme Graphic Arts Technology. He graduated in 2007 and employed himself the same year as an early stage researcher. He entered the postgraduate or doctoral study programme, respectively, where he has been conducting research in the field of communication, graphic and interactive technology. He devotes special attention to typography.

Lines of Activities in the Field of Further Training

Alexander Tsyganenko

Federal State Educational Establishment
"Institute for Further Training of Employees of Television and Broadcasting Branch"
amtsyganenko@yandex.ru

Keywords: further training, retraining

Abstract

Lines of activities in the field of further training

- Retraining of persons with higher education
(No less than 1000 teaching hours)
- Furter training of specialists of the branch
(Volume of 70 - 500 teaching hours)
- Short-range seminars
(Volume of 4 - 12 teaching hours)

Lines of retraining

- Television producing
- Dramatic art
- Multi media programs producing
- Sound producing
- Television producer activity
- Air presenter technique
- Television operator technique
- Television reporter technique
- Journalism of printing media
- Electronic editions
- Cross media technologies and printing

Lines of further training

- Television producing
- Air presenter technique
- Television and radio reporter technique
- Sound producing
- Television and broadcasting technique
- Foreign languages
- Dramatic art
- Television operator technique
- Economics and management in the television and broadcasting branch
- Special training montage courses according to television producting program
- Up-to-date technologies in publishing and printing industry
- Business in print media industry
- Up-to-date technologies in packing production

Short-range seminars

- Equipment and technologies of television and broadcasting
- Cross media technologies
- Convergence journalism
- Digital printing
- Software for information processing
- Up-to-date technologies in packing production
- Up-to-date technologies of information representation in advertising industry

Post-graduate course

Lines of training
- Journalism
- Cinematography, television and other screen-oriented arts

There is opened a dissertation panel for defence of Ph.D. and doctoral theses

В 2011 ГОДУ РЕАЛИЗУЕТСЯ ПРОГРАММА ПОВЫШЕНИЯ КВАЛИФИКАЦИИ ТЕХНИЧЕСКОГО ПЕРСОНАЛА ДЛЯ РАБОТЫ ПО ОСВЕЩЕНИЮ СПОРТИВНЫХ СОРЕВНОВАНИЙ ЗИМНИХ ОЛИМПИЙСКИХ ИГР В Г.СОЧИ В 2014 ГОДУ.

СПАСИБО ЗА ВНИМАНИЕ!

Development of knowledge and press-test based Heatset training simulator

Peter Herman[1], Laurent Grimaldi[1] and Gerd Carl[2]

[1]Sinapse Print Simulators
[2]UPM
France
peter.herman@sinapseprint.com

Keywords: Simulation, Heatset, Training

Abstract

Printing has evolved over the last decades. Training technology, for industry and education, has to follow.

This article will describe the implementation of a new generation Heatset press training simulator; its goals, means, methods and results.

The development was done in two stages:

1. The first step was to identify and model significant variables in the Heatset process that should appear in a training environment. Test scenarios were implemented so the results could be validated.

   This was done by a multinational group of industrial and academic partners coordinated by Sinapse: UPM, SUN Chemical, Goss International, Trelleborg, MegTec, HUT, KCL/VTT. This was a 3-year process.

2. Further paper and fault specific extensions were specified, analyzed and implemented in a 2-year project by UPM, KCL/VTT and Sinapse. The simulator architecture was modified to use external data curves.

The results respond to the training requirements from modern printers (ex RR Donnelley –world's largest): "technology-driven, self directed, available on site".

This simulator is currently in industrial use. This includes direct and distributed learning and supervision.

Author biography

Peter Herman is Managing Director of Sinapse Print Simulators, a French software company specialising in simulators and software for the graphic arts.

Consulting work for Polygram and CBS brought him to Europe many years ago. Graduate work in Artificial Intelligence and a few other distractions, like starting a software company, kept him there. The Sinapse print simulators are world leaders in their sectors, with over 1700 installed around the world. The Sinapse Sheetfed simulator is used in the WorldSkills competition.

A Networked Workflow for a Fully Automated CtP Calibration System

Shahram Hauck[1] & Sasan Gooran[2]

[1]*Shahram Hauck, Printing process and quality manager at manroland, Germany and Ph.D. student, Dept. of Science and Technology, Norrköping, Sweden, e-mail: shahram.hauck@manroland.com*

[2]*Sasan Gooran, Department of Science and Technology, Linköping University, Campus Norrköping, SE-601 74 Norrköping, Sweden, e-mail: sasgo@itn.liu.se*

Keywords: Automated CtP Calibration, Print Characteristic Curves Data base, Workflow Control System

Abstract

One of the most important targets on the graphic market is to realize standardization. The standardization defines the target value of solid Lab and dot gain in printing process. In addition the tolerance range of these two values will be described by standardization. The correct dot gain will be achieved during the measuring of the dot gain in printing process by the additional calculation of a correction curve well known as Print Characteristic Curve (PCC) [1]. The Raster Image Processor (RIP) needs the PCC for the imaging of printing plate with the correct tone value. In this paper we will propose a Networked Workflow (figure 1) with the Workflow Control System (or alternatively a MIS Management Information System). This Networked Workflow is necessary for the realization of a Fully Automated CtP Calibration System (figure 2).

The advantages of a Fully Automated CtP Calibration System are as following:

1. The system can replace the needed knowledge for CtP calibration.
2. Minimize operator mistakes during the generation of a PCC.
3. During the automation of generating and administrating, a high number of PCC will be available. That means the number of jobs and production inside the ISO definition will increase. There will be an increasing quality and a minimizing of reclamations for a printing company.
4. The renewing of the old PCC will be administrated completely automatically.
5. Time, consumables and money will be saved because the calibration procedure will be combined mostly with the daily production.

Introduction

The definition of the most famous and most important standardization for graphic market is described in ISO-12647.

ISO-12647 in short form:

1. Five different paper classes depend on the paper surfaces, and their Lab value and the gloss value of the paper surfaces.
2. Achieving the target Lab value for solid (KCMY) in printing process depends on each different paper class.
3. The printed tone value and the resulted dot gain have to be in the range of the respective ISO reference value.

The description of ISO-12647 is shown very clearly and seems to be easy. But realizing the third point of discretion can be difficult and expensive in practice. In order to print with the right PCC according to the standard range of tonal value, it should be considered how many combinations of consumables exist in the print workflow. In the practice, it is needed as many PCC as the possible combinations of consumables. The next difficult point is the fact that most of the PCC have to be renewed after 3-6 months. The reasons are that the quality of the consumables changes a little bit and the climate condition of different seasons are variable. All of that influence the dot gain and finally the print result, which means that the existing PCC have again to be renewed after a short time. An example for the combination of consumables and screening in a printing company:

- 3 different paper classes (5 possible paper classes)
- 2 different printing processes (conventional printing and UV printing)
- 2 different inks for each process

- 2 different dampening solutions (with alcohol for UV printing and alcohol free for conventional printing)
- 4 different screening types (60 l/cm, 70 l/cm, 80 l/cm, FM 20 μm)

The result in this case will be 96 possible combinations with different curve variations! There is no company which can realize, handle and renew the high number of needed print characteristic curves.

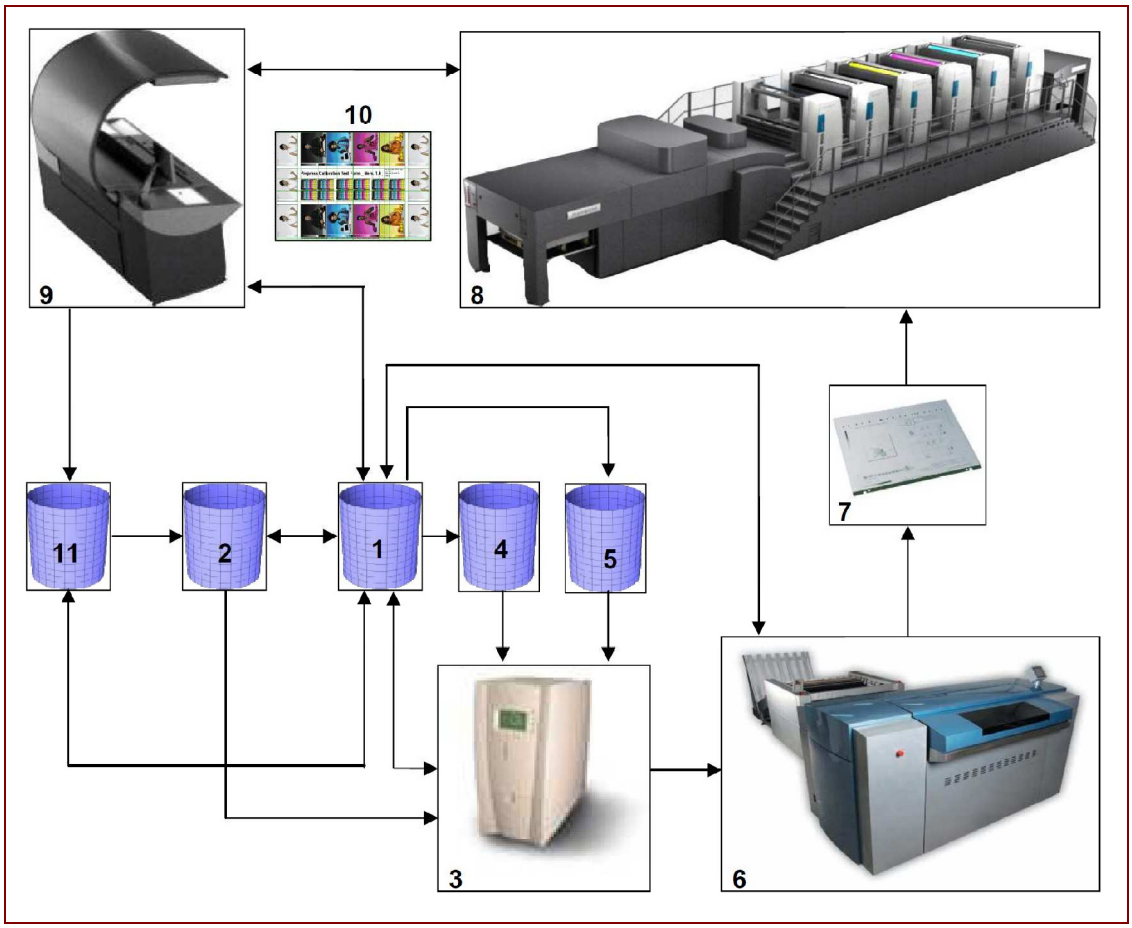


Figure 1. A Networked Workflow for a Fully Automated CtP Calibration System.

1. MIS (Management Information System)
2. PCC-DB (Print Characteristic Curve Data Base)
3. RIP (Raster Image Processor)
4. Layout and Print data
5. Imposition program (template)
6. CtP (Computer to Plate)
7. Printing plates
8. Press control desk
9. Press
10. Printed sheet
11. PQS-II program (non-iterative CtP-Calibrations tool)

Necessary Condition

The following conditions should be fulfilled generally for a Fully Automated CtP Calibration System (figure 2). The first condition is the ability of direct and non-iterative CtP calibration. The second condition is the ability to keep the printing process stable. And the third condition is the workflow networking and controlling. This paper describes only the third necessary condition.

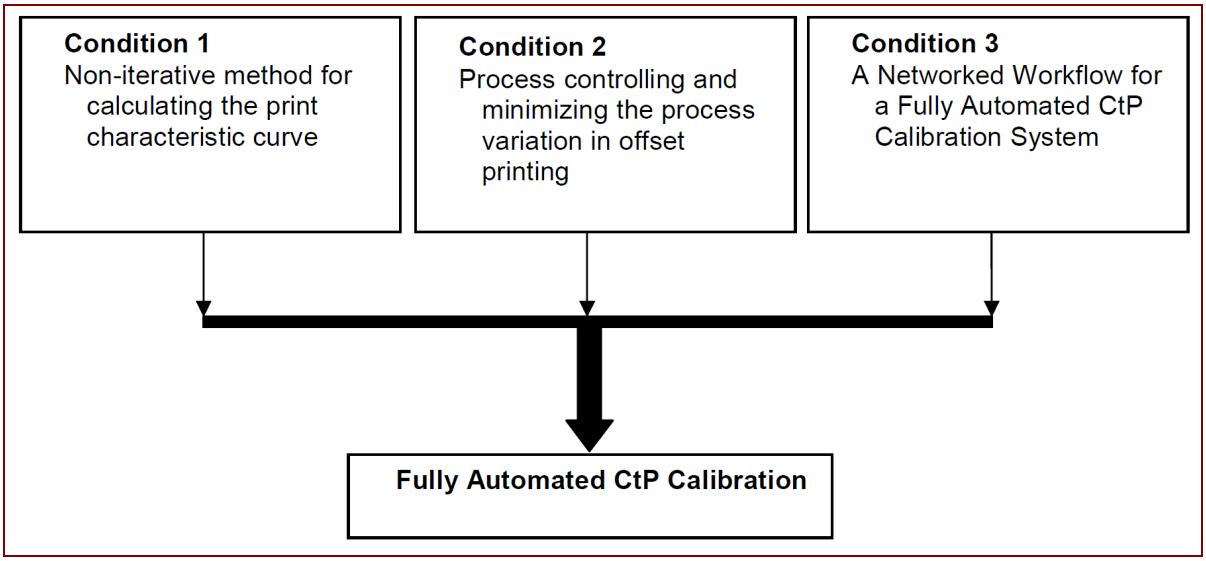


Figure 2. Three necessary conditions for realizing the aim "Fully Automated CtP Calibratin".

Condition 1

The mathematical function of dot gain is not linear. The calculation of this non-linear function is complex and depends on different parameters [2]. Therefore most of the existing methods for calculating the correction of the print characteristic curve are iterative. It means that the improving iteration should be in action in a loop as long as the print characteristic curve is in the range of the reference curve. For realizing the aim "Fully Automated CtP Calibration" there is a non-iterative method needed for calculating the print characteristic curve. This paper does not deal with the first condition.

Condition 2

For most of the press operators, the print quality means to print reproducibly and standardized product following e.g. ISO-12647-2. This is not an easy task because a high number of parameters such as consumables, temperature and humidity in the print room influence the printing workflow. Offset printing is surely one of the most sensitive printing processes and prone to variation. Because of that point the printing process should be controlled very attentively. Uncontrolled printing process is subjected to a relative high variation. For controlling the offset printing it is necessary to know the parameters that influence the printing quality. For realizing the aim "Fully Automated CtP Calibration" it is necessary to control the process and minimize the process variation in offset printing [3-14]. This paper does not deal with the second condition.

Condition 3

This paper deals with all of the important points of the third necessary condition for realizing of a Fully Automated CtP Calibration System. Please let us start with the explanation of the first figure. Figure 1 shows the needed networked workflow for a Fully Automated CtP Calibration System. The demonstrated networked workflow contains the following components:

1. MIS (Management Information System): For the controlling of the workflow a Workflow Control System or as an alternative a MIS is necessary. A controller is the logical and neuronal head of a workflow. All communication and logical processes will be controlled here. The needed commands and sequence and the definition of hierarchy will be managed by the controller. For the first viewing and the better understanding in figure 1.1 MIS is used, which is not the only possibility. We can also use another controller system. This can be integrated in PrintNet system (manroland) or Prinect (Heidelberg) or other print Workflow Control Systems. The problem with a MIS and JDF workflow is that an inconsistency between the systems and the components of a workflow still exists. The workflow components are not really able to communicate with each other for 100%. Because of this point the term Workflow Controller System (integrated e.g. in PrintNet system or Prinect) instead of MIS will be used in this paper.
2. PCC-DB (print characteristic curve data base): As mentioned in the introduction a huge number of PCC can be necessary in a printing workflow dependent on the number of consumables, parameters and resulting combinations. Therefore renewing PCC and finally the handling and managing of different PCC are required. The most printing companies use a small number of PCC. This is because of the complexity and the high cost of generating the PCC manually. Consequently a big part of the printed products cannot be

printed with the absolutely correct PCC hence these products are not in all quality point of ISO-12647-2 definition. The proposed PCC-DB is a new component in an offset printing workflow. PCC can be saved and used dependent on the combination of consumables and processes in PCC-DB. It is also possible to save a huge number of PCC in PCC-DB. The managing (saving, overwriting, and calling) of the PCC in PCC-DB will be done via the Workflow Control System. A new PCC should be renewed between 3 up to 6 months after its generating. The reason is the quality of consumables and the print machine setting changes a little bit over the time. The climate in the printing room can also change dependent on the season. All of that cause a drift after a few months in adjusted process. Because of that point it is necessary to save the date of generating a PCC and to determine a date for the earliest (e.g. 3 months after generating the PCC) and the latest (e.g. 6 months after the generating of PCC) renewing date. An already existing PCC should be renewed between the earliest and the latest time.

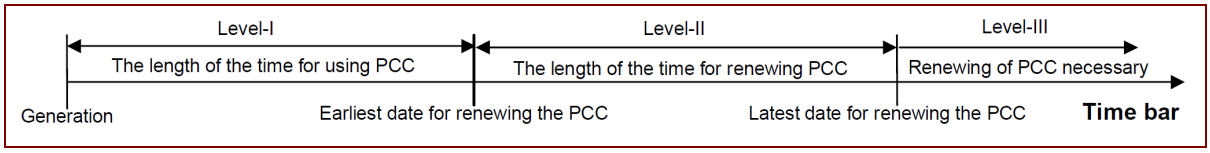


Figure 3. The time bar for the demonstration of generating, using, and renewing a PCC.

3. RIP (Raster Image Processor): A RIP is a component used in a printing workflow which produces a bitmap from the layout data. Then the bitmap is sent to the CtP to image the printing plate. The input is normally a page description in a high-level page description language such as PostScript, or Portable Document Format.
4. Imposition program (Template-I and Template-II): Imposition is important in the prepress, press, and post press. Normally an imposition defines the position of pagers after folding a printing sheet. But an imposition program can also be used if you do not have a folding sheet, e.g. for the printing of packaging sheets or labeling sheets. You can use different levels of an imposition program and you can use predefined printing sheets (template). A template contains a predefinition of the position of a printing control strip, the register marks, and of course the reserved area for printing the layout of a job. In our workflow we use two different general templates for our imposition.

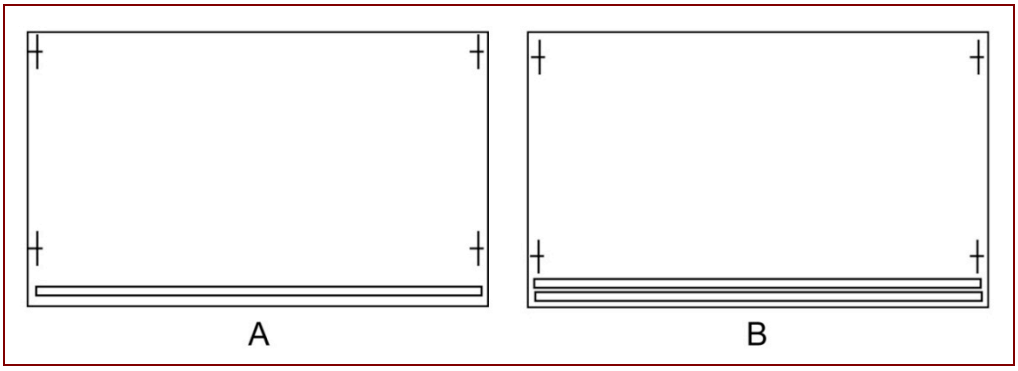


Figure 4- (A)The Template-I for the second case (figure 7). The ink control strip, and register mark. (B)The Template-II for the first and third case (figure 6 and 8). The ink control strip, PCC-Strip, and register mark.

5. CtP (Computer to Plate)
6. Computer to plate is an imaging technology which images the bitmap sent from RIP on the printing plate (e.g. for offset printing processes).
7. printing plates
8. Press control desk: The central place for all process and production related commandos at the press.
9. Press
10. printed sheet
11. PQS-II program: A PCC-Generator program (or tool) for the non-iterative CtP-Calibrations. This program evaluates the PCC-Strip at the Template-II (figure 4(B)) on the printed sheet and generates a PCC. This program has to be “non-iterative” (first condition, figure 2) to realize the aim “Automated CtP Calibration System”.

PCC information

In a printing company the number of necessary PCC is depended on the number of combinations of consumables, machines and even the setting of the machines. This parameter can result in a high number of combinations. It is useful to have a system (nomenclature) for the generated PCC. Hence a usefully PCC-denotation should content following information:

- Consumables
  - Paper class
  - Ink
  - Plate
  - Blanket
  - Dampening
- Machine
  - Press no.
  - Process
  - Machine setting
- Date
  - Date of generation of PCC
  - The earliest date for renewing
  - The latest date for renewing

Job generating and the three possible cases

In the practice (figure 1) there will be three possible cases (figure 5) for the print production with a right PCC in a workflow:

- First case: generating and saving a new PCC (figure 6)
- Second case: using a suitable PCC (figure 7)
- Third case: renewing an existing PCC (figure 8)

In the following each of three possible cases will be shown by flowchart and then described. The flowcharts and the descriptions help to understand this workflow and its working principle. The next flowchart (figure 5) shows the job generating in the Workflow Control System (e.g. Printnet, or Prinect, or a MIS). Dependent on different situations it can result in generating, using, or renewing a PCC. That depends on the needed consumables and the availability of a PCC for printing a job. The flowcharts (figure 6 to 8) show the process of generating, using or renewing of the corresponding PCC.

The working principle of the Workflow Control System

The working principle of the Workflow Control System is described in 6 steps (figure 5):

A: The Workflow Controller System (e.g. Printnet, Prinect or a MIS) builds a list with all of the needed consumables after generating a job. Then the information of this list will be compared with the existing list in PCC database. If there is no suitable PCC, then a similar* or compatible* PCC (see below) will start (figure 5, step-B). If a suitable PCC is available, then the controller will start (figure 5, step-C).

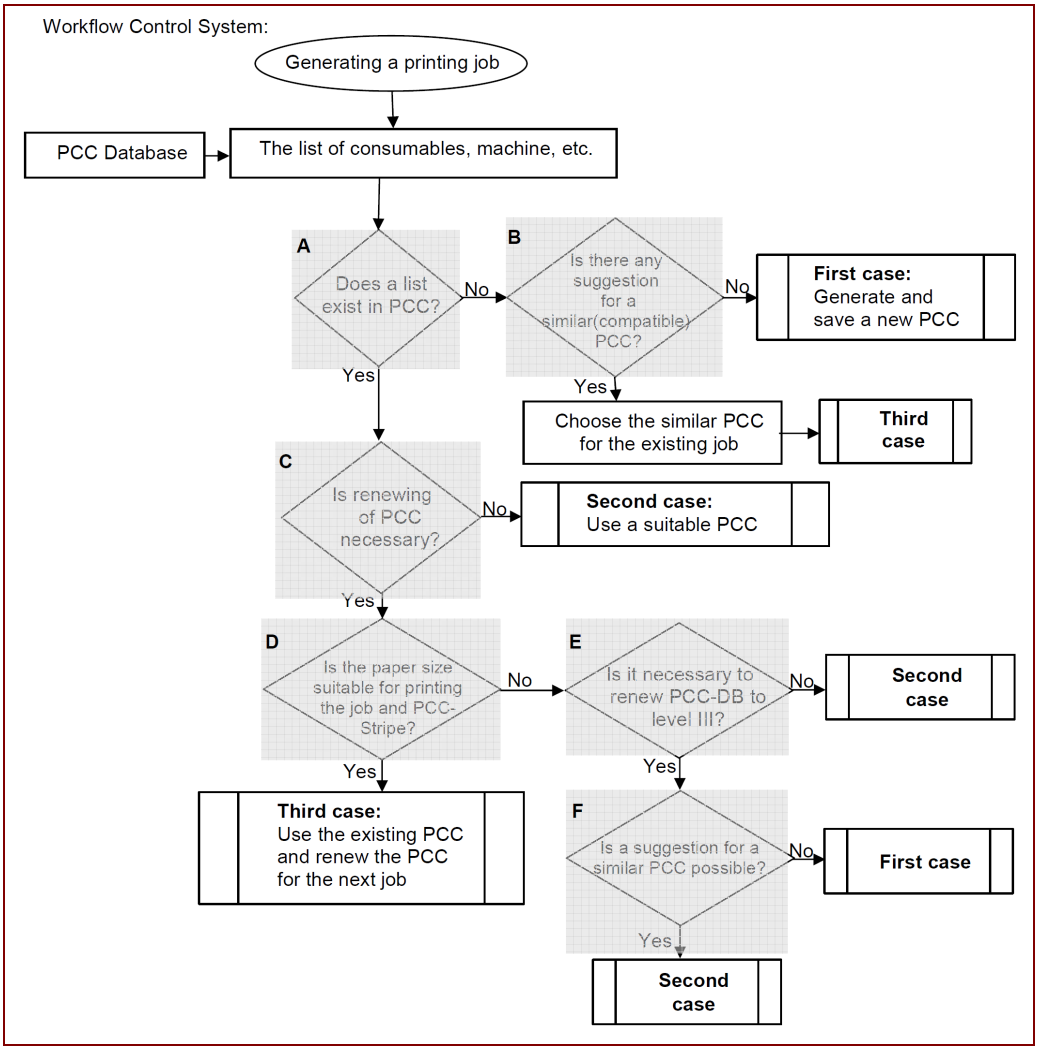


Figure 5- Job generating in the Workflow Control System and the possible three cases.

D: If the paper size is suitable for PCC-Strip, then the third case will start. If the paper is not suitable (small), then the Workflow Control System will have to check if the already funded PCC can still be used (figure 3, level II) or if the PCC is old and cannot be used (level III). In that case the step-E has to start.

E: If it is not implicitly necessary to renew the PCC and the PCC is still in level II status (Figure 3), then the second case has to start. If it is implicitly necessary to renew PCC from level III right now, then the Workflow Control System will have to check if a similar or compatible PCC is available or not (figure 5, step-F).

F: If a similar or compatible PCC is available, then the second cases will start, or else the first cases will be called.

*A similar or compatible PCC

There are different priorities for the list of used consumables and process. For example the most important priority for a PCC is the paper class and the fabrication of the ink. Surely the type of a blanket is also important, but not as important as the paper class and the fabrication of an ink. Dependent on the workflow and production, some consumable in the workflow can have a highly important or a less important priority. This is important for searching a similar or compatible PCC. Dependent on the priority a compatible or a similar PCC can be used to avoid the happening of the first case.

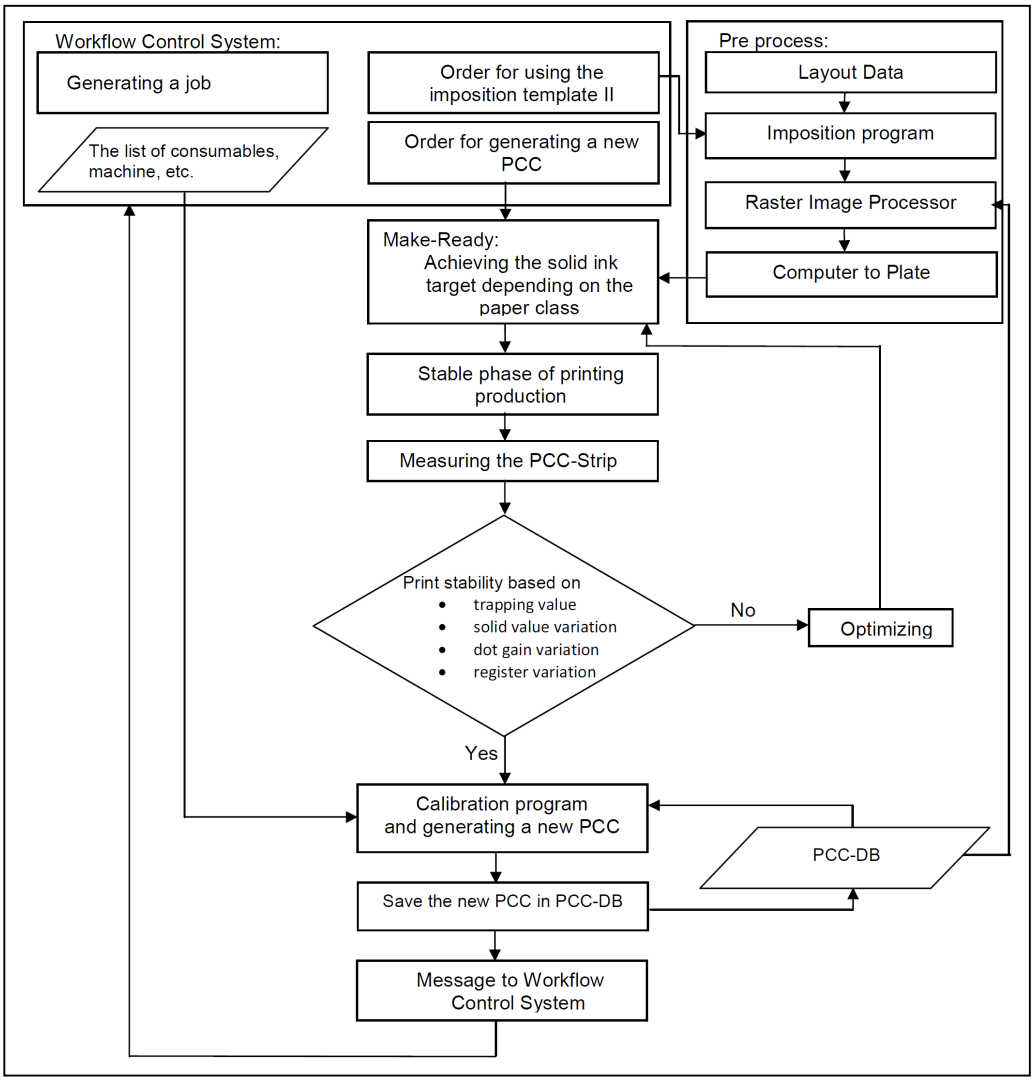


Figure 6- First case: Generating and saving of a new PCC.

Description of three possible cases

Dependent on the needed consumable and availability of a PCC, the Workflow Control System differ in three cases: Generating, using, or renewing of a PCC as already demonstrated in Figure 5. Now all of these three possible cases and the corresponding processes with the PCC are described. Figure 6 describes the first possible case, which is important for starting the "Fully Automated CtP Calibration System". Normally the first case should be an exception compared to the other two ones.

First case

The Workflow Control System decides to generate a new PCC. First the imposition program receives an order for using template-II, which contents the PCC-Generating-Strip (in this paper called PCC-Strip) in addition to register-mark, print control strip, printing job or a testing motive (figure 4(B)). After the plate imaging through CtP, the printing at the press can start. When the make-ready (adjustment of image-register and achieving the solid ink value) is finished, the printing phase (production or in this case test printing) can start. For an exact generating of PCC the printing process should be stabled and controlled (figure 2, condition 2). Hence the PCC-Strip should contain elements which also allow checking the stability of the printing process. Before we calculate the PCC the stability must be checked. In case of variation the calibration process is to be interrupted. After make ready and stabilization of the printing process the PCC-strip can be measured for the evaluation and calculation of the PCC. During the production the operator of press has to take several printing sheet and measure that for controlling the press and the inks. The inline ink control systems do this procedure automatically and, of course, inline. The inline ink control system contains the analyzing of the ink solid target, homogeneity, solid value variation, register variation, and trapping variation. Before we calculate the PCC the process stability should be checked. The process variation must be minimal. If all of these conditions are

fulfilled, then the measuring system will have to measure and evaluate the PCC-Strip. After measuring several printed sheets (10 or more) an average value will be built. This workflow will be worked only if the printing process is stable. Hence the interruption variation is an absolute exception (that means the system should tolerate maximum < 5% interruption). If the printing process is stable then the generation of PCC can start. For the calculation of PCC in this automated workflow a "non-iterative PCC generating program" is absolutely necessary (figure 2, condition 1). Some generating programs need the data of the actual PCC. Dependents on the PCC generating programs, the PCC-Strip is imaged linearly or not. If the PCC generating program is able to calculate a new PCC even if the PCC-Strip is not linear, in this case the PCC generating program will need the Look up Table (LUT) for the actually used PCC. This data will be called from PCC-DB. For a meaningful name or term of a PCC it is useful to have information about the consumables. That can be done by the help of "The list of Consumable and Machine" from the Workflow Control System (see the PCC information). After the generating of a new PCC, it will be saved in PCC-DB. After having saved the new PCC the Workflow Control System will get a feedback that the PCC is saved and the process was successful and has been finished now. The name of the new PCC will also be saved in the Workflow Control System.

Second case

Now the Workflow Control System decides to use only an existing PCC (figure 3, Level-I) and does not generate a new one. First the imposition program receives an order for using template-I, which contents only the register-mark, print control strip and printing job or a testing motive (figure 4(A)). The RIP imports the right LUT (which is already chosen from the Workflow Control System) of the PCC from the PCC-DB. After the plate imaging via CtP the printing at the press can start. If the make-ready (adjustment of image register and achieving the solid ink value) is finished, the printing production phase can start.

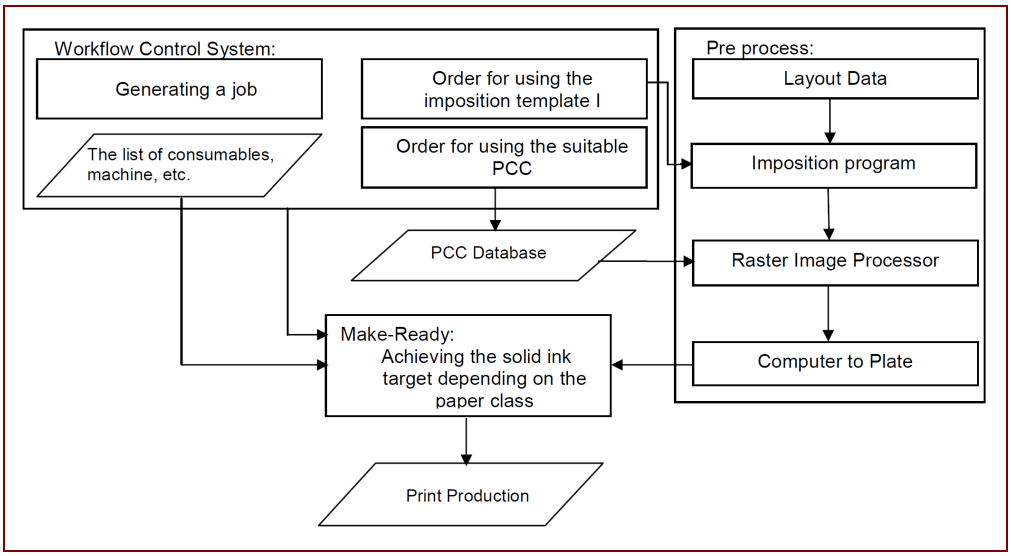


Figure 7- Second case: using of a suitable PCC.

Third case

Now the Workflow Control System decides to use an already existing PCC for the printing of the actual printing job and to renew this PCC parallel to the production for further needs. First the imposition program receives an order for using template-II, which contents the PCC-Strip in addition to register-mark; print control strip and printing job (figure 4(B)). The RIP imports the right LUT of the PCC from the PCC-DB. After the plate imaging through CtP the printing at the press can start. If the make-ready is finished, the printing production phase can start. For an exact generating of PCC, the printing process must be stabled and controlled (figure 2- condition 2). The PCC-Strip must also contain elements which allow proving the stability of printing process. Before we calculate the PCC the process stability should be checked (like the first case). The process variation must be minimal. If all of the conditions are fulfilled, then the measuring system will have to measure and evaluate the PCC-Strip. After measuring a few printed sheets (10 or more) an average value will be built. As mentioned before a non-iterative PCC Generating program is necessary for generating a new PCC in this "Automated Workflow" (figure 1- condition 1). After generating the new PCC this should be saved in PCC-DB and the old PCC should be deleted from PCC-DB. After the new PCC was saved and the old one was deleted, the Workflow Control System gets a feedback that the process was successful and has been finished now.

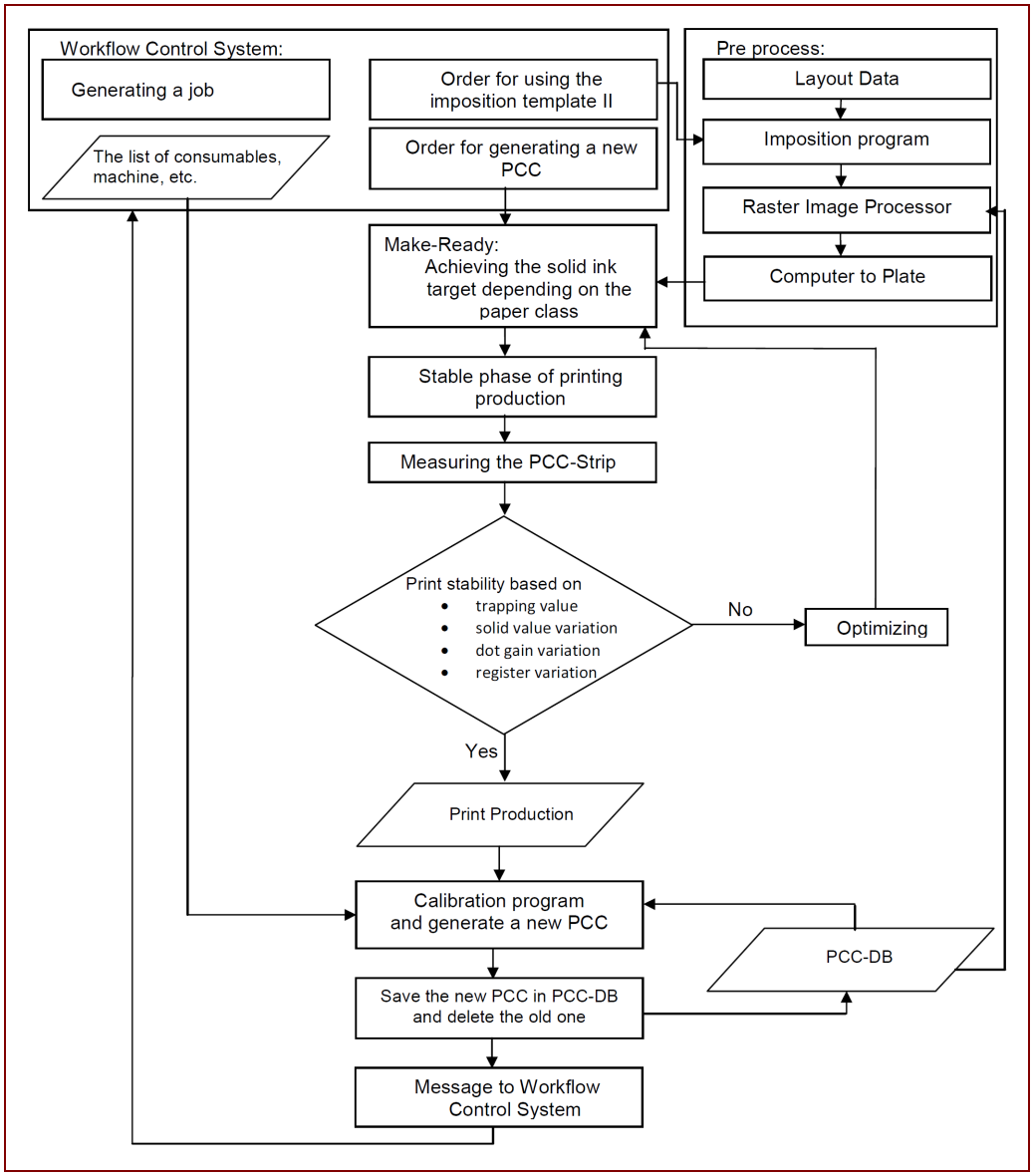


Figure 8: Third case, the renewing of an existing PCC.

Conclusion

This paper introduces a part of three complex conditions which are necessary to realize a "Fully Automated CtP Calibration System". The "Third Condition" describes the needed control and the necessary logical communication between the workflow of prepress and press. Different PCC will be used for an exact production according to a standard (e.g. ISO-12467-2). The numbers of needed PCC in a printing process depends on the number of combination of consumables and process parameters. We introduced the possible different cases in a Workflow Control System and summarized these cases to three possible cases in generating, and using, and combination of using and renewing of PCCs. Each of these three cases is graphically illustrated and explained separately in the flowchart. The suggested workflow will allow reducing the costs extremely and the time needed for manually generating or manually renewing the PCCs. During the automation a high number of PCCs can be generated and administrated. This causes a huge increase of print production quality and relieves enormously the work of the personal at the prepress, press, and quality management.

References

[1] S. Gooran , "Digital Halftoning", http://staffwww.itn.liu.se/~sasgo/TNM011/Digital_Halftoning.pdf

[2] M. Namedanian, S. Gooran. "High-Resolution Analysis of Optical and Physical Dot Gain", Proc. TAGA (Technical Association of the Graphic Arts), (2010)

[3] S. Hauck, S. Gooran, “An Alternative Method to Determine Register Variation by using a Spectrophotometry Tool”, Proc. TAGA (Technical Association of the Graphic Arts), (2011)

[4] S. Hauck, S. Gooran, “An Alternative Computational Method of Trapping for the Print Machine Operators”, Proc. TAGA (Technical Association of the Graphic Arts), (2011)

[5] S. Hauck, “Feuchtwerk für eine Druckmaschine“, patent DE102006002502A1, (2007)

[6] S. Hauck, “Verfahren zur Erfassung druckqualitätsrelevanter Parameter an einem Druckprodukt“, patent DE102006010180A1, (2007)

[7] S. Hauck, “Bogendruckmaschine”, patent DE102006025789A1, (2007)

[8] S. Hauck,“Bogendruckmaschine”, patent DE102006025787A1, (2007)

[9] S. Hauck,“Bogendruckmaschine”, patent DE102006020907A1, (2007)

[10] S. Hauck,“Bogendruckmaschine”, patent DE102006020906A1, (2007)

[11] S. Hauck,“Bogendruckmaschine”, patent EP000001854628A2, (2007)

[12] S. Hauck,“Bogendruckmaschine”, patent DE102006030355A1, (2008)

[13] S. Hauck,“Druckmaschine, sowie Verfahren zur Abstimmung der Farb- und Feuchtwerkseinstellungen“ patent E102008007272A1, (2009)

[14] R. Chung and, F. Hsu. “Predicting color of overprint solid” Advances in Printing Science and Technology Vol. XXXVI, iarigai, (2009)

Author biography

Hauck is a Process & Quality Manager at the Print Technology Center of manroland Germany. His activity field is prepress and printing process (print system analyzing and optimizing, and process controlling). He consults and supports the key customers of manroland worldwide. Hauck has invented and registered a lot of novel ideas and patents in different fields of the printing industry during his activity at R&D. Additional to his activity at manroland he is absolving a Ph.D. study at the LiU in Sweden.

Stability evaluation of printing

Anna Berdovshchikova

Moscow State Ivan Fedorov University of Printing Arts, Russian Federation
berdanna@yandex.ru

Key words: offset, quality, stability, statistical control methods.

Abstract

It is known that the main requirement of the printing process is its stability, by which means the process that provides for the given operation conditions the stability of the normalized values of the printing quality over the entire run.

The quality of the printed image is usually assessed through determine the values of the following individual parameters: optical density, color difference, color-to-color register, dot gain, uniformity of the ink on the print. Typically, these indicators and their values are introduced in the normative documents - international, national and industry standards.

The practice of print shops indicates non-compliance with these normative documents, the cause of which is the lack of a unified automated processing facility, including equipment, supplies and test equipment. Sometimes with the proper equipment during the print run there are deviations of values, resulting in offshade and increased waste.

In several diploma works have been assessed the stability of the sheet-fed offset printing machines for specific workshop conditions, as well as an attempt to compare different devices for online monitoring and quality control. Were also considered possibilities to characterize the stability numerically, by using statistical methods and coefficients.

The value of the optical density of print, and, consequently, the color coordinates are random variable obeying a Gaussian distribution. Thus, to analyse these indicators can be applied statistical methods, by calculating the arithmetic mean and standard deviation. On the graph of the variation dynamics are located the measured values, as well as the average. Applying the law of Gauss, we obtain the field of possible values (with the probability of 0.956 or 0.997). By posting on the same graph tolerance limit of the standards upheld by a printing house, we get a clear picture of changes in the entire printing run. These charts are relatively easy to obtain and easy to analyze, but they can not give an unambiguous numerical stability characteristics. There was made an attempt to develop a numerical indicator for more convenience.

Printing quality

In the process of manufacturing printed products for its quality affects a large number of factors. Each of them can lead to what the end result will not match the expected result. These factors include:

• original image selected for printing;

• quality of the original image;

• paper used for printing. Each type of paper used for certain purposes. Therefore, the same image will have a completely different appearance depending on the paper.

• printing inks;

• printing equipment;

• level of professionalism and efficiency of their printing works. Human factors affect the print quality in any case, even by automated printing presses.

Only constant testing and standardization of all processes of platemaking and printing can provide high quality products.

To maintain print quality and stability of the printing process it is nesessary to monitor compliance with the normalized parameters of color reproduction on the basis of developed technological instructions for the printing process. As a basis to use modern standards– ISO 12647-2, GRACoL, also national or local standards.

For each process that primarily determine the parameters (indicators), which change significantly and markedly, and those that depend on technological factors and regulated modes.

In the visual evaluation of prints selected indicators should be placed in order of importance. This ranking is a difficult task, because the importance of quality can vary greatly depend on the depicted object. For some objects it is important to give greater contrast to the other - small parts, for the third - smooth tonal transitions or accuracy of the individual colors and shades etc.

Basic printing quality characteristics are:

• reproduction of pure colors (cyan, magenta, yellow, black) at different relative dot area 10, 20 … 90 и 100%;

• color accuracy for production prints compared to the color proof;

• reproduction of tone gradations and fine details in the highlights and shadows of the original;

• reproduction of "memorable colors" (skin, leaf green, sky etc.);

• reproduction of black and gray.

There are two methods for assessing the quality of prints: the integral and parametric.

The integral assessment is carried out in the whole visual impression of some observers, who express their opinion on the totality of symptoms. When given by averaging their estimates can be obtained sufficiently reliable information about product quality. Visual assessment of the express words of "good", "better", "excellent", "bad", without distinguishing what is reproduced well and that not very much. This estimate can still be defined as psychological (consumer).

The second method is a parametric visual and instrumental evaluation of the quality of prints by some indicators. As a result, visual assessment can determine how certain technological factors affect the tone-and color reproduction, and select the optimum conditionssuch as platemaking, printing and other signs of quality assessment Instrumental performed with instruments and accompanied by an indication of technological factors and modes of - the causes leading to a change in the trait.

Parametric estimates can be defined as industrial or professional. This assessment modes and modalities of the process rather than product quality.

The integral and parametric evaluation of the quality of interconnected and interdependent: the first is formed on the basis of the second. The individual parameters of quality can be very significant impact on the result of an integrated assessment. On the other hand, provide an objective assessment of cumulative impressions based on the parameter values estimates is difficult because it is difficult to identify and assess the weight of the individual parameters of quality in terms of consumer.

Visual assessment of each property is particularly important when it comes to defects such as unevenness of tone plates or large homogeneous background regions and parts of the image. The eye quickly picks up even the slightest breach in the smoothness of tone and color transitions, say, the image of the sky. Trace the same for such a violation of densitometric data is difficult (because the measurement and processing of the results takes a long time), and sometimes simply impossible. Most people can easily notice even a slight distortion of commemorative colors, such as the face, and do not pay attention to the serious (according to the testimony of the densitometer) background color distortion or psychologically insignificant parts of the image.

To objectively evaluate characteristics of color and to keep their options more stable over the entire run will densitometric and spectrophotometric monitoring of prints.

The most important objective densitometric characteristics of color images on the print are:

• solid optical density;

• interval of optical densities;

• change in optical density;

• dot area;

• reproduction of gray and color (according to some printing inks) scales;

• gray balance;

• trapping.

To determine the spectral characteristics of the prints used spectrophotometers, which objectively quantifies the color through the spectrum of the radiation (transmission, reflection). Control of each of the main technological parameters by measuring the elements of a print test and measurement scale.

Statistical control

One of the methods of research process is a statistical analysis of their stability and accuracy. By statistical analysis of the accuracy and stability of the process involves determining the accuracy characteristics and patterns of occurrence in time process using statistical methods.

Statistical analysis includes:

• selection of quality parameters of production prints;

• choice of ways to measure them;

• accumulation and mathematical treatment of statistical data;

• assessing the stability of the process;

• identifying and addressing the causes of deviation from the norms of the process;

• establishment of normative values.

Optical density of sites on the print, which are an indicator of the quality of print in the printing process varies from the fixed to the approved list. The magnitude of deviations on each imprint can not be predicted with certainty, so the obtained values of optical density are random. Random variables are optical density values obey a normal distribution. The main parameters that characterize the distribution, are the mathematical expectation (M), dispersion (D) and standard deviation (σ).

Determines the mathematical expectation of the average value, around which are grouped the values of the random variable:

$$\mathrm{M}(x) = \frac{1}{n}(x1m1 + x2m2 + x3m3 + ... + xkmk) = \frac{1}{n}\sum ximi \quad (1)$$

m_i – number of identical values;

n – number of measurements.

Variance and standard deviation shows the degree of dispersion of a random variable around the mean.

Variance:

$$D(x) = \frac{1}{n}\sum_{i=1}^{k}\left(xi - \bar{x}\right)^2 \quad (2)$$

Standard deviation of a random variable X is the square root of the variance.

$$\sigma(X) = \sqrt{D(X)} \quad (3)$$

In a normal (Gaussian) distribution, we can calculate the probability that a random variable in intervals that are multiples of the standard deviation (Fig. 1).

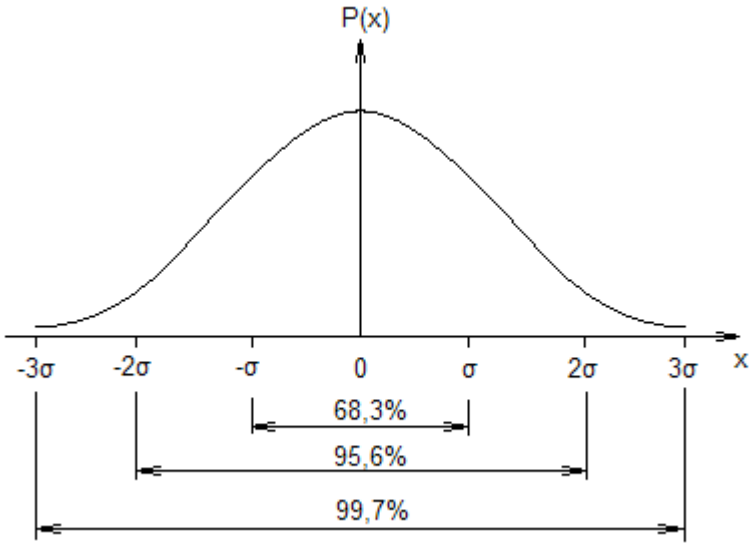


Fig. 1. The graph of the probability density of normal distribution and the percentage of hits of a random variable into segments that are multiples of the standard deviation.

So, the probability that a random variable deviates from its expectation by an amount greater than three times the standard deviation is practically zero.

In such statistical measures as mean and standard deviation based tool known "control chart". Standard GOST 15895-77 "Statistical methods of quality management" formulates a definition as follows: map to graphically display the changes in level of customization and precision process, which are entered the values of statistical characteristics of the next sample or samples and record the process parameters and modes. With the development of automated systems for measuring and monitoring established in the printing machine or in the pressroom, and allow for the rapid control and management of quality indicators in real time, the need for manual filling out checklists disappeared, but the principles are still used. [1]

Practical part

The practical part of the work carried out within the framework of the graduation projects of several students in a real operating printing plants. The process of the flat offset printing with moisture as the most common, as well as those affected by many factors.

We investigated the stability of quality - optical density, dot gain, trapping, coordinate colors - one for print edition. In the experiments we used a modern sheet-fed printing equipment (machines Heidelberg Speedmaster 102 and XL-105, manroland 700) and materials, allowing to obtain high-quality prints that match the requirements of standard ISO 12647-2. Some vehicles were equipped with measuring devices and control unit performance. Nevertheless, it is not in all cases enhanced the qualitative performance of printed works

Consider one example. For three different runs are made checklists, control charts (Fig. 2) and calculated statistics.

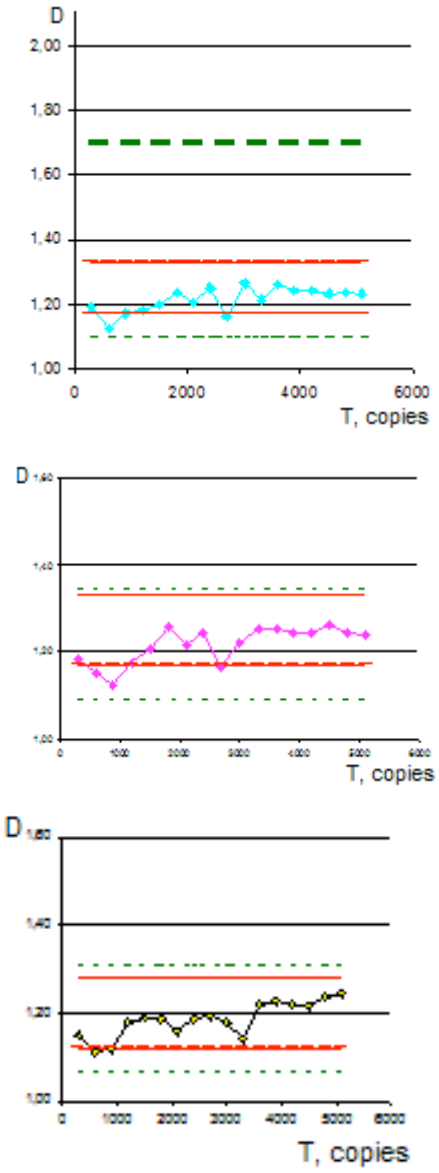


Fig. 2. Control charts for one run, optical density: a) cyan, b) magenta, c) yellow; green dashed lines - probability space for density values, red straight lines – dencity tolerances.

The literature offers two numerical coefficient to calculate the indicator of stability of the process. [2]

Accuracy factor K_T process is defined as the range of the scattering parameter to the field of tolerance Δ-adjusted price of dividing the measuring device d. If the value of quality characteristic is distributed in a Gaussian, then

$$K_T = \frac{6\sigma}{\Delta + d} \tag{4}$$

Should seek such precision manufacturing process, in which K_T = 0.6 + 0.85, since the K_T <0.6 process is unnecessary precision, while K_T> 0.85 the accuracy is poor.

The concept of technological stability criterion related to the level (stock) the stability of the printing press, that is, with its ability to maintain a certain technological measure within the tolerance.

Technological stability criterion (K_{TS}) is defined as a percentage using the following relation:

$$K_{TS} = \frac{\bar{x}}{x_S} \cdot \frac{x_{\max} - x_{\min}}{\Delta} \cdot 100\% \tag{5}$$

$\bar{x}$ — average value;

x_S — standart value.

The limit values of K_{TS} are: K_{TS} =0, in that case, if the statistical evaluation of the technological measure is on the border of the allowable values, and printing machine does not have the margin of stability on the technological parameters; if $\bar{x}/x_S=1$ and $(x_{max}-x_{min})/\Delta=0$, the statistical evaluation of the technological measure is equal to one, printing machine has a maximum margin of stability on the technological parameters and K_{TS} =100%.

In assessing of the printing uniformity or stability initially are calculated statistics, production data and then, finally, establishes the criteria for process stability. Margin of stability is normal (0), if he does not go beyond the alleged accuracy of the estimate and 5%. Consequently, the estimated value of K_{TS} can be characterized by three categories: normal (0), above normal (> 0), below normal.

Table 1. The coefficients for the reporting print run

	K_T	K_{TS}
Cyan	2,1	1
Magenta	2,29	16
Yellow	2,17	12

Analyzing Table 1, we find that the circulation has an unsatisfactory accuracy of the process in all colors, as Km much greater 0.85. For this print run of the norm can be attributed only printing blue ink, purple and yellow shows values above the norm.

Circulation was unstable as a result of the analysis of graphs of the dynamics of change in optical density and the coefficient of exactly K_T. Technological stability criterion shows a significant accuracy for the blue paint, despite the fact that the control card, it goes beyond the limits. Yellow paint on a small piece out of the norm, but the coefficients of this process is characterized as insufficiently precise, while K_{TS} gives a smaller deviation from the norm, which is closer to the truth.

Conclusion

In general, the evaluation process of other runs with different K_T and K_{TS}. In the analysis of some of the print run K_T and K_{TS} agree to the assessment of instability

K_{TS} equally accurate estimates unstable circulations. K_T was more accurate in the assessment of circulation, differing average spread, however, is absolutely indicative of values that can be replaced with graphical trend change in optical density, it does not. K_{TS}, which takes into account the size of the average and range, but not taking into account the probability distribution of optical densities around the mean, is not accurate enough to assess the cases with an average swing. So, none of the indicators can not clearly express the accuracy and stability of the process. The most informative is the control chart on which the specification limits are applied, the field of probability (6σ) and warning limits (4σ).

References

[1] Standard GOST 15895-77 "Statistical methods of quality management. Terms and definitions."

[2] Veisberg E.V., Shakhova I.I. System of statistical quality control and regulation of the 4-color offset production. – Moscow, 1990. (Printing industry. Informpechat. Issue 1).

Author biography

Anna Berdovshchikova graduated from Moscow State Ivan Fedorov University of Printing Arts (MSUPA) with a Master's degree at 2003. She is teacher at Chair of Print and PostPress Processes, MSUPA. The sphere of her interests include conventional printing, digital printing and process optimization.

Characterization of the silver halide printing plate's surface properties

Tomislav Cigula, Sanja Mahovic Poljacek, Tamara Tomasegovic

University of Zagreb, Faculty of Graphic Arts, Getaldiceva 2, 10000 Zagreb
tcigula@grf.hr, smahovic@grf.hr, ttomaseg@grf.hr

Keywords: Lithography, silver halide printing plate, contact angle, surface roughness, material wear

Abstract

Lithography is a highly complex process, based on different physical-chemical properties of image and non-image areas. Image areas are hydrophobic and oleophilic which enables them to adsorb printing ink, while non-image areas are hydrophilic to adsorb fountain solution. It is essential to obtain and keep wanted surface characteristics throughout whole printing process to achieve desired quality level of imprints.

Majority of the offset printing plates used are made of an aluminium foil which is mechanically, chemically and electrochemically processed to make a thin porous aluminium-oxide film which forms nonprinting areas. The foil is then covered with a photoactive layer which enables image transfer on the printing plate and builds image areas. There are many photoactive layers used, among others is silver halide layer. The usage of the silver halide technology in the graphic reproduction is not a novelty. The filmmaking phase is based on the usage of the silver halide as the photoactive ingredient.

This paper presents results of the surface characterization of Computer to Plate (CtP) silver halide printing plates used in newspaper printing. The investigation was divided in two parts; first part was to determine influence of the processing solution's saturation due to the number of plates made and second to determine changes in surface characteristics by the exploitation process.

Results of the investigation showed that increasing number of processed printing plates causes decrease of its electrical conductivity causing change in wetting properties of nonprinting areas. Printing process is causing wear of the printing plate but depending on the printing machine construction and position of the plate in it wear of the printing plate is changing.

Introduction

Offset printing is a highly complex process characterized by two features, printing ink is carried from the printing plate on the printing substrate by a blanket cylinder and the image and non-image areas are in the same plane. The selective adsorption of printing ink is achieved by opposite physical-chemical properties of image and non-image areas. Non-image areas are hydrophilic which enables them to attract water bases solution – fountain solution while image areas are hydrophobic and oleophilic to attract printing ink but in the same time repel fountain solution [1].

Lithographic printing plates are mainly made of aluminium foils. In order to improve the fountain solution adhesion and to enhance the adhesion of the photosensitive coating during the printing process [2,3] the foil needs to be roughened by electrochemical graining and anodic oxidation [4]. Roughening of the aluminium surface and forming of thin aluminium oxide film are necessary for a number of reasons:

- It enlarges the functional properties of the surface and causes better fountain solution adsorption.
- It enlarges the better adsorption of the photosensitive coating.
- It enlarges the functional properties and causes better ink adhesion.
- It increases stability of the fountain solution and printing ink on the non-image and image surfaces during the reproduction process.
- It ensures the better mechanical properties of the printing plates and thus, longer print runs with the plates [5].

Quality of the plate making process and stability of the printing plates during the printing process has an essential role for the quality of the final product. Digital plate making process, Computer to Plate (CtP) enables greater control and standardization of the plate making process in contrast to analogue processes. It is important

to observe all the factors and aspects of the plate making process which could cause instability and insufficient quality of the printing process. The most important factors are definitely the consistency and quality of the photoactive and aluminium oxide layers of the printing plates. Due to the fact said, the aim of this research includes defining the plate making process as well as stability of the photoactive coating and aluminium oxide layer on the printing plates before and during the printing process.

The plate making process is in most cases consisted of two main processes – the exposure with defined electromagnetic irradiation and developing process. There are many various photoactive coatings present at the market but majority of them need to be chemically processed after exposure process. The exposure with a defined electromagnetic radiation causes physical and chemical change in the photoactive layer making it soluble in the developer solution. Developer is usually chemically aggressive solution often highly alkaline which enables it to dissolve aluminium-oxide layer and change its surface structure. Developer is during process getting saturated with dissolved parts of the photoactive coating. These new chemical compounds sediment into aluminium-oxide structure making it less adsorbing for fountain solution [6]. Both of those facts stress the importance of keeping all processes in the plate making in strict boundaries to enable printing plates of desired quality level but in the same time limiting expenses.

Printing plate is in the printing process under chemical influence of the chemicals (printing ink, fountain solution, paper particles) used and mechanical influence of the parts of the printing press (fountain solution, ink rollers, blanket cylinder). During printing plate wear surface properties of it are deteriorating and consequently leading to reduction of the imprints' quality level. [7].

This study is made to determine changes of the developing solution by number of the printing plates made and secondly investigate surface characteristics of the printing plate after printing process.

Experimental

Printing plates

Printing plate used in this research were AGFA Lithostar LAP-V based on a positive working silver-halide (AgX) layer (irradiated places will be nonprinting areas). The process is based on the diffusion of the silver-halide salt through barrier layer (Figure 1).

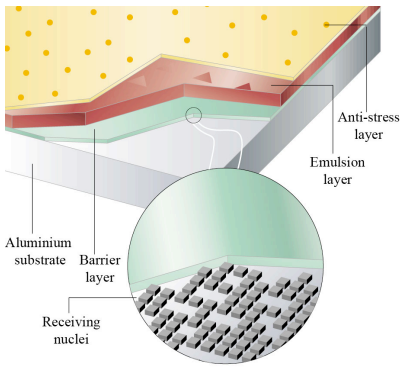


Figure 1. Structure of the AgX printing plate

The printing plate is made in four phases:

1. Exposure – a laser irradiates future nonprinting areas activating silver halide particles
2. Developing – printing plate is processed in a highly alkaline processing solution fixing activated particles in the emulsion layer
3. Diffusion – the unexposed silver ions are mobile and pass through barrier layer and travel to the receiving nuclei where they form printing areas
4. Wash off – after finishing diffusion process emulsion layer and the water soluble barrier layer must be removed opening silver ions that form printing areas and the aluminium-oxide layer which builds nonprinting areas [8].

The printing plates were made in a fully automated process using in line platesetter and developing unit (AGFA Polaris XTV platesetter and Agfa Ultra LB82 developing unit). The plates were processed by commercial processing solutions defined for the used plates.

For the purpose of determination influence of the printing process two sets of printing plates were made, one as a referent sample and second to use in the printing process. Printing process was conducted on the web offset GOSS Universal 70 printing press. Printing was made on the paper for newsprint, weight of 45 gm^{-2} with coldset printing inks. Printing process was made in the print run of 80.000 imprints.

Measuring methods

Determination of the processing solution was made by measuring its electrical conductivity as electrical conductivity is a measure which developing unit takes into account when adding amount of concentrate for refreshing of the solution. Measurements were conducted by the WTW GmbH LF 330/SET conductometer. Before start of the measurement device was calibrated according to the procedure determined by the manufacturer. Measurements were performed on the set of 200 plates made.

Contact angle is a measure which indicates solid-liquid interaction. It is defined as an angle between tangent on the liquid drop and a tangent on the solid shape crossing in the point where liquid, solid and vapour phase meet. Contact angle is direct consequence of the solid's and liquid's surface tension as could be seen in the Young equation:

$$\sigma_s = \sigma_l \cos\Theta \qquad (1)$$

where σ_s is surface tension of the solid, σ_{sl} surface tension at solid-liquid interface, σ_l surface tension of the liquid and Θ contact angle.

Contact angle measurements were performed by Dataphysics' OCA30. This device enables static and dynamic characterization of liquid/solid interfaces by contact angle measurement procedure. Measurements of the contact angle were made using *Sessile drop* method.

Characterization of the printing plate's surface properties was made by application of the three reference liquids of known surface tension (Table 1) and a fountain solution used for printing. Results of the contact angle measurements of the reference liquids enable calculation of the surface energy, its polar and dispersive part.

Table 1. Surface free energy (γ_{lv}) and their dispersive (γ^d_{lv}) and polar (γ^p_{lv}) components and viscosity of liquids

Liquid	Surface tension γ (mNm-1)		
	γ_{lv}	γ^d_{lv}	γ^p_{lv}
Diiodomethane (*Ström et al.*)	50.8	50.8	0.0
Glycerol (*van Oss et al.*)	64.0	34.0	30.0
Water (*Ström et al.*)	72.8	21.8	51.0

Surface energy calculation was made using Owens-Wendt-Rabel and Kaeble (OWRK) analysis method.

This method is developed from Young equation and the fact that surface tension can be divided on the polar and dispersive part.

$$\frac{(1+\cos\sigma)*\sigma_s}{2\sqrt{\sigma_l^D}} = \sqrt{\sigma_S^P}\sqrt{\frac{\sigma_l^P}{\sigma_l^D}} + \sqrt{\sigma_S^D} \qquad (2)$$

where σ_{LS} is the surface tension of solid-liquid interface, σ_l is the surface tension of the liquid, σ_s is surface tension of the solid, σ^D disperisve part of surface tension, σ^P polar phase of surface tension [9].

Surface tension and its polar and dispersive part is then calculated by observing equation (2) in graphic presentation of the function $y = mx + b$, where m is square root of polar part of solid's surface tension and b is square root of dispersive part of solid's surface tension.

To determine changes of the printing areas measurement of the printing element geometry was made. Measuring was performed by a Gretag Macbeth iCPlate II Platereader. This kind of measuring unit enables coverage value measurement, as well as dot radius measurement and gives a preview of the measured area.

Roughness of the surface was measured by Portable Surface Roughness Tester TR200 provided with a diamond tip with 2 μm radius.

Results and discussion

Processing solution ageing

In Figure 2 one can see the change of the processing solution's electrical conductivity by increase of the number of printing plates processed.

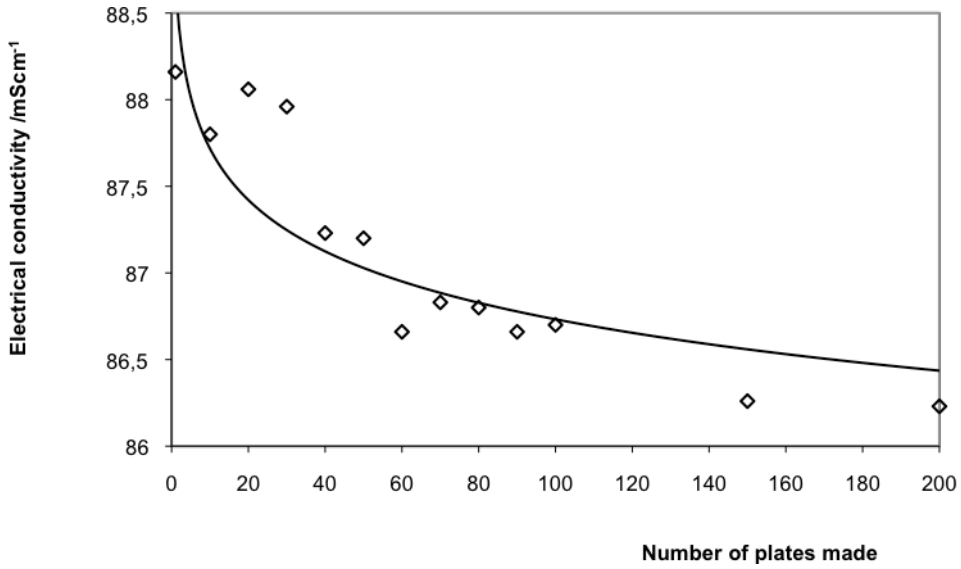


Figure 2. Electrical conductivity of the processing solution vs. number of plates made

It can be seen that electrical conductivity of the processing solution is decreasing with number of processed plates. Although decrease of the electrical conductivity is not high (cca. 2 percent) but it indicates that solutions composition is changing by the developing process.

During developing process soluble parts of the photoactive layer are dissolved and new chemical compounds are staying in the processing solution changing it chemical composition. Results of the electrical conductivity measurements indicate that those compounds don't dissociate and therefore reduce concentration of movable ions in the solution. This effect is likely reduced by adding fresh concentrate, but leads to printing plate's processing time and possibly quality.

Observing results presented in Figure 3 one could see that contact angle values between fountain solution and the nonprinting areas of the printing plate is increasing its value with increase of the processing solution saturation. As contact angle is an indicator of future behaviour of the nonprinting areas in the printing process one could conclude that saturation of the processing solution results with lower quality of the nonprinting areas.

Saturation of the printing plate decreases the speed of the developing process which could result with some remains of the photoactive layer in the aluminium-oxide pores or possible deposition of the chemical compounds turn up by dissolving of photoactive layer on the aluminium-oxide film as detected in other developing processes [6].

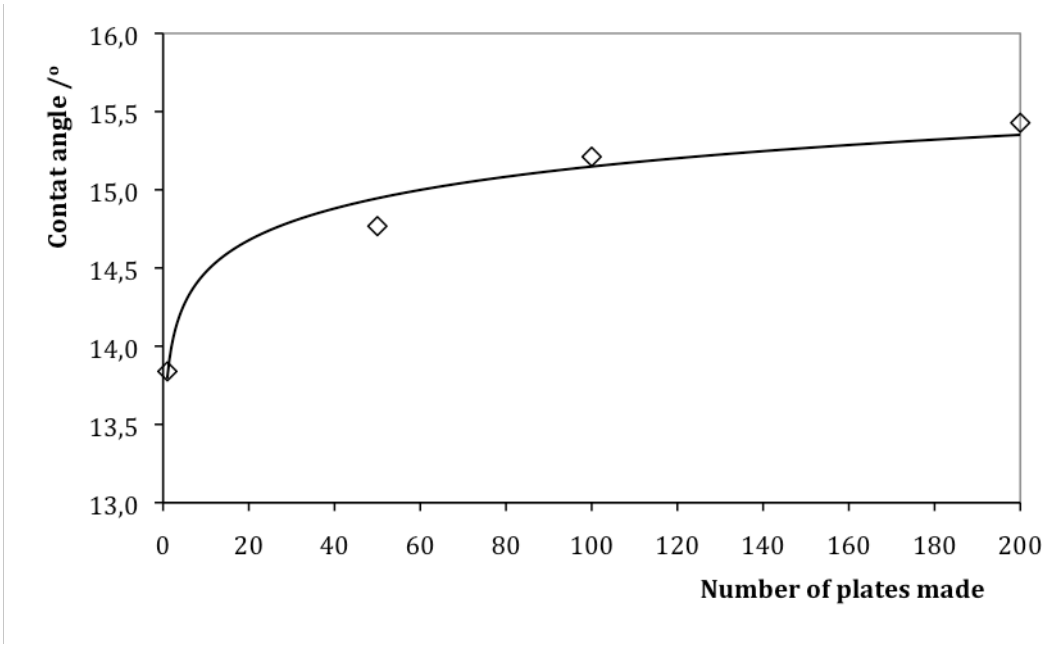


Figure 3. Contact angle vs. number of plates made

Results of the printing process influence investigation

Investigation of the printing process influence was made by observing dot radius on the cyan printing plate and the black printing plate as they being first and last in the printing sequence. Evaluation of the nonprinting areas was done by calculating surface free energy of the surfaces and determining contact angle between fountain solution and the nonprinting areas of the printing plate.

In Figure 4 one can see results of the dot radius measurement in the positive and negative dot, i.e. low and high coverage values, C meaning printing plate for cyan and B meaning printing plate for black colour.

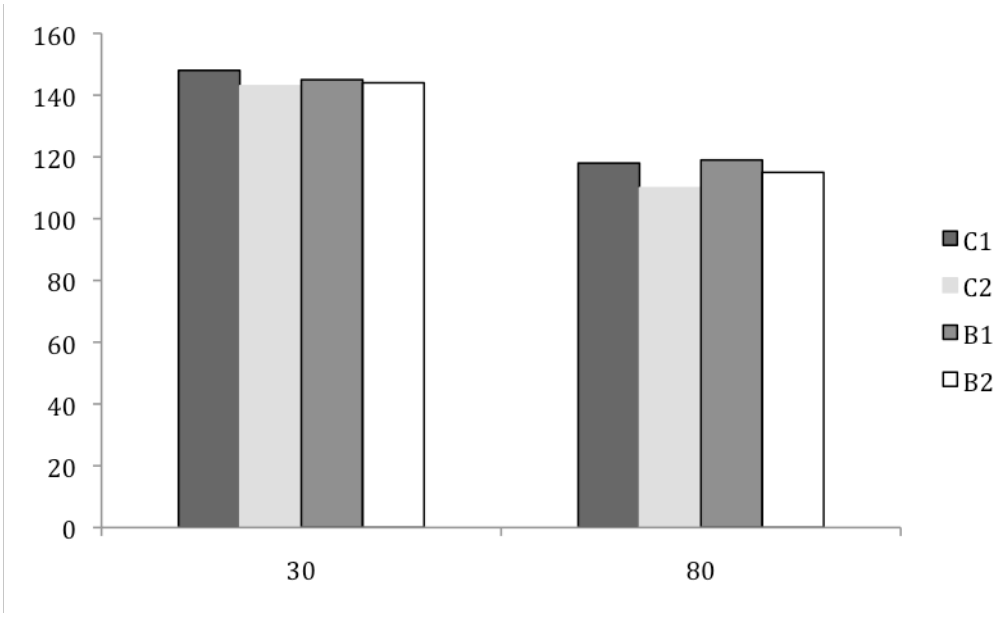


Figure 4. Positive (30 % coverage value) and negative (80 % coverage value) dot radius, C1 and B1 printing plates before printing, C2 and B2 printing plates after printing

It can be seen that printing process causes decrease of the positive and negative dots resulting with decrease of the low coverage values but increase in the high coverage values which is persistent with previous research [10].

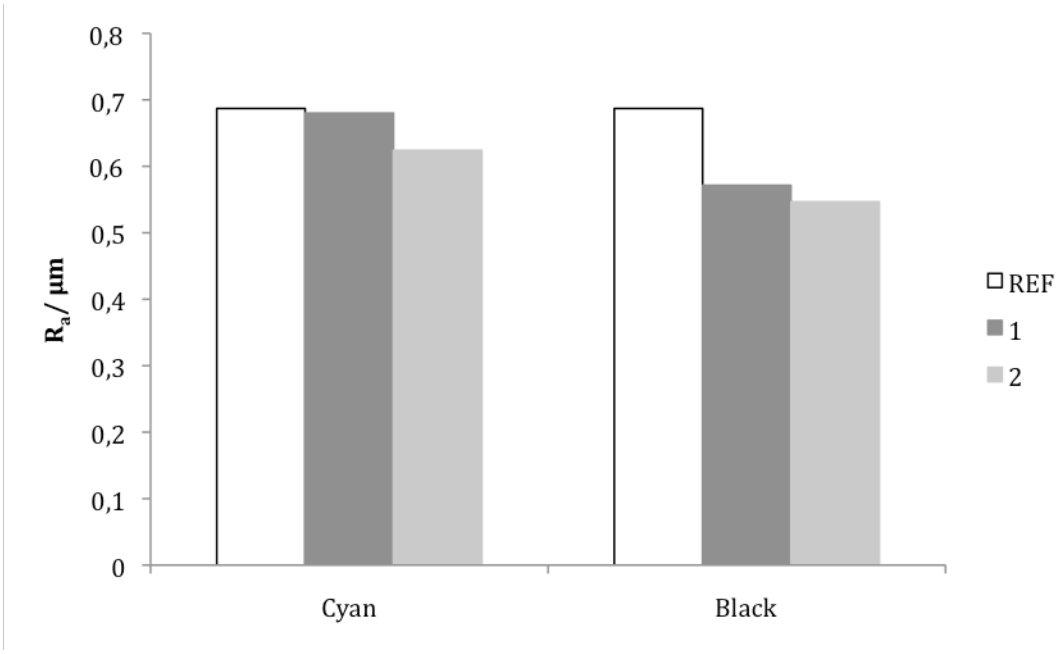


Figure 5. Ra rpoughness parameter value of the image areas, REF – printing plate before printing process, 1 – printing on the feld sideof the paper, 2 – printing on the wire side of paper

Decrease of the dot radius is larger at printing plate for cyan than by the printing plate for black. This could be the consequence of the printing colour sequence. Printing plate for cyan is first and therefore impact of the paper dust is larger, on the other hand difference in printing ink composition could also cause such behaviour. This was also supported by the results of the R_a parameter presented in Figure 5.

Investigation of the nonprinting areas was made by determination of the surface free energy. Table 2 presents results of the surface free energy calculation.

Table 2. Surface free energy of the nonprinting areas before and after printing process

	Surface free energy [mN/m]		Dispersive part [mN/m]		Polar part [mN/m]	
	before	after	before	after	before	after
Cyan printing plate	60,3	53,79	30,92	25,59	29,38	28,21
Black printing plate	59,96	50,54	29,62	26,42	30,35	24,11

From the data presented in Table 2 one can see that printing process causes decrease of the surface free energy. Decrease of the surface free energy could be the consequence of the roughness change due to the wear of the aluminium-oxide layer. Printing plates before printing process have nearly the same surface free energy which indicates well set plate making process with small impact to the nonprinting areas.

The printing process' influence was also investigated by the contact angle measurements between fountain solution and the nonprinting areas.

Table 3. Contact angle between fountain solution and nonprinting areas of the printing plate

	Contact angle [deg]	
	before	after
Cyan printing plate	10,3	20,4
Black printing plate	10,2	27,5

Table 3 shows results of the contact angle measurement on the printing plate for cyan and for black. The results are consistent with the surface free energy results showing largest value on the nonprinting areas of the printing plate for black after printing process where smallest value of the polar part of the surface free energy is detected. These results indicate lower adsorption level of those areas and making more fountain solution needed to repel printing ink. This could lead to problems with paper mechanical properties caused by higher water absorption.

Conclusions

This research included defining influences of the developing process to the nonprinting areas and the processing solution and printing process on the printing plate surface. The nonprinting areas properties were defined by observing their behaviour in the solid-liquid interface measuring contact angle when applying reference liquids for surface free energy calculations or fountain solution to determine their functionality. Printing areas was observed by visual analysis and surface roughness measurements.

Investigation showed that developing process is influenced by saturation of the processing solution. Increasing number of the printing plates made processing solution changes it composition and results with negative consequence on the nonprinting areas' functionality.

Printing process causes decrease of the coverage value in the lower coverage area but increases in the higher coverage area. In the same time surface free energy of the nonprinting areas decreases causing higher contact angle with fountain solution.

To conclude, negative influences of the investigated parameters must be continuously observed to get even better insight on the cause of the printing plate's surface change. This knowledge will help to standardize and improve the plate making process and on the other hand improve durability of the printing plate in the printing process.

References

[1] MacPhee, J. "Fundamentals of Lithographic Printing", Volume I Mechanics of Printing, GATFPress, Pittsburg, (1998)

[2] Dimogerontakis, Th., Van Gils, S., Ottevaere, H., Thienpont H., Terryn, H, "Quantitative topography characterisation of surfaces with asymmetric roughness induced by AC-graining on aluminium", Surface Coating Technology. 201, pp. 918-926, (2006)

[3] Lin, C.S., Chang C.C., Fu, H.M., AC electrograining of aluminum plate in hydrochloric acid //Materials Chemistry and Physics 68, pp. 217-224, (2001)

[4] Hoellrigl, G., Smith, G., Process for manufacturing a strip of aluminium alloy for lithigraphic printing plates, Patent No.: US6,655,282 B2, (2002)

[5] Brinkman, H.J., Kernig, B., "Aluminium for lithographic applications", ATB Metallurgie R&D Hydro Aluminium, 43(1-2), pp. 130-135,(2003)

[6] Mahovic Poljacek, S., Risovic, D., Cigula, T., Gojo, M., "Application of electrochemical impedance spectroscopy in characterization of structural changes of printing plates", Journal of solid state electrochemistry, published online, http://www.springerlink.com/content/75lr10p361326821/fulltext.pdf

[7] Cigula, T., Pavlovic, Z., Gojo, M., Risovic, D, "Wetting of offset printing plate's non-printing areas as a function of print run", Proceeding of The Fifth International Symposium GRID 2010, pp. 211-218, (2010)

[8] http://www.inkland.co.uk/pdfs/Agfa_Lithostar_CtP_Plate.pdf, 5.8.2011.

[9] Owens, D.K., Wendt, R.C., "Estimation of the surface free energy of polymers", Journal of Applied Polymer Science, v.13, (1969)

[10] Romano, D.J. "An Investigation Into The Printing And Wear Characteristics Of Laser Exposed Plates", MSc. thesis, Rochester Institute, (1995)

Author biography

Tomislav Cigula is since October 2006 working as a teaching assistant at Faculty of Graphic Arts, Department for printing forms in Zagreb, Croatia. His field of interest is investigation of printing plates, plate making process and interaction of materials at solid-liquid interface. Currently he is a PhD student at Faculty of Graphic Arts and researcher on several national and international scientific projects concerning surface phenomena at solid-liquid interface and solid surface characterisation methods.

Possibilities of the lasers use for plastic package production

Tetiana Kyrychok[1]& Kateryna Diptan[2]

[1] PhD, associate professor
[2] post graduate student
NTUU «KPI», Kiev, Ukraine
t_kyrychok@ukrpost.ua
katran1986@ukr.net

Keywords: package, plastic, laser, creasing.

Abstract

The work is devoted to making clear of the possibilities and directions for the laser radiation using in technological operations for plastic package production. The authors developed classifications of the lasers use in printing industry on the whole and in particular for treatment of printing materials.

In this article the authors ground the expediency of laser equipment use for the complex package production that allows to plate text and illustrative information, to cut out the reamers of products and to produce scoring of the material for the subsequent folding and to do all these actions in one operation. The attention is stressed on the last of the problems. It is also mentioned the regularities of slots parameters influence, that were made with laser scoring, on technological and operating descriptions of the finished packages.

It is impossible to imagine the modern world without package. This industry is put in the forefront with its social and economic functions, industrial output, the level of achievements in science and engineering, and it determines some main indexes of national economy.

There is sustainable development of package production in Ukraine, as well as in the whole world. The industrial output of this branch in 2010 was multiplied in comparison with 2007 up 18,0% and makes 5,4 billion UAH. The biggest part of package production is used by agricultural sector. There is Ukrainian package market division in 2010 in the Fig. 1.

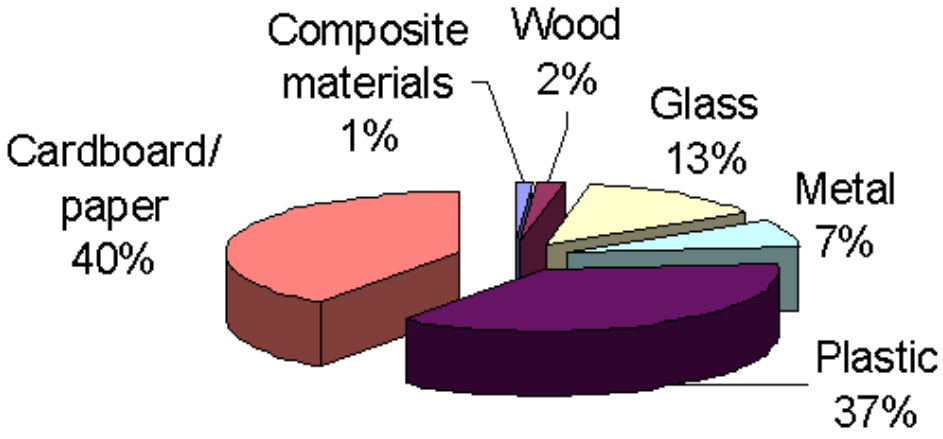


Figure.1. Diagram of the Ukrainian package market division by the materials in 2010

The plastic package is the second important wrapping material that is made in Ukraine (look on Fig. 2 and Fig. 3). The demand for it grows, and businessmen do everything in order to satisfy it, investing in new equipment and multiplying the productivity for the purpose of the improved products creation, including material for printing and multi-layered plastic. As a rule, its producers in Ukraine are petrochemical companies or their subsidiary production units, which are situated widely in the country [2].

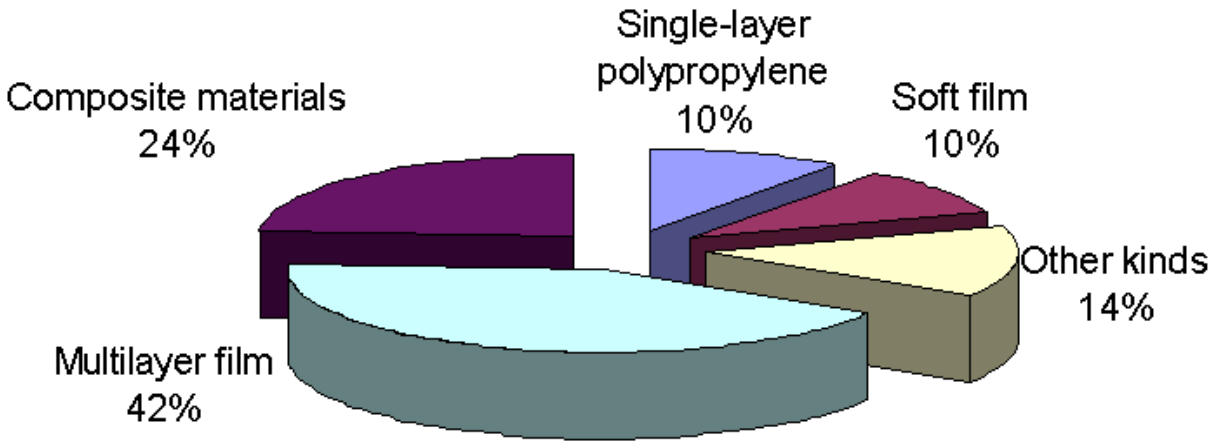


Figure. 2. The Ukrainian production of the plastic package by its kinds

On the basis of the analysis of the Ukrainian plastic package production by its kinds the diagram of Ukrainian package market division by the cost of materials was made (Fig. 3).

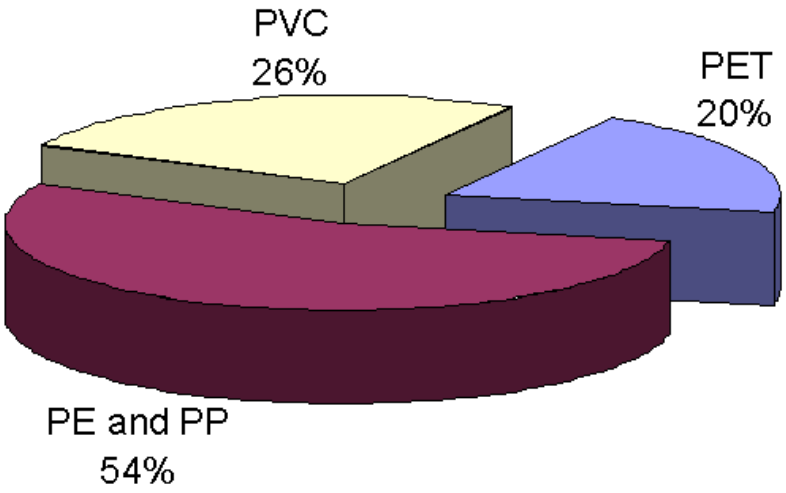


Figure. 3. Ukrainian package market division by the cost of materials

From the previous analysis it is possible to make general conclusion about wide application of a plastic in printing production. Consequently, it needs to be treated, so it needs to search new productive, flexible, efficient and economically sound methods of treatment.

The development of laser treatment methods allowed using them in the printing industry to product short-run products, package, personalized products, seals and stamps, and also printing plates for different printing methods. For printing industry most perspective kinds are the gas and solid-state lasers [3].

Using the laser treatment it is necessary to take into account the following parameters: material that is needed to process, kind of treatment, requirement specification (for concrete material), technological operation, series treatment etc.

The kinds of printing materials treatment with laser radiation are the following processes: engraving, marking, cutting, scribing, heat treatment, hole drilling, rapid prototyping. With the use of laser treatment it is possible to do various technological operations, namely: cutting, carving, creasing, image embossing, making printing plates, anilox rolls, bindings, marking of the prepared products and so on.

A laser radiation is widely used in printing industry, especially in prepress and postpress treatment of various printing materials.

Different technological processes that use the laser radiation are mentioned in many professional printing magazines. But until now there were not offered the classifications of laser application in printing industry,

which can clearly outline the field of their application and would enable a technologist to determine with possibility and necessity of the use of this technology to decide the assigned requirement specification.

Today pretty advantageous and perspective thing is production of package for the different kinds of consumer goods. Such materials as cardboard, plastic, combined materials are used for this purpose. There are some important problems in package production with a plastic, namely: to print on this material, its postpress treatment. Especially it applies for the technological process of creasing and carving of the plastic. Also we need to concern that if we have short runs the production of such package with stamp carving is economically unprofitable.

It is also necessary to investigate possibilities of the laser radiation use for plastic package production in the efficient and flexible production of the single packages or short runs.

As a result of analysis of scientific and technical magazines the classification of laser radiation use in the publishing and printing production was developed (Fig. 4). As the classification signs were selected the next: devices, products and technological processes, where it is possible to use the lasers.

Classification of laser treatment application of different printing materials was also made for such classification signs as: kind of treatment, materials, technological operation, and level of material integrity deterioration (Fig. 5).

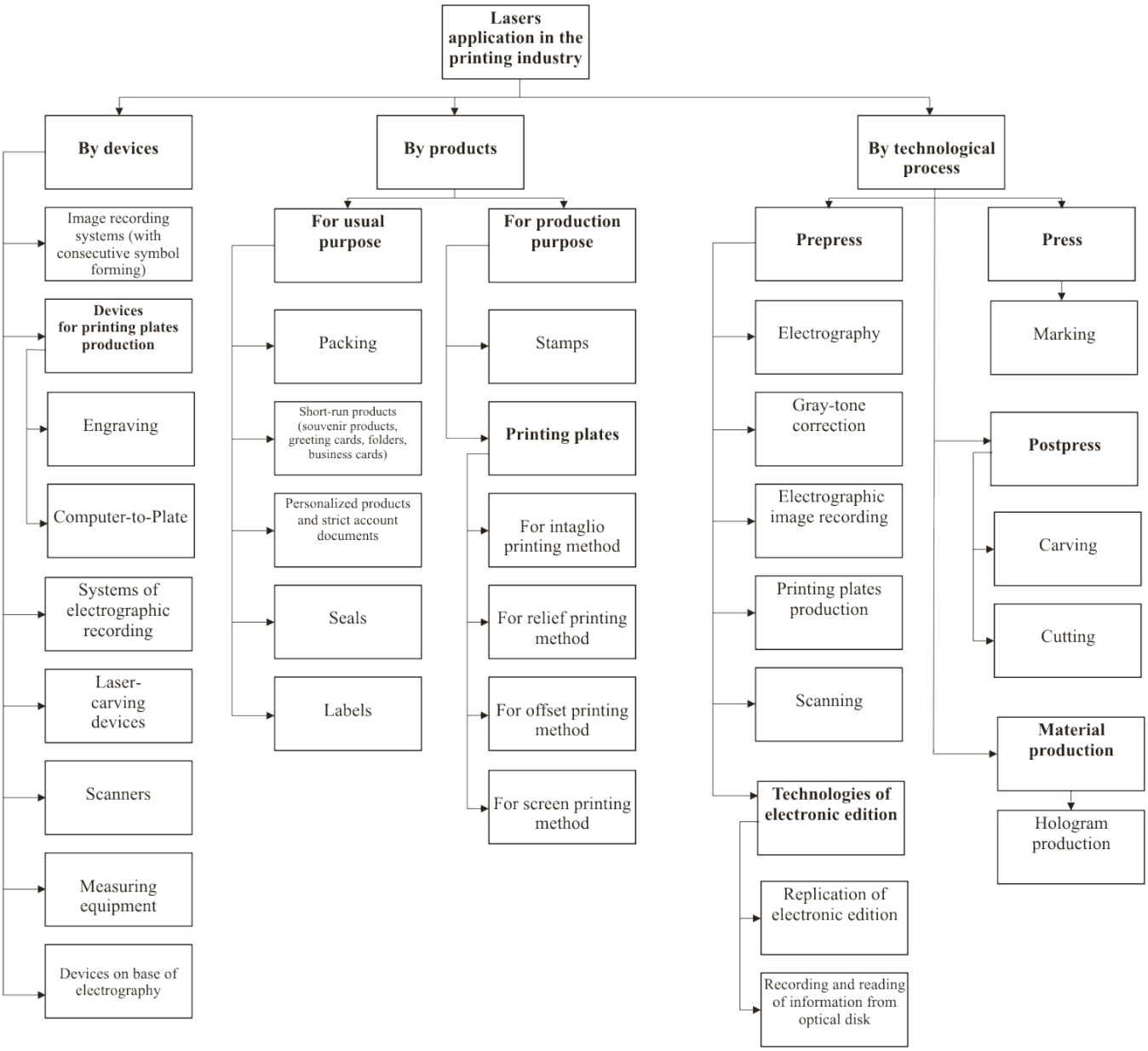


Figure. 4. Classification of lasers application in the printing industry

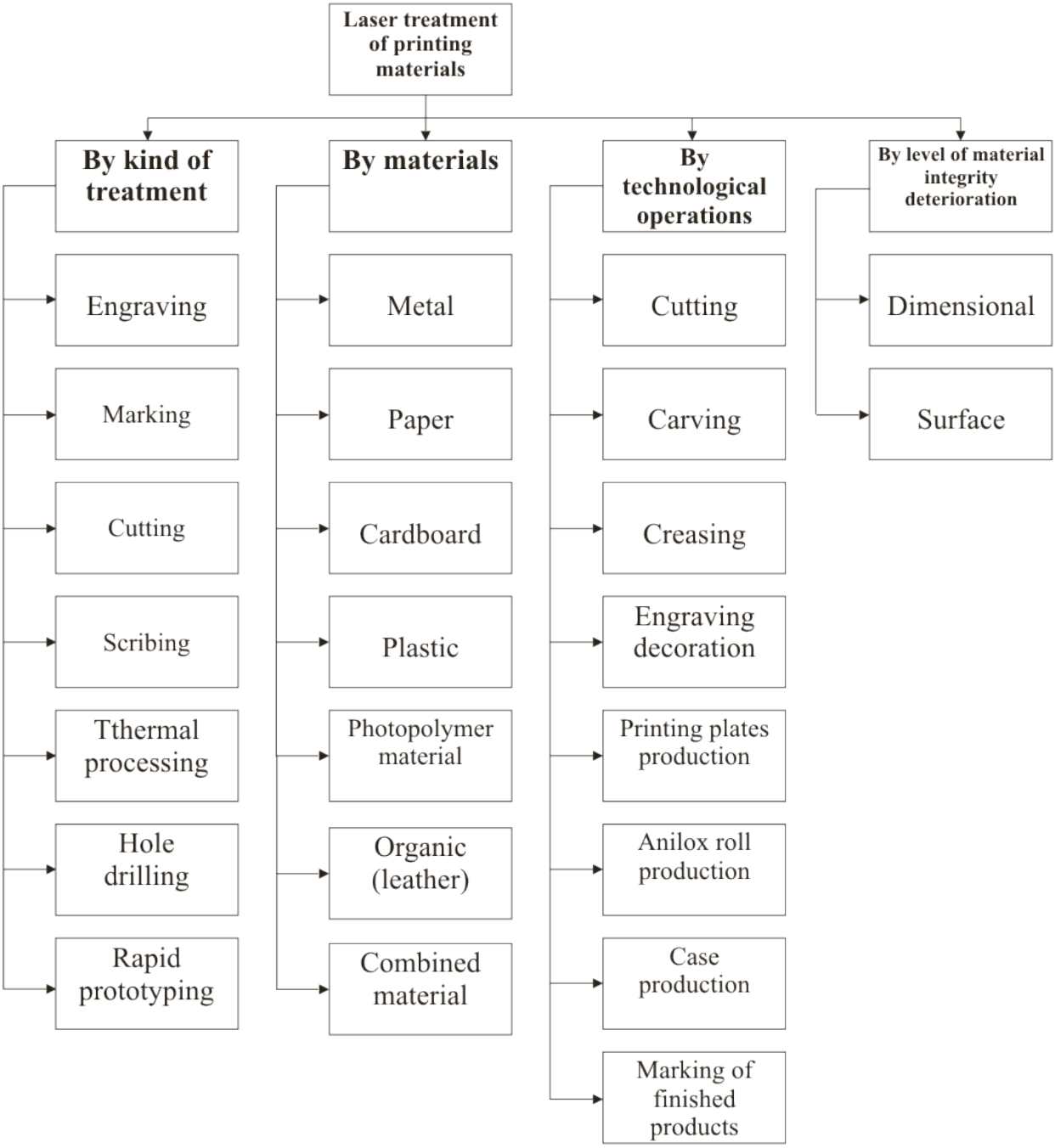


Figure. 5. Classification of laser treatment of printing materials

The developed classifications clearly describe application of laser equipment in printing industry, and also uses of laser treatment of different printing materials. One of application branches of laser treatment is treatment of material for its creasing. This technological process is pretty important on the postpress stage of making printing products. Because in fact the quality and durability of product characteristics are mainly depend on the treatment method. Especially for package production the quality of this operation depends not only on equipment and terms of production, but mainly on material of the products.

Nowadays there is a tendency that technical requirements increase to the products (it needs higher durability, inflexibility, water resistance), strengthening of protective properties (for example, for package) is needed, and also requirements to original appearance of products increase [5].

To provide the requirements to the finished products mentioned above the following properties of polymeric materials can be used: durability properties, color, transparency, water resistance, chemical stability etc [5].

The plastic is widely used in the industry as wrapping material, because of its low weight, cost, and good physical and mechanical properties. In addition, the plastic must obey certain operational requirements, and important thing is folding resistance, tensile strength and tear resistance. That is why it is important to investigate physical, mechanical and operational properties of the plastic and plastic package.

To investigate it we used the thermoplastic polymer - polypropylene. The main characteristics of polypropylene are: low density and good resistance to the high temperatures, the high level of durability and chemical stability, a polypropylene is physiological harmless, has high water resistance and good welded, the structure of polypropylene is characterized with fragility at low temperatures, with low resistance of friction and low shock durability.

The creasing is important technological operation in package production process, because it provides a form and durability properties of product in future. For conducting of research it was decided to get a bend on material after treatment with a laser ray. The scheme of laser treatment is on Fig. 6. On this scheme we can see that as a result of this concentrated energy source ray action the slot with the preset parameters appears in material – they are width and depth. To establish the dependence of the treated material durability properties and the slot parameters we carried out experiments to research tensile strength and tear resistance of the preliminary prepared standards.

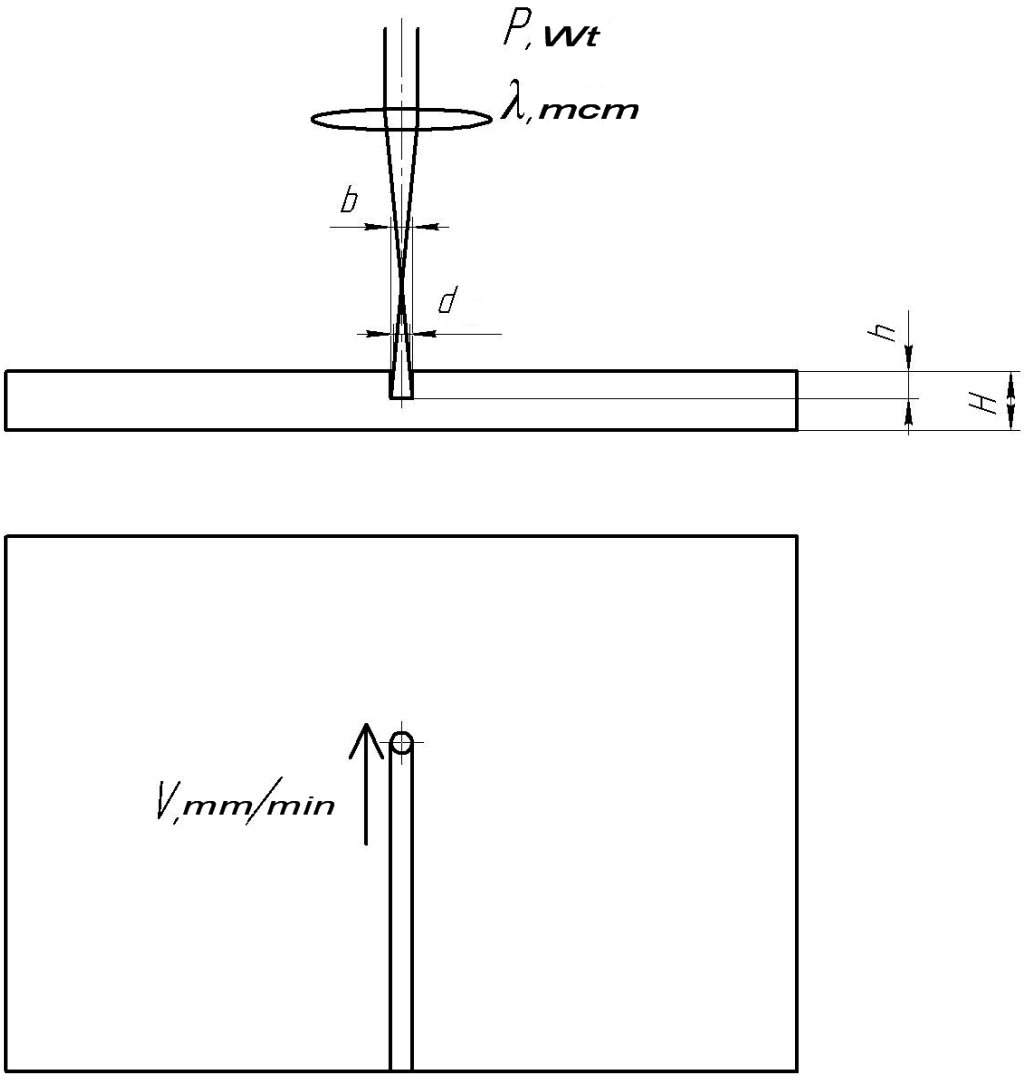


Figure. 6. Scheme of laser treatment

After preparation of standards, we investigated the tensile strength and tear resistance of the plastic. A method consists of the stretch of the tested standard with permanent speed of deformation, for determination of necessary indexes.

The following equipment and instruments were used for research: machine tester TIRATEST-2151, micrometer MK-25, and trammel with the digital indication of counting out.

Standards as ribbons (Fig. 7, 8) were cut out from a polypropylene sheet, preliminary treated with a laser ray. To cut the standards it was used a metallic line by State Standard 427-75 and scissors.

Figure. 7. General view of standards for a test prepared with laser treatment

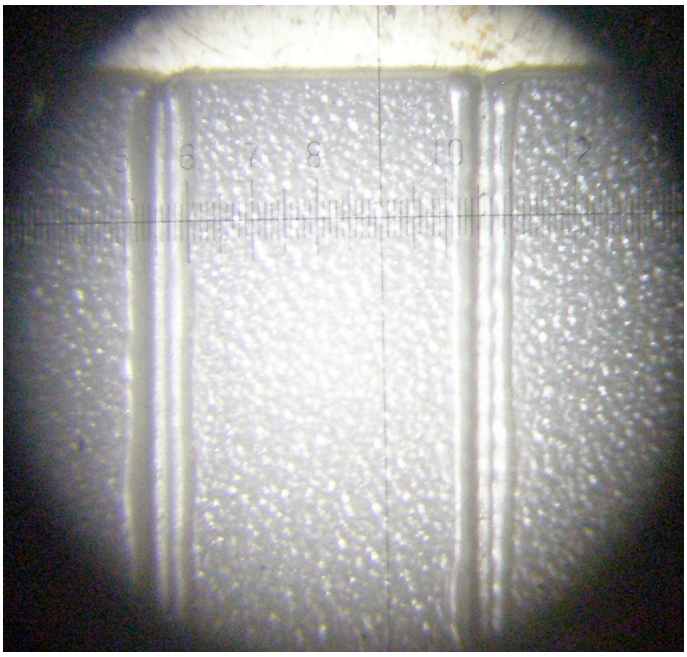


Figure. 8. The enlarged view of standard prepared with laser treatment

As a result of research of tensile strength and tear resistance value (Fig.9) of polypropylene plastic the results were got and processed.

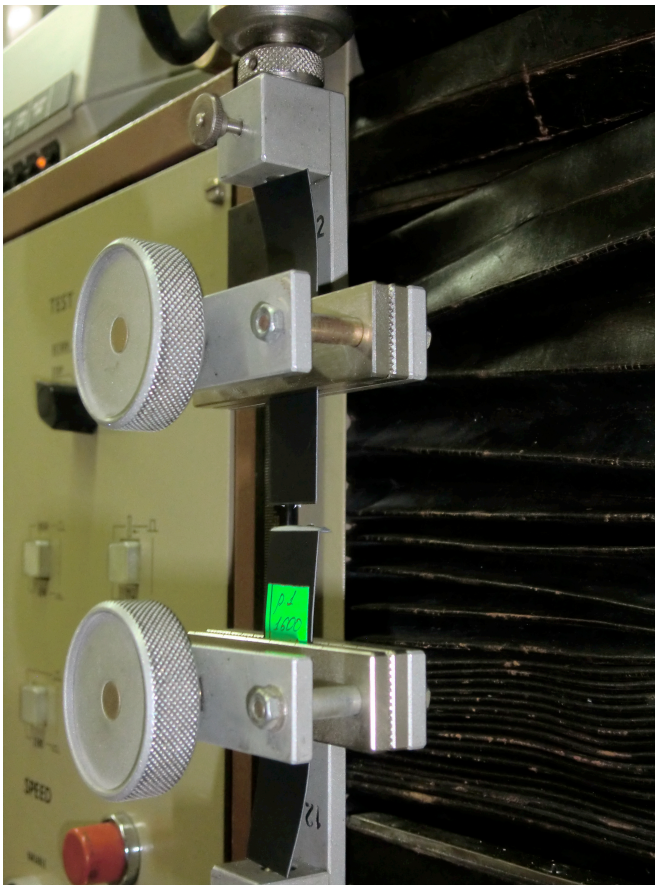


Figure. 9. Test bench for the test tensile strength and tear resistance

It was necessary to get the dependences which would take into account the following things: parameters of the slot (depth and width), got under the action of laser radiation, tensile strength and tear resistance.

By mathematical methods the dependence of tear resistance on the root of sum of squares of width and depth of the slot was got, that is resulted on Fig. 10. On Fig. 11 the dependence of tensile strength is resulted on the root of sum of squares of width and depth to the slot.

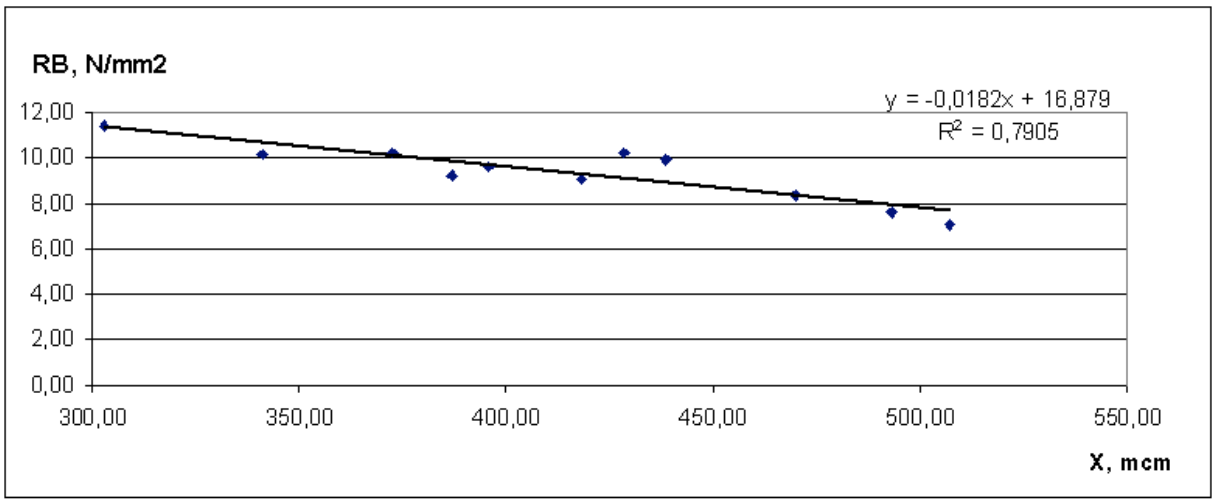


Figure. 10. The dependence of tear resistance on width and depth of the slot

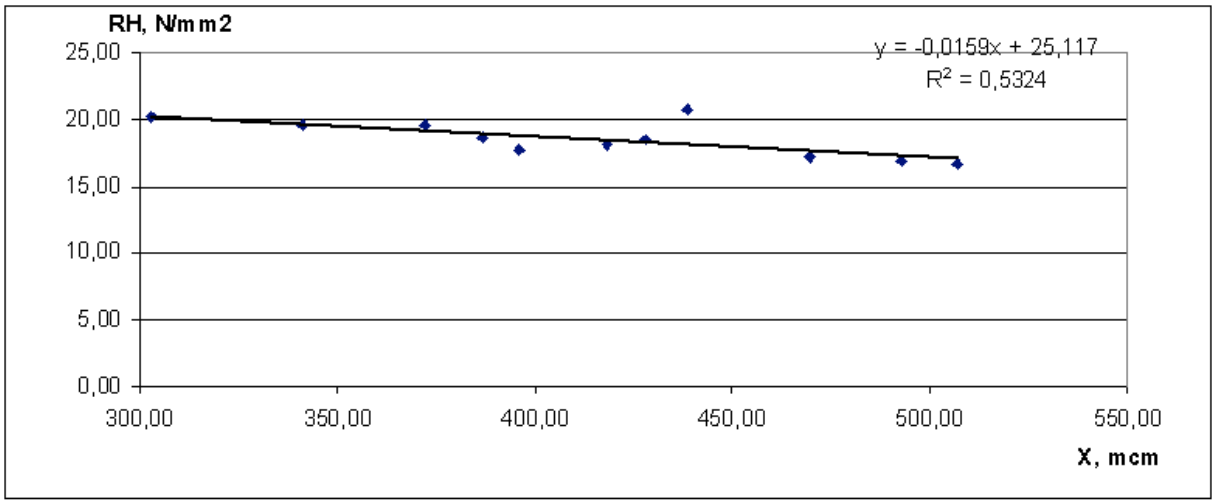


Figure. 11. The dependence of tensile strength on width and depth of the slot

Approximating curve that is represented on Fig. 10 and has the following formula:

$$RB = -0{,}0182 \cdot \sqrt{h^2 + b^2} + 16{,}88$$

When the slot parameters have zero value, it means that there is no treatment and a maximal tear resistance is 16,88 N/mm^2.

Approximating curve that is represented on Fig. 11 has the following formula:

$$RH = -0{,}0159 \cdot \sqrt{h^2 + b^2} + 28{,}12$$

When the slot parameters have zero value, it means that there is no treatment and a maximal tensile strength is 28,12 N/mm^2.

We got formulae those are the mathematical models of dependences of tensile strength and tear resistance on slot geometrical parameters and can be used for the package design with the fixed operational characteristics.

These results allow defining maximal tear resistance with the fixed slot geometrical parameters. It can allow forecasting on time the properties of a slot which influence on durability characteristics and ability of forming the finished product on the stage of package design.

More frequent application of lasers for treatment of various printing materials is related to that the use of laser treatment has a row of advantages: wide spectrum of the processed materials (metal, paper, cardboard, plastic, photopolymerization materials, rubber, covering materials), exactness, reliability, high performance, flexibility and operability of production. The choice of this technology is related to automation of processes of treatment which the modern complexes of lasers allow to get.

References

[1] Kozak A. What package is the most appropriate? // «Food and processing industry». - 2010. - №1 (353). - P.28-30.

[2] Review of Ukrainian package market // «Packaging R&D». - 2009. - №6(8). - P.23-26.

[3] A. Laskyn From solid-state lasers to fiber lasers // «Flexo Plus», 2002. - №2 (26). - P.41-43.

[4] Electronic resource: <http://publish.ruprint.ru/> S. Spylka Direct laser graving against laser ablation: pros and cons, 2008.

[5] Electronic equipment of printing production: P. 2. Lasers in printing industry: Tutorial / under the editorship of A.S. Sydorov. - M.: PH MSUP, 2001. – 284 p.

[6] Electronic resource: <http://print.adverman.com/modules/news/article.php?storyid=114> Press release: Laser equipment for advertisement production, 2006.

Author biography

Kateryna Diptan - post graduate student, lecturer, Institute of Publishing and Printing, NTUU «KPI», Kiev, Ukraine. I have graduated from National Technical University of Ukraine «Kyiv Polytechnic Institute» Institute of Publishing and Printing in 2009, and I have a qualification of «technologist engineer» of specialty «Publishing and Printing business».

I do my scientific work on theme «Technological supplying of plastic packaging production».

Now I work as a planning engineer at Planning and Production Department of Government Enterprise "Kiev Military and Cartographical Factory".

The Advertising and Brands Protection by the New Printing Methods

Alexander Kondratov, Evgenia Anokhina and Konstantin Antipov

Moscow State Ivan Fyedorov University of Printing Arts
Russia
APK@newmail.ru

Keywords: intelligent brand packaging, counterfeit protection of label, tactile marks, authentication by the buyer

Abstract

The advanced systems of flexible packaging, labels, advertising brands and tags made of the new interval shrinkable polymer films were developed in our university. The systems are meant for control of counterfeit producers of mass consumption goods and for counterfeit protection of low cost value brands. On or under the multilayer labels, tags are applied advertising information and bar codes with a high counterfeit protection rate. The counterfeit protection is provided by special properties of packaging materials. For development of new materials with special properties are used thermoplastic polymers, such as polyvinylchloride, polyamide, polyester and polyolefin widely used on chemical products market worldwide. The blanks for new film materials are produced by a conventional technology of heat shrinkable goods including the heat orientation stretching and cooling fixation of stressedly-deformed polymer structure.

The gradient of mechanical properties or area with various shrinkage rates are formed in the films by additional local thermal modification of a supramolecular polymer structure on the specified material areas (intervals) which could be recurrent bands, and could form water marks coated with ink layers and hidden from the visual identification. During imaging process on these films or printing of information marks, or ornamental design which consist of thin parallel lines is produced a printing product (such as packaging, brand mark, label etc); these products could be easy authenticated by heating to the defined temperature for realizing an inhomogeneous shrinkage of polymer film. The required temperature for product authentification can change depending on product within a wide range determined by the chemistry of polymer; and can coincide with the maximum permissible temperature of single heating of the intelligent packaging content. On the rise of reference temperature on the printing material surface appear the visual identifiable water marks, instrumental measured distortions of information symbols or tactile marks.

It's proposed to use the films and methods of their authentification for counterfeit control of brands e.g. during the film packaging production for mass consumption goods or for production of labels for perishables like food products and drugs.

Introduction

There is an objective necessity for counterfeit control of printing products in Europe and Russia now. The current acuteness of this problem is determinated in many respects by the development and a wide distribution of printing equipment. The firms and state enterprises, which are producing unique products and securities, are continuously improving the process of production and the methods of counterfeit protection. The range of protection of printing products is determined by three components, there are the complexity of processes, the limited access to materials and equipment, the novelty and inaccessibility of actual methods. For the counterfeit protection of commodities brands of mass consumption goods, e.g. cosmetics of known firms or ecological pure products for baby food, are developed composite multilayer labels made of bright, shiny, flickering, flexible, textured etc. self-adhesive materials with a temporary (weak and multiple) fixing.

The multilayer, composite and self-adhesive labels have an effect on the buyers as a magnet attracting attention to the new or known goods of a known brands producer. The attraction is based on the possibility of detection of a discount, a prize or additional latent information about the goods. The "unstick and read" labels give the manufacturers an opportunity to use it for the purposes of widest advertising and marketing.

The counterfeit of such labels is not difficult and could be realized easily and quickly on the copying or printing equipment. One of the efficient methods of counterfeit reaction is the use of special printing materials which could be authenticated by customer or representative of brand producer.

For manufacture of such labels the Moscow State Ivan Fyedorov University proposes to use the polymer materials with special changeable – depending on external conditions - controlled properties and structure.

Experimental part

For the analysis of physic mechanical properties and design of an "intellectual" packing, multilayer labels, advertising brands and labels made of new interval heat shrinkable polymer films were used thermoplastic polymers, such as polyvinylchloride (PVC), polyamide (PA), polyester and polyolefin. The blanks for the new film materials were manufactured by a conventional technology of heat shrinkable goods including the heat orientation stretching and cooling fixation of stressedly-deformed polymer structure. The gradient of mechanical properties and the areas with various shrinkage ranges were formed in heat shrinkable films under pressure by additional local heat treatment on the specified material areas (intervals).

The development of engineering and complexity of processing technology of high-molecular substances at the close of the 20th century led to the necessity and possibility of manufacturing of polymer products with changeable physical and physicochemical properties within one component. As examples could serve the surface-modified films [1], sheet materials hardened around the periphery or weakened on the areas of target breaking [2] as well as the locally reinforced composites [3]. The local changes of properties, material structure or blank are laid at the product formation stages or are of final processing operations nature. The first variant is as a rule a merely chemical or prescribed-technological one, and the second one is a physical or physicochemical method of product or packing production.

Results of the theoretical and experimental study and their discussion

The gradient and the heat shrinkable films [4, 5], developed in the Moscow State Ivan Fyedorov University of Printing Arts, should be considered among gradient materials on the basis of macroscopic nonuniformity of mechanical properties (the deformability has double or triple differences within one sample), but they differ markedly in the chemistry, structure and mechanical properties from the previously defined polymer bodies [6, 7]. The gradient polymer film materials are manufactured of any resin, including the large-capacity thermoplastic resin, by melt extrusion with orientation afterstretching and cooling fixation of stressedly-deformed film structure by a local heat treatment or an additional local stretching on the material areas (intervals) with the hidden water marks (unobtrusive by the naked eye). Thereby the gradient materials are anisotropic polymer films with a macroscopic inhomogeneous structure, which local shrinkage is not a constant magnitude in any direction (at least in one), but it increases or decreases monotonously or in step-vise and periodically, i.e. it has a constant or variable gradient of internal stresses as respects to the sign and the magnitude, which causes an inhomogeneous deformation (shrinkage) on heating.

On the macroscopic mechanical tests, such as at the extension with a constant speed of standard samples cut out from gradient materials is not revealed any change of original modulus. On the increase in intensity of the local thermal film modification, consisting in the time and heating temperature increase of the "water-marks" forming areas, are essentially decreasing the forced elasticity limit and the flow characteristics of films. It's advisable to use the new materials for the counterfeit protection of printing products, e.g. for manufacturing of film packing for mass consumption goods or for labels for expensive products, spoiling under multiple heating, irregular thermal conditions, storage or transportation troubles [8,9]. The sizes of local inhomogeneity of polymer structure and nonuniformity of local film shrinkage, significant for graphic arts, specifically for manufacture of protected elements of packing, should be commensurable with transverse sizes of the line elements of printing image, and should have an average size of the order of one millimeter. The film parts with a local shrinkage, different from the rest part of material, are as a rule repeated in the range of several millimeters. As a gradient film example with a printed line image, meant for production of counterfeit protected flexible packing, on the Figure 1 is shown a film fragment with a latent "water-mark" after its heat treatment in hot water. The photo is made by transmitted light microphotography with a low-enlarging lens microscope. On a calendered film of plasticized polyvinylchloride with an average shrinkage about 65 percent in direction of calendering by a strip heater were modified the narrow extensive material bands in the form of strips directed at an angle of ninety degrees to each other and at an angle of forty five degrees to the direction of calandering. In the cited example is the modification process a local heat treatment during 0,5÷2 seconds of a 1,5÷2 mm width film section to the temperature of 85÷100 centigrade degrees with an afterpressurizing of material for cooling to the temperature below the glass transition temperature of polymer.

The gradient heat shrinkable film sample, produced in such a way, was coated with a layer of an opaque light ink on FlexiProof 100 RK flexographic proof press; and after that in screen printing was applied an image consisting of parallel dark strips. The "water-mark" is invisible on the print.

After heat treatment of a printed sample, e.g. by a blow dry air stream heated to 100 ± 15 degrees centigrade or by its sinking in hot water on the film surface appears a cross-shaped "water-mark" hidden in polymer structure; this mark is clearly discernible with naked eye, and can be tactile perceptible (to the touch) for blind or purblind persons.

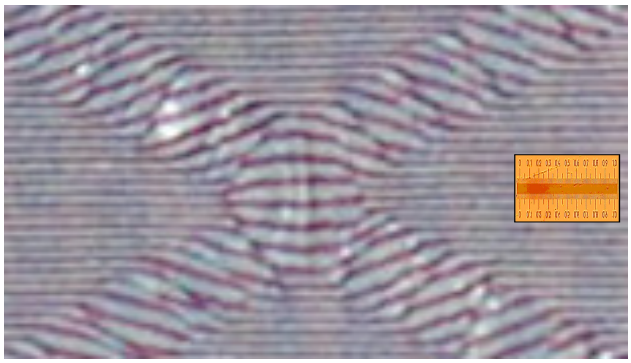


Figure 1: The photomicrography of sample sections of printed heat shrinkable polyvinylchloride film with a cross-shaped "water-mark" identified by heat treatment. Development of a tactile mark

The efficiency of visualization and the possibility of tactile identification of a “water-mark" on an interval film depends first of all on geometrical factors and on ratio of local shrinkage magnitudes of polymer on the modified and not modified areas. By the geometrical factor is meant a width, a frequency and a regularity of the alternation of modified and not modified areas as well as the angles between directions of preferred orientation (shrinkage) of film and the arrangement of printed lines.

The direction of strips and spaces in a transition zone at an optimum motif arrangement changes after heat treatment on 30÷40 degrees, what provides the visual identification of a "water-mark" and depends first of all on the shrinking property of material by thermal action.

As a thermoplastic for manufacture of gradient heat shrinkable films can be used: plasticized polyvinylchloride (PVC elastron), polypropylene, and polyethylene of low density, polyethylene of high density, fluor-containing thermoplastic polyolefin, polyamide, and polyethylene terephthalate. In accordance with one of the technology variants, developed at our university, the primary blanks for gradient, i.e. heat shrinkable, films are made of large-capacity thermoplastics by melt extrusion through a slot-hole or ring dies with cooling to the temperature below the crystallization, with orientation stretching and cooling fixation of stressedly-deformed condition for film ‘form-oriented memory’ (heat shrinkage).

The temperature dependence of maximum shrinkage of all investigated materials has an S-shaped view with a representative (mean) temperature of the linear dimension reducing, depending on the chemical nature of thermoplastics and production technology of films. For polyvinylchloride elastron it makes 70±5 degrees centigrade, for isotactic polypropylene 150±5 degrees centigrade, for polyethylene of low density 40±5 degrees centigrade, for polyethylene terephthalate 235±15 degrees centigrade depending on the molecular-weight characteristic of polymer.

The maximum film shrinkage makes as a rule 40÷70 percent and appears by temperatures much lower than the fusion point of crystallizing polymers and is 50 degrees centigrade below the flow point of amorphous thermoplastics and lower.

Based on the incompressibility postulate of condensed substances and in conformity with regularities accepted by Poisson in the mathematical formulation of solid deformation, the shrinkage, i.e. the reduction of overall dimensions of film in the line of preferred orientation direction of polymer, should be accompanied by the increase of film dimensions in the direction of two other reference axes. The ratio of the relative deformation of reduction of film dimensions to the tensile deformation (increase of film dimensions) is negative, and is a hyperelastic analog of Poisson's ratio [4]. The possibility of process control of longitudinal and transversal mass transfer of polymer is of great importance in the view of application of gradient heat shrinkable film in printing industry and packaging production. At the reduction of longitudinal dimensions of films or sheets by heating process in free state to the temperature more than the shrinkage temperature are possible two emergency cases of overall dimensions change. Those were the increase of material thickness under constant width and the increase of material sample width under constant thickness. The type of shrinkage effect depends on technological heredity of the blank and appears at the modification of heat shrinkable films by heat treatment in free state. The

gradient materials can show a monotone change of thickness in perpendicular direction to the shrinkage or various thickenings in the area of the "water-mark" (Fig. 2).

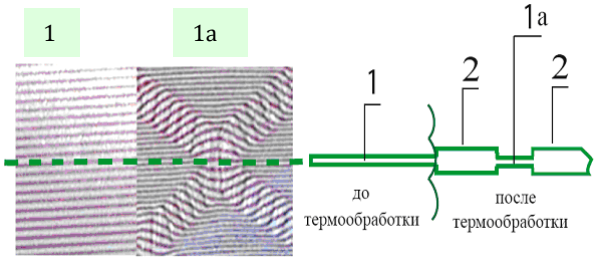


Figure 2: The sectional view of the local zones of interval heat shrinkable film in the area of "water-mark" prior to heating (1) and after that (1a). The relief (of tactile mark) and the cross-shaped sign are hidden (1). The relief and the cross appear (1a) under heating of the label in hot water, oven, microwave oven, with blow drier or iron

The elimination of thickness differences of gradient polymer films under conservation of "form-oriented memory" is a complicated technological problem connected with the necessity of study of structural mechanism and regularities of longitudinal and transversal material transfer by shrinkage as well as with the search of level control techniques of local internal stresses in thermoplastic films of various chemical nature.

At our university [4, 5] was regularly investigated the dependence of shrinkage factors of thermoplastic films on the temperature. So it was defined that the ratio of the factors, reflecting the overall dimensions change of samples, is not a constant and depends essentially on technological heredity of polymer film. The shrinkage of many polymer films lengthways of the samples was accompanied by a simultaneous increase of their width and thickness. The ratio of orthogonal factors has here a negative sign, and changes as a rule within the limits of -1, 4 ÷ 0 depending on chemical nature of polymer, rate and conditions of film process orientation.

The thickness increase of films in the production of counterfeit protected labels, brands and packing, made of gradient heat shrinkable films, is an undesirable effect complicating the qualitative image embossing and marking in letterpress printing. For the identification of film materials which don't have any preferential thickening at the lengthwise shrinkage, were investigated various oriented materials produced in different techniques.

The asymmetry of shrinkage, namely the width invariability under the lengthwise shrinkage, have a positive effect on the planar view of a label, as it does not change the label after heat treatment, but leads to the areas with high thickness differences in gradient film material, which could make 180 percent. It is possible to avoid the thickness differences of gradient film materials by various methods, such as local heat treatment of the "water-mark" forming areas and their cooling under pressure, local heat treatment of film blanks with fixed overall dimensions, ultrasonic machining under pressure, etc. The detailed review of operating practices of local modification and features of image embossing on the films by various printing methods will be realized in the next papers and publications. We are demonstrating here on the figures 3-5 the future-proofing of flexible packing, labels, advertising brands and tags made of new interval heat shrinkable polymer films which authenticity could be controlled by users or producer's representatives by heating in hot water or with blow drying.

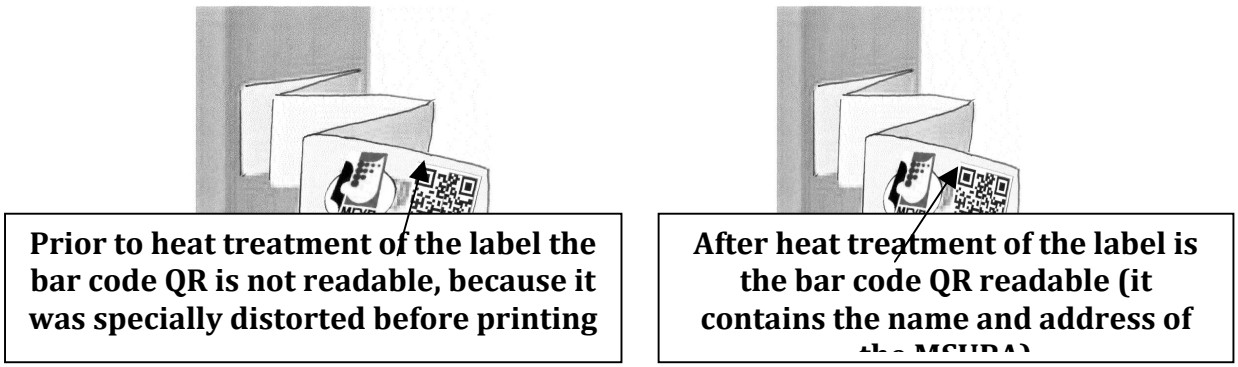


Figure 3: The scheme of a complex book-shaped label made of interval heat shrinkable film with the MSUPA logo and protected bar code

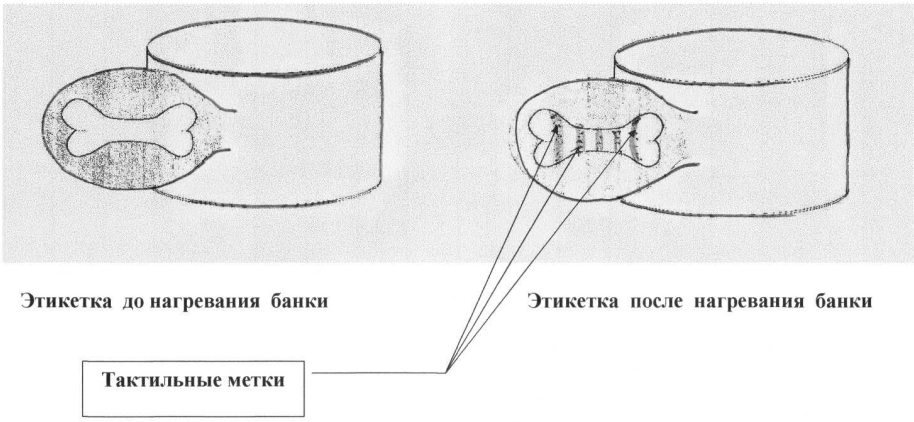


Figure 4:.The Scheme of an unstuck label with tactile marks appearing at the heating in oven, water, etc.

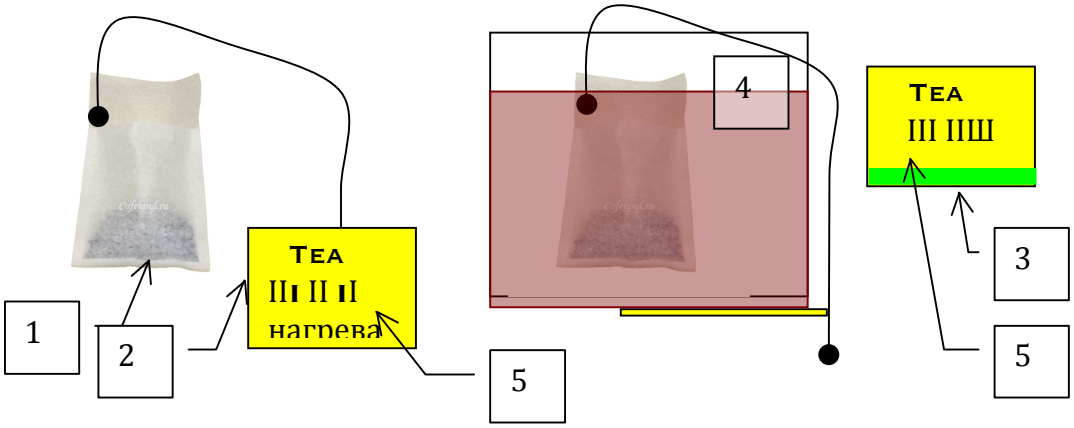


Figure 5: The scheme of a tea bag (1) with a label (2).
The tactile mark on the label made of interval film (3) and the bar code (5) appear after heating of the label under the cup (4). The bar code is readable by scanner only after heating of the label.

The conclusion

The local structure change of heat shrinkable polymer films under controlled conditions allows of a wide variety of modified packing materials for original products and of a new technology for counterfeit protection of mass consumption goods brands thanks to “form-oriented memory’ effect. The advantage of the offered materials, advertising methods, developed on their basis, as well as of the counterfeit protection of printing products over the analogous engineering solutions consists in availability of large-capacity polymers, the high-production equipment for conversion of thermoplastics into oriented or heat shrinkable films under their insignificant design debugging, as well as in application of high-speed printing (planar) technologies for “roll to roll” tape recording of data.

References

[1] Nazarov V. G, “Modification of polymers”, Moscow, MSUPA. 474 p. 2008

[2] Efremov N.F., “Packaging and its production”, Part 1 “Production of packaging, made of polymer films and sheets”, Moscow, MSUPA, 400 p., 2009

[3] Kondratov A.P., Gromov A.N., Manin V. N., “Encapsulating in polymer films”, Moscow, Chemistry, 192 p., 1990

[4] Kondratov A.P., “Gradient and interval heat shrinkable materials for counterfeit protection of printed products”, “News of High Schools”, “Problems of Printing and Publishing”, Issue 4, 57-62 p., 2010

[5] Kondratov A.P., Dryga M. A, Hursa V. I., “Polyolefine films with "water-marks" for the protective printing, News of High Schools”, “Problems of Printing and Publishing”, Issue 4, 64-50 p., 2010

[6] Askadskij A.A., Goleneva L. M, Bychko K. A, Afonicheva, O.V.Sintez, “Research of mechanical behavior of gradient Polyisocyanurate materials based on Polybutadiene rubber”, “High-molecular Compounds”, 1209 – 1222 p., 2008

[7] Karabanova L.V., Sergeeva L.M., Lutsyk E.D., Kuznetsova V. P, “Manufacture of gradient polymer materials”, “High-molecular compounds”, Issue10, 1700-1712 p., 1996

[8] Kondratov A.P., Babliuk E.B., Erofeeva A.V., Shulina T.M., “The counterfeit protected film packing”, Patent of Russian Federation of 04.03.2010, MPK B65ND 81/00, published on 10.11.2010

[9] Kondratov A.P., Erofeeva A.V., Benda A.F., “Data-protective label”, Patent of Russian Federation, MPK B65ND 81/00, published 2010

Author biography

Alexander Kondratov, Moscow State Ivan Fyedorov University of Printing Arts
Pryanishnikova Str. 2a, 127550 Moscow, Russia
Phone/Fax: +7 (495) 976 25 42, mobile: +7 963 605 70 27
E-mail: APK@newmail.ru

Alexander Kondratov is a doctor of technical science, professor at the department of materials science, expert in the field of physical-chemical polymer mechanics, supramolecular micro and macroscopic thermoplastic structure, film printing and packaging materials used in printing industry. During the last 5 years he is engaged in development of film materials for protective printing and intelligent packaging, identification methods of printing production.
He has 12 patents of Russian Federation for his inventions in this field.

The Static Electricity Protection Method for Packing Materials

Evgenia Anokhina

The Moscow State Ivan Fyedorov University of Printing Arts
Russia
evgeniya_anohina@list.ru

Keywords: quality management, electrization process, printing materials, polymer films

Abstract

The intensive development of packing industry as well as a wide application of polymeric packing materials in various industrial areas enforces the development engineers of new packing processes, and the producers of packing materials to constant improvement in this area.

The trend in the field of improvement of packing processes is in many respects connected with the increase of their productivity. That results in the increase of transportation speed of polymer films on the tape feed tracks of process equipment. The productivity increase of process equipment used for polymer films production and for packing processes leads to the probability increasing of electrization of polymer materials under air contact and contacting parts of the tape feed tracks. This fact affects the quality of packing and printing processes. In this paper are considered the experimental results of efficiency evaluation of polymer dispersion coating on the surface of polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET) films for reduction of electrization of packing materials.

Introduction

Having analyzed the patent and scientific-technical literature in the field of static electricity protection [3-6], it was marked that the formation effect of tribocharge on polymer films is in direct relation to the surface microroughness. Therefore for reduction of triboelectrization and for quality improvement of winding of roll polymer films are added the fine-dispersing additives (kaolin clay, titanium dioxide, silicon dioxide, etc.) Obviously the favorable conditions are thereby created for running off of an accumulated electrostatic charge.

The experience of static electricity protection is interesting in such areas as production of explosives, gunpowder, halogen-silver photographic materials, magnetic data mediums; in other words in areas where the accumulation of electrostatic charge affects the process safety or leads to the impossible functional using of product. In order to avoid the unwanted level of electrostatic charge in these areas of science and engineering to the formula of process compositions are added substances for improving of surface electrical conduction or are created conditions for quick running off of an accumulated charge.

In this regard is very notable the way of static electricity protection of materials which had been realized by the Kodak Company, the leading producer of film photomaterials [6]. The essence of the patent is that the particles of methyl methacrylate, polystyrol and etc. copolymers were added to one of many layers of photomaterials which rough the film surface and worsen the optical characteristics of photomaterials not considerably. Further it was noted that the effect of electrization reduction was independent of that on which material side the copolymer particles were applied.

In scientific and practical regard it was reasonable to check an application possibility of such method of static electricity charges protection of packing materials.

Experimental Part

As subjects of research were selected the polymer films which are most often used as packing materials for foodstuff. Those are polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET) polymer films.

The industry samples of stated materials were chosen. The 30 micron thick PE film was produced by method of extrusion through a ring-type head with later blown orientation. The 20 micron thick PP film and the 25 micron thick PET film were produced by method of melt slot extrusion through a flat die with later stretching in two perpendicular directions. The reduction ratio for the PP films was 8 × 8, and for the PET films it made 4 × 4.

As anti-electrostatic compositions were used the aqueous dispersions of methyl methacrylate and maleic anhydride copolymer. The percentage of copolymer was varied within 5 – 20 percent. The particle size of copolymer in dispersion was within the range of 2 - 2.5 micron.

The aqueous dispersion of an anti-electrostatic composition was coated on the polymer films samples with a screen roller on the FlexiProof 100 proof press. (Fig. 1)

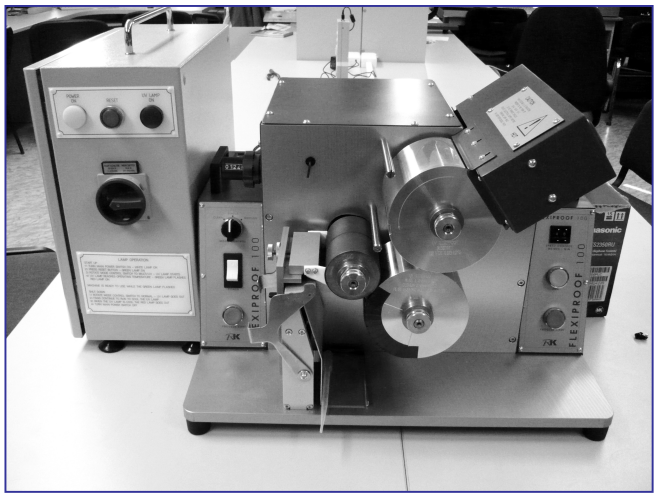


Figure 1 FlexiProof 100 proof press

Prior to the coating of an anti-electrostatic composition the polymer films samples were treated with a high-frequency corona discharge on a special plant. On the plant for corona discharge treatment was simulated the advance speed of tape feeding of 20 m/min. The treatment efficiency of polymer film's surface was estimated by the value of limiting wetting angle.

The surface charge density on the triboelectrized polymer films was sized by the device for measuring of electric field parameters, such as electric potential, surface charge density and electrostatic field intensity.

The electrization of samples was realized by friction of polymer films surface and vinyl polymer roller.

The operations were conducted in the following consecution:

- A polymer film sample of 50 × 100 mm was cut with an office knife and a metallic ruler;
- The film sample was fixed on a steel plate by an adhesive tape;
- The polymer sample surface was intensively rubbed (10 motions in 15 sec.) by a plastic roll;
- The parameters of a generated electrostatic field were measured.

The sizing of the surface charge density and the electrostatic field intensity of electrified film samples was made in 10, 20, 30, 60, 120, 180, 200 seconds.

In measuring process of electrostatic field parameters were inspected the relative air humidity and temperature in the workroom with psychrometer and thermometer which values were 65 ± 3 percent and 20 ± 2 degrees centigrade correspondingly.

The morphology of polymer films surface with coated composition layers was studied by using of the polarizing optical microscope "Polam-P312" by phase contrast method.

Results and Discussion

As a result of the investigation of made samples in comparison with origin polymer film samples (without composition layer) was noted the reduction of initial electrostatic charge density and its relaxation time (Figures 2, 3 and 4).

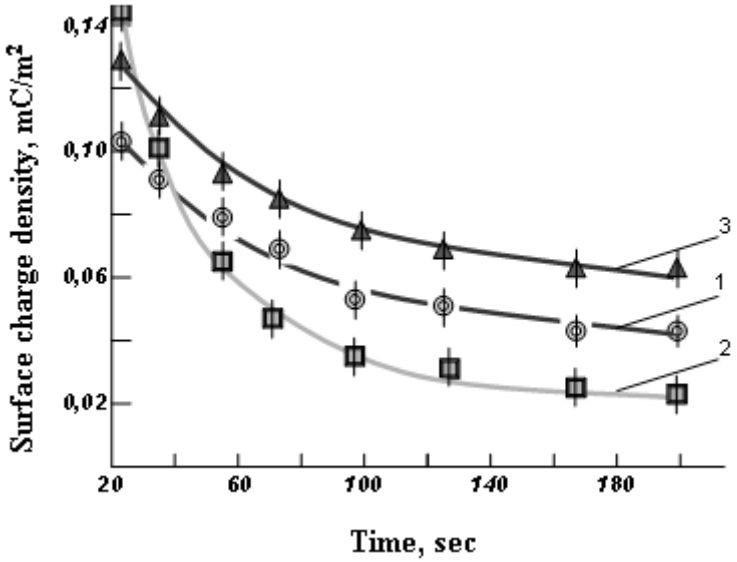


Figure 2. History of triboelecric charge for samples of PP (1), PET (2), PE (3) films, electrified by vinyl polymer roller

As evident from the results shown on the figure 2 for the original PE and PET film samples are the values of initial electrostatic charge density on the original PE and PET film samples higher than on the PP film samples. But the reduction of electrostatic charge density in unit time is most essential for the PET films. At the same time the electrostatic charge for all three samples doesn't relax completely during the 200 seconds experiment. In other words is the electric residual charge a danger to realization of various technological operations in packaging production.

The coating of methyl methacrylate and maleic anhydride copolymer dispersion has an essential infuence on both the triboelectric charge value and its kinetic recession. That is proved by the obtained dependencies (Figure 3).

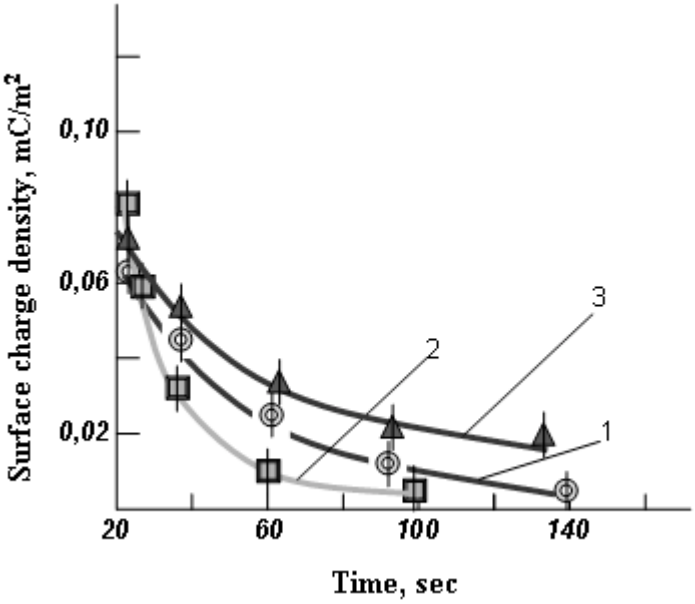


Figure 3. History of triboelectric charge for PP (1), PET (2) and PE (3) films samples with a copolymer layer (copolymer concentration in water dispersion is 5 percent) electrified with a plastic roller

It was of interest to study the influence of copolymer content in dispersion coating on the triboelectrization of polymer films.

The experimental results of the relaxation time investigation of triboelectric charge for polymer films coated with a layer of aqueous dispersion of methyl methacrylate and maleic anhydride copolymers are shown on the Figure 4.

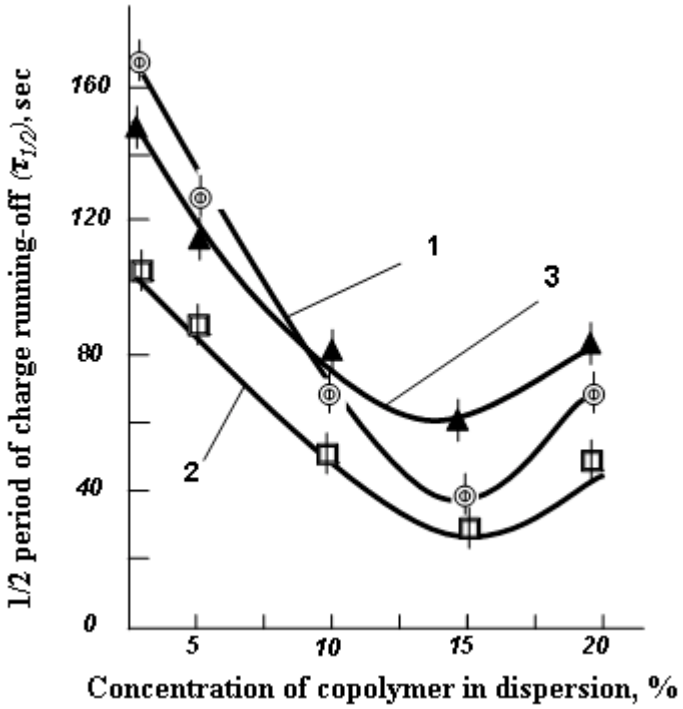


Figure 4: History of semi-period of triboelectric charge running-off for samples of PP (1), PET (2) and PE (3) depending on copolymer concentration in the coating dispersion.

The result analysis shown on the Figure 5 confirms that the 15 percent concentration of particles of methyl methacrylate and maleic anhydride copolymer in water dispersion for polymer films coating is an optimal concentration. Under this concentration the triboelectric charge value on PP, PET and PE films surfaces is reduced in 2 times in 50, 30 and 60 seconds correspondingly.

For the original samples (without the layer of copolymer aqueous dispersion) this value is reduced in

- 165 seconds (for the PP films samples),
- 100 seconds (for the PET films samples) and
- Even in 200 seconds this value is not reduced (for the PE film samples).

Obviously the presence of dispersion on the surface of polymer films causes a certain microroughness, which makes for charge running off. Concentration dependence $\tau_{1/2}$ is connected probably with frequency distribution of polymer particles on the polymer film surface. At the concentration strengthening of copolymer in water dispersion by over 15 percent start the copolymer particles agglomerating and reduction of surface micro-roughness.

The preceding is confirmed with micro photos of PET film surface with a polymer dispersion layer in comparison with the original sample (without copolymer layer) (Figure 5).

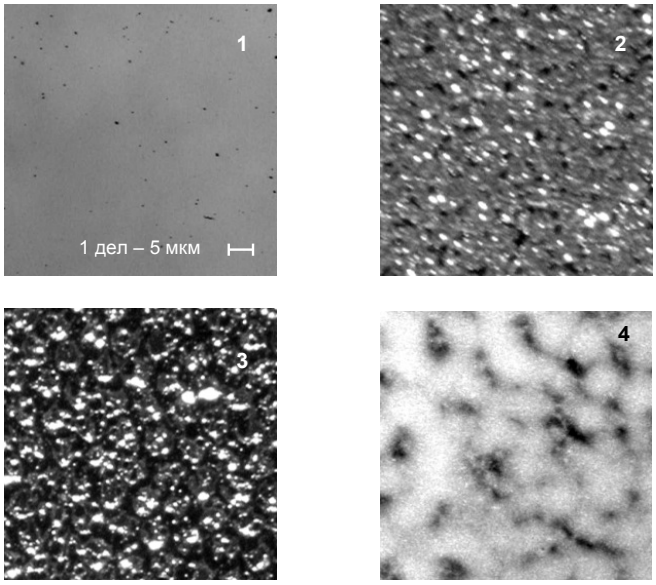


Figure 5 – Micro photos of PET film surface samples:
1 – original film without copolymer layer; 2 – film with copolymer layer, applied as a 10 percent concentration dispersion; 3 – as a 15percent concentration and 4 – as a 20 percent concentration

The similar photos were made for the PE and PP films too.

Conclusions

On the basis of obtained results of experimental research could be recommended - as an additional stage in technology of packaging materials production - the coating of copolymer aqueous dispersions, especially of methyl methacrylate and maleic anhydride copolymer, as a reduction method of triboelectrization of polymer packaging materials.

It may be necessary the operation of experiments for investigation of the influence of chemical nature of copolymers, used as water dispersions for coating of polymer films. It will make it possible to find the most optimal variant in respect to the effective static electricity protection.

References

[1] Blythe E.R., "Electric properties of polymers", Phismatlit, Russia, 376 p., 2008

[2] Vasilenok Y.I., "Prevention of polymers static electrization", Chemistry, St. Petersburg, 2nd Edition, 190 p., 1981

[3] Dyakonov A. N., Zavlin P. M., "Polymers in Film and Photomaterials", Chemistry, St. Petersburg, 240 p., 1991

[4] Gube Roland, "Polymerhaftung auf plasmabehandelten Polypropylenfasern", doctoral thesis (Diss. Dockt. Naturwiss), Univ. Stuttgart. 101 p. 2003

[5] Sheverdyaev O. N., "Antistatic polymer materials", Moscow, 1983

[6] Patent, USA, No. 3794839, 1971.

Author biography

Evgenia Anokhina, Moscow State Ivan Fyedorov University of Printing Arts, Pryanishnikova Str. 2a, 127550 Moscow, Russia, Phone: +7 926 620 17 95, evgeniya_anohina@list.ru

Anokhina Evgenia Alexandrovna is a post-graduate student of the Moscow State Ivan Fyedorov University of Printing Arts and assistant of the Department of Innovative Technologies and Management. The areas of her professional interest are

quality management and control, printing production processes, certification of production. Spheres of scientific research are electrization processes, methods of protection of polymer films against electric charge in printing production and achievement of the best quality of printing materials.

Evaluation of Voids on a Shrink PVC Film by Varying Gravure Process Variables

Akshay V. Joshi

Department of Printing Engineering, Faculty of Engineering
College of Engineering and Technology, Pune,
India
joshiakshay22@rediffmail.com

Keywords: Shrink PVC, Void area minimization, Gravure, Process variables

Abstract

Due to the fast pace of the growing packaging industry, the demand for PVC in India has increased from 11% to 30% in the year 2009. According to study conducted by Reliance Polymers, the consumption of PVC in 2006 was 1.215 MMT which would be doubled till end of the year 2010. [1] The biggest challenge in printing, packaging and decorative sector is to retain and fulfill the demands of the customers. Gravure printing is widely used in these sectors on wide range of substrate and has a major impact on the massive targets. The advantage of this process is its simplicity i.e. fewer variables to control. It offers excellent print consistency with higher speeds for medium to long runs on variety of stocks. [2,3] PVC is one such plastic substrate printed by gravure process for shrink application. During the manufacturing of PVC films, impurities and un-plasticized gels lead to imperfections. These films during print run do not allow the surrounding area to print leading to the formation of a print void with an uncomfortable visual appearance as seen in Fig. 1. This results in customer complaints, wastage of material and ultimately product rejection thus reducing the profits of an organization. Minimization of voids while printing shall potentially allow for further business opportunity.

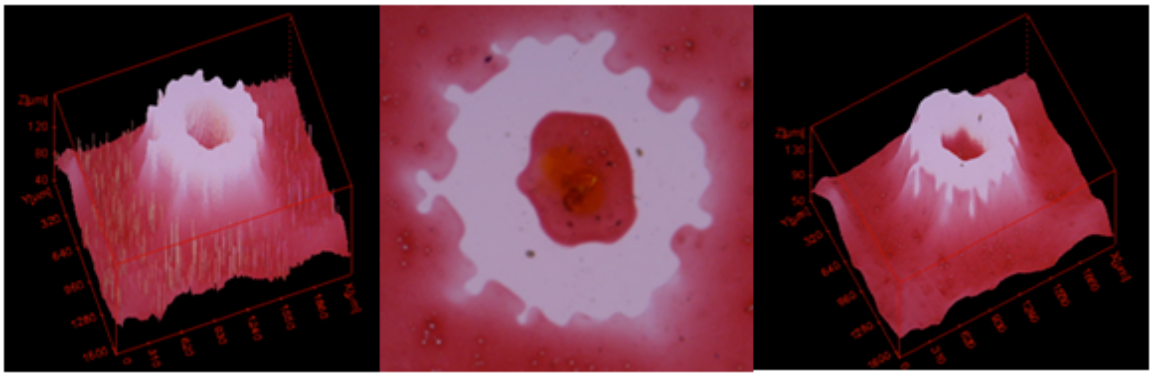
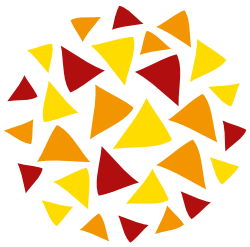


Fig. 1: 2-D and 3-D View of Print Void

The research involves minimization of these print voids on shrink PVC film by using quality technique and continuous improvement process. The methodology involves defining the problem i.e. print void and baseline. The goal was set to minimize these print voids up to 50% from the baseline with best combination of process parameters for shrink PVC film. The undesired effects (UDE's) for the gravure process affecting the void area were prioritized. The root cause analysis was done to identify the parameters that were critical to the process (CTP's). A fractional Design of Experiments (DOE) for 6 factors was performed and analyzed that were further improved and checked for consistency. The result showed that the behavior of lower viscosity, lower pressure, lower speed, lower hardness, higher screen ruling and higher depth reduced the void area to 60% from the defined baseline of 0.143mm2 for laser engraved (LE) cylinder. A 50% reduction in void area from the baseline for electronic engraved (EE) cylinder was observed with a lower viscosity, higher pressure, higher speed, lower hardness, higher screen ruling and higher stylus angle with improved surface characteristics of PVC film. A control run was conducted thrice that showed a consistent behavior for both Laser and Electronic cylinder with mean of 0.06mm2 and 0.0714mm2 respectively. The visible void counts have also reduced to 60% and 50% for LE and EE cylinder.

Author biography

Professor Akshay V. Joshi is a Research Coordinator in Printing Engineering Department at P. V. G's College of Engineering and Technology, Pune, India. He teaches subjects like Gravure, Flexo and Flexible Packaging for more than 15 years. His research focuses on Gravure and Flexo printing and is been funded by National and International organizations.



IC 2011
NORRKÖPING
19 - 23 September

Proceedings

of the 43rd conference of the International Circle of Educational Institutes for Graphic Arts Technology and Management