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Contents

Influence of surface roughness on print quality on digitally printed self adhesive foils

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Abstract

The printing substrate, together with its characteristics, has a significant influence on print quality. The substrate topography, or roughness, is one of the most significant printing substrate factors. Substrates with different topography reflect light in various manner which leads to various print quality. Print quality itself can be defined as a complex term that includes both the desired colour reproduction and a satisfactory reproduction of image elements. In this paper we focus on print quality analysis of ink-jet printed PVC self adhesive substrates. The study includes evaluation of mottle, line quality, dot roundness, print sharpness and colour reproduction. Based on our analysis, it can be concluded that substrate roughness and other parameters, such as colour properties and reverse side printing, have a significant influence on print quality.

Keywords: PVC self adhesive foil, roughness, mottle, line quality, dot roundness, print sharpness, colour gamut

1. Introduction

Estimating print quality is a demanding task since it implies using objective methods to define the perception of printed material (which is a subjective matter). A common way to analyze print quality is to quantitatively assess the tone and colour of an image. In a series of experiments it has been shown that print quality is not a monotonic function of saturation, chroma and colourfulness (Fedorovskaya, Blommaert and de Ridder, 1993; de Ridder, 1996; Fedorovskaya, de Ridder and Blommaert, 1997; Pedersen, Bonnier and Hardeberg, 2011). Evaluation of print quality is dependent on a number of quality attributes, i.e., terms of perception such as colorfulness, contrast and sharpness. These quality attributes influence the overall print quality differently and knowledge about their relative importance can be used to achieve an optimal reproduction of an image (Fedorovskaya, Blommaert and de Ridder, 1993). In order to obtain the bigger picture of print quality, it is necessary to estimate the reproduction of image elements (dots, lines, solid ink areas) as the basic parts of any reproduction. It can be stated that the line and dot structure

reproducible by a particular printing process substantially influences the appearance of an image (Dhopade, 2009), which is why it is important to evaluate the reproduction of these elements, together with the colour reproduction control. By analyzing dots and line attributes, additional quality parameters such as sharpness and artifacts can be defined as well as some non-desirable effects (ink bleeding, non-uniformity etc.).

In a work by Pedersen et al. (2009) the quality attributes found in literature are reduced to the following six: colour, lightness, contrast, sharpness, artifacts (such as noise and banding) and physical quality attributes (such as paper properties and gloss). Engineers from Torrey Research Group (Torrey Pines Research, 2003) investigated the influence of different attributes on print quality in ink-jet printing and, as a result, stated that the attributes that they emphasized could be used to evaluate the quality of any imaging systems. As the most critical attributes for the evaluation of prints the authors defined permanence, edge quality, artifacts, resolution/ad-

dressability, linear tonescale/colour reproduction and solid area quality. Some of these parameters are also accentuated by Dalal et al. (1998). The authors divided quality attributes into two groups: fundamental quality attributes, and stability and material quality attributes. Attributes from the first group are visually relevant and can be assessed for both coated and uncoated substrates. Some of the addressed attributes are: text and line quality, micro-uniformity, macro-uniformity, adjacency, gloss uniformity, effective resolution, etc.

The importance of evaluating defined quality attributes cannot be disputed; hence many methods and algorithms have been developed in order to improve quality control. Kipman (1988) suggested some tests that are easy to implement and could be useful to evaluate media dependent image quality issues. These tests include: dot quality (including tests for dot placement accuracy and variations in dot formation), halftone quality (including tests for area coverage), line quality (including tests for sharpness and edge noise as well as detectability tests for negative lines), text quality (including tests for connectivity and edge degradation), color quality (including tests for color registration and CIE L*a*b* measurements), smear/overspray and spatial resolution (Kipman, 1988).

PVC substrates can be printed by screen printing, offset printing and digital ink-jet printing. Nowadays, PVC substrates are mostly printed by digital ink-jet printing technology with water based inks or, so called, latex inks. Latex inks are pigmented, water based inks designed for commercial and industrial printing. Water based inks offer environmental, health and safety advantages over eco-solvent/low solvent inks. Latex inks consist of a liquid ink vehicle that carries latex polymer and pigment particles to the surface of the print media. Physical and chemical properties of the ink vehicle are critical both for drop ejection performance and control of ink/media interactions. Prints printed with these inks are fully dried inside the printer and do

not require external dryer or drying time. Latex inks enable printing on low-cost uncoated papers and foils with excellent image sharpness while solvent inks require more expensive coated substrates to achieve the same results. These inks achieve excellent image quality and produce high-resolution prints up to 1 200 dpi with dense, saturated colours and offer display permanence as well as scratch, smudge and water resistance. Latex inks have excellent flexibility and can stretch with the foils during mounting without cracking. In addition to this, latex inks soften, rather than dissolve, the surface of the print medium, providing better long-term adhesion and elasticity.

Image quality attributes are primarily defined for ink-jet printing and have been evaluated for other digital printing techniques and offset printing. In this paper, focus is placed on reproduction of image elements in ink-jet printing. The aim of our work was to evaluate the influence of substrate surface properties on the quality of image elements in ink-jet printing. Three PVC self adhesive substrates with different surface properties were used. In a study by Lindberg (2004), numerous print quality attributes were reduced to four: mottle, colour gamut, colour shift and print sharpness. In a work by Engeldrum (2004), it was stated that observers will not perceive more than five quality attributes simultaneously. Based on these conclusions, we chose to evaluate some of the basic print quality attributes - mottle, dot roundness, print sharpness, line quality and colour gamut. Mottle was chosen to measure non-uniformity in ink application, while dot roundness gave us information about dot distortion during printing. Print sharpness was estimated by measuring the modulation transfer function. Reproduction of lines was estimated by measuring line wicking and line intercolour bleed. Colour reproduction was assessed by comparing original and obtained colour gamut. This research concerns quality attributes for line work printing. Our assumption is that the results obtained can be applied for continuous tone printing.

2. Theoretical background

Print quality is partly determined by substrate characteristics. The most significant substrate characteristics that influences print quality are surface energy and surface roughness. The research reported in this paper is focused on the investigation of the influence of surface roughness on print quality. The substrate topography, or roughness, has a significant influence on print quality properties such as gloss, mottle and uncovered printing areas. In order to maintain uniformity of printing, the definition of the substrate surface properties is of high importance (Rentzhog, 2006). There are many roughness parameters which can be used for surface characterization but the most commonly used is the R_a (average surface roughness) value (Mahović, 2007; Dedijer and

Novaković, 2010). R_a is the average value of the vertical deviation of a surface profile from an absolutely smooth, ideal surface within an evaluation length equation [1]. In other words, it represents the arithmetic mean of the absolute values of profile deviation from the mean within the sampling length. The R_a value is defined by the ISO 4287:1997 standard (ISO, 1997):

$$R_a = \frac{1}{l} \int_0^l |y(x)| dx \qquad [1]$$

Macro non-uniformity is determined by measuring mottle. Mottling is one of the most significant defects in printing and can be defined as undesired unevenness

in perceived print density, or more precisely as non-uniformity occurring on a scale greater than 1.27 mm (Sadovnikov et al., 2005). Print mottle plays a significant role in print quality. One of the causes for mottling is uneven absorption of ink into the substrate, producing a blotchy or cloudy area (Dhopade, 2009). The degree of mottling can be defined by the mottling index, which ideally should be zero. The mottling index, or so called non-uniformity number (NU), is calculated from averages of dot intensity above the median (Ux) and those under the median (Lx) as in equation [2] (Muck, Hladnik and Stanić, 2009):

$$NU = Ux - Lx \qquad [2]$$

Since the level of print non-uniformity is connected with an intensity width span of picture dots, the larger the NU value is, the larger the mottling.

Dot roundness is a very important parameter that represents the shape of the dot relative to a perfect circle. Printed dot fidelity is determined by evaluating dot area and roundness (Sarafano and Pekarovicova, 1999). The ideal circular dot is one whose area is $\pi/2$ of that of the corresponding square pixel. Printing a circular dot with diameter less than the diagonal of the square pixel at every addressed point will necessarily leave some area uncovered (Fleming et al., 2003). Similarly, if a dot is not perfectly round its deviation can cause uneven ink coverage. Dot roundness is defined as (Fleming et al., 2003):

$$roundness = 4\pi \, (A/p^2) \qquad [3]$$

where A is the area of the dot and p is its perimeter. The roundness is equal to 1 for a circle, and is less than one for any other closed figure. The closer to 1 the roundness, the better the quality of the dot. Fleming et al. (2003) state that their analyses and interpretations are general and applicable to any printing processes where image quality is governed by the smallest printable dot.

A common way to assess print sharpness is by measuring the modulation transfer function (MTF). MTF represents the contrast at a certain spatial frequency compared with that of a low frequency. The spatial frequency is usually measured by cycles or pairs per length unit (mm or inch), although cycles per pixel, or line width per picture height of the observed image (LW/PH), are the most common measurement units. High spatial frequency corresponds to fine details (Rilovski, 2011).

The ability of a system to reproduce details is captured in its modulation transfer function (Bonnier and Lindner, 2010). MTF is commonly measured by the slanted edge method. The slanted edge method is often used to measure the MTF of a scanner or any capture device and can be adapted to measure the MTF of a printing system (Bang, Kim and Choi, 2008). During the analysis, one edge of a digitalized test image is selected as the region of interest (ROI). The analysis is visualized in Figure 1. For each line of the ROI there is a transition from black to white - a step function (Figure 1a). The position of the transition of each step function is estimated and the lines are shifted so that the transitions are all vertically aligned. Then the average of all the shifted step functions is calculated along this vertical line to reduce the influence of noise (Figure 1b). The derivative of this mean step function is ideally a Dirac delta function, but in reality it is a peak of a certain width (Figure 1c). The absolute value of the Fourier transform of this peak is the MTF (Figure 1d) (Bonnier and Lindner, 2010).
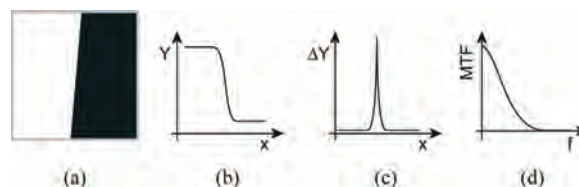
Figure 1: Basic principle for MTF measurement using the slanted edge method: (a) region of interest, (b) average of Y values from shifted lines, (c) derivative with noise suppression, and (d) Fourier transform and normalization resulting in an estimation of the MTF

A common way to evaluate print sharpness is by the MTF 50 parameter. MTF 50 is the spatial frequency where MTF is 50 % of the low frequency MTF. The print quality of an observed image can be established based on the MTF 50 parameter. It is necessary to divide the MTF 50 value (in LW/PH units) with the image height (inch as unit). To determine print quality, the obtained values are compared with reference values.

Table 1 is a guide to the quality requirements.

Table 1: Print quality level according to the MTF50 parameter and image height

	Quality level
150	**Excellent** - Extremely sharp at any viewing distance.
110	**Very good** - Large elements look excellent, although the quality suffers under magnification. Small print still looks very good.
80	**Good** - Large print looks OK when viewed at normal distances, but looks somewhat soft when examined closely. Small print looks soft (adequate, perhaps, for the "average" consumer).

Line quality can be assessed by measuring ink wicking and line intercolour bleed. Line wicking, i.e., the wicking of ink into the substrate thus blurring the printed lines, can be characterized by measuring line area and perimeter. Excess wicking can make text look either too fuzzy or bold. Also, halftone areas darken as wicking increases (Briggs, 2002). Increased wicking leads to decreasing print sharpness.

Line intercolour bleed is the tendency of wet ink of one color to bleed into wet ink of another color (Briggs, 2002). Intercolour bleeding tends to make lines wider; therefore the degree of bleeding can be assessed by estimating the changes in line width. One of the methods for determining intercolour bleed is to measure the width of two lines which form a colour pair. A colour pair can be defined as, for example, a cyan line on a magenta field and a magenta line on a cyan field. In an ideal case, the two lines would have exactly the same width which indicates zero bleed. But this is not possible since a certain bleed value is always present.

Intercolour bleed can have a negative effect on the quality of small coloured text printed on a colour background. When the ideal letter area and perimeter deviate significantly from the measured values, it indicates poor text readability. As a matter of fact, intercolour bleed causes reduction of the printer resolution. (Briggs, 2002). The substrate can have a significant effect on intercolour bleed and, when evaluating substrates for intercolor bleed, every primary and secondary color combination should be measured. This is necessary due to the difficulty in predicting which colors will bleed. According to a study by Lindberg (2004), mottle and colours are the main influential parameters on the print quality. The common way of describing colour reproduction is by measuring CIE Lab colour values and comparing obtained colour gamuts. The colour gamut is the set of possible colours within a colour system. No system can reproduce all possible colours in the spectrum. The colour gamut of a certain device is determined by factors such as physical characteristics of substrates and inks (Pintier, Nedeljković and Nedeljković, 2010).

3. Methods and materials

In our study, three PVC self adhesive materials were chosen as printing substrates: Neschen Solvoprint 80 GP (glossy surface), Neschen Solvoprint 80 GP Nolite (glossy surface), and Neschen Solvoprint 80 MP (matte surface). All materials had a thickness of 80 μm. Neschen Solvoprint 80 GP Nolite had a dark grey adhesive back side; the other two materials had a transparent adhesive back side.

Substrate specifications are given in Table 2.

Table 2: Printing substrates specifications

	Neschen Solvoprint 80 GP	Neschen Solvoprint 80 GP Nolite	Neschen Solvoprint 80 MP
Thickness (μm)	80	80	80
Gloss (graduations)	> 50 (20° measuring angle)	> 50 (20° measuring angle)	15 to 30 (85° measuring angle)
Adhesive type	Polyacrylate dispersion, transparent	Polyacrylate dispersion, black	Polyacrylate dispersion, transparent
Roughness R_a (μm)	0.414	0.578	2.767

A test image containing different elements used for print quality control as shown in Figure 2 was created using Adobe Illustrator CS5 software. The test image dimensions were 210 x 555 mm. The elements assessed were an ISO 12233 test chart, an ECI 2002 Random test chart, an area for macro non-uniformity control, horizontal and vertical lines with widths between 1/8 and 2 pt, positive/negative lines in cycles from 5 to 0.5 line pairs per mm, dot circularity control consisting of dots with different diameters ranging from 0.1 to 0.6 mm in the four process colors, positive/negative text in sizes from 6 to 12 pt and elements for intercolour bleed control consisting of four lines with 1 mm width in process colours placed over four CMYK fields.

The test image was printed on an HP Scitex LX 820 ink-jet printer, using HP Latex inks. Printing was performed at the predefined 600 dpi resolution for printing materials. After printing, the test image was digitalized using a CanonScan 5600F scanner. The scanning reso-

Figure 2:
Test image used in evaluating print quality
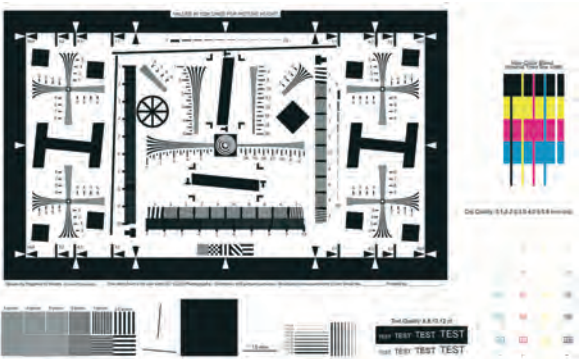
lution was set to 1 200 lpi and all automatic functions were turned off. The significant image elements were saved as separate tiff files and compared with the same elements in the rasterized original test image. Mottle, dot roundness and line quality as print quality attributes were calculated using ImageJ software. The MTF 50 parameter was determined by Imatest SFR software. For colour gamut analysis, the ECI 2002 random test chart was measured using a GretagMacbeth Spectro Scan spectrophotometer. ICC profiles were created by GretagMacbeth/ProfileMaker Pro 5.0.5, while the colour gamut of created ICC profiles were displayed using CHRO-Mix ColorThink Pro software. In order to visually determine the deviations from ideal reproduction, some of the image elements were also captured with a Sibress Pit camera (the elements were magnified 20 times).

Macro non-uniformity (mottle) was assessed on a 25 x 25 mm area covered with black ink (100 % TV). So as to determine the non-uniformity number (mottling index), we used a plug-in for the ImageJ software developed and described by Muck, Hladnik and Stanić (2009).

4. Results and discussion

4.1 Mottle analysis

The degree of mottle was defined using the non-uniformity number. Table 3 shows the change in mottle on different substrates. The minimum values of the non-uniformity number were obtained on the Neschen Solvoprint 80 GP substrate (substrate with glossy surface). The highest values of the non-uniformity number were obtained on Neschen Solvoprint 80 MP (substrate with matte surface).

Comparing non-uniformity values for different substrates, it can be inferred that an increase in substrate roughness causes an increase in mottle. Figure 3 compares two fields covered by 100 % TV of black ink, with high and low values of macro non-uniformity.

Table 3: Degree of mottle

Material	Mottle (Non-uniformity number)
Gloss	3.3007
Gloss Nolite	3.1922
Matte	15.9615
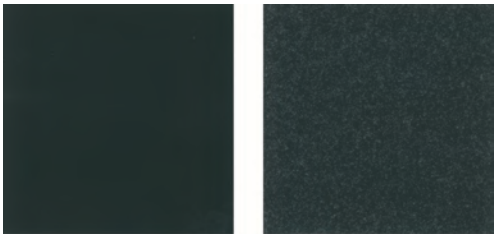
Figure 3: Mottle seen on glossy (left) and matte (right) substrate

Line quality was assessed by measuring line wicking and line intercolour bleed. Line wicking was determined by measuring area and perimeter of 2 point thick lines. Intercolour bleed was assessed by measuring the deviation of line thickness from the ideal determined value (1 mm).

This measurement was performed for all process colour combinations. Dot roundness analysis was based on measuring the influence of dot size and substrate topography on roundness. We conducted the measurement of dot roundness on dots with perimeter ranging from 0.1 to 0.6 mm. The roundness was obtained as a mean value of the roundness of 6 dots, where the dots to be measured were sampled randomly. Print sharpness was assessed using the MTF 50 parameter. The MTF 50 value (in LW/PH units) was divided by the image height (inch as the unit). In this work, the image height was 5 inch - the height of the printed ISO 12233 test chart. To determine print quality, the obtained values were compared with reference values (Table 1). The measurement results for each parameter were obtained as an average value of ten measurement values.

4.2 Line quality analysis

4.2.1 Line wicking

The results obtained from measuring a 2 point wide line area, when printing is performed on different substrates, are given in Figure 4.

It can be noticed that when the substrate roughness increases the line area also increases. Glossy substrates have uniform roughness and line area deviation values. The glossy substrate with a transparent adhesive back side had a deviation of 4.06 % from the ideal case, while the gloss substrate with a dark grey adhesive back side had a deviation of 3.14 %. The value of deviation for the matte substrate was 17.67 %.

Figure 4: Areas of 2 point wide lines printed on different substrates

The results obtained from measuring the perimeter of a 2 point wide line, when printing on different substrates, are given in Figure 5.

It can be concluded that all materials have a deviation from the ideal case. At the same time, the substrate

with the highest value of roughness has the lowest deviation value.

Figure 6 compares magnified 2 point wide lines printed on different substrates.

Figure 5: Perimeters of 2 point wide lines printed on different substrates

Figure 6: 2 pt lines on different substrates (magnified 20 x)

4.2.2 Line intercolour bleed

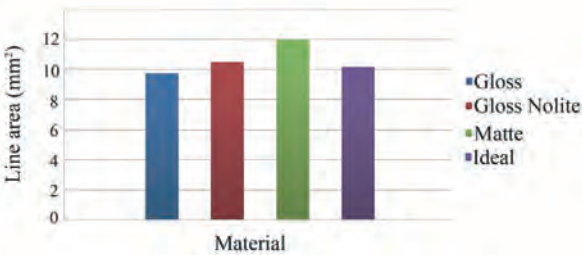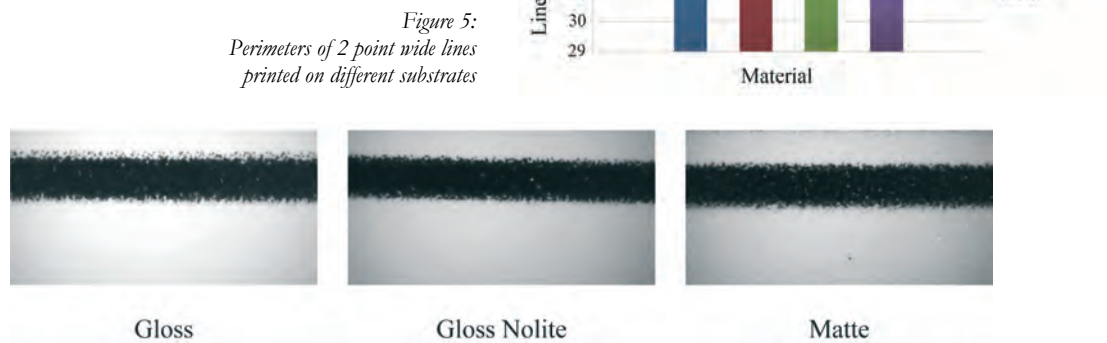The value of intercolour bleed was assessed by measuring line width deviation of colour lines printed on background fields of contrasting colours (e.g., a magenta line on a yellow field). The line width deviation was measured by comparing measured line widths with the ideal line width of 1 mm.

The obtained line intercolour bleed values for each substrate and colour combination are given in Table 4. The presented values are given in mm as the unit.

Table 4: Line intercolour bleed values (in mm)

Material	Colour combination					
	Black/Yellow	Black/Magenta	Black/Cyan	Cyan/Magenta	Cyan/Yellow	Magenta/Yellow
Gloss	0.462	0.314	0.314	0.412	0.215	0.970
Gloss Nolite	0.271	0.158	0.243	0.412	0.186	0.864
Matte	0.356	0.144	0.314	0.377	0.292	0.737

The measured values indicate that substrate roughness does not have an impact on intercolour bleed, since all substrates gave similar results. Nevertheless, the colour combination influences the value of intercolour bleed. On all three substrates, the highest intercolour bleed value was seen in the combination of a magenta line on a yellow field. The assumption is that this is a consequence of clogging of the ink jet nozzle system which was used in printing the magenta colour.

Figure 7 shows intercolour bleed in different colour combinations.

Figure 7: Intercolour bleed on a glossy substrate
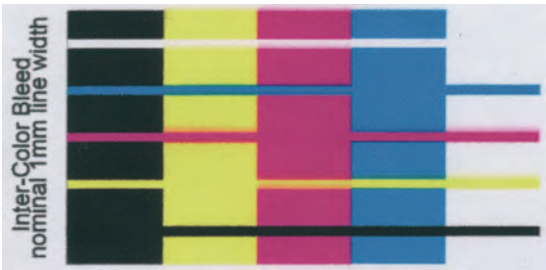
4.3 Dot roundness analyisis

The dot roundness analysis was based on measuring the influence of dot size and substrate topography on roundness. The obtained values for each material and dot size are given in Table 5. It can be noticed that the substrate roughness does not have a significant impact on dot roundness values. Dots with the same diameter have approximately equal dot roundness values. It can also be seen that the dot perimeter has a more significant influence on dot roundness values.

As seen in Table 5, dots with a 0.3 mm diameter have the highest dot roundness values. It can also be seen that a dot diameter increase leads to a decrease of dot roundness values.

Table 5: Dot roundness values

Material	Dot diameter (mm)				
	0.2	0.3	0.4	0.5	0.6
Gloss	0.835	0.900	0.878	0.852	0.810
Gloss Nolite	0.807	0.860	0.832	0.787	0.749
Matte	0.822	0.868	0.854	0.825	0.866

Figure 8 illustrates the dot deviation from the ideal round shape by showing the reproduction of dots with a 0.3 mm diameter on different substrates.

Figure 8: Dots with 0.3 mm diameter printed on different substrate (magnified 20 x)

Gloss   Gloss Nolite   Matte

4.4 Print sharpness analysis

The print sharpness was assessed by measuring the modulation transfer function (MTF). The results obtained from the PVC substrates, where the MTF was measured on the ISO 12233 test chart by the slanted edge method, are given in Table 6.

Table 6: MTF50 parameter values

Material	MTF 50 (LW/PH)
Gloss	667.8
Gloss Nolite	761.6
Matte	631.9

It can be noticed that the material with the highest roughness value (the matte substrate) has the lowest MTF 50 value. Glossy substrates have approximately equal roughness values but their MTF 50 values vary. The assumption is that this phenomenon is caused by the different types of adhesive back sides. When scanning the Gloss Nolite substrate, the dark grey adhesive back side absorbs a fraction of the light which prevents undesirable reflection. The adhesive back sides of the other two substrates do not absorb light, which results

in the appearance of undesirable reflection that is observed by the photosensitive scanner sensor. This leads to the decrease of sharpness on the scanned image that was used in measuring the MTF parameter of the printed image. The print quality of the observed images was determined by dividing the MTF50 value with the image height, 5 inches (Table 7).

Table 7: Quality level obtained by the MTF50 parameter divided by the observed image height

Material	Quality level
Gloss	133.56
Gloss Nolite	152.32
Matte	126.38

The resulting quality level indicates that the prints printed on matte and gloss surfaces possess a very high quality level, while prints printed on the substrate with a dark gray adhesive back side have an excellent quality level.

Figure 9 shows positive/negative lines in cycles from 5 to 0.5 pairs per mm printed on the glossy substrate with a dark gray adhesive back side as indicators of sharpness.
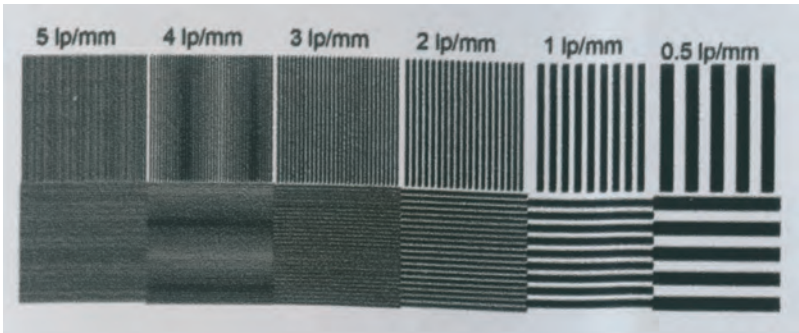
Figure 9: Positive/negative lines in cycles from 5 to 0.5 pairs per mm printed on the Gloss Nolite substrate

4.5 Colour reproduction analysis

After printing on the PVC substrates, ICC profiles illustrating colour gamut were created by spectrophotome-

tric measurements. The results are shown in Figure 10. It can be concluded that the glossy substrate with a transparent adhesive back side has the largest colour gamut. It is followed by the glossy substrate with a dark

grey adhesive back side, while the matte substrate possesses the smallest colour gamut. Furthermore, it can be noticed that the glossy substrates have somewhat different colour gamuts but the differences are not drastic. Taking these results into account, it can be concluded that the surface roughness influences the colour gamut. An increase in surface roughness leads to a decrease in colour gamut.
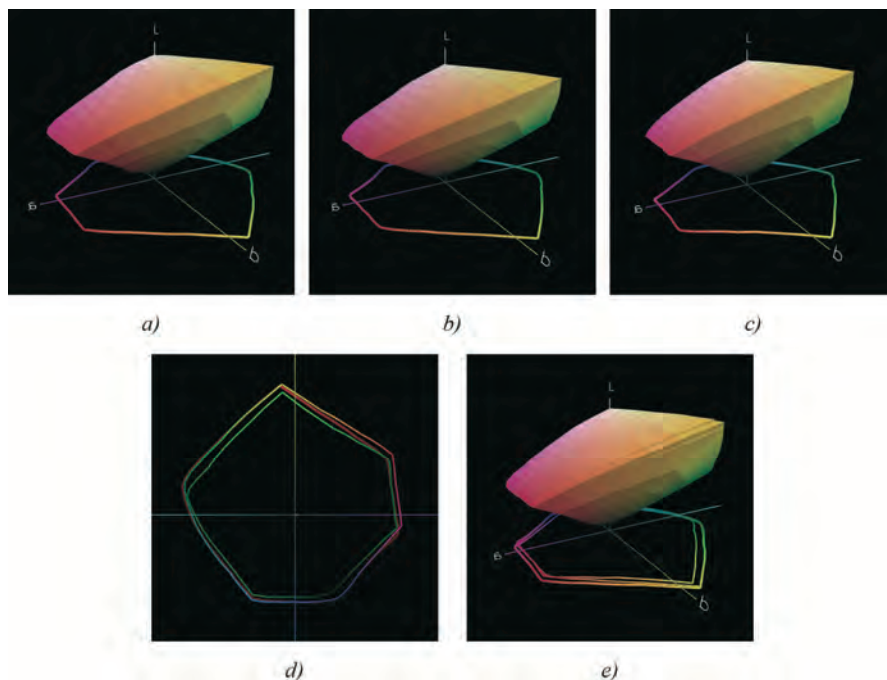
Figure 10: Reproduced colour gamuts: a) Gloss substrate, b) Gloss Nolite substrate, c) Matte substrate, d) Colour gamuts for all substrates in the 2D Lab colour space (Gloss - true colour, Gloss Nolite - red, Matte - green), e) Colur gamuts for all substrates in the 3D Lab colour space

5. Conclusions

The aim of this paper is to determine the influence of substrate topography on print quality in ink-jet printing. Printing of a test image was performed on three PVC self adhesive substrates with different surface properties. Using spectrophotometric measurements, ICC profiles were created, while mottle, dot roundness, print sharpness, line quality, as some of the basic print quality attributes, were determined by image analysis.

Based on variations in the non-uniformity number, it is concluded that an increase of substrate roughness leads to an increase in the mottling index. Line wicking assessment shows that line areas and perimeters differ from the ideal case for all substrates used. Furthermore, it can be noticed that the deviation from the ideal case is more noticeable for matte substrates. The intercolour bleed results indicate that substrate roughness does not have an impact on intercolour bleed. On the other hand, it was noticed that the colour combination has an important impact on this quality parameter. It can also be concluded that this parameter is influenced by the characteristics of the ink-jet printer used. In future research, printing should be done using different ink-jet printing equipment in order to obtain device independent results. The dot roundness measurements indi-

cate that substrate roughness does not have an influence on this parameter. It can be noticed that this parameter is influenced by the dot perimeter. The print sharpness measurements show that surface roughness influences print sharpness and the substrate with the highest roughness value had the lowest print sharpness value. Furthermore, glossy substrates possess similar roughness values but have very different print sharpness values. We suppose that the reason for this is the presence of different types of self adhesive back sides. Another possible cause is the manner of digitalization of the printed samples. The color reproduction results show that surface roughness has an impact on the colour gamut and the material with the highest roughness has the smallest colour gamut.

Taking all results into account, it can be concluded that substrate roughness has a significant influence on print quality. In addition to this parameter, it was shown that other parameters, such as colour properties and back side material, influence print quality. In order to confirm these results, further testing should be performed and other components, such as back side thickness, the influence of different colours on mottle, dot roundness and print sharpness should be tested.

In order to more completely understand the influence of the printing substrate on print quality, further research should also include an analysis of the influence of the surface energy of the printed materials on print quality.

Acknowledgments

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A simple color separation model based on colorimetric and spectral data

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Abstract

A color separation model which separates a target color inside the gamut of a printing system into the combination of process inks used in the system is a crucial part of the printing procedure. A simple color separation model for CMY printing is presented in this paper. It is based on a color prediction model proposed in our previous papers. This color prediction model, which was based on CIEXYZ (CIELAB) values, is extended in this paper to work also for spectral data. Therefore, the color separation model is executable for target colors represented by both CIELAB and spectral data. Two experiments are designed and carried out to evaluate the accuracy of the proposed models. The first experiment proves the accuracy and stability of the forward (color prediction) model. The second experiment shows that our simple inverse model (color separation) has a satisfying accuracy for different target colors in terms of giving less ink consumption and small CIELAB color difference (ΔE_{94}) or small spectral difference (ΔRMS). The proposed color separation model has the potential to be applied to practical printing systems due to its simplicity and accuracy.

Keywords: spectral printing, color separation, color prediction, dot gain, effective coverage map

1. Introduction

Many color prediction models have been proposed to predict the color output of printers since the 1930s (Wyble and Berns, 2000). The most well-known regression based models are the Murray-Davies model (Murray, 1936) and the Neugebauer model (Neugebauer, 1937; Viggiano, 1990). Aiming to gain higher accuracy, these models have been refined into different forms during the past decades.

The Yule-Nielsen model (Yule and Neilsen, 1951; Ruckdeschel and Hauser, 1978) is one of the most popular color prediction models. It considers the reflectance spectra of a color patch to be composed by the reflectance spectra of the involved full tone ink and white paper in an exponential form which makes it no longer linear, as assumed in the Murray-Davies model. The Yule-Nielsen modified spectral Neugebauer model, which is a modification of the original Yule-Nielsen model, combines the Yule-Nielsen and Neugebauer models and involves all the primary and secondary color elements in the model by using Demichel's equations (Demichel, 1924). A recent version of this model is the improved Yule-Nielsen modified spectral Neugebauer model (Hersch and Crété, 2005) which gives more accurate predictions by optimizing the n factor in the Yule-Nielsen model, as well as by optimizing the effective coverage of each involved ink.

Our previous work has focused on building a simple regression based color prediction model (Gooran, Namedanian and Hedman, 2009; Qu and Gooran, 2011). Dot gain characterization is an essential part in most regression based color prediction models. Our model was initialized by the idea that defining only one dot gain curve for each ink to be used in Neugebauer's equations may not be completely correct. This idea was supported by the fact that the three characterization curves obtained using CIEX, CIEY, and CIEZ for each ink are different from each other. In addition, since optical dot gain is included in the measured data, the calculated three effective coverage values for a certain amount of ink include both the physical and optical dot gain (Gooran, Namedanian and Hedman, 2009). Therefore, our model does not employ the n factor that is used to deduce the optical dot gain in Yule-Nielsen equation based models (Ruckdeschel and Hauser, 1978). More details about the dot gain characterization will be briefly described in the next section.

The effective coverage of a certain amount of primary ink changes without obeying any observable rule when ink superposition happens. Therefore an effective coverage map is preliminarily proposed and put into a coordinate system whose three axes refer to the reference ink coverage of the three primary inks (Qu and Go-

oran, 2012a). The points in the map correspond to the training patches and they are filled with the effective coverage values based on CIEXYZ values for each primary ink.

The performance of our model based on CIEXYZ was tested by using a laser printer (Xerox Phaser 6180) together with uncoated A4 office paper and also an inkjet printer (Epson Stylus PRO 4000) together with photo quality paper (Qu and Gooran, 2012). These two types of printers are commonly used in practical digital printing and the two printers mentioned are the printers we currently have in our laboratory. The good prediction results (Qu and Gooran, 2012) indicate that our color prediction model based on CIEXYZ is not obviously affected by the type of printer and paper used.

Note, that the CIEX, Y and Z tri-stimulus relate approximatively to three special wavelength bands along the visible wavelength spectrum interval. We have attempted to divide the visible wavelength interval into more than three subintervals. For each subinterval, one effective dot gain curve should be defined. Hence, it requires the spectral reflectance of printed color patches instead of the CIEXYZ values. By doing this, we extend our model from CIEXYZ color space prediction to spectral prediction. The motivation for the extension is that the spectral or reflectance match ensures color equivalence and avoids the problem with metameric match which is important for the development of multi spectral color printing in the digital printing industry. Our color prediction model in its spectral form is different from other spectral prediction models by using an effective coverage map containing 36 subintervals for each ink.

2. The forward model

2.1 Model based on CIEXYZ

Our forward model differs from other models by characterizing the behavior of the dot gain of each primary ink (cyan, magenta and yellow) using three characterization curves based on CIEXYZ.

Beginning with single ink prints, take cyan for example: a group of printed cyan patches with reference coverage c_{ref} increasing from 0 to 100% enables us to get three characterization curves based on CIEX, Y and Z, respectively. These are denoted dgc^X, dgc^Y and dgc^Z in equations [1], which are derived from Neugebauer's equations.

In the equations, c_{eff}^X, c_{eff}^Y and c_{eff}^Z are the effective dot coverages of cyan corresponding to the reference coverage value c_{ref}. X_p, Y_p and Z_p are CIEXYZ tri-stimulus values of the paper while X_c, Y_c and Z_c are CIEXYZ tri-stimulus values of full tone cyan. The measured CIEXYZ values of each halftone cyan patch are Xc_{mea}, Yc_{mea} and

This paper presents a color separation model for a CMY printing system to represent any required color inside its gamut. The color separation is the inverse procedure of the forward color prediction model. In the forward model, inputs are CMY reference coverage and the outputs are the predicted colors represented by CIEXYZ, CIELAB or spectrum. As introduced by Wyble and Berns (2000), the more useful model form is the inverse model or color separation, where the reference CMY ink coverage values are predicted from the target color coordinates. Several methods have been proposed to estimate the ink combinations according to the desired color stimulus. Amongst them are the polynomial regression model (Xia et al., 1999), three dimensional interpolation using a lookup table (LUT) (Kasson et al, 1995), neural network methods (Tominaga, 1998) and analytical methods (Lee et al., 2001) using forward models.

Considering the high accuracy of our color prediction model, we propose a series of inverse procedures based on our forward color prediction model. It starts by repeatedly running the forward model using all possible ink combinations, resulting in a large color lookup table (CLUT). Due to the inevitable disturbing elements of the printer and the measurement system, reasonable tolerances or conditions are added to the CLUT.

In this paper, the forward model in different forms (CIEXYZ and spectrum) will first be briefly presented, then the inverse model for any target color represented by its CIELAB or spectrum is described. Different tolerances and conditions are applied to fulfill the goal of the inverse model itself as well as the opportunity of ink saving. The results of test print experiments to evaluate the models are then reported.

Zc_{mea}. The three characterization curves for magenta or yellow can be similarly obtained.

$$
\begin{cases}
c_{eff}^X = \dfrac{Xc_{mea} - X_p}{X_c - X_p} = dgc^X + c_{ref} \\[2mm]
c_{eff}^Y = \dfrac{Yc_{mea} - Y_p}{Y_c - Y_p} = dgc^Y + c_{ref} \\[2mm]
c_{eff}^Z = \dfrac{Zc_{mea} - Z_p}{Z_c - Z_p} = dgc^Z + c_{ref}
\end{cases} \qquad [1]
$$

When there are more inks involved in the prints, say cyan and magenta, Demichel's equations are used to obtain the fractional coverage over the patch using CIEX, Y and Z for each primary and secondary color. The tristimulus values (X_{cal}, Y_{cal}, Z_{cal}) of the print are then calculated according to equations [2]. For simplicity, we here only focus on the calculation based on CIEX. In the following, any calculation can be repeated with CIEX replaced by CIEY or CIEZ for the real execution of our approach.

$$
\begin{cases}
X_{mea} = c^X \cdot X_c + m^X \cdot X_m + b^X \cdot X_b + p^X \cdot X_p \\
c^X = c_{eff}^X \cdot (1 - m_{eff}^X) \\
m^X = m_{eff}^X \cdot (1 - c_{eff}^X) \\
b^X = c_{eff}^X \cdot m_{eff}^X \\
p^X = (1 - c_{eff}^X) \cdot (1 - m_{eff}^X)
\end{cases}
\qquad [2]
$$

X_c is the CIEX value of full tone cyan, and the indices c, m, b, p refer to cyan, magenta, blue and paper respectively. The superscripts X imply that the variables are based on CIEX. c^X, m^X, b^X and p^X are the calculated fractional coverages for pure cyan, magenta, blue and paper using Demichel's equations when there are only cyan and magenta involved in the printed patches.

As mentioned before, when cyan is printed together with magenta or yellow or both, the effective coverage values of cyan vary irregularly. In other words, even with the same c_{ref} the c_{eff}^X in equation [2] is no longer the same as that in equation [1] due to the ink superposition and complex light scattering. The pursuit of correct effective coverage values leads to the effective coverage map.

The main principle for building the effective coverage map has been described by Qu and Gooran (2012a). Here, we give a brief description of the process. The map is situated in a coordinate system whose three axes refer to the reference ink coverage of the three primary inks.

To create the map, several training patches are needed. If we choose [0, 25 %, 50 %, 75 %, 100 %] as the reference coverage options for the three inks respectively (training patches), then the map is a cubic box with 125 points located spatially uniformly in the coordinate system. Each point represents a training patch and its three coordinates correspond to the three reference ink coverages. Several of the training samples (those with reference coverage of yellow $y_{ref} = 0$, and $y_{ref} = 1$) are shown in Figure 1. Each point in the map will be filled with nine values which are the three effective coverages for each ink based on CIEX, Y and Z respectively. They are denoted by

$$c_{eff}^X , \ c_{eff}^Y , \ c_{eff}^Z , m_{eff}^X , \ m_{eff}^Y , \ m_{eff}^Z \ \text{and} \ y_{eff}^X , \ y_{eff}^Y , \ y_{eff}^Z$$

in Figure 1.
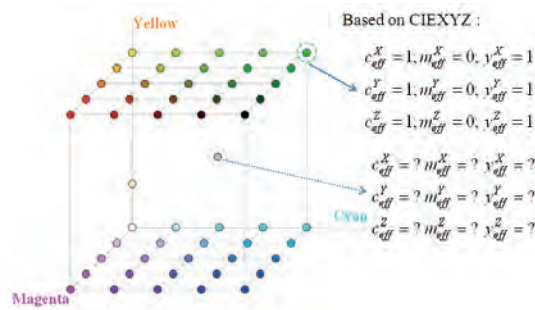
Figure 1: Illustration of the effective coverage map, each point on the map containing nine effective coverage values based on CIEXYZ

We denote the procedure of filling the points with correct effective coverage values as "mapping". During mapping, the training patches involving one or two inks are treated differently from those with three inks.

When the effective coverage map is built, given any ink combination, the corresponding effective coverage based on CIEXYZ can be calculated by cubic interpolation

over the map. Finally, the predicted color tri-stimulus values can be calculated by equations [3].

c^X, m^X, y^X, r^X g^X, b^X, k^X and p^X are the fractional coverages for pure cyan, magenta, yellow, red, green, blue, black and paper respectively. They are calculated similarly to c^X, m^X, b^X and p^X in equations [2] which use Demichel's equations and the effective coverage values of involved primary inks.

$$
\begin{cases}
X_{cal} = c^X \cdot X_c + m^X \cdot X_m + y^X \cdot X_y + r^X \cdot X_r + g^X \cdot X_g + b^X \cdot X_b + p^X \cdot X_p + k^X \cdot X_k \\
Y_{cal} = c^Y \cdot Y_c + m^Y \cdot Y_m + y^Y \cdot Y_y + r^Y \cdot Y_r + g^Y \cdot Y_g + b^Y \cdot Y_b + p^Y \cdot Y_p + k^Y \cdot Y_k \\
Z_{cal} = c^Z \cdot Z_c + m^Z \cdot Z_m + y^Z \cdot Z_y + r^Z \cdot Z_r + g^Z \cdot Z_g + b^Z \cdot Z_b + p^Z \cdot Z_p + k^Z \cdot Z_k
\end{cases}
\qquad [3]
$$

2.2 Model in spectral form

The extension of our model from CIEXYZ to the spectral form is carried out by applying the spectral data at several visible wavelength bands instead of CIEX, Y and Z values. In this paper, the spectral data used is within the wavelength range between 380 nm and 730 nm

with a step of 10 nm; this means that 36 characterization curves are used.

By replacing the CIEXYZ values with the spectral data R that consists of $i = 36$ subintervals, equation [4] is obtained for the case of single ink prints, for example cyan.

$$R_{mea}^i = c_{eff}^i \cdot R_c^i + (1 - c_{eff}^i) \cdot R_p^i \quad i = 1, 2, 3, \ldots, 36 \qquad [4]$$

where R_{mea}^i is the measured spectrum at the i-th wavelength subinterval of a halftone cyan patch. Therefore $(R_{mea}^1, R_{mea}^2, \ldots R_{mea}^{36})$ represent the measured spectrum of a halftone cyan patch; $(R_c^1, R_c^2, \ldots R_c^{36})$ are the measured spectra of the full tone cyan while $(R_p^1, R_p^2, \ldots R_p^{36})$ are the measured spectra of unprinted paper. $(c_{eff}^1, c_{eff}^2, \ldots c_{eff}^{36})$ are the effective coverage of cyan corresponding to each wavelength interval.

By using the measurements of halftone cyan patches, several groups of $[(c_{eff}^1, c_{eff}^2, \ldots c_{eff}^{36}) \text{-} c_{ref}]$ corresponding to different reference coverage c_{ref} are obtained and shown in Figure 2. For illustration purposes, Figure 2 shows only seven curves which are randomly chosen from those 36 curves. The 36 characterization curves for magenta or yellow can be obtained similarly.

The effective coverage map is built in a similar way as for the model based on CIEXYZ values to show correct effective coverage values when ink superposition is present. As in the CIEXYZ based model, the above 36

curves are used directly in the interpolation procedure when there is only one primary ink involved. Otherwise, the effective coverage map is used.

Figure 2: Characterization curves using spectral data for cyan printed by a laser printer using AM600 dpi-100 lpi; only seven curves are illustrated here

Regarding mapping using spectral data, the CIEX data in the equations (for example equation [2]) is replaced by the spectra at a certain wavelength subinterval. Equations [5] represent the spectral form of equation [2] and involve three inks (not two, as in equation [2]) to explain the processing using spectral data.

$$
\begin{cases}
c^i = c_{eff}^i \cdot (1 - m_{eff}^i) \cdot (1 - y_{eff}^i) \qquad m^i = m_{eff}^i \cdot (1 - c_{eff}^i) \cdot (1 - y_{eff}^i) \\
y^i = y_{eff}^i \cdot (1 - m_{eff}^i) \cdot (1 - c_{eff}^i) \qquad r^i = m_{eff}^i \cdot y_{eff}^i \cdot (1 - c_{eff}^i) \\
g^i = c_{eff}^i \cdot y_{eff}^i \cdot (1 - m_{eff}^i) \qquad b^i = c_{eff}^i \cdot m_{eff}^i \cdot (1 - y_{eff}^i) \\
k^i = c_{eff}^i \cdot m_{eff}^i \cdot y_{eff}^i \qquad p^i = (1 - c_{eff}^i) \cdot (1 - m_{eff}^i) \cdot (1 - y_{eff}^i) \\
R_{mea}^i = c^i \cdot R_c^i + m^i \cdot R_m^i + y^i \cdot R_y^i + r^i \cdot R_r^i + g^i \cdot R_g^i + b^i \cdot R_b^i + p^i \cdot R_p^i + k^i \cdot R_k^i \\
i = 1, 2, 3, \ldots, 36
\end{cases} \qquad [5]
$$

Equations [5] are using the data at a certain wavelength subinterval that we denote as the i-th subinterval, $i = 1$, or 2 … or 36. $c^i, m^i, y^i, r^i, g^i, b^i, k^i$ and p^i are the fractional coverages for pure cyan, magenta, yellow, red, green, blue, black and paper respectively. R_{mea}^i refers to the i-th subinterval of the measured spectrum of a certain patch. $R_c^i, R_m^i, R_y^i, R_r^i, R_g^i, R_b^i, R_p^i$ and R_k^i are the i-th subintervals of the spectrum for each full tone primary and secondary colors. c_{eff}^i, m_{eff}^i and y_{eff}^i are the effective ink coverage values in the effective coverage map. An individual set of effective coverage values, i.e., c_{eff}^i, m_{eff}^i and y_{eff}^i for a certain point in the map is fixed during mapping using the effective coverage values of its neighbors. A point is a neighbor of another point if they have a reference coverage in common.

In the mapping with spectral data, the constraints *effective coverage - reference coverage* $\geq$ - 0.2 and *effective coverage* $\leq$ 1.2

need to be obeyed at the possible cost of inequality between the two sides of the last formula in equation [5]. Please observe that one procedure is dealing only with the data of one specific subinterval and hence, to completely fill the effective coverage map, the mapping is repeated 36 times.

If we choose [0, 25%, 50%, 75%, 100%] as the reference coverage options for the three inks, the effective coverage map built in the spectral model will be similar to the cube shown in Figure 1, but the nine effective coverage values at each point are replaced by 3*36 values.

For any given reference ink combination, the corresponding effective coverage values c_{eff}^i, m_{eff}^i and y_{eff}^i are obtained by cubic interpolation and the value of $c^i, m^i, y^i, r^i, g^i, b^i, k^i$ and p^i by equation [5]. The spectrum of a test color patch is then predicted by equation [6].

$$R_{cal}^i = c^i \cdot R_c^i + m^i \cdot R_m^i + y^i \cdot R_y^i + r^i \cdot R_r^i + g^i \cdot R_g^i + b^i \cdot R_b^i + p^i \cdot R_p^i + k^i \cdot R_k^i \qquad [6]$$
$$i = 1, 2, 3, \ldots, 36$$

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The cube shown in Figure 1, presenting the spatial locations of the training samples for the effective coverage map, may give the erroneous impression that this model is based on the cellular model proposed by Rossier (2010).

It must be pointed out that they are different. The main difference is that the cellular model applies additional "primaries" in addition to the original eight Neugebauer primaries while no additional "primaries" are used in this model.

3. The inverse model - color separation

In this paper, the set of printing conditions including printer, ink, paper and halftoning method is referred to as the printing system. The capability of the printing system to reproduce colors, i.e., the color gamut of the printing system, is central to the color separation procedure (Tzeng, 1999). It is possible to specify the color gamut of the test printing system theoretically by printing and measuring as many printed colors as possible (Balasubramanian and Dalal, 1997). Apparently, collecting all the reproduced colors to form the color gamut is a massive operation and is not commonly recommended. A general method for estimating the color gamut of a printing device is based on the characterization of the behavior of the printing system (Ostromoukhov, 1993).

According to the principles of our forward color prediction model, as soon as an effective coverage map is built, based on either CIEXYZ or spectral reflectance, given any reference ink combination, the color after print can be predicted. This leads to our attempt to determine the color gamut of the test printing system by color prediction using our forward color prediction model.

Before calculating the color gamut, an evaluation of the stability of the printing system and the performance of our color prediction model when applied to the test printing system is necessary. We have carried out this evaluation by repeatedly applying the forward color prediction model on various test prints at different times. A group of training patches (125 in this paper) was printed and measured to build the effective coverage map. Additionally, a group of test color patches, composed by random ink combinations and special ink combinations, was designed. The special ink combinations are the ones whose reference coverage values were chosen from [0, 13 %, 25 %, 33 %, 50 %, 66 %, 75 %, 88 %, 1]. Since 125 of them were used as training patches, the remaining 604 are the special test color patches used in this paper. The reason why these patches are special is explained in an earlier paper by Qu and Gooran (2012a).

The designed test color patches were printed at different times and in different arrangement but using the same printing system. Table 1 illustrates the order of the training and test patches that are placed on the test charts. There were totally 1248 samples printed on three A4 pages for each day. By day 1, day 2 and day 3 we indicate the dates when the printing and measurements were carried out. Day 1, 2 and 3 were within one month.

Table 1:
The printing order of the training and the test patches that are placed on the test chart

Test print on day 1	Test print on day 2	Test print on day 3
125 training samples mixed with 604 special samples	125 training samples mixed with 604 special samples; Different order compared to day 1	125 training samples
		604 special samples
519 test samples with random ink combinations	519 test samples with random ink combinations Different order compared to day 1	519 test samples with random ink combinations Different order compared to day 1 and day 2

On day 1, the training samples and test samples were mixed and numbered in a certain order when they were printed and measured. On day 2, all the color patches were rearranged from the order on day 1 before they were printed. On day 3, the training samples and test samples were printed and measured separately (see Table 1).

An effective coverage map was built using the training samples printed and measured on day 1 in both CIEXYZ and spectral form. This effective coverage map was then used for color predictions of all the samples printed on the three days. Using exactly the same effective coverage map, if the prediction errors on different days would turn out to be dramatically different, we could conclude that the color prediction model is probably not suitable for the test printing system or that the test printing system is too unstable over time. Reversely, if the prediction errors on different days are within acceptable limits, we can conclude that our color prediction model works well for the test printing system.

The prediction errors obtained from the experiment are presented in Table 2. The first column presents the setting of the printing system and the number of the test samples printed on each day. For the special samples, the maximum differences between the predicted and measured data in both forms are relatively constant over time. The corresponding average color differences of the special samples are increasing but the differences are not large. Random samples always have small color differences regardless of when the samples are produced. Similarly, we also made color predictions for all the prints on these three days using the map that was built using the data obtained on day 2. The results were as satisfying as those presented in Table 2. This shows that our color prediction model based on CIZXYZ values, or spectral reflectance, is reliable for the test printing system over time.

Table 2:
The color difference (ΔE_{94} and ΔRMS) between measurement and predicted color values

AM600dpi-100lpi Laser printer Spectrophotometer D65 light source		Based on CIEXYZ, with effective coverage map on day 1			Based on spectrum, with effective coverage map on day 1				
		ΔE_{94}			ΔE_{94}			ΔRMS	
		Max	Mean	> 4	Max	Mean	> 4	Max	Mean
Test print day 1	Special (604)	4.48	1.31	3	4.66	1.29	1	0.2533	0.0508
	Random (519)	3.94	1.50	0	4.07	1.48	1	0.2031	0.0624
Test print day 2	Special (604)	5.12	1.69	10	5.17	1.63	6	0.2578	0.0677
	Random (519)	3.21	1.29	0	3.30	1.25	0	0.1513	0.0518
Test print day 3	Special (604)	5.07	2.03	17	4.96	1.91	13	0.2255	0.0758
	Random (519)	3.65	1.74	0	3.44	1.62	0	0.1705	0.0630

Setting the series [0:0.01:1] as the reference ink coverage options for cyan, magenta and yellow, respectively, leads to 101×101×101 ink combinations. The colors of this large number of ink combinations are predicted by our color prediction model using the effective coverage map obtained by the measurement data on day 1. These predicted colors include most of the printable colors within the test printing system, which form a large color lookup table (CLUT), representing the color gamut of the test printing system. This color lookup table presents the mapping between the reference ink combinations and the color values after print, and is available in both CIELAB (transformed from CIEXYZ tri-stimulus values) and spectral space.

For a lookup table, such as the mapping CMY-CLUT-CIELAB or CIEXYZ-CLUT-CMY, as introduced by Green and MacDonald (2002), usually an interpolation algorithm is created between the input and output spaces to estimate the output for any input. However, it should be mentioned that, in this paper, a search over the lookup table rather than an interpolation is carried out in order to find an output for a certain input. The projection between the input and output spaces is the forward color prediction model, which cannot be classified as a proper interpolation algorithm.

Note, that the required effective coverage map was created using the data obtained on day 1 and was used for all the printed samples on days 1, 2 and 3. The color prediction results presented in Table 2 show that the effective coverage map in our forward color prediction model is valid for the test printing system over a normal job period (at least one month according to the experiment from which the results in Table 2 were obtained). This indicates that the test printing system is stable and the obtained CLUT or the color gamut could be used repeatedly during a period of time.

The estimated color gamut of the test printing system is used in the inverse model, i.e., the color separation model. Figure 3 shows the framework of the color separation.
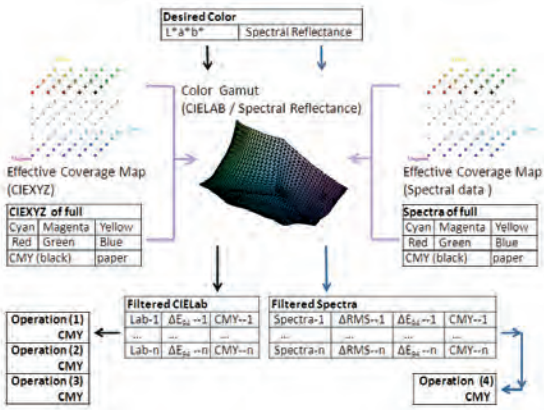

Figure 3: Framework of the inverse model; from color coordinates to reference CMY ink combinations

As soon as the color gamut is estimated by the color prediction model, for a specific target color with certain CIELAB colorimetric values inside the gamut we search through the gamut of the test printing system in CIELAB space. By setting a rough tolerance scope around

the desired CIEL, a* and b* values respectively, a list of CIELAB values close to the target color is obtained. The ink combinations corresponding to the listed CIELAB values and the ΔE_{94} color difference to the target color are also recorded.

Different operations are designed to select different ink combinations to reproduce the desired color, see Figure 3. For simplicity, we shorten the data collection (the listed CIELAB value, ΔE_{94} color difference between the listed CIELAB value and the desired CIELAB colorimetric values, ink combination) to (Lab, ΔE_{94}, CMY).

Operation (1): Sort the obtained list of (Lab, ΔE_{94}, CMY) along the column "ΔE_{94}". Pick the first three rows that have the smallest ΔE_{94} - these three values correspond to the three reference CMY combinations. Take the average reference coverage values of these cyan, magenta and yellow respectively as the final ink combination.

Operation (2): Select the (Lab, ΔE_{94}, CMY) having the smallest "ΔE_{94}". The corresponding ink combination CMY is considered to give the desired color in the printing system used.

Operation (3) aims at saving ink: Set a tolerance for the color difference, for example $\Delta E_{94} = e$. Pick out all the groups of (Lab, ΔE_{94}, CMY) with ΔE_{94} less than e.

Choose the one with least ink consumption (the sum of cyan, magenta and yellow). If there are several combinations giving the same low ink consumption, choose the one with the smallest ΔE_{94}.

For a desired color with a specific spectrum, a search is executed through the gamut of the printing system with spectral data. By setting the tolerance root mean square of the spectral difference $\Delta RMS = 0.1$ and the tolerance color difference $\Delta E_{94} = 3$, a list of spectra is obtained together with their corresponding ink combinations giving both $\Delta RMS < 0.1$ and $\Delta E_{94} < 3$.

Operation (4) deals only with spectral data: Pick 3 groups of (spectrum, ΔRMS, ΔE_{94}, CMY) that give the smallest ΔRMS and ΔE_{94}; a smaller ΔRMS has priority over a smaller ΔE_{94}. Then take the average of the respective cyan, magenta and yellow values, which gives the final reference ink combination.

Since both *operation* (3) and *operation* (4) use threshold values for ΔE_{94} or for both ΔRMS and ΔE_{94}, it might turn out that all the candidates during the search are beyond the threshold limit. In this case, *operation* (3) is replaced by *operation* (2). Similarly *operation* (4) should take the group of (spectrum, ΔRMS, ΔE_{94}, CMY) that gives the smallest ΔRMS.

4. Experiment and results

The inverse model, i.e., the framework shown in Figure 3, is executed using 416 target colors represented by both CIELAB and spectral data. These target colors are created from real measurements of previous random prints to make sure that the data used in the experiment for the inverse model are inside the color gamut of the printing system used. The experimental set-up is illustrated in Figure 4.

The color gamut used is constructed using the same effective coverage maps and color records of full tone primary and secondary colors that were produced or used in the calculations corresponding to Table 2. All the operations introduced in Figure 4 are executed according to the desired input color. *Operation* (3) is carried out twice with two different color tolerance differences, ΔE_{94} (equal to 1 and 2 respectively). For each desired color, ink separations are calculated from different operations which are denoted by CMY1, CMY2, CMY3-1, CMY3-2 and CMY4 in Figure 4. They are printed using the same printing system and measured.

The measured data of the real printed colors using the resulting separation are compared with the desired color values. This comparison is marked by the dashed double headed arrows in Figure 4 and its results are shown in Table 3.

Figure 4: Experiment for evaluating the inverse model; from color coordinates to reference CMY ink combinations

Recall, that *operations* (1) to (3) are for the inverse model dealing with CIELAB values, and *operation* (4) is for the inverse model dealing with spectral data. We consider and compare the ink consumption during the inverse model dealing with CIELAB data but not with spectral data because in the latter case it is of higher priority to find out the CMY ink combination that gives the closest spectrum (smallest ΔRMS) to the desired one.

Table 3: Comparison between the measured values of the real printed colors using the color separation resulting from the model and the desired input color values, based on both CIELAB and spectral reflectance

416 Colors with CIELAB & 416 Colors with spectral data	ΔRMS		ΔE_{94}			Ink Saving (%)
	Max	Mean	Max	Mean	> 4	Compared to *operation* (2)
Operation (1)	×	×	4.70	1.70	4	- 0.1
Operation (2)	×	×	4.70	1.62	6	0
Operation (3) with color difference tolerance $\Delta E_{94}< 1$	×	×	5.07	1.66	6	3.33
Operation (3) with color difference tolerance $\Delta E_{94}< 2$	×	×	4.86	1.89	11	7.01
Operation (4) with the limitations ΔRMS < 0.1 and $\Delta E_{94} < 3$	0.2096	0.0669	4.60	1.80	12	×

In order to estimate the ink savings, we take the ink consumption calculated from *operation* (2) as the reference since *operation* (2) is designed to select the CMY ink combination that gives the smallest color difference (ΔE_{94}). The ink saving is calculated by equation [7]. Ink consumption refers to the sum of the ink requirements of all the 416 color patches.

A negative result means spending more ink than that by *operation* (2) while positive result means the opposite.

$$ink\ saving = (reference\ ink\ consumption - ink\ consumption) / reference\ ink\ consumption \qquad [7]$$

The results from operations (1), (2) and (3), show that outcomes of *operation* (1) are almost the same as those of *operation* (2), looking at both the color difference between the measurements and desired CIELAB, and ink consumption. The ink saving is 0 for *operation* (2) because it is compared with itself in this experiment.

Operation (3) is performed twice using different tolerance color difference ΔE_{94} in the inverse model, resulting in different ink consumption requirements, as expected. Using the color difference tolerance in the inverse model, ink saving is shown to be possible compared to *operation* (2), and the larger the tolerance the smaller the ink consumption. Ink is saved by 3 % if the tolerance is 1 and by 7 % if the tolerance is 2. By checking the color differences between the measurements of the prints obtained from the inverse model and the desired colors, we can see that, even though *operation* (3) using a color difference tolerance of $\Delta E_{94} = 2$ gives a smaller maximum color difference (4.86 in Table 3) than that of *operation* (3) using a color difference tolerance of $\Delta E_{94} = 1$ (5.07 in Table 3), it gives a larger mean color difference and more color difference larger than 4. Hence, there is a tradeoff between less ink consumption and accuracy of the inverse model.

The outcome of ink combination or color separation for a desired color depends not only on the color gamut of the printing system used, which is built by the forward model in our paper, but also on the printing system itself. Errors during printing and measurement are inevitable. Therefore, it is reasonable to compensate the printing and measurement errors by setting a tolerance in the inverse model. A suitable tolerance can be determined for different printing system by experiments. For the printing system used in this paper, according to the results in Table 3, we consider a color difference tolerance $\Delta E_{94} = 2$ to be acceptable.

When applying the inverse model in spectral form, we use the ink combination that gives the closest spectrum to the desired one under the limitation that the ΔRMS should be less than 0.02 and the corresponding ΔE_{94} should be less than 3. As mentioned before, a larger ΔRMS does not correspond to a larger color difference ΔE_{94}, or vice versa. For example, the maximum ΔRMS obtained in Table 3 for *operation* (4) is 0.0349 with a corresponding color difference ΔE_{94} in this printing system of 2.02 while the obtained maximum color difference ΔE_{94} for *operation* (4) in Table 3 is 4.60 with a corresponding ΔRMS of 0.0231. Therefore, the double limitation ΔRMS < 0.02 and $\Delta E_{94} < 3$ is reasonable and necessary.

Since the ΔRMS does not give detailed information on the difference - e.g., it is hard to say exactly what the negative effects are if ΔRMS changes from 0.0231 to 0.0349 - we look at the corresponding color difference ΔE_{94} to evaluate the performance of the inverse model using *operation* (4).

The color difference ΔE_{94} between measured and desired data exhibits a maximum value of 4.6 and a mean value of 1.8; 12 of 416 samples have a ΔE_{94} larger than 4. Comparing this with the results from *operation* (3), the differences obtained from *operation* (4) are satisfying.

Note, that the measured spectra of the same white patch at different points in time using the same spectrophotometer (BARBIERI Electronic Spectro LFP RT, D65, 2° observer) show a difference of $\Delta RMS=0.0092$. Regarding the ΔE_{94}, two patches with exactly the same ink combination but located differently on the same sheet of paper were measured, and the color difference ΔE_{94} between them was approximately 1.1. Therefore, the average errors presented in Table 3 are within the noise level of the printer and measurement system.

5. Conclusions and discussion

In the experiments, when processing using CIEXYZ values, creating the color gamut consisting of more than one million different ink combinations took around 40 seconds using Matlab on an old regular PC (manufactured around five years ago). Based on the created color gamut using CIELAB values (converted from the predicted CIEXYZ values), without putting much effort on speeding up the inverse operation process, the color separation of a specific desired color took around 0.1 second. Notice, that using another programming language, such as C++, on a faster computer could greatly reduce this time cost.

The time cost and memory requirements for the creation of the same size (more than 1 million combinations) color gamut using spectral reflectance were more expensive compared with those based on CIELAB values (CIEXYZ). However, as discussed before, the color gamut obtained could be used repeatedly in the color separation model during a time period. This means that, although time and memory cost for the spectral color gamut is high, once a thorough color gamut is created it can be used over a period of time.

The color separation is fast no matter if dealing with CIELAB values or spectral reflectance. Nevertheless, a sparse color gamut containing fewer samples also helps to shorten the time. In our experiment, a sparse color gamut based on spectral reflectance (containing 9261 nodes with steps of 0.05 in reference coverage for CMY, respectively) was created within 3.2 seconds. In the corresponding color separation, an approximate search over this sparse gamut was executed in advance to narrow the searching area in the gamut. Thereafter, a fine search followed over this narrow area to produce the ink combination for the desired spectrum. Using this strategy, the time cost of the color separations for 416 desired spectra was around 40.1 seconds.

To make the approach applicable and executable in real time for any input image, a profile could be created prior to the separation by constructing an array containing as many CIELAB values as possible and their corresponding ink combinations. After this array or profile has been obtained, we can just look up any color or spectrum and find the corresponding CMY. Based on an efficient computer programming language, for example C++, searching and processing using a hash table for millions of inputs can take less than 1 second (Alcantara et al., 2009; Preshing, 2011).

In practical color separation for printing, the targets are the colors present in an image (at each pixel of the image) rather than a number of individual colors. The probability is high that some of the involved colors are beyond the color gamut of the printing system. Although such cases were not considered in the proposed color separation model, it is possible to include this in the future in our color separation model by using color gamut mapping strategies (Urban, Rosen and Berns, 2008; Farup, Gatta and Rizzi, 2007).

An inverse procedure for color separation in color printing was introduced and implemented out in this paper. The proposed forward color prediction model and separation models are executable for colors represented by either CIELAB or spectral data. Ink saving is also considered in the separation by setting a certain tolerance for the ΔE_{94} color difference. The introduced forward and inverse procedures using colorimetric values or spectral reflectance are stable, simple and gives acceptable accuracy. They show potential to be used in color management in practical printing systems.

In our tests we have also attempted to replace CMY (cyan on magenta on yellow) by black in the bitmaps in order to investigate whether or not we can apply UCR (Under Color Removal) or GCR (Gray Component Replacement) in our models. Unfortunately, we noticed that our test printing system suffers from mis-registration of the black ink resulting in a color shift. Therefore, the results of the forward prediction model were not as good as anticipated. Research on CMYK color prediction based on our simple model will be continued in our future work either by using a printing system with higher precision or suitable compensation of the bitmaps prior to printing.

The forward prediction model is also being studied for application to multi-channel printing. For example, CcMmY printers utilize lighter magenta and lighter cyan in addition to the traditional cyan, magenta and yellow inks. Based on our experiments, the prediction accuracy using our simple model for the combinations of cyan, lighter cyan, magenta and lighter magenta (meaning four inks) should be acceptable. The mean and maximum color differences ΔE_{94} obtained are 1.12 and 3.47 respectively over 590 CcMm print samples. Future work is planned to test and improve our model on more complex ink combinations. We believe that additional color inks bring new challenges and also possibilities to be considered in the proposed color separation model.

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Interactive and social - A study of Swedish online newspapers

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Abstract

This study explores how established media services such as online newspapers meet the increasing popularity of social media. A case study of *Aftonbladet.se* was conducted in order to understand how one of the leading Swedish online newspapers uses social media and relates to this new media form. The most important evidence of the influence of social media on *Aftonbladet* is apparent in the way its role as an online newspaper is expressed: "*Aftonbladet* wants to be a meeting place (…). The whole experience builds on interactivity and community". The case study results of *Aftonbladet's* social media use are interesting because they offer indications of Sweden's leading online newspaper's take on new media development and more specifically of the reasoning within the newspaper organization around the changing user relations.

Keywords: media, interactivity, media convergence, participation, users

1. Introduction

During a typical day in Sweden in 2010, among people aged 9-79 years, 19 % read online newspapers and 35 % used social media (Nordicom, 2011). Social media is here defined as a social network/community/discussion forum/chat group or blog. Social media have become increasingly popular and compose a growing part of the total daily media use. This development raises the question of how established media institutions such as online newspapers meet this new competition regarding their audience's time. Accordingly, Nygren and Zuiderveld (2011) state that there is reason to discuss the roles media companies will play in the network society.

Previous research indicates that the amount of interactivity offered by Swedish online newspapers websites has increased since the mid-2000's (Karlsson, 2010; Nygren and Zuiderveld, 2011). However, Chung (2008) has shown that online audiences do not extensively use interactive features. In a Swedish context, Bergström (2008) also found that the general audience shows little interest in participating in creating content on news si-tes. The same study also found the active group to be small, as only 16 % had commented on a news article during the past 12 months. According to Picard (2010, p. 375), the use of many social media and new technologies in traditional media online in most cases only serves 5-20 % of the entire digital audience.

Swedish media companies have been claimed to lack strategic plans (Alström and Hedman, 2008; Picard, 2010). According to many media company representatives it is no longer possible to plan more than six months ahead, due to the continuous technological and behavioral changes (Alström and Hedman, 2008). Although possibly lacking strategic plans, or perhaps as a result of this, Swedish media companies have been early in implementing new innovations. Deuze, Bruns and Neuberger (2007) point out the Scandinavian countries as suitable for identifying emerging practices in the area of participatory media-making. Altogether, several aspects of previous research indicate a need for further research on social media use and strategies of Swedish online newspapers.

2. Research questions and methods

This paper will present an overview of the social media use of Sweden's leading online newspapers. The study has a newspaper perspective and its main focus is on the social media use for conversational interaction on online newspaper websites. The overarching research question of this study is:

How do Swedish online newspapers respond to the increased significance of social media?

In order to answer this, the following underlying questions are to be answered:

1) Which social media features do the most visited Swedish online newspapers have on their websites?

2) In what ways does the most visited Swedish online newspaper Aftonbladet *use social media for conversational interaction with its users, and what problems are encountered when a mass media company engages in social media?*

3) In what ways have social media affected editorial content?

4) How and to what extent does Aftonbladet *work strategically with social media?*

A mapping of the social media features on the websites of the five most visited Swedish online newspapers *Aftonbladet*, *Expressen*, *DN*, *SVD* and *GP* (Orvesto, 2011) was conducted in spring 2011. The weekly reach of the studied online newspapers can be seen in Figure 1.
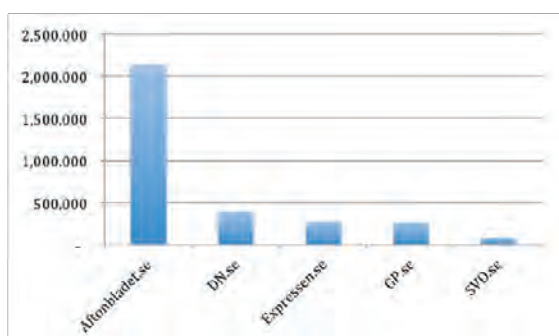

Figure 1: Weekly reach per online newspaper in Sweden in terms of number of individuals (Orvesto, 2011)

The initial study was followed by a richer case study with focus on the social media use of the evening news-

paper *Aftonbladet*. The website *Aftonbladet.se* was chosen as a case study object partly because it is the most visited Swedish online newspaper (Orvesto, 2011) and partly because of the media company *Aftonbladet's* past record of being early in introducing new technology and services. An example of such early moves by *Aftonbladet* could be seen when the online newspaper responded to the increasing popularity of social media services such as Facebook and YouTube abroad by offering an own community (Widell, 2008) and video sharing service (Vidlund, 2007) for its users in 2008.

The *Aftonbladet* case study was also conducted in spring 2011 and is based on a review of *Aftonbladet's* social media use on its website and two interviews with *Aftonbladet* staff members. The case study review examines the ways in which social media features are used, primarily on the website but also on the Facebook pages. In the interviews, questions were raised about how *Aftonbladet* works with social media in a strategic sense: Have social media affected the journalistic work or the role of the online newspaper? How is the development of social media features on the website planned, given the fast changes in digital media? How and why does the online newspaper *Aftonbladet* use social media? Is user generated content used editorially? How is the value of social media features evaluated?

This study's focus on one case makes the generalizability of the results limited. Additionally, not many online newspapers have resources and consumer base similar to *Aftonbladet*. Therefore, *Aftonbladet* is not typical for Swedish online newspapers. However, it's position as one of the leading online newspapers makes it an interesting case.

3. Social media and interactivity

The concept *social media* is currently not consistently defined in academic literature. Various ways to describe the concept have been presented, but the absence of an agreed-upon definition leads to a vagueness of the term. Generally, some sort of user participation or interaction is central to the concept. Social media typically allow many-to-many communication and often combine different features of previous computer mediated communication forms (Hogan and Quan-Haase, 2010). Currently, social media may include all of, or different combinations of the following digital features: blogs, social networking sites, forums/chat rooms, media sharing sites, podcasts, videocasts, livecasts, wikis, social news, social games, social bookmarking, collaborative project spaces.

The concept social media may also be understood by individually defining the composing terms *social* and *media*. The concept *media* can be interpreted convention-

nally. However, the term *social* in social media is problematic, since all media have a social element (Hogan and Quan-Haase, 2010). Still, *social* can in this context refer either to *the situation*, or to *the effects* of social media. In the former sense, it is meant that the user is *being social,* whereas the latter sense implies that social media are being used to *strengthen or maintain social bonds* between users.

As opposed to traditional mass media (print, radio and television) social media enable extensive many-to-many communication. Furthermore, social media can be used to support and/or manage social relations and the content is typically produced by its users and published online. However, despite all these social affordances, social media may also be used in a private, closed and non-social manner. In this article, the concept social media is understood in a technology-oriented sense as *web-based applications, enabling many-to-many communication that is published online.*

What is in this article described as *social media features* are by some researchers instead referred to as *interactive features*. For instance Deuze (2003, p. 214) makes a subdivision of interactive options on news websites into three types: *navigational interactivity*, which refers to site navigation affordances (such as menu bars and links, for example); *functional interactivity* that allows users, at least to some extent to participate in the production process of the site by interacting with producers or other users (for example through email-links to journalists and moderated discussion lists); and *adaptive interactivity*, which means that the users' actions have consequences on the site content (such as allowing upload of content, offering chatrooms, etc.).

Since this study of social media use in online newspapers has its focus on social media related interactivity *adaptive* and *functional interactivity*, in Deuze's (2003) terms, are key features. However, while mapping the social media use at the online newspapers' websites it was found that this classification was not suitable as so-me of the social media related features were only indirectly related to the interactivity classifications presented by Deuze (2003). Deuze's model is from 2003, and now - ten years later - the interaction found on on-line newspapers looks somewhat different. In the final part of this paper, the results obtained in the *Aftonbladet* case study are therefore used to discuss what Deutze's classifications mean today and also to suggest how they could be modified in order to better reflect current practice.

Consequently, Deuze's interactivity model is not used in this study. Instead, the more open expressions *social media features* and *social media related features* are used to describe the affordances studied at the Swedish online newspapers. In this context, *social media features* include, e.g., commentary features allowing users to publicly comment on published articles. *Social media related features* on the other hand, include hyperlinks to external social media platforms and information about social media activities, etc.

4. Traditional media and social media

4.1 The implementation of social media features in the publishing context

This section presents some previous research on traditional media's use of social media and user generated content (UGC) relevant to this study. Since this study has its focus on online newspapers, the emphasis of this section is on this industry.

A study of user participation on American and European (but not including Swedish) newspaper websites by Rebillard and Touboul (2010) shows that the websites studied did little to invite page visitors to participate. Only one in four of the studied newspapers published users' reactions on their website and the authors concluded that their study supports the claim of journalists and editorial staff maintaining their domination and control in news media, and thus contradicts the conception of a digital revolution in journalism. (Rebillard and Touboul, 2010).

In his study of the British tabloid *The Sun* and the Swedish online newspaper *Aftonbladet.se,* Örnebring (2008, p. 783) finds that the only UGC that was given similar status as material produced by the news organization was user photos of breaking news events. Holt and Karlsson (2011) discover tendencies of traditional patterns even in citizen media production. For instance, their study shows that much of the "citizen" contribution can actually be traced to professional journalists, lobbyists and organizations. Furthermore, such professional contributions are privileged in terms of visibility (Holt and Karlsson, 2011). In an overview of previous research, Bergström (2008, p. 64) finds that user parti-cipation mostly means feedback from users to producers, not content creation. All these studies indicate that the way content is produced and presented in online newspapers has not yet changed remarkably. Other research states that news organizations are still working out whether and how to integrate user participation within existing norms and practices and how to implement and utilize such features (Hermida and Thurman, 2008, p. 9; Chung, 2007, p. 56). Chung (2007, p. 57) also describes that several site producers had explored incorporating interactive features that facilitate interpersonal communication, but had then drawn back from fully incorporating such features because the conversational environment was difficult to control.

4.2 Factors affecting social media use

On one hand, news organizations have been criticized for conservatism and slow adoption of interactive publishing techniques (Bergström, 2008, p. 65). On the other hand, criticism has also claimed the opposite, that news media should reassess their use of social media and consider their actual benefits for journalism and the business for journalism (Picard, 2010, p. 375).

Different studies have considered factors affecting whether social media become parts of the strategic work or published content within online newspapers. Regarding problems and concerns related to social media features, the following aspects are commonly mentioned in earlier research: quality and legal issues, costs, increased workloads and fear of being marginalized. The concern about *the quality* of the UGC is commonly raised as a problem with social media features (Bergström, 2008, p.

65; Chung, 2007, p. 56). *Legal issues* are also considered important. In Sweden, the editor-in-chief is legally responsible for what is published on the website, including the UGC (Bergström, 2008, p. 65). The fear that these features will lead to an *increased workload* (Bergström, 2008, p. 65; Chung, 2007, p. 56) typically refers to the need of quality control, editing and moderating of UGC. Moderating is considered important to keep the quality of discussions high (Paulussen and Ugille, 2008, p. 38; Chung, 2007, p. 56; Hermida and Thurman, 2008, p. 350). *The costs* for implementing and maintaining social media features are also declared a problem (Bergström, 2008, p. 65; Chung, 2007, p. 56; Hermida and Thurman, 2008, p. 352). Hermida and Thurman (2008, p. 352) identify the costs involved with audience participation - especially for moderating - to be one of the reasons smaller news organizations had *not* implemented such features. Lastly, the *fear of being marginalized* is identified as a factor that seems to affect decisions on social media use. A study of British online newspapers' integration of UGC similarly shows that fear of being marginalized by user media is one reason for an increase in adopting such features (Hermida and Thurman, 2008, p. 347). In a recent Swedish study, Nygren and Zuiderveld (2011, p. 83) similarly note a fear among online newspapers of not keeping up with trends, of doing wrong or missing important arenas.

Despite the perceived challenges described, previous research also shows that there is a general awareness of the importance of UGC and user participation (Paulussen and Ugille, 2008, p. 35; Chung, 2007, p. 50). Regarding the value of UGC, user contributions are sometimes used by professional journalists as sources for stories (Hermida and Thurman, 2008, p. 352). However, Hermida and Thurman (2008, p. 354) suggest that in the longer term, established news organizations are shifting towards the retention of a traditional gate-keeping role towards UGC, and conclude that this finding is in line with *"the risk-averse nature of newspapers and reflects editor's continuing concerns about reputation, trust and legal issues"*.

4.3 User participation in online news media

According to Bergström, comments on news sites are typically written by frequent online news users (2008, p. 76) who tend to be interested in new technology (2008, p. 72). Still, the most frequent commentators consider commenting facilities important to a lesser extent than other groups do (Bergström, 2008, p. 72).

Bergström (2008, p. 65) states that there has been little evidence of the interest in these services among the general news audience. The findings presented by Bergström (2008, p.76) indicate *"little general interest in the kind of participation demanding more activity and creativity from the users when it comes to news sites"*. From their assessment of past work on online news consumption, Mitchelstein and Boczkowski (2010, p. 1086) state that during the

past few years the user habits of online news consumers have not changed drastically, despite the increase of sites and technologies.

As mentioned in the introduction, according to Picard (2010) only 5-20% of the total audience are served by social media and services based on new technology in news media. Picard (2010, p. 372) also states that heavy users of media tend to be socially, politically or economically active individuals and typically represent about 15-20 percent of the population. A study by Larsson (2010) confirms that the most active users of Swedish online newspapers' interactive features tend to be socially engaged. Interestingly, previous research shows that the contributions made by active users are appreciated by more passive users (Bergström, 2008, p. 76; Larsson, 2010, p. 1192).

An example from the television industry shows that viewers of user generated videos broadcast by traditional media find the content quality to be crucial for the experience. The conclusion is that participation is not enough, media consumers demand high quality also in user generated content. (Carpentier, 2009)

4.4 Jenkins' convergence theory and challenges for social media

Jenkins' (2006) theory describing convergence culture as a transition period is relevant when studying the use of social media by previous media forms, and may help understand the development occurring around social media. Jenkins maintains that this period is characterized by unclear directions and unpredictable outcomes (Jenkins, 2006, p. 11). Furthermore, Jenkins (2006, p. 16) emphasizes that convergence refers to a process, not an end point and states that convergence involves a change both in the way media is produced and in the way media is consumed. One of the central characteristics in Jenkins' idea of convergence culture is *"increased contact and collaboration between established and emerging media institutions"*. (Jenkins, 2006, p. 274)

Regarding user involvement, Jenkins presents the concept of "affective economics" used in marketing research. It is strongly related to the matter of companies' social media use. In the theory of affective economics, engaged consumers are believed to be the most loyal, and an ideal consumer is described as active, emotionally engaged, and socially networked (Jenkins, 2006, p. 20).

Related to the question of quality of UGC mentioned above, in recent media discourse two main standpoints can be recognized regarding the general impact of social media. On one hand, social media are regarded as revolutionary and democratizing tools because they offer anyone the possibility to publish their own thoughts and ideas (Benkler, 2006; Gillmor, 2004). On the other

hand, criticism of Internet's democracy effects is also raised. For instance, Jenkins states that there is a tendency to assume grassroot media to be resistant to dominant institutions, and also to see *"democracy as an 'inevitable' outcome of technological change"* (Jenkins, 2006, p. 294). Challenges of participatory culture mentioned by Jenkins (2006, pp. 292-293), include racist and sexist contributions and deep-rooted hostility between different groups. In response to these tendencies, Jenkins

advises not to ignore the ways in which our current culture falls short on democracy and diversity (2006, pp. 293-294). Instead, he states a need to identify and try to resolve these challenges and to be attentive to ethical dimensions. Such challenges have recently been highlighted by Swedish online newspapers. This will be described in the next section where the social media features found on the studied online newspapers are elaborated.

5. Social media features on Swedish online newspaper websites

This section gives an overview of social media features and social media related features on the five most visited Swedish online newspapers: *Aftonbladet, DN, Expressen, GP* and *SvD*. The reason for including this overview is the ephemeral nature of new media features online. Both the features offered and their uses are likely to evolve continuously. Therefore, this part both serves as an overview and a snapshot of the social media features and related services available on the studied online newspapers in the spring 2011.

The studied Swedish online newspaper websites contained several social media features and social media related elements. The social media related elements included references to external social media features and information about interaction occurring around the content. On their main pages, all five online newspapers studied presented a box displaying the most commented and/or most read articles. One of the social media elements found during the mapping was the article commenting feature. Although the layouts and styles of the websites studied varied somewhat, the social media features and the social media related elements numbered

from 1 to 5 (see Figure 2) were used by all of the studied online newspapers:

1. The number of Facebook recommendations made to the articles. Articles that allowed users to comment in a commentary feature sometimes also showed the number of comments made to the article, next to the Facebook recommendation information.

2. Links to blog posts about the articles were published in the article fields.

3. Facebook recommend buttons, by which Facebook users could easily share the article with their Facebook friends.

4. Links for article sharing via external social media platforms e.g. Facebook or Twitter.

5. User comments to an article, and the possibility to add a comment.

6. Most online newspapers also displayed the number of comments made to the articles, along with the links to these.

Figure 2:
A typical Swedish online newspaper website containing most of the social media related elements marked in the screenshot (Aftonbladet.se, 2011)

Comparisons of the studied online newspapers' uses of social media related features are presented in Tables 1 and 2. The evaluation shows that all five online newspapers offered sharing of articles via Facebook. Even though email is not regarded as a social media in this article, it is included for comparison.

Content sharing was also offered for external social media services such as Twitter, the social bookmarking service del.icio.us and the Swedish link sharing website Pusha. Besides the options seen in Table 1, *Expressen,* as the only one of the five online newspapers offered a long list of possibilities for sharing the article with links to Bloggy, Digg, FriendFeed, MySpace and other services. However, overall the similarities in the social media related features offered by the studied online newspapers were striking. This finding can be compared to previous research on factors affecting social media use, which has indicated *fear of being marginalized* as an important reason for news organizations' implementing of new features.

Table 1: Possibilities for the online newspaper consumers to share and save article content

Online newspaper	Share by email	Share on Facebook	Share on Twitter	Share on Pusha	Add to del.icio.us
Aftonbladet.se	X	X	X		
Expressen.se	X	X	X	X	X
DN.se	X	X	X	X	X
SVD.se	X	X	X		
GP.se	X	X		X	

At the time of the study, *Aftonbladet* and *SvD* both belonged to the media company Schibsted and used the Content Management System (CMS) Escenic. *Expressen* and *DN* were parts of the Bonnier media company and used EPiServer and Bink respectively, whereas *GP* was owned by the media company Stampen and used Polopoly. The selection of affordances offered by the online newspapers shown in Table 1, indicates that the ownership, rather than the CMS used did impact which features were offered. This observation implies that some differences may be explained by strategic decisions made on corporate level. However, in contrast the Facebook features offered show significant similarities based on genre rather than ownership. Table 2 shows that all of the five online newspapers allowed article comments, which is remarkable if compared to the results of Rebillard and Touboul (2011), showing that only one in four online newspapers published users' reactions on their websites.

Table 2: An overview of online newspapers' use of certain social media related features

Online newspaper	Comment	Facebook like box	Facebook interaction	Links to tweets	Links to blog posts
Aftonbladet.se	X	X	X		X
Expressen.se	X	X	X		X
DN.se	X				X
SVD.se	X			X	X
GP.se	X				X

Only the evening paper based online newspapers *Aftonbladet* and *Expressen* used the "Facebook like box"(see Figure 3) and the "Facebook interaction". The like box had a hyperlink to the newspapers' Facebook page, a "Facebook like button" and information about the number of people liking the page.
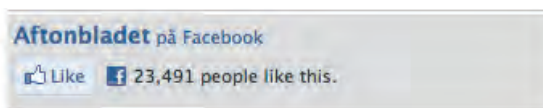

Figure 3: The "Facebook like box" on Aftonbladet.se's starting page (Aftonbladet.se, 2011)

Users being logged in to Facebook while visiting the online newspaper could see a personalized box showing news content shared by the users' Facebook friends; here called the "Facebook interaction box". Table 2 shows that all five online newspapers published links to blog posts written about their articles and enabled user comments to at least some of their content. Some of the online newspapers allowed anonymous comments whereas others demanded some form of registering in order to use the feature.

The case study and the mapping were both conducted in the spring of 2011. After the mass murder incident in Norway, in July 2011, a major publicist debate arose on the problems with racist attacks and other hostile behaviour in the commentary features of Swedish online newspapers. Although discussions about the commentary feature had been ongoing prior to these events, they now became intensified. This public debate resulted in a temporary closing down of the commentary features of many major online newspapers. Having been closed down for a few weeks, *Aftonbladet.se* re-launched its commentary feature in September 2011 with a mandatory Facebook login for users wishing to post comments. The acting manager for reader contribution at *Aftonbladet.se* found the new system to have improved the debate climate (Westin, 2011). This development confirms that the concern about the quality of UGC emphasized in previous studies and by Jenkins (described in the previous section) still applies.

6. *Aftonbladet's* use of social media

6.1 Description of *Aftonbladet.se's* social media features

As was seen in the previous section, the studied online newspapers were in many ways remarkably similar in terms of their social media use. The following separate description of *Aftonbladet.se's* social media use is more detailed than the comparative mapping presented above.

In spring 2011, *Aftonbladet.se* used different social media features on its website. Four such features - commentary, *Debatt-live* (live debate), *Cover-It-Live* and *Superlive* - are described in this section. Most of the articles on *Aftonbladet.se* allowed commentary, and this feature was placed in a box below the article (see Figure 4).

Figure 4: Screen shot that shows the graphic user interface for the commentary feature on Aftonbladet.se (2011). The header says "What is your opinion?"

The comments made were published in a thread, visible for all page visitors. However, in order to add a comment the user had to register with an email address. It was possible for *Aftonbladet.se's* editors to follow discussions and delete remarks that were believed to spoil the discussion or break the rules. However, the majority of the moderating was done by the external company *Interaktiv Säkerhet* (Interactive Safety) that post-moderated all comments. In spring 2011, about 6 000-7 000 comments were made daily on the website. Overall, politics and sports raised most comments.

According to one of the staff members interviewed at *Aftonbladet*, they had *"self-evident rules such as that one is not allowed to degrade ethnic groups, threaten anyone, etc."*. But they also tried to keep the discussions on a reasonable level *"so that one criticizes opinions and not people"*. The respondent had also learned from experience that the discussions in the user comments improved when the journalists were active and asked the commentators to keep a proper tone. (Interview A, 2011)

In 2011, *Aftonbladet.se* introduced the feature *Debatt-live*. Every weekday a topic was raised for discussion, and the users were encouraged to participate with questions and comments. The matters discussed in *Debatt-live* were typically related to articles about some current issue. A live debate might consist of a debate between two experts with different standpoints and a moderator lifting users' questions and comments into the discussion during the debate. Alternatively, the users were invited to discuss a topic together with an invited guest or expert and thus contribute more actively to the discussion.

Aftonbladet.se also introduced a *Cover-it-live* feature in which a journalist followed a course of events live whereas the users were invited to participate by asking questions or making comments. This feature was used in different ways: users could be invited to chat with experts, interact with reporters or use the chat as a tool for referencing. In March 2011, *Cover-it-live* sessions were held to report news from the Fukushima nuclear power station accident in Japan (see Figure 5). In this case, a journalist followed news about Fukushima while reporting these in a live chat. Meanwhile, users could ask questions and share information and links in the same chat window.

Figure 5: This screen shot shows an ongoing Cover-it-live session on Aftonbladet.se, March 17, 2011

The *Superlive* feature was introduced on *Aftonbladet.se* in 2010 and was used to present major events live. During the first year, it covered the Royal wedding in Stockholm, the Swedish Idol finale, the Nobel prize banquet, the parliamentary election and other media events. During *Superlive* events, the whole *Aftonbladet* website was topped with live TV, chats, Twitter feeds, *Cover-it-live* coverage and interactivity. *Superlive* may be described as an extended version of *Cover-it-live*. The interactive aspect of *Superlive* was emphasized in one of the interviews (Interview A, 2011): *"Much focus is put on live feeling and contact with our readers"*. *Superlive* aimed to offer a common experience for the users, and social aspects were prominent.

In addition to the printed newspaper *Aftonbladet*, its mobile site and the Aftonbladet.se website, at the time at

of the study, the media company *Aftonbladet* also held two major social media platforms; the community *Snack*, and the blog service *Aftonbladet Blogg.* However, both these services were closed down in June 2011. The community *Aftonbladet Snack* was introduced in the spring 2008, with the goal to aggregate UGC from *Aftonbladet's* blogs, its forums and the video sharing service *Mitt Klipp (My Clip),* which was closed down early in 2011. The ambition of the community was to create stronger bonds to the users and make them increasingly participative

(Widell, 2008). The *Snack* social network service allowed its users to create a profile page, send/receive messages, discuss, and share photo/video content. The blog service offered the general public to create and run a blog but was also used by reporters, chroniclers and invited guest bloggers. (Interview A, 2011)

Moreover, the media company *Aftonbladet* also had external activities on Facebook, i.e. the *Aftonbladet* Facebook page (see Figure 6) was in-troduced in 2010.

Figure 6: The Facebook page of Aftonbladet (www.facebook.com/aftonbladet, 2011)

Wall postings made by *Aftonbladet* typically consisted of a question connected to an article link to *Aftonbladet.se*. The link comprised a header, an image and a short text describing the news article. In spring 2011, *Aftonbladet* typically posted content on the Facebook page twice a day during week-days. Responses to these postings, in terms of comments and likes varied. Wall postings made by page visitors were intermittent and overall non-editorial postings consisted of possible news topics, event recommendations and questions about *Aftonbladet's* digital features and services.

Aftonbladet also maintained separate Facebook pages for several of its editorial departments. Furthermore, some departments as well as some individual employees used Twitter to communicate, more or less representing *Aftonbladet*. These activities were based on individual initiatives and the media company *Aftonbladet* had no general policy for Twitter use. At the time of the interviews, the users were believed to primarily use Facebook, whereas Twitter was considered to be narrower. (Interview A, 2011).

6.2 Company insights

Two interviews made at *Aftonbladet,* with the acting manager for reader contribution and a media analyst, provided additional information about the social media fea-

tures described earlier in this chapter. The interview results complement the analysis of function and content presented earlier. They provided insights into the discussions, ideas and experiences surrounding the social media use within the media company *Aftonbladet* in terms of motivations, identified problems and goals. The main interview conclusions are presented below, starting with what are considered to be the most interesting findings.

A central verification of the influence of social media on *Aftonbladet* was evident in the description of *Aftonbladet's* role as an online newspaper: *"Aftonbladet wants to be a meeting place, it could be in terms of comments or Cover-it-live coverage (…). The whole experience builds on interactivity and a sense of community".* (Interview A, 2011)

This identification was the result of a branding project and is thus closely related to strategic aspects of the company's social media work. In this study, this turned out to be a key description of how social media use was reflected upon within the media company *Aftonbladet*. In spring 2011, *Aftonbladet* had started to let go of its community-like services because *"it is not the role of Aftonbladet to directly compete with Facebook and YouTube".* Instead, it was decided that the online newspaper *Aftonbladet.se* would focus on what was identified to be its strength, professionally produced news content. (Interview A, 2011)

However, since people spend much time on Facebook, the importance of being mentioned there had been reflected on within the company. Further, it was believed that in the future much media activity would be centered on social media but without knowing exactly how. The question of how much *Aftonbladet* should do outside their own site had been raised. In general *Aftonbladet* wanted people to come to its own website, but the online newspaper had to some extent been forced to change that approach. At the time of the interviews, *Aftonbladet* used social media to drive traffic, get user contact and input, make inquiries, ask people of their opinions and strengthen the brand (Interview A, 2011).

At *Aftonbladet.se*, the traffic analyses comprises an important decision basis when assessing how to prioritize and how to place content on the website. The media analysts at *Aftonbladet* followed how different parts of the web-site were used over time, what types of articles generated the most comments and how the number of comments changed over time. Users' attitudes towards the interactive features were also studied. *Facebook Insights* is a service providing information about how the newspaper's fans act on Facebook, e.g., the share of fans interacting with each *Aftonbladet* post. The social media marketing software *Meltwater Buzz* was used to keep track of how the media company *Aftonbladet* and its products were being mentioned in social media. According to the media analyst interviewed, one way to quantify the value of activities in external social media services was to study the generated number of clicks on the site, but also in terms of premium services sold. (Interview B, 2011)

The commentary feature had become very successful and had exceeded all expectations. The acting manager for reader contribution at *Aftonbladet* (Interview A, 2011) said that it is evident that *Aftonbladet.se* has a lot of discussion on the site, but it could be debated if they should work more with raising the quality of the discussions or do this in a different manner. A focus group project conducted by *Aftonbladet* showed that users want to know what others think, even those not taking part in the commentary discussions. However, the same project also showed that too much fuss is detrimental for the experience. In terms of news production, the discussions in the commentary feature had given some

good cases and ideas leading to breaking news. There was at the time of the interview no systematic way of working with those examples, although it had been identified as a way of developing the service. Overall, social media were believed to have affected the journalism to some extent, but the changes were still considered rather small. (Interview A, 2011)

The interviewed manager highlighted that it is problematic for a mass media company to enter the social media arena, as it is not possible to start talking personally with everyone. Instead they have to find a middle way: *"At the moment Facebook works rather well for us, but if we start having five million readers there ..."*. This was considered challenging, as *Aftonbladet's* ambition was to be active, and not just use the Facebook page as a show window. (Interview A, 2011)

Regarding the rapid changes in technology developments and user behavior, the media company *Aftonbladet* tried to keep up with what happened, but also had some long-term thinking around how they wish to work (Interview A, 2011): *"Much is uncertain as behavioral patterns change quickly for media consumption and online activities. Furthermore, the constant introduction of new devices for media use also makes predictions complex"*. Moreover, the *Aftonbladet* Facebook pages were initially created by enthusiasts in the editorial staff and not based on strategic decisions. After some more or less successful efforts to try out new ideas, a need for guidelines started to emerge. This need also arose from the growth in number of users on the Facebook pages, which made it increasingly important to have some idea of how to act and what to do there.

However, the guidelines were still quite rudimentary and there were plans on continuing to sort out how to work with these aspects. Generally, the media company *Aftonbladet* had a tradition of testing things to find out how they turned out, whereas they today increasingly work with development projects and a more structured way of working and with proper goal statements. The condition is that they do not know how the development will go but work according to the way it looks right now, with the reservation that in two years it may look quite different. (Interview A, 2011)

7. Discussion and conclusions

7.1 Discussion structure

This concluding section is divided into five thematically arranged subsections, starting with *"Social media features on Swedish online newspaper websites"*, followed by *"Aftonbladet's use of social media for conversational interaction"*, *"The effects of social media on the online newspaper"*, *"A lack of long-term strategies?"* and finally *"Interactivity and social media in online newspapers"*.

One of the main findings of this study is that many of Jenkins' characteristics of convergence can be observed in the Swedish online newspapers' approach to and use of social media. Overall the social media uses of the studied online newspapers show little variation and still seem rather explorative. However, despite the resemblances, *Aftonbladet.se* seems to have taken its social media use one step further than its competitors by emphasizing the social function of news and journalism.

Aftonbladet.se offers several social media features closely connected to the journalistic content. Nevertheless, this study also confirms previous research stating that user participation on news sites is mainly limited to interpersonal communication between the users and does not significantly affect the editorial content.

7.2 Social media features on Swedish online newspaper websites

As described earlier, Rebillard and Touboul (2010) found that European and American online newspapers did little to invite users to participate and only sparsely published users' reactions. The continuous development occurring in online media practice makes asynchronous comparisons difficult and uncertain, and there may also be cultural variations. Nevertheless, the results of this study of Swedish online newspapers offer a rather different picture and indicate a development towards more interaction and increased use of social media features on the websites. The mapping of five major Swedish online newspapers and the *Aftonbladet* case study in particular, both show features supporting several levels of user participation.

The concept of social media can be understood as media used to support and manage social relations. However, the social media features found on the studied online newspapers' websites, e.g., the commentary feature, rather seemed to afford the act of *being social*. Yet, some of the social media related features such as the article-sharing feature for Facebook indirectly supported existing social relations.

Generally, the five online newspapers studied showed significant similarities regarding social media use on their websites. This clear tendency may be explained by several factors. As found by Nygren and Zuiderveld (2011) there seems to be both an uncertainty among many Swedish media companies regarding how to use social media and a fear of being left behind. By offering the same portfolio of social media features as the main competitors, the online newspapers reduce the risk of losing users to competitors due to lack of features. Overall, in accordance with earlier research (Hermida and Thurman, 2008, p. 9; Chung, 2007, p. 56) this study indicates that the social media uses of the studied online newspapers were still rather explorative in 2011.

7.3 *Aftonbladet's* use of social media for conversational interaction

Only after some hesitation and internal discussions did *Aftonbladet* formally decide to invest in activities outside its own site, specifically by working with the *Aftonbladet* Facebook page. The aim was to drive traffic, interact with users and strengthen the brand (Interview A, 2011). Jenkins (2006, p. 274) identifies *"increased contact and collaboration between established and emerging media institutions"*

as a central characteristic of convergence culture. Such trends were distinctly seen in Swedish online newspapers' use of social media, e.g., in *Aftonbladet's* use of Facebook boxes on its websites, its links to external blog posts and tweets, its own Facebook pages and the features offered for sharing articles to friends via external social media services. *Aftonbladet.se's* introduction of a Facebook login for its commentary feature is a distinct example of such increased proximity between established and emerging media institutions. Jenkins (2006) highlights the democratic and diversity challenges of participatory culture. Chung (2007, p. 57) also found that several news site producers had experienced interpersonal communication difficult to control. Through the Facebook login, *Aftonbladet.se* and other online newspapers aimed to enhance the quality of the discussions and improve the debate climate of the commentary feature. This act demonstrates a concrete initiative from the online newspapers to meet problems occurring in their commentary features. This case study indicates that, regarding social media use and UGC, the quality issue was one of the concerns most emphasized at *Aftonbladet*.

According to Jenkins (2006, p. 16), convergence involves a change both in the way media is produced and consumed. This study shows that whereas social media did affect consumption related aspects in Swedish online newspapers, they had not affected the news production significantly in terms of user contribution. Instead, a balance between allowing users to contribute versus maintaining the gatekeeping role was found in the different social media features offered on *Aftonbladet.se*. The commentary feature can be regarded as a compromise: users could participate by sharing their opinions, however journalists rarely participated in these discussions and it was still relatively unusual that the deliberations resulted in news content. The *Cover-it-live* and the *Debatt-live* features were both co-creative features in which users could, to some extent, contribute to the content production. On the other hand, the filtering was more extensive in these features than in the commentary fields where a majority of the postings were published. Also, the introduction of the Facebook login to the commentary feature denotes a stricter attitude towards user contributions. This development accords with Hermida and Thurman's (2008, p. 354) prediction that *"established news organizations are shifting towards the retention of a traditional gate-keeping role towards UGC"*.

However, the aim to raise the quality of user contributions is supported by earlier research concluding that the quality of UGC is crucial for users and that merely allowing participation in traditional media is not enough (Carpentier, 2009). Correspondingly, *Aftonbladet's* focus group study shows that the quality of user contributions affects the overall experience of the website. Consequently, it seems as if the need for professional filtering and polishing will remain and that traditional media's

gatekeeping role is at least to some extent supported by the users' demand for high quality content.

7.4 The effects of social media on the online newspaper

As mentioned in the introduction, Nygren and Zuiderveld (2011) state a need to discuss what roles traditional media will take in the network society. The findings of this case study show that previously unclear directions indirectly seen at *Aftonbladet* had in 2011 been countered by a clearer definition of the online newspaper's strengths. The discussions taking place on the *Aftonbladet* website - around its journalism - were identified to be the "big thing" at *Aftonbladet.se*. This identification appears to mirror a reconsideration of what the online newspaper *Aftonbladet* should be. It was decided that *Aftonbladet.se* would focus on its core business: professionally produced news content, and combine this asset with social media features enabling and encouraging users to interact about the news content in order to emphasize the social role of the newspaper. This clarification is probably an important step in the process of defining a new role of the online newspaper in the network society.

Regarding the effects of social media on the media company *Aftonbladet*: these were not considered significant. They had affected the journalism somewhat, but at the time of the interviews the main question was rather how the online newspaper should work outside its own website (Interview A, 2011). The perceived limited effects of social media at *Aftonbladet* were probably related to the external moderating of the commentary feature, resulting in a separation of user comments and the editorial context. Although the journalists were encouraged by the department for reader contribution to take part in the commentary debates, placing the moderating on an external actor meant that the journalists could keep focusing on producing news content in a traditional way. In their studies of online newspapers, Bergström (2008), Örnebring (2008) and Holt and Karlsson (2011) all display traditional patterns in news production and publishing. Accordingly, this case study of the online newspaper *Aftonbladet* shows that user contributions still infrequently lead to news.

7.5 A lack of long term strategies?

This study confirms that Jenkins' (2006) theories on convergence are useful for understanding the social media use of Swedish online newspapers. Jenkins (2006) states that an age of media transition is mainly characterized by unclear directions and unpredictable outcomes. Such signs are recognized in the findings of the *Aftonbladet* case study. The claimed lack of long-term strategies within news organizations (Alström and Hedman, 2008; Picard, 2010) could at *Aftonbladet* be seen most clearly in the continuous policy changes regarding its social media features.

It may be asked if it is possible to state long-term strategies in an unpredictable and continuously changing media environment. At the media company *Aftonbladet*, the management mainly tried to keep up with the development in technology and media use. However, some long-term strategies could be distinguished, e.g., in the identification of what *Aftonbladet* should be. Long-term strategies can become manifest as responses to perceived phenomena, e.g., testing new ideas may help identify what is and is not in line with what the media company should do. This could be seen when the services *MittKlipp*, *Snack* and *Aftonbladet Blogg* were closed down only a few years after being introduced. It is likely that *Aftonbladet* realized that these services could not compete with popular sites like YouTube and Facebook, as these had become well established on the Swedish market. The closing down of these features was an act based on the strategic decision that *Aftonbladet* would place its journalism in focus for the social media features. The closed down features were not directly connected to the editorial content and it seems they were aimed at attracting a target group broader than the one of the online newspaper *Aftonbladet*. The more recently introduced social media features *Cover-it-live, Superlive* and *Debatt-live* all use social media to support and extend the news content. The *Debatt-live* feature is a concrete example of a social media feature with explicit proximity to the editorial content and it shows how journalism can be used to generate commentary discussions. By cutting off social media features not strongly related to journalistic content, *Aftonbladet.se* found a way to refine its product and distinguish it from external social media services.

As mentioned before, Hogan and Quan-Haase (2010) maintain that all media have a social element. It seems that *Aftonbladet.se* has taken its social function one step further by its social media use and particularly its aim to be a *meeting place* and to deliver an experience built on interactivity and community. This development is in accordance with Jenkins' (2006) description of affective economics. Particularly the blogs, the commentary feature and the live chats offered on *Aftonbladet.se* encourage and even depend on user commitment. In the long term, getting users to participate may create a stronger brand loyalty, as in Jenkins' (2006) description of "affective economics" (mentioned in section 4.4). In a shorter timeframe, participation results in users spending more time on the websites and may thus generate increased advertising revenues.

7.6 Interactivity and social media in online newspapers

In 2003 Deuze presented a classification model for interaction on online newspaper websites (briefly described in section 3). Ten years later, this model is still applicable in many ways. However, during this study it became clear that there are now also more recently introduced interactive elements, which have no obvious

place within the three classes described by Deuze (2003) - navigational (links, etc.), functional (allows users to some extent to participate in the production process of the site) and adaptive interaction (actions that affect the site content). Therefore, Deuze's interaction model was not applicable for this study. There are, however, some interesting aspects worth mentioning.

The most obvious difference from 2003 is the occurrence of connections with external social media services. These connections could, for instance, consist of links from one site to the other or of online newspapers displaying information from related activities on connected social media sites. But there are also more complex, bilateral adaptions between these connected websites which make the interaction model from 2003 problematic to use. For example, when using the "recommend" buttons (that allow sharing of news content on Facebook) found on online newspaper websites, acti-

vity posts are created outside the newspaper website. Subsequently, the online newspaper website displays the updated number of recommendations made. In this case, the connection to the external site is highly relevant. Therefore, "externally connected interactivity" could perhaps form an additional interaction type for online news sites. Thus, the connections to related user activities in external services would be emphasized.

In this article, social media features in Swedish online newspapers in the year 2011 have been identified and different forms of interaction within these features have been described. Perceived problems for mass media engaging in social media have been reviewed, and the ways in which social media features have affected the online newspaper and its journalistic and editorial content have been described. Lastly, the question of long-term strategies for online newspapers' social media use has been discussed.

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Professional communication

Comparative analysis of Braille dot parameters using relative integral criteria

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Abstract

Relative integral evaluation criteria for the comparative analysis of the Braille character shape have been suggested based on the fact that there are significant differences in national requirements. A set of Braille character profiles has been built through computer simulation and the impact of the geometrical dimensions of the elements on the integral criteria has been determined. The limit value of the integral evaluation criteria of Braille character shapes has been determined.

Keywords: Braille fonts, mathematic modelling, Braille dot shape, Braille dot dimensions

1. Introduction

Maximum efficiency of any access to information for people with various problems of perception needs to be ensured, taking into consideration the fundamental principle of equal opportunities. One of the problems is the partial or complete loss of vision. The method of presenting information using the Braille method for the visually impaired has long been known and the development of printing technologies has created new opportunities for extending the range of materials that can be used for Braille printing and for improving the quality of perception.

There are national standards and requirements concerning the Braille parameters when used for publications, packaging labelling and manufacturing information signs (Tiresias, 2009; Fajdetić, 2011; State Standard of Russia, 1996; European Committee for Standardization, 2010; Douglas et al., 2008). These requirements have considerable differences in the definition of geometric parameters of the Braille font (dot element diameter, dot height). For example, the basic element diameter is usually between 1.0 and 1.9 mm, typically 1.4 or 1.6 mm. However, the requirement on the element height is in the UK at least 0.12 mm, in Sweden at least 0.25 mm and in France up to 1.0 mm (Golob and Rotar, 2007; Douglas et al., 2008). Thus, the element height may be located within the range from 0.12 to 1.0 mm. Such a large difference in the height impedes the comparative analysis of character elements.

The shape of Braille dots is important due to the threshold of sensitivity and the reliability of the tactile senses. The tactile thresholds depend on the size and shape of Braille dots. The visually impaired most effectively perceive relief dots that have a conical-spherical shape. These dots create pressure on a very small area of the skin. Most skin reactions take place at the location where the stimulus is applied, resulting in a more accurate sensation.

If the dot has the shape of a flattened cylinder, the pressure is distributed on a relatively large area of the skin, the impression therefore not being accurate. The same vague impression arises from the tactile perception of a flattened spherical dot. It is known that visually impaired people have difficulty reading Braille in old books that have long been in use, since the dots have been deformed, preventing accurate perception. Focusing pressure on a smaller skin surface contributes to the perception; however, there is a certain limit, i.e., a threshold which must not be crossed, as the mechanical stimulation of a very small area of the skin can affect the pain receptors and cause discomfort to the reader (Syniova, 2003).

From a technological aspect, a mathematical description of a Braille dot is important. The calculation of printing plate parameters (stamps, counter-stamps) in their design is somewhat problematic, taking into account the wide variety of modern materials. Using an analytical description of the optimal dot shape, we can mathematically describe the surface and make a printing plate (stamp) the use of which will provide the optimum dot shape on an appropriate material. Obviously, such a process will require several approximations, since the optimization of the dot shape should take into account the characteristics of the Braille material used (Kibirkštis et al., 2011). Furthermore, an analytical description of the optimal dot shape can provide parameters for other possible manufacturing processes of Braille, such as 3D printing.

2. Braille dot shape description

The mathematical description of the embossed surface shape of the Braille relief element is a complex task due to the partially subjective nature of the concept of shape and its diversity. We should note that the element surface is symmetric; hence, to simplify the task, we shall move from a three-dimensional to a two-dimensional representation. For the mathematical description of the surface shape of the Braille element, we suggest a function that describes the shape of the curve of the axial vertical intersection of the element. We will call this the function of the Braille element profile.

The shape set of element profiles can be divided into two types: a circular shape with a semicircular element top and slightly rounded sides, and a U-shape with a flat element top and more rapid transitions from the side walls of the base material. Therefore, the mathematical description of the element shape using a Gaussian distribution function is not possible.

There are also methods in signal theory to describe the shape as a sum of orthogonal functions or lines of various kinds. Nevertheless, the application of these techniques to describe a U-shaped element with a flat top and steep sides is complex, inaccurate and inconvenient when creating a profile set and for computer simulation.

We suggest a mathematical model for the Braille element as a function of the profile which describes the shape of its vertical intersection (Equation 1),

$$Y(x) = \left[1 - \frac{1}{\sqrt{1+v^r u^r}}\right]h \qquad [1]$$

where h is the nominal height of the character element, v and u are spatial parameters of the element (spatial frequency) that define the shape of the element, and r is an integer exponent.

The spatial variable u has the shape of a triangle and is given by Equation 2:

$$u(x) = \begin{cases} 0 & for \quad 0 \le x \le P \\ Ax & for \quad P \le x \le \dfrac{P}{a} \\ A\left(\dfrac{a}{2} - x\right) & for \quad \dfrac{a}{2} \le x \le (a-P) \\ 0 & for \quad (a-P) \le x \le a \end{cases} \qquad [2]$$

where x is a spatial variable, A is the maximum amplitude of the spatial variable, P is the threshold of cropping of the spatial variable basis (triangle base).

Figure 1 shows an example of a graph of the spatial variable u(x) and the geometric parameters of the Braille character element.
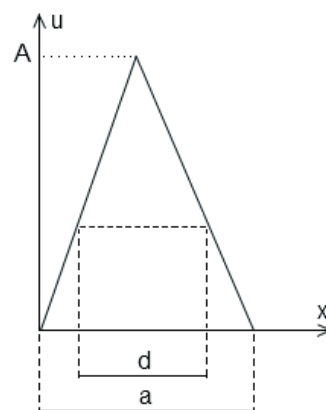

Figure 1:
Example of a graph of the spatial variable u(x)

We should note that the spatial variable u has a limited spatial interval [0-a] and is symmetric with respect to the vertical axis of the character element.

To solve the problem of element modelling, it is necessary to conduct modelling studies, calculations, analyses and visualization of results. Thus, we have selected the software package MATLAB-Simulink which provides a rather good combination of possibilities of mathematics with advances in computer technology and programming (Gulayev, 1999). The availability of operating blocks of various linear and nonlinear functions, blocks of signals and blocks of visualization in the Simulink library makes this a versatile universal method for solving diverse academic and applied engineering problems.

We propose a set of relative integral criteria for evaluating the Braille element for a comparative analysis. The first relative integral criterion is (Equation 3):

$$j_1 = \frac{[Y]}{[Y_3]} \tag{3}$$

where [Y] is called the first integral criterion, $[Y_3]$ is a set value for the integral assessment. The second relative integral criterion is (Equation 4):

$$j_2 = \frac{[Y_1 - Y_2]}{[Y_3]} \tag{4}$$

where $[Y_1 - Y_2]$ is called the second integral criterion and $[Y_3]$ is a set value for the integral assessment.

Depending on the purpose of the study, there are two basic choices for the given value $[Y_3]$ of the integral assessment. When comparing the parameters of the Braille character in different countries, we should choose the maximum possible criterion value (Equations 5):

$$j_1 = \frac{[Y]}{[Y_{max}]}, j_2 = \frac{[Y_1 - Y_2]}{[Y_{max}]} \tag{5}$$

where [Y] is the first integral criterion, $[Y_1 - Y_2]$ is the second integral criterion and $[Y_{max}]$ is the maximum possible assessment value.

We should note that the numerical values of relative assessments will be located within the interval 0-1. It could be more convenient to compare parameters in percentage. Then the expression of the relative assessment in per cent is (Equation 6):

$$j_1 = \frac{[Y]}{[Y_{max}]} \times 100\%, j_2 = \frac{[Y_1 - Y_2]}{[Y_{max}]} \times 100\% \tag{6}$$

For the computer simulation, we chose the element diameters 1.4 and 1.6 mm, and the element heights 0.2, 0.4, 0.8 and 1.0 mm. The comparison is done using the relative integral criteria in percentage.

3. Simulation results

In our first series of computer simulations, we studied a U-shaped profile and used the element heights 1.0, 0.8, 0.4 and 0.2 mm and the following parameters of the profile function: the exponent r = 8, the spatial constant v = 0.25. We then calculated the integral criteria. The results of the simulation as a set of U-shaped profiles are presented in Figure 2. Integral criteria assessments of the profiles for these parameters are given in Table 1.
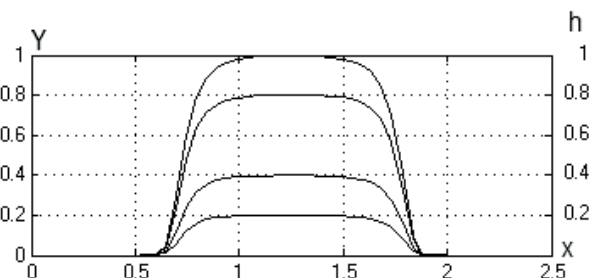

Figure 2:
Graphs of U-shaped profiles of a Braille element for diameter = 1.4 mm and v = 0.25

As we reduce the height to 0.4 or 0.2 mm, the shape of the element is deformed, and side walls become more inclined. We can try to make them steeper by increasing the spatial constant.

Therefore, in our second series of computer simulations, we studied the U-shaped element profile with the previously defined heights using the spatial constant v = 0.5 and the exponent r = 8. The results of the computer simulation as a set of U-shaped profiles are presented in Figure 3 and Table 1. As can be seen in Figure 3, the sidewalls of the element become steeper and it is easy to notice the changes in the profile shape.

Figure 3:
Graphs of U-shaped element profiles of a Braille
character element for diameter = 1.4 mm and v = 0.5
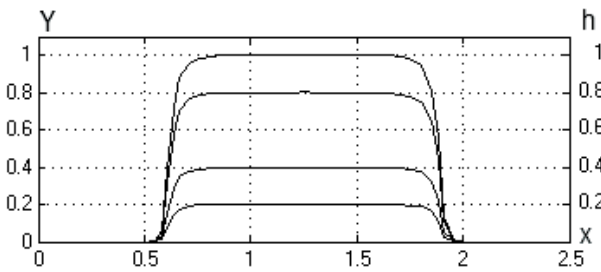
Similar studies were conducted for an element base diameter of 1.6 mm. The simulator was adjusted to the value of the base diameter d = 1.6 mm and we set the element height to 1.0, 0.8, 0.4 and 0.2 mm for calculating the relative integral criteria.
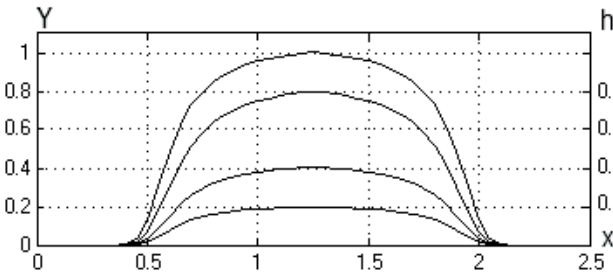
Table 1: Integral criteria of U-shaped element parameters for different base diameters

Height	Integral profile criteria			
h (mm)	$[Y_{1.6}]$	$[Y_{1.4}]$	$[Y_{1.6}-Y_{1.4}]$	$[Y_{1.6}-Y_{1.4}]/[Y_{1.4}]$ (%)
1.0	1.3040	1.0040	0.3000	29.88
0.8	0.9837	0.7440	0.2397	32.22
0.4	0,4626	0.3720	0,0906	24.35
0.2	0.2459	0.1860	0.0599	32.20

These results suggest that an increase of the base diameter from 1.4 to 1.6 mm, i.e., an increase of 0.2 mm, significantly changes the element shape. The gain in the second integral criterion is about 30%; however, this does not depend strongly on the height of the element. This implies an important practical conclusion for the printing devices that print Braille texts: the tolerance of the printing diameter of the symbol element should be less than 0.1 mm.

In the third series of computer simulations, we studied a semicircular profile, given the previous height and profile function parameters: exponent r = 4, space constant v = 0.25, and element diameters 1.4 and 1.6 mm. Typical simulation results for a set of semicircular profiles are shown in Figure 4.

Figure 4:
Typical graphs of semicircular element
profiles with base diameter d = 1.6 mm

It is easy to notice that the element is wider and the element tops have a pronounced spherical shape. Table 2 shows the results of the computer simulation of semicircular character element profiles for the diameters 1.4 and 1.6 mm (r = 4, space constant v = 0.25).

Table 2: Integral criteria of semicircular element parameters for different base diameters

Height	Integral profile criteria			
h (mm)	$[Y_{1.6}]$	$[Y_{1.4}]$	$[Y_{1.6}-Y_{1.4}]$	$[Y_{1.6}-Y_{1.4}]/[Y_{1.4}]$ (%)
1.0	1.2100	0.8693	0.3407	39.19
0.8	0.9100	0.6333	0,2767	43,69
0.4	0.4606	0.3169	0.1437	45.35
0.2	0.2273	0.1585	0,0688	43,40

Comparing the results of Tables 2 and 1, we can conclude that a change in the base diameter by 0.2 mm in the semi-circular shaped elements leads to an increase in the second integral assessment by on an average 30-42 %. Thus, semicircular elements are more sensitive to changes in the diameter than U-shaped elements.

4. Conclusions

1. The suggested method of Braille element description can effectively describe its shape.

2. Through computer simulations, we have made a comparative analysis of the element shapes and determined an admissible value of the relative integral criterion $j_1 = 30\%$, the excess of which can adversely affect the efficiency of perception.

3. We have determined a recommended manufacturing tolerance of $\pm$ 0.1 mm in the diameter of the Braille element base.

4. Changing the base diameter by 0.2 mm in the semicircular profile elements leads to an increase in the second integral criterion by 30-42 % on an average. Thus, semicircular elements are more sensitive to changes in diameter than U-shaped elements.

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Topicalities

Edited by Raša Urbas

Contents

News & more

Bringing color to wide format workflows

Ricoh's portfolio of wide format multifunction products has been supplemented with new full-color digital imaging system. With copying, scanning and printing capabilities, the Ricoh MP CW2200SP streamlines low-volume, wide format workflows while offering impressive features that make this a device suitable for architectural, construction and engineering firms operating in CAD-centric environments.

The printer enables quick and easy sharing of high-quality documents, both color and black-and-white. Full-color originals can be scanned and distributed via Scan-to-Email/Folder/FTP/HDD or embedded Software Developer Kit (SDK) architecture to integrate GlobalScan NX for optimal electronic file management.

Documents can be immediately accessed in the field via any Web browser with Scan-to-URL. Built-in USB and SD card slots offer mobile workers the convenience to save documents and generate prints directly at the device for on-the-go productivity.

The device uses GELJET™ ink technology. This fast-drying, waterproof gel ink doesn't soak the page like traditional inkjet devices. Rather, its color-fast properties allow the ink to dry on contact, minimizing bleed to produce more durable documents that are required to stand the test of time, such as blueprints, schematics and design plans.

A host of advanced security features are available to protect confidential and proprietary documents from getting into the wrong hands. User authentication restricts access to print jobs from unauthorized users with password or ID card verification. PDF encryption maintains the integrity of scanned PDFs during distribution with password protection and the DataOverwriteSecurity System (DOSS) automatically destroys latent images and data on the HDD.

The printer enables full-color capability and high-speed monochrome output (0.6 - 1.1 color prints per minute in A0/A1 paper format) in high quality printing at 600 dpi.

High-quality indoor textile decoflex

Heytex has expanded its PVC-free HEYTex® digitex® range by adding the high-quality indoor textile decoflex to offer the proven Heytex quality for all fields of application to their customers.

HEYTex® digitex® decoflex distinguishes itself by numerous excellent material properties. The acrylate-coated fabric on polyester basis is elastic, tear-resistant and robust, 200 g/m² light and of course flame retardant in accordance with B1 standards. It can be easily processed with silicone welt, was developed for print with Dyesub inks and convinces at the fair stands and POS by brilliant and first-class print results. It is available in maximum width of 310 cm.

Expanded family of flexographic printers

Italian company Celmacch has presented at the International Exhibition for the Corrugated and Folding Carton Industry, CCE International, this March in Munich, Germany, new family of flexographic printing systems.

The novelty system - HBL Chroma print 170 EVO complements the existing range of solutions series Chroma Print. This printing machine enables printing in maximum formats of 1 700 x 1 280 mm, with printing height of maximum 1 300 mm.

Chroma Print 170 and the 210 Ecologis have been designed and manufactured paying particular attention to the expense reduction of the purchasing and operating, spare parts and technical assistance. Both versions are the bottom printing machines with fixed units, which guarantee high printing quality, easy use, reduced energy consumption with low wash water consumption and offer simple and reduced maintenance.

Fiery® XF Version 5

Fiery® XF Version 5 is new flexible and scalable high-speed RIP and color management workflow for wide to super-wide format production, which streamlines print production with customizable automated workflows from job creation to printing and verification.

Accurate color management by measurements, with advanced spot and process-color optimization, enables easily achieve stunning, precise and predictable quality prints.

Automated workflows eliminate touch points and remove the need for manual job submission, saving operators time and reducing error rates. A fully customizable user interface allows tailoring of the application to each operator's tasks and skill set.

Cutting plotters

New line of cutting plotters from Mutoh America has been presented to the world market. The ValueCut roster comprises three models: ValueCut 600, 1300 and 1800 with 610, 1320 and 1830 mm cut width.

All three VC models are designed for long-run cut jobs and precision accuracy, enabling simultaneously printing and cutting.

Standard features include: newly designed sheet-off feature; roll support system; multi-segment registration; spare blade; oil-ball point pen; SAi Flexi starter software; and more. A floor stand and media-catch basket are standard on the VC 1300 and 1800 models (optional on the 600). Maximum media thickness is 1 mm. Dual-roll support system is optional.

Systems for sheet paper lamination and bonding

The Swedish company Lamina System, a specialist in the development of management systems for sheet paper lamination and bonding, presented the novelty at this year's CCE fair. Special among the innovations is certainly a new fully automatic controlled system solution or lamination.
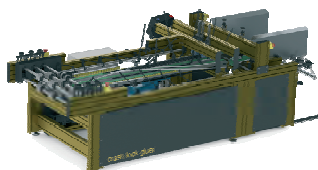
The Lamina Crash Locker Gluer is a very compact and effective fully automatic folder gluer. The machine is equipped with a non-stop suction belt feeder and a variety of guides and belts to handle standard one-point glued boxes of three-point glued crash lock boxes.

Set-up time is very easily achieved due to the compact construction and the machine is able to run even small quantities, maintaining a high quality. The machine is a perfect solution to go from manual to automatic gluing operations for a low investment.

Speedmaster XL 106

The Speedmaster XL 106 was premiered at the last drupa and it soon gained a lot of interest in the market. The press was very well received by the highly industrialized commercial printers and by packaging printers due to high production - producing over 40 million sheets or more a year or productivity of 18 000 sheets per hour with one or two-color reverse-side printing.
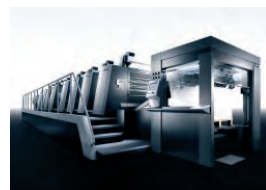
Because of the increased speed of 18 000 sheets per hour, the press is equipped with an optimized delivery with a longer drying section and this enables the sheets to pass directly from the delivery to postpress. The configuration enables 4/4 jobs and also jobs which are printed using multi-color printing and coated in straight mode.

The Speedmaster XL 106 therefore offers the broadest range of configurations in the 70 x 100 cm format. It extends from two to 19 units, with or without perfecting. As a customized press, it is available as an L-P-L configuration (coating unit before and after sheet reversal), as a Duo press with flexographic printing units before the offset units, or as a rotary die cutter for products such as inmold labels. In the LPL version, the front and reverse sides of the sheet are printed and coated in a single pass, the sheet arrives on the pile completely dry, and can be passed on directly to postpress. This enables productivity 30 to 40 percent higher than for a straight press.

The machine impresses with its high productivity thanks to the interplay of preset functions, color presettings, simultaneous plate changing with AutoPlate XL, Prinect Inpress Control, and extremely straightforward operation. The operator only needs to enter the length, users have praised its high availability and stable sheet travel, which are maintained even at maximum speeds thanks to a new perfecting and delivery concept and an adapted sheet control system. Operating at 18 000 sheets per hour in both straight and perfecting modes, the Speedmaster XL 106 achieves maximum productivity and processes a wide range of substrates up to 0.8 mm thick in perfecting mode. It can therefore process everything from inmold foils to kraft board. With the 75 x 106 cm sheet format, the maximum print format of 73 x 105 cm in perfecting mode can be used in its entirety, which means a larger die-cutting border for packaging printers and more repeats per sheet for gang forms in web-to-print.

The digital halftone proof

In platesetting, parameters like screen, overprinting and trapping settings, as well as correction curves, have a decisive influence on the subsequent printed result. Should problems occur at this point, such as an unfavorable screen angle, incorrect trapping or overprinting settings, and also interpretation errors, this can only be detected at an early stage by means of a halftone proof created with the original imagesetter data.

A halftone proof is also indispensable for printing processes using coarse screening, since this has a major influence on the visual impression. GMG DotProof® allows direct processing of 1-bit imagesetter data, so that they can be inexpensively proofed on inkjet printers, and errors detected before the platesetting operation or even the start of printing. Agencies, publi-

shing houses and print buyers can use the integrated GMG RipServer to create 1-bit data themselves, enabling advance simulation of the subsequent screen effect.

GMG DotProof produces a genuine, color-accurate halftone proof of contract-proof quality. It simulates the color appearance by supplementing the print dots with tiny, colored microdots. In this way, both the screen dot and the color are accurately reproduced. This application supports all common spot color systems and processes up to 64 separations in one image.

Freely editable spot color databases are included in the scope of supply. The opacity of the spot colors and the order in which they are printed can likewise be specified at will. White underprinting can be defined as a color of its own.

GMG ProofControl Inline permits fully automatic verification of halftone proofs on printers with integrated measuring instruments. The control strip is measured and evaluated automatically. Depending on the printer model, the results are printed directly on the proof printer, alongside the control strips, or on a separate label printer. If necessary, GMG ProofControl Inline also starts printer calibration. It also validates spot color control strips, accurately identifying colors which cannot be reproduced by the proof printer.

In combination with GMG ProofControl Inline spot colors can be quickly and automatically optimized with the help of the integrated measuring device. The wizard guides the system through the process with step-by-step instructions.

A WebClient enables multiple users to simultaneously create, edit and monitor proofing jobs on any PC or Mac within the corporate network. The configuration of spot color channels is likewise simplified by the Web Client. The effects of changes in spot colors can be seen and controlled in a visual job preview.

The GMG DotProof XG module enables users to exploit the advantages of the Canon imagePROGRAF iPF, Epson Stylus Pro x900 and HP Designjet Zx200 printers with an expanded color gamut, allowing far more spot colors to be simulated.

The intelligent solution for label inspection

Ensuring the high quality control and reliability during the finishing processes of label webs is very important. Conventional methods are often limited and complicated to use while automatic image control systems are oversized and quite expensive for many applications. The concept of TubeScan, developed by Eltromat company, set new standard with the original combination of imaging technology and the stroboscopic principle.

"Digital strobe web viewing" original function of TubeScan provides considerably better and higher process reliability because it delivers a steady image and true color fidelity - regardless of the line speed. Thus, the operator retains in control of the entire production, even during the critical start and stop phases of the machine. Built in camera makes up to 30 images per second, showing each repeat in real time.

New generation of Spectro-densitometers

The SpectroDens is an accurate, fast and easy-to-use hand held Spectro-densitometer. It combines the qualities of a highly accurate spectrophotometer and an easy-to-use densitometer.

The device evaluates color accuracy and displays a Pass or Fail based on customer color requirements. Optional 1.5 mm measurement aperture can read patches as small as 3 mm. It can measure, save and view up to 250 sample measurements without the need to be connected to a computer. One measurement displays all four CMYK density values for each color in full G7 functionality.

The device is easy to maneuver and position over the target wherein possesses no mechanical moving parts.

UV printers for different substrates

New models of Azonprinter UV A2 - QL and Q ROTAX allow printing on wide range of substrates. This are cost effectively digital printing systems with an intelligent laser beam print head protecttion. Standard model enables printing in eight colors (CMYKWWWW) with a gloss or primer (CMYKWW) option.

Azon UV white ink creates a very dense image, allowing users to print on any colored substrate and produce amazing, bright colors with a white under base, while gloss ink gives gloss or multi-coat effects to the surfaces of printed objects.

UV printers offer application on objects up to 20 cm and with outstanding reproduction quality of 1440 dpi. The finest image details, crisp text and vibrant, full-color images with outstanding durability on a variety of substrates and 3D objects, from wood and stainless steel to ceramic tiles, plastics and glass can be reproduced.

Water based inks for packaging

Heubach and Huber group have presented in collaboration new water based printing inks for packaging. With the addition of other chemical components this inks could also be used in flexographic systems for packaging printing.

New program products HYDRO-X GA/MGA have a modular foundation and are mainly suitable for packaging printers. GA version is suitable for packaging production according to the GMP demands, while MGA version is more reliable in terms of pigment migration in food packaging products, which is in direct contact with its content.

Web Tension systems

ABB's unique tension measurement system Pressductor® Technology is a measurement principle based on the magnetoelastic effect - the magnetic properties of a material are influenced by the mechanical force applied to it.

It improves web processes regardless to quality, reliability and performance, enabling the production of perfectly wound reels with a perfect tension profile across and within the web.

Better barrier solution against mineral oil migration

EVAL™ EVOH presents a solution against MOSH/MOAH mineral oil migration. A layer of just a few microns (4 μm) provides proven protection.

Used either as an extremely thin coated layer on the paperboard or in an all-plastic barrier liner, EVAL™ also provides a gas barrier 10 000x more effective than LDPE. Flavor and aroma are locked inside, oxygen, odours and MOSH/MOAH are kept out where they belong.

The equipment ensures clear image reproduction even with reflective materials. Images are automatically synchronized over the entire speed range of up to 250 m/min. Unlike commercially available strobe lights the one in TubeScan presents no health risks and has less tiring.

The "missing label detection" function is not only counting accurately labels and missing labels per lane and in total, but also detects the remains of label matrix across the entire web width. This saves the use of more expensive sensor technology with their annoying and time-consuming adjustments.

Pigment ink solutions

One of the leading producers of chemical solutions Kornit Digital has introduced unique inks which are specially formulated to bind together with its pre-treatment solution, printing the design immediately after its application. The inks offer vivid colors, high vibrancy and an extended color gamut. They provide high elasticity and durability, along with a print quality maintained after many washes. Kornit's inks uphold stringent ISO standards, providing excellent wash and light-fastness.

Pre-treatment solution increases the efficiency of printing garments, saving time and cutting costs. The Wet-on-Wet solution allows the printing of the design just moments after the pre-treatment is applied, without waiting for drying. The solution together with inks combine to allow the ink to fixate to the garment fibers, creating an optimum printing result that is completely wash-resistant.

Kornit's water-based, pigment ink solutions provide better color density and significantly improve color quality. They are distinguished with excellent color fastness, high elasticity and non-cracking attributes, they need no pre-treatment and are environmentally friendly - Oeco-Tex and AATCC approved.

Certification of media for Latex printing

Mimaki Engineering Co., Ltd. has in partnership with Color Concepts started a program of certification of media for use with Mimaki's JV400LX printer and Latex inks. The Mimaki Media Certification Program (MMCP) is available to providers of media in Europe, the Middle East and Africa (EMEA). The company also anticipates expanding this program to other Mimaki printers and ink technologies in the future.

Mimaki will offer end users information about new available profiles or updates of their current profiles that have been downloaded via the MMCP system. As a part of the program, special MMCP Media Swatch books printed to Mimaki's quality standards will be produced. This process will enable availability of swatch books with minimal effort on the part of the media supplier.

News & more - J. Print Media Technol. Res. 2(2013)2, 109-114

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Four new models of UV flatbed printer

Océ has introduced four new models in the Océ Arizona® 400 printer Series - *Océ Arizona 460 GT*, *Océ Arizona 460 XT*, *Océ Arizona 440 GT* and *Océ Arizona 440 XT*. Joining the Océ Arizona 480 GT and Océ Arizona 480 XT models introduced in October 2012, these models complete the Océ Arizona 400 Series of next-generation UV flatbed printers that feature exceptional quality, improved productivity, application versatility and the ability to upgrade as business grows.

 The Océ Arizona 400 printer Series includes six different UV flatbed printers featuring four, six or eight independent ink channels in two different flatbed sizes, offering a range of applications capabilities and capacity to suit any mid-volume print service provider.

And as a provider's needs change, an upgrade path is available to ensure that the investment in an Océ Arizona 400 Series printer is protected from obsolescence.

Océ VariaDot® imaging technology, included in these new models, can produce near-photographic quality with sharpness equivalent to 1 440 dpi or higher. Text, as small as 2 pt, is perfectly legible, even when printed reverse (white ink on a black field). Active Pixel Placement Compensation assures image sharpness, density and uniformity, wherever it is printed on the flatbed or on the Roll Media Option.

A variable vacuum system featuring six vacuum zones on the Océ Arizona 400 Series GT models (seven on Océ Arizona 400 Series XT models) are configured to match the majority of standard-sized graphics arts media to reduce or eliminate manual masking, thereby decreasing operator intervention and increasing productivity.

A batch mode supports complex, multi-layered jobs - those requiring multiple passes for specialty applications. These jobs can now be streamlined using the new batch mode tools, eliminating any operator intervention between operations. Included on all Océ Arizona 400 Series models, batch mode can also be used to produce sets of prints sequentially for easy collation and fulfillment.

Océ Arizona 460 GT and 460 XT models include six independent ink channels with the first four configured for standard CMYK printing. Channels five and six can be configured in two ways that offer flexibility to meet the demands of various jobs:

- *Varnish + White*
  Using white ink, print service providers can produce exceptional quality prints on a variety of non-white substrates (including backlit prints) that can command premium prices. Varnish can be used as a spot or flood decorative element for attention-getting results at premium prices.

- *Varnish + White*
  Alternatively, when not required for use in printing varnish, the sixth channel can be used as an additional white ink channel to provide double the opacity in a single printing pass for higher productivity when printing white ink jobs. This is particularly beneficial for backlit and industrial applications.

Print service providers can use these two channels in whichever configuration best suits their needs, changing from Varnish + White to Double-White (and vice versa) on demand.

Supermetallic gloss papers

Le Bon Image has introduced new metallic photo paper which replenishes the portfolio of metalized papers - *Bonjet Atelier Supermetallic* premium RC photo paper.

This papers offer a true metallic appearance, without change of the image tone and base tint. The metal effect is catchy and well visible in all image areas, looking similar to the metallic RA-4 papers like the Fujicolor Crystal Archive Digital Pearl Paper or Kodak Endura Metallic VC.

The paper is available with two surfaces: a brilliant glossy and a true pearl texture. With their use a fascinating metallic effect, noticeable as a metal sheen, evoking an irresistible attention from the viewer could be achieved. The effect is visible in all areas of the image.

Bonjet Atelier Supermetallic papers have a heavy resin-coated paper base and a nanoporous inkjet coating of the latest generation which not only warrants best compatibility with all water based dye and pigmented inks as well as a superb image quality, but also features instant drying, even gloss and a high scratch resistance.

The paper is available in grammages of 290 g/m² and in two versions: with a glossy finish which delivers high sharpness, vibrant colors and rich blacks with almost no matting, and with a pearl texture which gives prints a precious appeal and avoids reflections. Supermetallic photo paper is available in rolls of 43.2 cm, 61 cm and 111.8 cm, or in sheets A4, A3 and A3+.

Bonjet Atelier photo papers feel instantly dry after printing and are resistant against smearing and water splashes. The possible ink load is high; the media are very robust against adverse conditions.

They are fully compatible with all water based dye and pigmented inks commonly used in photo quality desktop and large format printers.

Compostability of waxed-paper packaging

A recent study of EuroWaxPack association, performed by the independent laboratory OWS (Organic Waste Systems) in Ghent (Belgium), showed that a typical waxed paper packaging material is industrially compostable according to the strict tests of EN 13432 - "Requirements for packaging recoverable through composting and biodegradation".
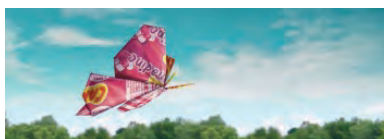
The results confirmed that the wax coated paper material tested fulfills the evaluation criteria for material characteristics, biodegradation (after 75 days), disintegration (after 12 weeks), and compost quality (the material did not cause a negative effect on compost quality), which are outlined in CEN norm EN 13432.

It was proven that wax-coated paper as tested is fully compostable, and delivers high performance in packaging for confectionery such as sweets, chocolates, and chewing gum. Users of packaging materials are therefore also able to comply with EN 13432, and achieve "OK Compost" and "Compostable" certification.

New inspection and reporting capabilities

Global Vision released its new Digital-Page artwork inspection and ScanTVS print inspection software (version 3.0).

Digital-Page™ is a powerful solution for automatically comparing graphic files in seconds instead of hours.

It increases packaging accuracy and reduces inspection time. The software can quickly detect and identify missing text and graphics, incorrect fonts and text size, as well as broken type and color deviations.

Version 3.0 introduces advanced PDF tools unique to the industry for pre-press and printing companies to automate image handling.

The software is fully compliant with FDA 21 CFR Part 11 requirements, while offering complete lifecycle and validation documents.

Océ Arizona 440 GT and 440 XT models include CMYK ink channels only, for those shops that do not initially need the capacity for Varnish or White Ink printing.

The Océ Arizona 400 Series printer family is designed to grow with a print service provider's business. Owners can upgrade at any time to add more application versatility and improve productivity.

Laser process for safety punching and perforation

Hunkeler presented an innovative, patented laser process for safety punching and perforation HL6. The system enables the use in different areas of applications including the production of checks, coupons and direct mail pieces where the dynamic stamping of distinct individual shapes for safety characteristics or any arbitrary dynamic perforation pattern is required.

The laser module works with an until now unheard of speed of up to 150 meters per minute, in 1-up or 2-up mode and can be integrated into all Hunkeler configurations. The CO_2 laser, with the power of 80 to 750 W, can cut through the materials of 40 to 16 g/m^2.

The laser performs cut outs with holding points, also die cutting or kiss cutting with additional advantage of dynamic text or graphic engraving (i.e. security features on checks) can be performed.

New inkjet web press

The Fujifilm Jet Press 540W is an inkjet web press, available either as a standalone machine or, with the integration of elements from Fujifilm's post-press line-up, as a complete production system and some other possibilities.

It is aimed at printers looking to produce short-run books, manuals, leaflets, newspapers and transactional print more efficiently. Fujifilm adds that the machine's ability to integrate with the XMF workflow and a wide range of different finishing solutions also makes it suitable for customers looking to produce more customized work.

The Jet Press 540W uses a combination of Fujifilm technologies, including the manufacturer's Vividia inks range. This allows high-density images to be printed at high speed, with less ink transfer from sheet to sheet, with high-quality reproduction possible even on thin paper. A variety of ink types, including both pigment and dye-based inks, have been developed for the use.

The 540W also utilizes Fujifilm's own screening technology which is based on FM screening and, as reported, delivers smooth colors and sharp text. Top printing speed of 127 m/min, when operating at 600x480 dpi, is easily achieved.

Bookshelf - J. Print Media Technol. Res. 2(2013)2, 115-118

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Bookshelf

Inkjet Technology for Digital Fabrication

Whilst inkjet technology is well-established on home and small office desktops and is now having increasing impact in commercial printing, it can also be used to deposit materials other than ink as individual droplets at a microscopic scale. This allows metals, ceramics, polymers and biological materials (including living cells) to be patterned on to substrates under precise digital control. This approach offers huge potential advantages for manufacturing, since inkjet methods can be used to generate structures and functions which cannot be attained in other ways.

Beginning with an overview of the fundamentals, this book covers the key components, not only piezoelectric print-heads and fluids for inkjet printing, but also the processes involved. It describes specific applications, e.g. MEMS, printed circuits, active and passive electronics, biopolymers and living cells, and additive manufacturing. Detailed case studies are included on flat-panel OLED displays, RFID manufacturing and tissue engineering, while a comprehensive examination of the current technologies and future directions of inkjet technology completes the coverage.

With contributions from both academic researchers and leading names in the industry, *Inkjet Technology for Digital Fabrication* is a comprehensive resource for technical development engineers, researchers and students in inkjet technology and system development, and will also appeal to researchers in chemistry, physics, engineering, materials science and electronics.

Inkjet Technology for Digital Fabrication
Editors: Ian M. Hutchings, Graham D. Martin
Publisher: Wiley, 1st edition (2012)
ISBN: 978-0470681985
390 pages
175 x 23 x 254 mm
Hardcover

Applications of Organic and Printed Electronics:
A Technology-Enabled Revolution
(Integrated Circuits and Systems)

Organic and printed electronics can enable a revolution in the applications of electronics. This book offers readers an overview of the state-of-the-art in this rapidly evolving domain. The potentially low cost, compatibility with flexible substrates and the wealth of devices that characterize organic and printed electronics will make possible applications that go far beyond the well-known displays made with large-area silicon electronics.

Since organic electronics are still in their early stage, undergoing transition from lab-scale and prototype activities to production, this book serves as a valuable snapshot of the current landscape of the different devices enabled by this technology, reviewing all applications that are developing and those can be foreseen. It provides a complete roadmap for organic and printed electronics research and development for the next several years. It includes an overview of the printing processes for organic electronics, along with state of the art applications, such as solar cells.

Digital Alchemy: Printmaking techniques for fine art, photography, and mixed media
Author: Bonny Pierce Lhotka

Publisher: New Riders
Press, 1st edition (2010)
ISBN: 978-0321732996
320 pages
203 x 20 x 231 mm
Paperback

This work shows how to turn standard inkjet printer into a seemingly magical instrument capable of transforming printed images into true works of art. Using plenty of visuals and straight-forward terms, Lhotka walks the reader step-by-step through over a dozen projects.

The reader can learn how to transfer and print images to a variety of surfaces including metal, wood, fabric, stone, and plastic using the techniques that the author spent years developing. This book provides the information on the use of carrier sheets and paintable precoats for printing on almost any surface and how to achieve near lithographic quality digital prints with transfer processes to uncoated fine art paper.

In addition to the tutorials in the book, there is also included DVD-ROM, which has over 60 minutes of video footage where you can learn how to perform an alcohol gel transfer, transfer an image to a wooden surface, use your inkjet printer to achieve remarkable prints, and more.

New Epson Complete Guide to Digital Printing
Author: Bonny Pierce Lhotka

Publisher: New Riders
Press, 1st edition (2010)
ISBN: 978-0321732996
320 pages
203 x 20 x 231 mm
Paperback

Renowned digital photography author Rob Sheppard presents the possibilities of highest exploitation efficiency of Epson printing equipment. His work outlines the most efficient workflow, provides printing tips and techniques as well as suggests a wealth of other methods that go far beyond the basics.

The book explains how to handle the most up-to-date technologies; it offers step-by-step tips, and practical, proven real-world strategies which the author has learned from experience.

The work discusses light emitting diode (OLED) displays, including the different types of OLED pixels in commercial use and in development, and it gives an insight into the most relevant display and backplane issues. It provides an overview of OLED for lighting applications, including a description of the materials, physics, architecture and benchmarking of OLED lighting devices, as well as fabrication methods, reliability and commercial applications.

Beside mentioned the book reviews the state-of-the-art of chemical sensors based on organic electronic device and it offers a vision for the future of organic electronics based on organic thin film transistors (OTFTs), including applications such as organic RFIDs and smart objects enabled by the integration of OTFTs with sensors and actuators.

Applications of Organic and Printed Electronics:
A Technology-Enabled Revolution
Editor: Eugenio Cantatore
Publisher: Springer (2012)
ISBN: 978-1461431596
192 pages
155 x 15 x 234 mm
Hardcover

Printed films: Materials science and applications in sensors, electronics and photonics

Printed films are used in sensors, actuators, circuit components, heaters and solar cells. The goal for most applications is the creation of disposable devices on low cost flexible substrates while retaining yield, longevity and manufacturing ease.

This book covers developments in printed films and the challenges, opportunities and progress towards new devices. Part one focuses on the materials and properties of printed films, beginning with a review of the concepts, technologies and materials involved in their production and use. It discusses printed films as electrical components and silicon metallization for solar cells, conduction mechanisms in printed film resistors and thick films in packaging and microelectronics. Part two looks at the varied applications of printed films in devices. Chapters cover printed resistive sensors, the role of printed films in capacitive, piezo-electric and pyro-electric sensors, mechanical micro-systems and gas sensors.

Other chapters review screen printing for the fabrication of solid oxide fuel cells and laser printed micro and meso-scale power generating devices. Part two concludes with an exploration of the applications of printed films in bio-sensors, actuators, heater elements, varistors and polymer solar cells.

The content of the book provides a much needed review of the most significant developments in thick films in recent years. It covers the wide range of applications and materials for thick film devices, with a primary focus on the most promising recent developments

Printed films: Materials science and applications
in sensors, electronics and photonics
Editors: Maria Prudenziati, Jacob Hormadaly
Publisher: Woodhead Publishing (2012)
ISBN: 978-1845699888
608 pages
155 x 33 x 234 mm
Hardcover

Biofabrication: Micro and Nano-fabrication, Printing, Patterning and Assemblies

Biofabrication presents new cross-disciplinary scientific field which focuses mainly on biomanufacturing processes (technologies, materials, devices, mo-dels). It focuses on biomanufacturing processes, which ultimately aim at the development of products relevant to the living system. These products may involve living (cells and/or tissues) and nonliving (bio-supportive proteins, scaffolds) components or their combination. They maybe drugs, therapeutic solutions, design principles or quantitative models. Whereas in the more narrow field of tissue engineering, for example, the primary objective is to build specific tissue substitutes (skin, cartilage, cardiac, etc., with whatever method), in biofabrication the focus is on the development of technologies with which this objective could be reached in the most efficient and optimal way. Biofabrication techniques facilitate the advance of tissue engineering from 2D cell culture to the 3D methods required for future developments in regenerative medicine, including potentially the growth of entire human organs.

The book covers a range of important biofabrication technologies (cell printing, patterning, assembling, 3D scaffold fabrication, cell/tissue-on-chips) as a coherent micro or nano-fabrication toolkit. The book is designed as a practical guide to these key emerging technologies, with real-world examples to help readers gain a working knowledge of how to apply biofabrication techniques in areas such as regenerative medicine, pharmaceuticals and tissue engineering.

Biofabrication: Micro- and Nano-fabrication,
Printing, Patterning and Assemblies
Author: Gabor Forgacs
Publisher: William Andrew, 1st edition (2013)
ISBN 978-1455728527
288 pages
190 x 23 x 234 mm
Hardcover

Learning OpenGL ES for iOS:

A Hands-on Guide to Modern 3D Graphics Programming

OpenGL ES technology underlies the user interface and graphical capabilities of Apple's iPhone, iPod touch, and iPad as well as devices ranging from video-game consoles and aircraft-cockpit displays to non-Apple smartphones. In this friendly, thorough introduction, Erik M. Buck shows how to make the most of Open GL ES in Apple's iOS environment.

This work focuses on modern, efficient approaches that use the newest versions of OpenGL ES, helping to avoid the irrelevant, obsolete, and misleading techniques that litter the Internet. The author embraces Objective-C and Cocoa Touch, showing how to leverage Apple's powerful, elegant GLKit framework for maximizing the productivity, achieving tight platform integration, and delivering exceptionally polished apps.

Learning OpenGL ES for iOS:
A Hands-on Guide to Modern 3D Graphics Programming
Author: Erick M. Buck
Publisher: Addison-Wesley Professional, 1st edition (2012)
ISBN: 978-0321741837
352 pages
168 x 18 x 216 mm
Paperback
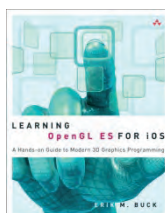
Color Management: Understanding and Using ICC Profiles

Editors: Phil Green, Michael Kriss

Publisher: Wiley,
1st edition (2010)
ISBN: 978-0470058251
314 pages
178 x 23 x 244 mm
Hardcover

Color Management serves as a comprehensive guide to the implementation of the International Color Consortium (ICC) profile specification, widely used for maintaining color fidelity across multi-media imaging devices and software. The book draws together many of the White Papers produced by the ICC to promote the use of color management and disseminate good practice; the ICC specification has become widely accepted within the color industry, and these papers have been updated, expanded and edited for this collection.

Other chapters in the book comprise material that will go on to form future ICC White Papers, as well as some original content. The ICC review process ensures that the material and recommendations included are collaborative, reflecting the input of the wide community of color and imaging scientists and developers who make up its membership. Readers can be assured of the best advice for achieving optimum results.

The book provides an overview of color management in applications and the role of ICC profiles in a color reproduction system. It presents user guidelines on color measurement procedures and discusses measurement issues for media such as optically-brightened papers and inkjet prints.

The readers are offered comprehensive guidance on the latest version of the specification and the application of the perceptual rendering intent with its reference gamut. Content of the book examines the construction and benefits of different types of ICC profiles, and sets out compliance test considerations, implementation notes and evaluation of profile quality. Useful glossary of terms is included.

This book is written for color and imaging scientists developing, implementting and using color management systems within a range of imaging devices and software. Senior undergraduate and postgraduate students will also find the book of use.

Bookshelf

Academic dissertations

LED-based light scattering measurements of papers for printing applications

High-quality printing requires the control and therefore an accurate prediction of the reflectance spectrum of the printed product. This reflectance is a result of various factors; one of them is the light scattering property of the substrate, which is in most cases paper. Fitting a typical printer model is cost-intensive since it requires printing and measuring test patches. This gets even more important for an increasing number of inks because the possible combinations of overprints rise exponentially.

So-called first principle models reduce these costs by modeling different effects separately. A typical approach is decoupling optical and physical dot gain. A key element of modeling optical dot gain is the measurement of sub-surface light scattering in the substrate.

This work presents the necessary means to design a setup for the measurement of light scattering in paper or other substrates. One measurement setup is introduced and analyzed, and representative results are shown. The main enhancements of the derived measurement setup are the advanced focusing tools, the investigation of the sources of possible measurement errors, and the angular resolved measurement for detecting anisotropy in light scattering.

A theoretical study on conventional screens showed that optical dot gain can be predicted without printing any patches. Describing light scattering using a point spread function, only the measurement of one parameter is necessary, if ink transmittance and screen frequency are known. A prerequisite for this optical dot gain prediction is an accurate and reliable measurement of that parameter. The measurement setup presented in this work offers the possibility of such a measurement. Thus, this work is a contribution to improve first principle printer models by decoupling optical dot gain and other physical dot gain sources like ink spread.

Manufacture of membrane-electrode assembly of fuel cells by printing processes

In a context of fossil fuel shortage and hydrocarbon emission reduction, fuel cells are a promising solution for energy production. However, the cost of the energy they produce remains too expensive to be competitive and the conventional manufacturing processes used limit the scaling up of the production.

The core of Proton Exchange Membrane Fuel Cells (PEMFCs) is a stack composed of five constituents, in which the proton exchange membrane and the two gas diffusion layers can be considered as printing substrates, and the two catalyst layers can be printed by continuous printing processes.

This work demonstrated the relevance of flexography for manufacturing fuel cell components. It allows large production with low waste of expensive elements. Despite of the poor printability of the substrates, the catalyst layers printed by flexography reached similar electrochemical properties than those made by conventional processes.

Events

IFA 2013

Berlin, Germany
6 to 11 September 2013

IFA is a trade fair and congress which has been regularly taking place in Berlin since 1924. Today, with over 200 000 visitors and exhibitors from all over the world, this is the largest consumer electronics fair where both trade experts and the public can marvel at the latest technological developments.

IFA Berlin is a show for the professionals and technicians who wish to see the new inventtions made in electronic sector that incorporates home appliances, media and communication equipment and others.

The equipment displayed in the show is designed by implementing the advanced and latest technologies so that the attendees get the best range of lighting products in this platform. The show tends to bring the leading and established companies who are expert in designing and presenting these types of electrical equipment. The event has achieved to become the most important international field where a new scope and ray of hope is brought in to the mentioned sector. The show is the perfect place where the exhibitors are facilitated with new business dealings and also get a chance to enhance their business networks.

The IFA is equally known for its show program: the summer garden stage which features famous stars with their latest hits and on the various show stages, you can see nearly everything from cooking show to autograph sessions.

Print 2013

Chicago, USA
8 to 12 September 2013

A traditional event, PRINT 13 is the largest and most innovative global exhibition of digital, offset and hybrid technologies in 2013. Here, across the expansive show floor, attendees will come to explore demonstrations of the latest technologies, unique new applications, and products and services for every key facet of the graphic communications industry.

For the "Innovate, Integrate, Communicate" themed PRINT 13, demonstrating print driven multi-channel communications for the show's audience of 12 key market segments - from attendee and exhibitor communiqués, to the social media outreach - every aspect of the show has been crafted to stimulate 24/7 networking between industry experts and peers, and to facilitate connections among buyers and vendors to find the solutions that are just right for them.

Pack Print International

Bangkok, Thailand
28 to 31 August 2013

Since its debut in 2007 Pack Print International (PPI) has become Asia's premier event for all from the global printing and packaging sectors. Driven by the world-renowned and sectors' leading trade fairs drupa and Interpack, PPI will once again showcase technology, products and solutions serving the entire supply chain presented by international brand names and worldwide market leaders.

Together with seminars, technical presentations and a host of networking activities the 4th International Packaging and Printing Exhibition for Asia is a must-attend event for industry professionals to expand their business in the region. The 4-day exhibition will be open to trade visitors from 28 to 31 August 2013 at the Bangkok International Trade & Exhibition Centre (BITEC), Bangkok, Thailand.

FachPack 2013

Nürenberg, Germany
24 to 26 September 2013

FachPack is the event which combines the packaging and labeling process chain under one exhibition - from various materials, packaging machinery and finishing techniques to intralogistics.

According to the data from lasts years FachPack it represents one of the leading exhibitions for the European packaging industry.

This year more than 1 000 exhibitors and 35 000 visitors are expected to visit this international event where renowned packaging professional from Germany and abroad will present solutions for packaging, labeling and transporting products.

International Conference on Advanced ICT

Hainan, China
20 to 22 September 2013

The 2013 International Conference on Advanced Information and Communication Technology for Education - ICAICTE2013 will focus on using information and communication technology (ICT) in education mainly including practice, technology and theory.

ICAICTE 2013

The aim of this conference is to provide a worldwide forum, where the international participants can share their research knowledge and ideas on the recent and latest research on education in information and communication technologies and map out the directions for future researchers and collaborations and development.

Researchers and graduate students are welcomed to participate in the conference to exchange research findings in the frontier areas of Computers in Education.

Labelexpo Europe

Brussels, Belgium
24 to 27 September 2013

This year's Labelexpo Europe 2013 will be the largest event for the label and package printing industry in the shows 33 year history.

Event has through the years grown and it will occupy seven halls at Brussels Expo, covering around 31 500 m².

LABELEXPO EUROPE 2013

Labelexpo will this year, according to the organizers, showcase more products, more launches and more live demonstrations.

Beyond the presence of co-show CPP Expo 2013, which will amplify for show goers the array of package printing and converting technology plus related education and networking opportunities, PRINT 13 will also welcome 50 other individual co-located conferences, user-groups, meetings and events to be held in tandem with the global show.

PRINT 13 is expected to welcome more than 700 exhibitors who will fill the nearly 7 hectares of exhibit space, which has been designed to cater to a diverse spectrum of attendees including: In-Plant Printers, Transactional Printers, Package & Specialty Printers, Wide Format Printers & Imagers, Quick/Small Commercial Printers, Commercial Printers, Photo Imagers, Mailing & Fulfillment Professionals, Book Printers/Publishers, Newspaper Printers/Publishers, Marketing/Creative Services Professionals, and Media/Print Buyers.

Nanomaterials & Application

Portorož, Slovenia
22 to 26 September 2013

IOS
Institute for Environmental Protection and Sensors

NANOAPP is the most renowned scientific gathering of distinguished scientists in the field of nanomaterials. This event marks the first Nanomaterials conference for the past 20 years under the auspices IOS, Institute for Environmental Protection and Sensors Ltd. Such conferences offer scientists, world-wide, a forum to present state-of-the-art research and advanced discoveries in the emerging field of nanomaterials.

NANOAPP is a vehicle of exchange of ideas, techniques, experiments and applications in the exciting and rapidly developing field of nanomaterials, nanosciences and nanotechnologies. Conference will hopefully offer to a new breed of scientists and engineers a platform for presenting new ideas and future directions for the nanocommunity. NANOAPP advocates a unified approach in the assessment and management of potential human health, energy-related and environmental risks that may be associated with the use of nanomaterials and nanotechnologies.

This interdisciplinary conference will bring together people with shared interests in hybrid materials, including polymer chemists, physicists and engineers; biomaterials chemists, physicists and engineers; organic, inorganic and solid state chemists; sol-gel chemists; colloid chemists and physicists; zeolite, meso and microporous materials scientists; broad nano and materials scientists and many more.

SGIA Expo 2013

Orlando, Florida, USA
23 to 25 October 2013

SGIA EXPO

The 2013 SGIA Expo draws thousands of imagers from around the world to one expansive show floor. Attendees can see hundreds of exhibitors showcasing the broadest range of technology available on the international market.

In addition, this year we're bringing even more markets to the Expo floor to help attendees get the widest range of possibilities and opportunities available today.

The expo will cover digital imaging, screen printing, digital signage, finishing, pad printing, embroidery, graphics, textiles, signs, decals, garments, outdoor and transit advertising, fleet & vehicle graphics, advertising specialties, environmental graphics, fine art, printed electronics, membrane switch and much more.

Digital Print UK 2013

Birmingham, United Kingdom
5 to 7 November 2013

Digital Print UK is a new exhibition organized by Sign & Digital UK. The main focus of the event will be on the growing commercial digital printing market. It will showcase the very latest technologies, equipment, supplies and services for companies involved in digital printing, including production print, pre-press/media, print finishing, distribution, mailing and much more. It will also be an essential opportunity for those looking to enter this important market sector.

In addition to print production there will also be an area where visitors are able to view a wide range of applications/output that are enabled by digital printing technology and discuss the business opportunities they can bring.

Visitor targets will range from commercial printers keen on finding ways to take their business forward to brand owners, marketers and print specifiers who are keen to discover the latest in digital print technology and how these can fit into existing marketing campaign to drive return on investment.

Digital Print UK offers visitors the chance to see the latest technology in action, learn how to upgrade equipment, get more value from existing equipment, source the best deals and thrive in the digital printing market. In addition, there will also be free entry, free advice, free demos and free seminars.

WCPC Technical Conference

Swansea, Wales
18 to 19 November 2013

Welsh Center for Printing and Coating (WCPC) is a world renowned research center dedicated to advancing the understanding and productivity of all aspects of printing and coating.

WCPC enhances the understanding of the printing and coating processes, exploits novel manufacturing using printing and applies its scientific findings to the benefit of its global industrial partners. With extensive experience in packaging and graphics printing the WCPC has built on this knowledge and become a center for functional materials, plastic electronics and bio printing.

This traditional technical conference, taking place each November, is a unique opportunity to view the latest WCPC research in printing technology, to discuss the findings with researchers and to network with like-minded industrial delegates.

Packaging Innovations London 2013

London, United Kingdom
1 to 2 October 2013

Packaging Innovations is one of the leading trade fairs for packaging. It provides the perfect opportunity to source the latest innovations, listen to topical and informative seminars and network with your peers.

Attendees can see on the show innovative and environmentally friendly products and services for the industry.

It is an excellent opportunity to interact with new partners and suppliers and thus increase the own efficiency and productivity.

Packaging Innovations London has become the must attend event for designers, brand directors, marketing managers and communication directors.

These creative and forward thinkers use the show as an important part of the new product development process.

IFRA Expo 2013

Berlin, Germany
7 to 9 October 2013

For the first time IFRA Expo, the largest global trade exhibition for the news publishing and media industry, will take place in the German capital.

The largest global trade fair for the news publishing and media industry will be gathered on the grounds next to the Radio Tower in Berlin.

Exhibitors and trade visitors attending IFRA Expo in Berlin will find excellent opportunities to successfully establish and realize new business contacts. Part of the event will be strategic conferences and numerous workshops, featuring a number of topics of interest for the publishing sector

The Frankfurt Book Fair 2013

Frankfurt, Germany
9 to 13 October 2013

The Frankfurt Book Fair is the largest of its kind in the world - and the hallmark for global activities in the field of culture. It represents a meeting place for the industry's experts and the most important marketplace for books, media, rights and licenses worldwide.

FRANKFURTER BUCHMESSE

Be they publishers, booksellers, agents, film producers or authors - each year in October, they all come together and create something new.

CIC21

Albuquerque, New Mexico, USA
4 to 8 November 2013

Annual CIC conference is the premier technical gathering for scientists, technologists, and engineers working in the areas of color science and systems, and their application to color imaging. Participants represent disciplines ranging from psychophysics, optical physics, image processing, color science to graphic arts, systems engineering and hardware and software development. While a broad mix of professional interests is the hallmark of these conferences, the focus is color.

CICs traditionally offer two days of short courses followed by three days of technical sessions that include three keynotes, an evening lecture, and a vibrant interactive papers session. An endearing symbol of the meeting is the Cactus Award, given each year to the author(s) of the best interactive paper presentation.

InPrint Live 2013

Cologne, Germany
13 to 14 November 2013

InPrint is an exhibition for innovative print technology in industrial manufacturing. Manufacturing is undergoing a technological transformation and print

Deconstructing Media Convergence Conference

Salzburg, Austria
21 to 23 November 2013

The Innovation in Cultural and Creative Institutions (ICCI) Unit of the Center for Advanced Studies and Research (ICT&S Information and Communication Technologies & Society Center) will under the leadership of Professor Josef Trappel organize a conference focused on the topic "Deconstructing Media Convergence". The conference will take place at the University of Salzburg from the 21 to 23 of November 2013.

The concept of convergence was, until today, widely used as a buzzword for outlining the impact of digitalization. Challenging this concept this conference aims to bring together up to date research exploring the diversity of current developments in media and communications and draw attention to the inconsistencies in media convergence discourse. These concern changing values, practices, organizational settings and business models of cultural and creative industries and other institutions.

ICT&S Center

Together with acknowledged keynote speakers participants will have the opportunity to raise important key questions: What are the distinctions that are worth being looked at more closely in media and communication convergence research? In what way are services, technologies and texts being regrouped within the innovation process? How are tendencies of convergence (or de-convergence) expressed in the use of media? What are the implications of modularity and mass customization in the field of media and communications? What is the relationship between technological convergence and the organizational design? How do the users cope with the increased complexity that is characteristic of a converging (or de-converging) media landscape?

Program of the conference will focus on a variety of different topics: Materializations of convergence/de-convergence in different fields of media research and with regard to different technologies like the mobile phone, tablets or the networked television; Paradigmatic shifts in the conceptualization of convergence/de-convergence; Challenges and implications of convergence/de-convergence for the users like the increased demand for technical know-how and media expertise or the differentiation of the domestic media ensemble; Meaning production and cultural practices associated with media convergence/de-convergence; Convergence as rationale of mergers and acquisitions, or de-convergence as rationale of spin-offs and split-offs within/between media and ICT companies and associations; Analysis of increasing complexity of media and ICT ecosystems and value chains and many more.

WAN-IFRA India Expo 2013

Bangalore, India
11 to13 September 2013

The fourth edition of the biennial WAN-IFRA India Expo will take place at Bangalore International Exhibition Centre at Bengaluru from September 11 to 13. The Expo will be held along with the annual meet of publishers in the region titled 'Publish Asia'. WAN-IFRA Expo India, is the second-largest international exhibition in the world for trends and practices in the news-

paper printing and publishing industry. At the Expo, the industry's top technology and service providers will feature the entire newspaper production workflow.

The boundaries of innovation are constantly changing. Those who constantly monitor and realign themselves and their products are more likely to survive the market and the disruptive innovations than those who are not following them. This is especially visible in the news publishing business. Some of the most innovative products and services to help news publishers will be on display at the WAN-IFRA India Expo 2013.

The parallel conference tracks - Newsroom Summit for Editors and newsroom managers, Printing Summit for colleagues from production/technical departments and Crossmedia Advertising Summit for advertising and business managers - will offer inspiring case studies from around the world.

More than 35 speakers and 600 participants from more than 30 countries are expected to participate in this 21st annual WAN-IFRA event in India. It will offer opportunity to every news publishing executive to learn from and network with each other.

Expo is also offering 'Quick Learning Workshops' for all the qualified business visitors. Editors, technical directors, digital media experts and technology strategists from around the globe can share their experience which will change and improve their perception of publishing industry. Among many interesting topics to be discussed are: Online & Of-line Inserting and value addition to the Newspaper Products in Mailrooms, Eco-friendly Chemistry for Newspaper Production, Multimedia Newsrooms - Print, Broadcast & Digital, Publishing Profitably on Mobile, Smart technologies for the new challenges in cross media publishing and advertising, Simple, efficient, flexible & completely color managed workflow. An added value to Expo India will be a panel discussion on HTML vs App in news publishing.

JGAS 2013

Tokyo, Japan
2 to 5 October 2013

The Japan Graphic Arts Show (JGAS), a comprehensive international trade show on print media, (2 to 5 October 2013 in Tokyo), will demonstrate the latest products, technology, and services related to printing, paper converting and digital graphics. New products, cutting-edge technology and services related to prepress/pre-media, printing equipment, post-press, paper converting equipment, printing related materials, peripheral equipment will gather at JGAS2013. Various theme zones will be created, focusing on flexography, applications, IT/systems, environment, Japan Color and also a zone on advanced technology exhibiting research and study achievement by universities are scheduled.

Various seminar areas will be located within the exhibition venue and events such as panel discussions, lectures, and seminars will be held. Premier seminars by Japanese Society of Printing Science and Technology/Association of Graphic Arts Technology, AJPIA (All Japan Printing Industry Association) Forum 2013 organized by All Japan Printing Industry Association will also be held in the exhibition area.

technology is being added to a variety of processes across a wide spectrum of industries, from interior decor to medical, from automotive to ceramics, from 3D to printed electronics.

Featuring industrial inkjet, 3D and state of the art speciality print, InPrint is the perfect platform in which to connect with buyers looking for innovative technologies that will enhance, enrich and improve their manufacturing process.

Co-locating with Hannover Messe - the world's most important event for Industrial, manufacturing technology, InPrint represents a unique opportunity to access the lucrative industrial markets.

Beijing International Book Fair

Beijing, China
28 August to 2 September 2013

The Beijing International Book Fair is the largest publishing industry event in the Asian Market, and considering China is the most populous country in the world, it performs a pretty huge market, with enormous opportunities.

Much like the Arab market, the Chinese and, generally, Asian markets are starved for content to not only translate into their local languages, but also to purchase the rights to distribute English language content.

Over 200 thousand visitors made up of members of the trade and members of the public come to the show annually to see books from 56 different countries. The same, if not higher figures are expected in this year as well.

2013 also marks the second year in the newly build Beijing Convention Center. With all the first year kinks worked out in this state-of-the-art venue, the 2013 Beijing International Book Fair should continue its upward swing.

Call for papers

The Journal of Print and Media Technology Research is a peer-reviewed periodical, published quarterly by **iarigai**, the International Association of Research Organizations for the Information, Media and Graphic Arts Industries.

JPMTR is listed in Index Copernicus and Pira database (Smithers-Pira) and is on the way to be included in other major international databases and indexing services.

Authors are invited to prepare and submit complete, previously unpublished and original works, which are not under review in any other journals and/or conferences.

The journal will consider for publication papers on fundamental and applied aspects of at least, but not limited to, the following topics:

- Printing technology and related processes

    Conventional and special printing; Packaging, Fuel cells and other printed functionality; Printing on biomaterials; Textile and fabric printing; Printed decorations; Materials science; Process control

- Premedia technology and processes

    Color reproduction and color management; Image and reproduction quality; Image carriers (physical and virtual); Workflow and management

- Emerging media and future trends

    Media industry developments; Developing media communications value systems; Online and mobile media development; Cross-media publishing

- Social impact

    Environmental issues and sustainability; Consumer perception and media use; Social trends and their impact on media

Submissions for the journal are accepted at any time. If meeting the general criteria and ethic standards of scientific publishing, they will be rapidly forwarded to peer-review by experts of high scientific competence, carefully evaluated, selected and edited. Once accepted and edited, the papers will be printed and published as soon as possible.

There is no entry or publishing fee for authors. Authors of accepted contributions will be asked to sign a copyright transfer agreement.

Authors are asked to strictly follow the guidelines for preparation of a paper (see the abbreviated version on inside back cover of the journal). Complete guidelines can be downloaded from:

http://www.iarigai.org/publications/

Papers not complying with the guidelines will be returned to authors for revision.

Submissions and queries should be directed to:

journal@iarigai.org or office@iarigai.org

Guidelines for authors

Authors are encouraged to submit complete, original and previously unpublished scientific or technical research works, which are not under review in any other journals and/or conferences. Significantly expanded and updated versions of conference presentations may also be considered for publication. In addition, the journal will publish reviews as well as opinions and reflections in a special section.

Submissions for the journal are accepted at any time. Papers will be considered for publishing if meeting the general criteria and ethic standards of the scientific publication. When preparing a manuscript for JPMRT, please strictly comply with the journal guidelines, as well as with the ethic aspects. The Editorial Board retains the right to reject without comment or explanation manuscripts that are not prepared in accordance with these guidelines and/or if the appropriate level required for scientific publishing cannot be attained.

A - General

The text should be cohesive, logically organized, and thus easy to follow by someone with common knowledge in the field . Do not include information that is not relevant to your research question(s) stated in the introduction.

Only contributions submitted in English will be considered for publication. If English is not your native language, please arrange for the text to be reviewed by a technical editor with skills in English and scientific communication. Maintain a consistent style with regard to spelling (either UK or US English, but never both), punctuation, nomenclature, symbols etc. Make sure that you are using proper English scientific terms.

Do not copy substantial parts of your previous publications and do not submit the same manuscript to more than one journal at a time. Clearly distinguish your original results and ideas from those of other authors and from your earlier publications - provide citations whenever relevant. For more details on ethics in scientific publication, please consult:

http://www.elsevier.com/ethicguidelines.

If it is necessary to use an illustration, diagram, table, etc. from an earlier publication, it is the author's responsibility to ensure that permission to reproduce such an illustration, diagram etc. is obtained from the copyright holder. If a figure is copied, adapted or redrawn, the original source must be acknowledged.

Submitting the contribution to JPMTR, the author(s) confirm that it has not been published previously, that it is not under consideration for publication elsewhere and - once accepted and published - it will not be published under the same title and in the same form, in English or in any other language. The published paper may, however, be republished as part of an academic thesis to be defended by the author. The publisher retains the right to publish the printed paper online in the electronic form and to distribute and market the Journal (including the respective paper) without any limitations.

B - Structure of the manuscript

Title: Should be concise and unambiguous, and must reflect the contents of the article. Information given in the title does not need to be repeated in the abstract (as they are always published jointly).

List of authors: i.e. all persons who contributed substantially to study planning, experimental work, data collection or interpretation of results and wrote or critically revised the manuscript and approved its final version. Enter full names (first and last), followed by the present address, as well as the e-mail addresses.

Separately enter complete details of the corresponding author - full mailing address, telephone and fax numbers, and e-mail. Editors will communicate only with the corresponding author.

The title of the paper and the list of authors should be entered on a separate cover page (numbered as 0). Neither the title nor the names of authors can be mentioned on the first or any other following page.

Abstract: Should not exceed 500 words. Briefly explain why you conducted the research (background), what question(s) you answer (objectives), how you performed the research (methods), what you found (results: major data attained, relationships), and your interpretation and main consequences of your findings (discussion, conclusions). The abstract must reflect the content of the article, including all the keywords, as for most readers it will be the major source of information about your research. Make sure that all the information given in the abstract also appears in the main body of the article.

Keywords: Include three to seven relevant scientific terms that are not mentioned in the title. Keep the keywords specific. Avoid more general and/or descriptive terms, unless your research has strong interdisciplinary significance.

Abstract and keywords should be entered on a separate page, numbered as page 1. Do not continue with the main body of the text, regardless of the possible empty space left on this page.

Introduction and background: Explain why it was necessary to carry out the research and the specific research question(s) you will answer. Start from more general issues and gradually focus on your research question(s). Describe relevant earlier research in the area and how your work is related to this.

Methods: Describe in detail how the research was carried out (e. g. study area, data collection, criteria, origin of analyzed material, sample size, number of measurements, equipment, data analysis, statistical methods and software used). All factors that could have affected the results need to be considered. Make sure that you comply with the ethical standards, with respect to the environmental protection, other authors and their published works, etc.

Results: Present the new results of your research (previously published data should not be included). All tables and figures must be mentioned in the main body of the article, in the order in which they appear. Do not fabricate or distort any data, and do not exclude any important data; similarly, do not manipulate images to make a false impression on readers.

Discussion: Answer your research questions (stated at the end of the introduction) and compare your new results with the published data, as objectively as possible. Discuss their limitations and highlight your main findings. At the end of Discussion or in a separate section, emphasize your major conclusions, specifically pointing out scientific contribution and the practical significance of your study.

Conclusions: The main conclusions emerging from the study should be briefly presented or listed, with the reference to the aims of the research and/or questions mentioned in the Introduction and elaborated in the Discussion.

Introduction, Methods, Results, Discussion and Conclusions - as the scientific content of the paper - represent the main body of the text. Start numbering of these sections with page 2 and continue without interruption until the end of Conclusions. Number the sections titles consecutively as 1, 2, 3 ..., while subsections should be hierarchically numbered as 2.1, 2.3, 3.4 etc. Use Arabic numerals only.

Note: *Some papers might require different structure of the scientific content. In such cases, however, it is necessary to clearly name and mark the appropriate sections.*

Acknowledgments: Place any acknowledgments at the end of your manuscript, after conclusions and before the list of literature references.

References: The list of sources referred to in the text should be collected in alphabetical order on a separate page at the end of the paper. Make sure that you have provided sources for all important information extracted from other publications. References should be given only to documents which any reader can reasonably be expected to be able to find in the open literature or on the web. The number of cited works should not be excessive - do not give many similar examples. Responsibility for the accuracy of bibliographic citations lies entirely with the authors.

Please use only the Harvard Referencing System. For more information consult, e. g., the referencing guide at:

http://libweb.anglia.ac.uk/referencing/harvard.htm.

List of symbols and/or abbreviations: If non-common symbols or abbreviations are used in the text, you can add a list with explanations. In the running text, each abbreviation should be explained the first time it occurs.

Appendix: If an additional material is required for better understanding of the text, it can be presented in the form of one or more appendices. They should be identified as A, B, ... etc., instead of Arabic numerals.

Above sections are supplementary, though integral parts of the Scientific content of the paper. Each of them should be entered on a separate page. Continue page numbering after Conclusions.

C - Technical requirements for text processing

For technical requirement related to your submission, i.e. page layout, formatting of the text, as well of graphic objects (images, charts, tables etc.) please see detailed instructions at http://www.iarigai.org/publications/journal.

D - Submission of the paper and further procedure

Before sending your paper, check once again that it corresponds to the requirements explicated above, with special regard to the ethic issues, structure of the paper as well as formatting. Once completed, send your paper as an attachment to: **journal@iarigai.org**. You will be acknowledged on the receipt within 48 hours, along with the code under which your submission will be processed. The editors will check the manuscript and inform you whether it has to be updated regarding the structure and formatting. The corrected manuscript is expected within 15 days. At the same time the first (or the corresponding) author will be asked to sign and send the Copyright Transfer Agreement.

Your paper will be forwarded for anonymous evaluation by two experts of international reputation in your specific field. Their comments and remarks will be in due time disclosed to the author(s), with the request for changes, explanations or corrections (if any) as demanded by the referees. After the updated version is approved by the reviewers, the Editorial Board will consider the paper for publishing. However, the Board retains the right to ask for a third independent opinion, or to definitely reject the contribution. Printing and publishing of papers once accepted by the Editorial Board will be carried out at the earliest possible convenience.

The journal is publishing contributions
in the following fields of research:

- Printing technology and related processes
- Premadia technology and processes
- Emerging media and future trends
- Social imapcts

For details see the Mission statement inside

JPMTR is listed in

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