

# Journal of Print and Media Technology Research

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for thermochromic liquid-crystal printing inks

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Editor-in-Chief

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The International Association of Research  
Organizations for the Information, Media  
and Graphic Arts Industries

# Journal of Print and Media Technology Research

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To meet the need for a high quality scientific publishing platform in its field, the International Association of Research Organizations for the Information, Media and Graphic Arts Industries is publishing a quarterly peer-reviewed research journal.

The journal is fostering multidisciplinary research and scholarly discussion on scientific and technical issues in the field of graphic arts and media communication, thereby advancing scientific research, knowledge creation, and industry development. Its aim is to be the leading international scientific journal in the field, offering publishing opportunities and serving as a forum for knowledge exchange between all those interested in contributing to or learning from research in this field.

By regularly publishing peer-reviewed, high quality research articles, position papers, surveys, and case studies as well as review articles and topical communications, the journal is promoting original research, international collaboration, and the exchange of ideas and know-how. It also provides a multidisciplinary discussion on research issues within the field and on the effects of new scientific and technical developments on society, industry, and the individual. Thus, it intends to serve the entire research community as well as the global graphic arts and media industry.

The journal is covering fundamental and applied aspects of at least, but not limited to, the following topics:

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- ⊕ Media industry developments
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- ⊕ Social trends and their impact on media

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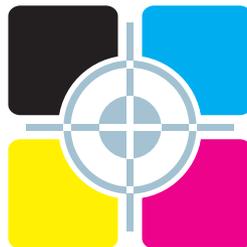
# Journal of Print and Media Technology Research

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## A letter from the Editor

*Gorazd Golob*

Editor-in-Chief

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The last issue of the Journal in 2018 is finally ready for publication. Unlike some of the previous ones, it contains four research papers, that again confirm the interdisciplinary nature of the field that we cover. In the first paper, the results of the study of printing materials are published, which through their properties, especially the optical density, influence the applicability of thermochromic printing inks based on liquid crystals. The second paper deals with the technical improvement of the system for direct laser engraving of printing plates for flexographic printing, which is needed to achieve a higher rendering resolution with the relatively large wavelength of CO<sub>2</sub> lasers used. The third paper presents an overview of the digital editions of Canadian magazines, both in respect to the strategic importance of the publisher on the market and the added value for the end user. The last paper is an overview of the impact and role of community radio in the natural disaster event. Namely, the effectiveness of the radio at the time of floods in Tamil Nadu, India is presented in detail. Despite geographical and thematic diversity, all authors of the papers feature an analytical approach, research curiosity and a comprehensive discussion of the topic.

In the Topicalities, the Associate Editor Markéta Držková prepared an overview of the CIE's activities and newly issued standards in the field of colorimetry and photometry. A summary of GWG (Ghent Workgroup) innovations is also presented, as well as an overview of selected projects, recommendations and publications contributed by the well-known German institute Fogra. The new books focus on colour, colour vision and colour management, as well as new publications from the field of Internet of Things, design, history, wettability, and new materials. There are also three doctoral theses presented. Simone Ganz dealt with printed transistors and methods for their characterization in the printing process in her thesis in the field of printed electronics, which she defended at TU Darmstadt. Dimitar Valtakari defended his thesis on wetting and electrical performance of fibre-based substrates and their modification by using various coatings and surface treatments at Åbo Akademi University, Turku. Ivana Jurić defended the thesis in the field of print uniformity and perceived quality by using different methods for analysis and evaluation of results at the University of Novi Sad. Topicalities round out with information on global upcoming events, symposia, seminars, and workshops from the areas covered by the Journal. We invite you to send information about interesting events and publications to [marketa.drzkova@jpmtr.org](mailto:marketa.drzkova@jpmtr.org).

Predictions for the future of the Journal are relatively good. The number of papers in review for the upcoming issues is promising. In 2019 we plan two special issues. The first one will be dedicated to Security printing, the other will be the result of the collaboration of two partner organizations – [iarigai](http://iarigai.org), which publishes the Journal, and the International Circle of Educational Institutes for

Graphic Arts Technology and Management, which will join this project. Some changes will also be made in the Editorial Board and the Scientific Advisory Board. All these changes will be introduced in order to improve the quality of the Journal and its visibility. This will also lead to the improvement of the status of the Journal among other indexed journals recognized by research and technical universities as appropriate for publishing the results of their research projects. The Journal has already been indexed in Scopus and in ESCI, it is already recognized as a scientific journal, but the final goal has not yet been achieved. In other words, we want to be comparable to the best and truly recognized in the innovative, broad, interdisciplinary field of Print and Media Technology. We will only succeed if we will be recognized by you, authors, readers and users of published research achievements as an appropriate publication. Naturally, this must be reflected in citing the published papers in other journals, where quotations confirm the relevance of the papers in the Journal and its impact.

Among the tasks for the year 2019, the online publication of the Journal is one of the important items. Currently, it is not fully comparable with other online published journals and therefore it should be improved, notably in better visibility and in direct access to individual papers.

In 2019, besides health, happiness, and success, I would like to wish you a lot of important research achievements and successful publications in the Journal.

Ljubljana, December 2018

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# The properties of printing substrates required for thermochromic liquid-crystal printing inks

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## Abstract

The color change of thermochromic liquid-crystal (TLC) printing inks occurs inside the microcapsules containing thermo-responsive material. It starts at the defined activation temperature ( $t_A$ ) and occurs in several degrees wide region above the  $t_A$  where the color changes throughout the whole visible spectrum, with the effect known as “color play”. Previous research showed that the “color play” effect of TLC printing ink is clearly visible if the ink is printed on a black substrate but on the white one no color can be observed. The presented research aims to answer what optical density ( $D$ ) of the substrate is needed for clear observation of the “color play” effect. The results show that mentioned effect of the TLC ink is observable if it is printed on grey substrate with  $D$  of at least 0.72. The research also shows that samples printed on uncoated black paper result in stronger temperature dependent optical properties of TLC printing ink compared to the samples printed on coated black paper. This effect is related to drying mechanism of TLC printing ink and absorption properties of printing substrate.

**Keywords:** optical properties of substrate, activation temperature, spectral reflectance, “color play” effect

## 1. Introduction

Thermochromic printing inks change color in dependence on the temperature. The color change of thermochromic liquid-crystal (TLC) printing inks occurs inside the microcapsules containing thermo-responsive material (Seeboth and Löttsch, 2008). It starts at the defined activation temperature ( $t_A$ ) and occurs in several degrees wide region above the  $t_A$  where the color changes throughout the whole visible spectrum from red over orange, yellow, green and blue to violet, the effect known as “color play” (Bamfield and Hutchings, 2010). The color activation region is frequently called “the color play interval” (Christie and Bryant, 2005). The width of activation regions can vary between 1 °C and 20 °C (Hallcrest, 2014) and can be somewhere between –30 °C and 100 °C, often with very high temperature sensitivity (Sage, 2011; White and LeBlanc, 1999). The TLC inks are colorless for the temperatures below or above the activation region. The transformation from colorless state to colored one takes place gradually when temperature reaches the lower limit of the activation region, i.e. the  $t_A$  value. Above the upper limit of the activation region the

purple color fades and the TLC ink becomes colorless again. The temperature needed to reach the colorless stage is called “the clearing point” (Hallcrest, 1991; Jakovljević, et al., 2017; Jakovljević, Lozo and Klanjšek Gunde, 2016). The TLC printing inks are finding many applications such as temperature indicators especially for packaging, security printing and brand protection (Sage, 2011; Hallcrest, 2014; Seeboth and Löttsch, 2008). In electronics, liquid crystals can be used to detect electrical shorts in circuits, open circuits and inoperative devices (Sage, 2011). The ability to monitor and map the temperature of a substantial area of surface can be a great advantage in detecting a fault or localizing activity manifesting themselves by temperature changes (Kakade, et al., 2009; Abdullah, et al., 2010; Christie and Bryant, 2005; Hallcrest, 2014).

Within “the color play interval”, the spectral color with given wavelength  $\lambda$  appears by reflection of the light on special structure of the liquid crystal when the elongated molecules inside the microcapsules develop a helical superstructure with pitch equal to  $\lambda$  of the light. As the temperature raises the length of helical pitches shrinks causing the shift of the peak in the reflectance

spectra towards shorter wavelengths, therefore the color of the material changes towards blue shades (White and LeBlanc, 1999; Seeboth and Löttsch, 2008; Hallcrest, 2014).

The “color play” effect of TLC printing ink is clearly visible if the ink is printed on a black substrate but on the white one no color can be observed (Jakovljević, et al., 2017). The reason for this is in the nature of the “color play” effect in TLC inks. The reflection on helical structure is rather weak effect thus most of the light transmits through the ink layer and hits the substrate. Here, it can scatter; on a white substrate majority of light scatters which practically totally obscure the light reflected on the molecular pitch. To prevent this, TLCs should be applied to black substrate which absorbs the light transmitted through the ink layer. Under such circumstances, the iridescent colors can be clearly seen (Jakovljević, et al., 2013). The effect depends on the amount of light reflected by the substrate, however, the currently available literature do not show what optical density ( $D$ ) of the substrate is needed for the observation of the “color play” effect. The presented research aims to answer it.

## 2. Experimental

### 2.1 Materials

Screen-printing TLC ink (SC-140-TC/0398; Printcolor, Switzerland) in a water-based formulation was used in this research. The  $t_A$  of the TLC printing ink was 25 °C and the activation region was from 25 °C to 30 °C. Outside of the activation region the ink is colorless. The clearing point of the ink is defined at 44 °C. All color changes in the TLC printing ink are considered to be reversible.

In this research white and black papers were used as printing substrates (Table 1). The white paper was a semi gloss paper digitally printed in six different  $D$ , defined as 20, 40, 50, 70, 90 and 100 percent tonal value fields of black ink. Nominal tonal values were sent to Konica Minolta C6000 printer using original Konica

Minolta black toner. Each one of these fields were measured for  $D$  (Table 2). The black substrates were uncoated and gloss-coated papers. The water-based TLC printing ink was screen-printed on all mentioned printing substrates, with two layers of ink (wet over dry), using SEFAR® PET 1500 43/110–80 W polyester mesh with 149  $\mu\text{m}$  openings. The prints were dried in a hot air tunnel at ~75 °C. Different activation phases of TLC ink printed on black uncoated paper and semi gloss paper digitally printed in different tonal values of black ink are shown in Figure 1.

Table 2: Optical densities of black ink digitally printed in different tonal values

Tonal value (%)	$D$
20	0.11
40	0.30
50	0.42
70	0.72
90	1.37
100	1.65

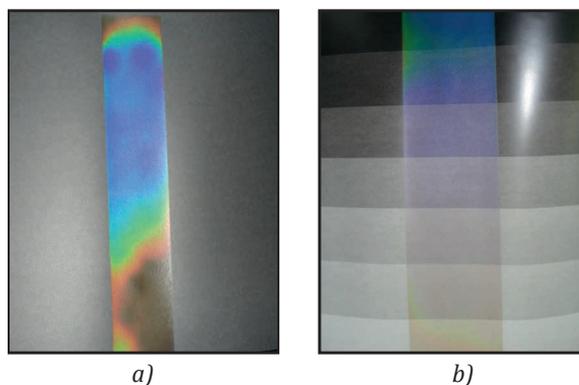


Figure 1: Different activation phases of TLC ink printed on uncoated black paper (a) and paper digitally printed in different tonal values of black ink (b)

### 2.2 Measurements

Temperature dependent optical properties of printed samples were determined by spectroscopic measurements. The “color play” effect of TLC ink was quanti-

Table 1: Properties of paper printing substrates used in the research

Producer	Paper color	Surface description	Thickness ( $\mu\text{m}$ )	Basis weight ( $\text{g}/\text{m}^2$ )
Mondi	white preprocessed (Table 2)	semi-gloss coated	162	160
Hahnemühle	black	uncoated	232	160
BYK	black	gloss coated	350	260

fied by spectral reflectance of the printed samples, measured in dependence on temperature. The temperature-dependent iridescent colors were calculated and presented as CIELAB colorimetric values. The D50 illuminant and 2° standard observer were taken into account, as recommended for graphic arts applications (Schanda, 2007).

For reflectance measurements, the 8°:di measuring geometry was obtained using Lambda 950 (PerkinElmer, USA) spectrometer with 150 mm wide integrating sphere. This measuring geometry allows illumination at 8°, where the light reflected in all directions is detected (diffusely reflected light with specular direction included). The reflectance spectra were measured in the 350–850 nm spectral region ( $\Delta\lambda = 1$  nm).

Optical densities of the samples digitally printed in different tonal values of black ink were measured using spectrometer i1 (X-Rite), density status T.

The printed samples were heated on the surface of water heated block (EK Water Blocks; EKWB d.o.o., Slovenia). Its base plate is made of copper coated with a nickel layer and polished. The thermostatically controlled water circulates through very thin acrylic channels inside this plate, transferring the heat from the water through the plate to the sample (Jakovljević, et al., 2017). The measurements were accomplished in the temperature range from 26 °C up to 79 °C using 0.5 °C, 1 °C, or 2 °C temperature steps, as required by the dynamics of spectral changes.

### 3. Results and discussion

The temperature dependent colorimetric properties of the applied TLC ink were first analyzed on the layers printed over the white preprocessed paper. Spectral reflectance ( $R$ ) of the TLC ink printed on printing substrate with different  $D$  are shown in Figures 2 to 7.

Figure 2 shows reflection spectra of TLC printing ink applied on printing substrate with  $D$  of 0.11. Compared to the samples with higher  $D$ , the overall reflection of light from TLC ink is the highest which is the result of reflectance on the substrate and the TLC layer causes only a negligible effect. The reflection peak appears better on printing substrate with  $D$  of 0.30 (Figure 3). At higher  $D$  the effect of the TLC ink increases (Figures 3 to 7).

At a selected temperature, the reflectance peak appears at approximately equal wavelengths, regardless of the  $D$  of the applied printing substrate. The intensity of the peaks,  $R_{\max}$ , increases as the  $D$  of the printing substrate increases, reaching its maximum at  $D$  of 1.65 (100 % covered by black, Figure 7).

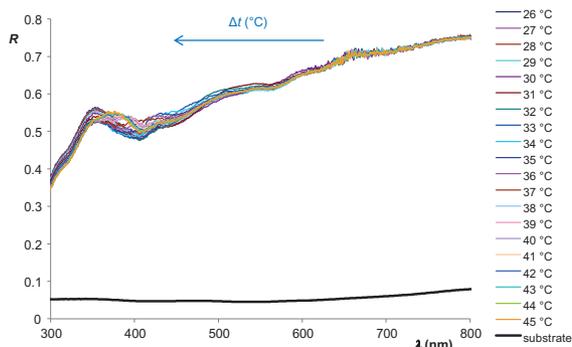


Figure 2: Spectral reflectance of TLC ink printed on substrate with  $D$  of 0.11

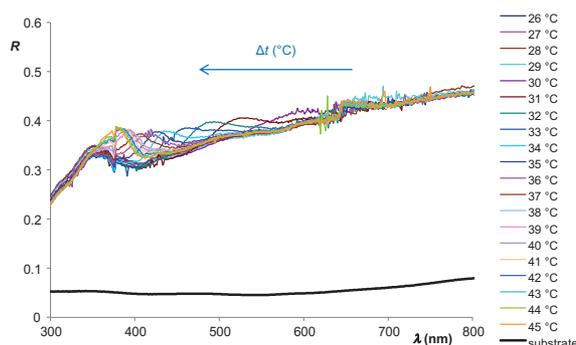


Figure 3: Spectral reflectance of TLC ink printed on substrate with  $D$  of 0.30

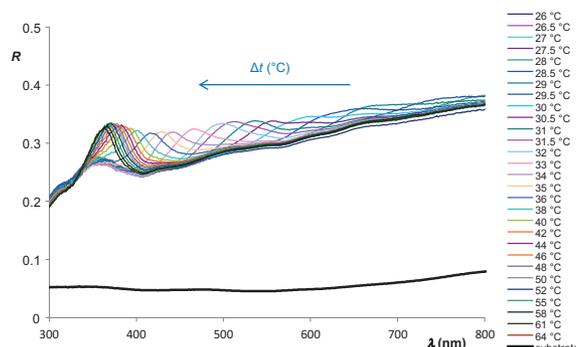


Figure 4: Spectral reflectance of TLC ink printed on substrate with  $D$  of 0.42

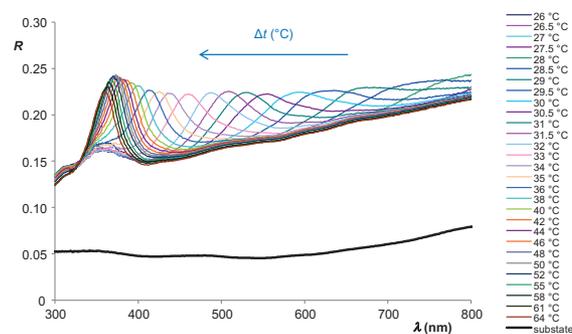


Figure 5: Spectral reflectance of TLC ink printed on substrate with  $D$  of 0.72

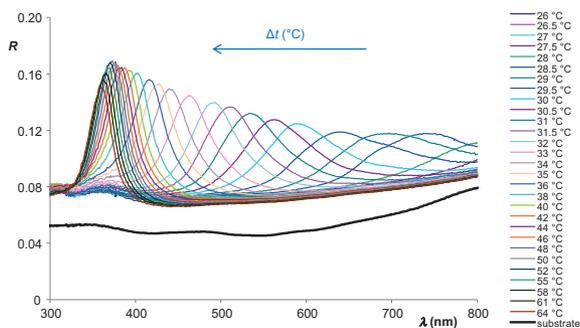


Figure 6: Spectral reflectance of TLC ink printed on substrate with D of 1.37

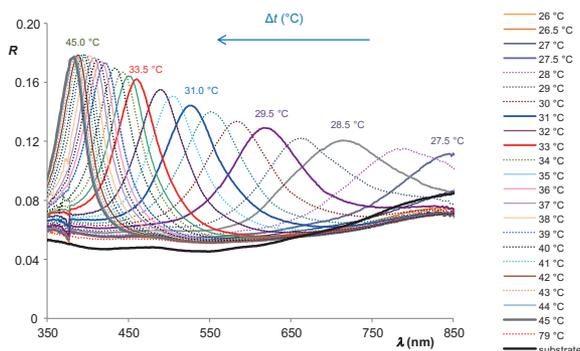


Figure 7: Spectral reflectance of TLC ink printed on substrate with D of 1.65

The CIELAB color values were calculated from the corresponding reflectance spectra and are shown in Figure 8. Printing substrate with  $D$  of 0.11 results in tightly closed curve in  $(a^*, b^*)$  graph. The curve extends only within the first quadrant of  $(a^*, b^*)$  graph, where colorimetric values are  $a^* > 0$  and  $b^* > 0$ . This indicates very weak thermochromic effect of TLC printing ink. With higher  $D$  of the substrate, the color loop becomes larger and crosses the boundary of the first quadrant at  $D$  of 0.42 where  $a^*$  values extend also slightly towards green ( $a^* < 0$ ). The first occurrence of a closed curve that extends across all quadrants of  $(a^*, b^*)$  graph appears at  $D$  of 0.72. This is the lower limit for  $D$  of printing substrate where the TLC layer could expose the entire “color play” effect. Printing substrates with higher  $D$  enable even stronger thermochromic effect of TLC printing inks, especially in the blue-green region ( $a^* < 0$  and  $b^* < 0$ ).

The results on Figure 8 show that the red-yellow shades of the TLC layer appear also on substrates with lower  $D$ , but much higher values are needed for resolving the blue-green colors. The results presented in  $L^*(t)$  graph (Figure 9) show direct temperature dependent properties of TLC printing ink. Temperature activation region of the ink is seen very clearly.  $L^*(t)$  graph shows a single peak at the same temperature (30.5 °C)

for all measured samples, i.e. at all  $D$  of the substrate. Temperature dependent effect is barely noticeable for the sample with  $D = 0.11$ . First sign of temperature dependent effect is visible in  $L^*(t)$  graph for sample with 0.30, while  $D$  of 1.65 results in the strongest effect of all samples. The effect of different  $D$  of the printing substrate printed digitally with black ink on the differences in lightness ( $\Delta L^*$ ) of the TLC ink is shown in Table 3.

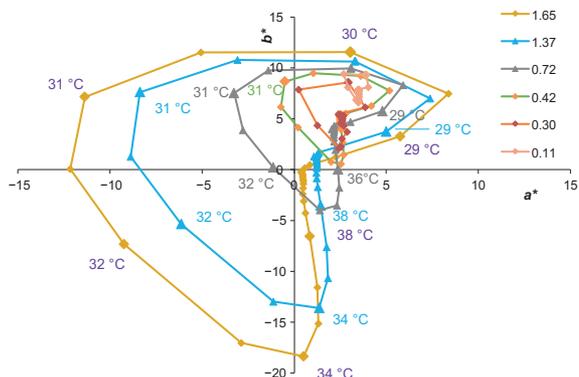


Figure 8: CIELAB  $(a^*, b^*)$  color values of TLC printing ink printed on substrates with different  $D$

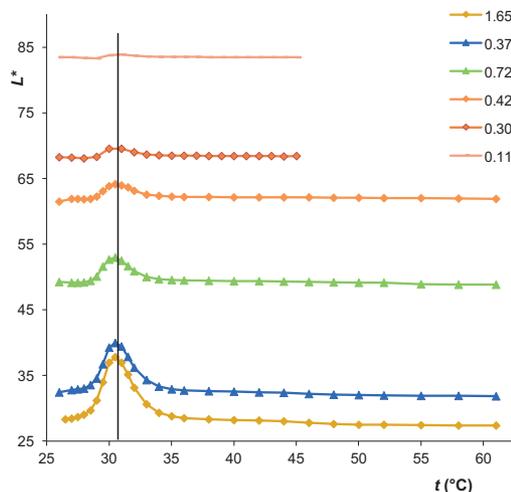


Figure 9: CIELAB  $L^*(t)$  temperature dependent color values of TLC printing ink printed on substrates with different  $D$  given in the legend

Table 3: Temperature dependent characteristics of TLC printing ink measured from the peak in the  $L^*(t)$  graph;  $\Delta L^*$  is the relative height of the peak

Tonal value (%) / $D$	$\Delta L^*$	FWHH (°C)
20 / 0.11	0.04	–
40 / 0.30	1.03	3.0
50 / 0.42	1.90	2.5
70 / 0.72	3.50	3.0
90 / 1.37	8.11	3.0
100 / 1.65	10.44	3.0

Full width at half height of the  $L^*(t)$  peak (FWHH) is almost the same for all samples. Presented results show that different  $D$  do not affect the activation region of the ink, but  $\Delta L^*$  changes as shown in Table 3.

The TLC layers printed on the uncoated black paper show stronger “color play” effect than the samples printed on the coated black paper (Figures 10 and 11). The  $(a^*, b^*)$  values obtained from the layer on the uncoated paper are larger and the effect gives larger color gamut (Figure 10) and stronger peak in the  $L^*(t)$  graph (Figure 11).

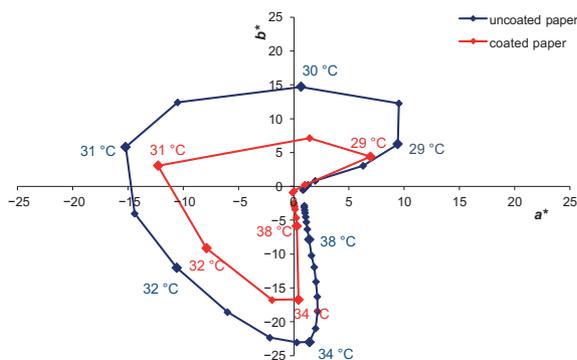


Figure 10: CIELAB  $(a^*, b^*)$  color values of TLC ink printed on black uncoated and coated paper

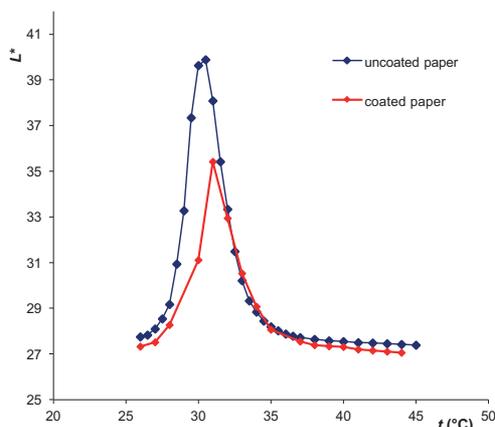


Figure 11: CIELAB  $L^*(t)$  color values of TLC ink printed on black uncoated and coated paper

For coated paper, the maximum value of  $L^*$  is 9.01 at 31 °C and for uncoated paper it is 12.41 and appears at 30.5 °C. These results confirm that the entire “color play” effect is obtained for the layer on both black substrates, but it is stronger on the uncoated one. The reasons for the above shown effect were analyzed by the help of SEM analysis (Figure 12). The micrographs of the TLC layer on the uncoated black paper shows microcapsules containing thermochromic material (Figure 12b), but such a structure is not visible for the layer on the coated black paper (Figure 12a). Appearance of microencapsulated pigments on the surface of the TLC layer can be explained taking into account the drying mechanism of the ink and absorption of ink into the printing substrate. Uncoated black paper is more absorbent than the coated one, therefore less binder remains in the dry ink layer. The large microcapsules (at least 10  $\mu\text{m}$  in size) cannot protrude the substrate and remain in the ink layer and are, in general, larger than the thickness of the remaining binder. This is why the microcapsules shapes are seen on the SEM micrographs. The coating on the paper prevents penetration of the binder into the substrate, thus it practically entirely covers the microcapsules (Figure 12a). It is reasonable to conclude that the “color play” effect in TLC pigments is weaker when they (i.e. the microcapsules) are well covered by the binder and stronger when they are on the top of the layer, practically with no covering of the binder. The TLC ink printed on uncoated black paper caused more revealed microcapsules after drying compared to coated paper. Microcapsules with a smaller amount of binder around them result in stronger reflection of light from helical superstructure of TLCs. In the case of coated paper, part of the incident light is most likely scattered due to the surface layer of the binder, leaving smaller portion of light which causes reflection from TLCs.

#### 4. Conclusions

The results confirm that “color play” effect of the TLC inks is observable if it is printed on grey substrate with  $D$  of at least 0.72. The larger  $D$  gives stronger effect. The “color play” effect of TLC printing ink is best shown on

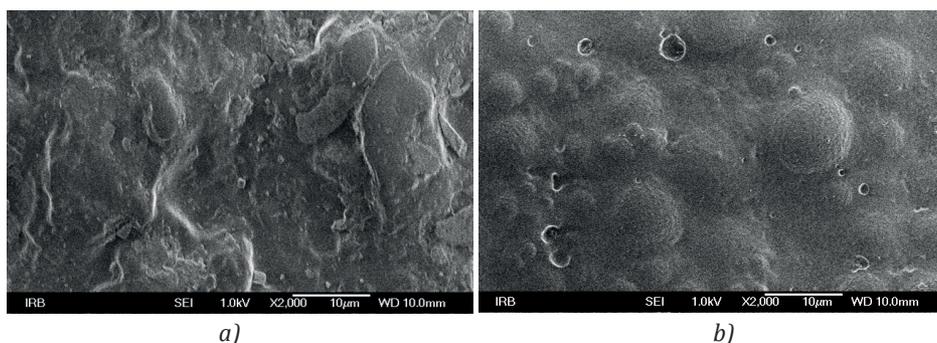


Figure 12: SEM analysis of TLC ink printed on coated (a) and uncoated (b) black paper

( $a^*$ ,  $b^*$ ) graph. The entire effect is visible if this curve extends across all four quadrants. Samples printed on substrate with  $D$  between 0.30 and 0.42 have resulted in closed ( $a^*$ ,  $b^*$ ) curves, but extending only within the first quadrant of ( $a^*$ ,  $b^*$ ) plane.

Appearing of blue and green shades needs higher  $D$  of the printing substrate, at least 0.72; larger  $D$  gives more deep green and blue colors. This effect was confirmed by spectroscopic measurements on preprinted white paper, showing the strongest reflection peak in each curve for the sample with  $D$  of 1.65 (100 % black). When comparing the black papers, the samples printed on uncoated black paper result in stronger colors

than the samples printed on coated black paper. This effect is related to the amount of binder covering the TLC pigments (microcapsules). This amount is smaller for uncoated substrate and larger for coated one and depends on drying of the ink on the substrates with different absorption properties. Microcapsules are more revealed if there is less binder around them. The effect of light reflection from helical superstructure of TLCs is stronger if the ink is printed on uncoated paper. The binder present around microcapsules after drying on coated paper represents a kind of light barrier, so the smaller amount of incident light causes reflection from the TLCs. The result is weaker reflection, i.e. "color play" effect of TLC ink printed on coated paper.

## References

- Abdullah, N., Talib, A.R.A, Jaafar, A.A., Salleh, M.A.M. and Chong, W.T., 2010. The basics and issues of thermochromic liquid crystal calibrations. *Experimental Thermal and Fluid Science*, 34(8), pp. 1089–1121. <http://dx.doi.org/10.1016/j.expthermflusci.2010.03.011>.
- Bamfield, P. and Hutchings, M.G., 2010. *Chromic phenomena: technological applications of colour chemistry*. 2<sup>nd</sup> ed. Cambridge: The Royal Society of Chemistry.
- Christie, R.M. and Bryant, I.D., 2005. An evaluation of thermochromic prints based on microencapsulated liquid crystals using variable temperature colour measurement. *Coloration Technology*, 121(4), pp. 187–192. <https://doi.org/10.1111/j.1478-4408.2005.tb00271.x>.
- Hallcrest, 1991. *Handbook of thermochromic liquid crystal technology*. Glenview, IL: Hallcrest.
- Hallcrest, 2014. *Handbook of thermochromic liquid crystal technology*. Glenview, IL: LCR Hallcrest. [pdf] Available at: <[http://www.hallcrest.com/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core\\_Download&EntryId=280&language=en-US&PortalId=0&TabId=163](http://www.hallcrest.com/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=280&language=en-US&PortalId=0&TabId=163)> [Accessed 30 March 2016].
- Jakovljević, M., Friškovec, M., Klanjšek Gunde, M. and Lozo, B., 2013. Optical properties of thermochromic liquid crystal printing inks. In: *Proceedings of Printing Future Days: 5<sup>th</sup> International Scientific Conference on Print and Media Technology*. Chemnitz, Germany, 10–12 September 2013. Berlin, Germany: VWB, pp. 169–173.
- Jakovljević, M., Lozo, B. and Klanjšek Gunde, M., 2016. Packaging added value solutions by thermochromic liquid crystal-based printed labels. In: *Printing for Fabrication: the 32<sup>nd</sup> International Conference on Digital Printing Technologies (NIP)*. Manchester, UK, 12–16 September 2016. Springfield, USA: IS&T.
- Jakovljević, M., Lozo, B. and Klanjšek Gunde, M., 2017. Spectroscopic evaluation of the colour play effect of thermochromic liquid crystal printing inks. *Coloration Technology*, 133(1), pp. 81–87. <https://doi.org/10.1111/cote.12257>.
- Kakade, V.U., Lock, G.D., Wilson, M., Owen, J.M. and Mayhew, J.E., 2009. Accurate heat transfer measurements using thermochromic liquid crystal. Part 1: Calibration and characteristics of crystals. *International Journal of Heat and Fluid Flow*, 30(5), pp. 939–949. <http://dx.doi.org/10.1016/j.ijheatfluidflow.2009.04.007>.
- Sage, I., 2011. Thermochromic liquid crystals. *Liquid Crystals*, 38(11–12), pp. 1551–1561.
- Schanda, J. ed., 2007. *Colorimetry: understanding the CIE System*. New Jersey: John Wiley and Sons, Inc.
- Seeboth, A. and Löttsch, D., 2008. *Thermochromic phenomena in polymers*. Shrewsbury, UK: Smithers Rapra Technology Limited.
- White, M.A. and LeBlanc, M., 1999. Thermochromism in commercial products. *Journal of Chemical Education*, 76(9), pp. 1201–1205. <http://dx.doi.org/10.1021/ed076p1201>.

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# Improvement of the optical system in direct laser engraving to increase the resolution of printing plates

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## Abstract

At the present time the direct laser engraving (DLE) technology is the most economical and ecological one to produce flexographic printing plates. But small resolution caused by lasers with a wavelength of 10.6  $\mu\text{m}$  led to insufficient quality of final print production. Thus an actual problem is the resolution increasing of DLE process, which will lead to increased quality of prints. The aim of this paper is to present the method of resolution increasing of direct engraving equipment. The calculation and design of an optical telescope intended to increase the resolution of the laser apparatus has been carried out. Testing of the performance of the telescopic system has been performed by calculating the distribution of the intensity of radiation in the focus of the optical system of the apparatus with and without a telescope with the help of a specialized application for optical designing, ZEMAX. A range of drawings and the simulation of a 3D model of the telescope have been done in the SolidWorks design application based on the conducted calculations of the optical system. The telescope then has been made and incorporated into the laser-optical system of the laser engraving device. The quality of focusing of the optical system before and after the modernization has been studied by engraving on a thermo sensitive film of a specially created test-scale that allows determining the convex caustic shape of the beam after its focusing by the optical system. During the comparative analysis of the laser engraving device before and after the optical system upgrade using a test image, it has been found that its technical parameters with respect to the resolution have been doubled.

**Keywords:** flexographic printing form, focusing spot, telescopic system, halftone resolution

## 1. Introduction and background

Historically, direct engraving of flexographic printing plates has begun the use of lasers in printing industry. This technology has long been widely used in flexographic printing enterprises for rubber printing plates manufacturing (Nykyrui, 2009). In this case, the equipment that works according to this method allows the engraving of closed images, that is, to form an infinite pattern (Bukwaits, 2006; Vefers and Apps, 2006). The essence of the technology of direct laser engraving (DLE) is the formation of printing elements by direct processing of the original material (rubber or special polymers) by a laser beam, with the ready-to-use plate obtained immediately after the laser treatment (Graßler, 2011).

The vast majority of manufacturers of DLE devices are using CO<sub>2</sub> lasers with an approximate radiation wavelength  $\lambda = 10.6 \mu\text{m}$ , giving up high resolution in favor

of processing a wide range of materials. The essential disadvantage of CO<sub>2</sub> lasers is that they do not allow the recording of image with the screen ruling required for the current quality level of flexo printing, such as 180 lpi. However, this does not mean that the method of direct engraving is not suitable for high-quality flexographic printing. By choosing a laser with a shorter wavelength, it is possible to provide the necessary conditions for high-resolution laser engraving, and therefore, to realize the production of high screen ruling of flexographic plates. The most suitable for this purpose is to choose a near infrared (NIR) laser whose wavelength of radiation is  $\lambda = 1.064 \mu\text{m}$ . Under other equal conditions in a system with such a laser, it would be possible to obtain a spot of focused laser radiation ten times smaller than that of a CO<sub>2</sub> laser. Choosing a computer-to-plate (CtP) device designed for laser ablation mask system (LAMS) technology will allow upgrade of the system to a smaller focusing spot by upgrading the optical unit. Obviously, the device is used as the basis,

in the software-hardware part of which there is the ability to work with the resolution of 5080 dpi. This will fulfil all modern requirements for the manufacturing process of flexographic plates. But because of the obvious prospect of using a fiber laser to manufacture flexographic plates, the introduction of this technology has been significantly hampered by a number of circumstances associated with materials for laser engraving that are sensitive to wavelengths of 1.06  $\mu\text{m}$ . First, the spectrum of materials here is substantially fewer than for a  $\text{CO}_2$  laser. Secondly, materials suitable for the production of flexographic plates in terms of printing properties (ink resistance, hardness, circulation durability) were practically inaccessible for a long time. In addition, these materials were preferably less sensitive to the wavelengths of 1.06  $\mu\text{m}$  than to 10.60  $\mu\text{m}$ , which led to lower productivity and caused the need for high-power lasers (Laskin, et al., 2001).

In order to provide the features of direct engraving technology that are acceptable for today's printing quality level, it is necessary to have plate materials with sufficient sensitivity for the NIR range (in particular, the wavelength of 1.06  $\mu\text{m}$ ) and to meet other requirements of the printing process (ink resistance, circulation durability, hardness, etc.). Such materials for DLE can be: BöttcherFlex 787 BN (SBR); BöttcherFlex 732 BN (EPDM), plates for DLE of the companies ContiTech, Kodak, etc. (Böttcher systems, 2011; ContiTech, 2017; Kodak, 2013).

In order to successfully implement the DLE technology in the production process of flexo printing plates, a detailed study of the influence of the characteristics of optical focusing systems on the technological parameters of engraving is required. Since the effectiveness of most laser processing processes is largely determined by the concentration of energy in the focusing spot, the main attention in the design of focusing systems should be paid to ensuring the minimum size of the focusing spot.

However, in order to improve the technology of manufacturing flexo printing plates by DLE method, it is necessary to increase the resolution of laser equipment. In its turn, in order to increase the resolution, it is necessary to reduce the size of the processed pixel, by reducing the minimum amount of engraving. This can be achieved by reducing the focusing spot, that is, beam waist diameter.

## 2. Materials and methods

The LaserGraver equipment for the production of flexographic printing plates, which was equipped with a fiber laser with the radiation wavelength of 1.06  $\mu\text{m}$ ,

was chosen to improve DLE technology. The parameters of the focusing system were calculated based on the following laws of optics. Obtaining the smallest focusing spots and the highest irradiation intensity is possible only in beams with a relatively simple configuration with the lowest order of transverse electromagnetic mode ( $\text{TEM}_{00}$ ). The intensity distribution in the resonator mode of the lowest order TEM,  $I_{00}$  has a Gaussian form given by Equation [1]:

$$I_{00}(R) = \exp(-2R^2/w^2) \quad [1]$$

where  $R$  is a radial coordinate and  $w$  is a radius of the beam cross section, on which the  $\text{TEM}_{00}$  mode intensity is  $1/e^2$  times smaller than the intensity on the axis of the beam (Ready, 1971),  $e$  being the Euler's number i.e. the base of the natural logarithm. If such beam is focused on the optical axis in focus of the lens, then the diameter of the focus spot  $d_k$  is determined by Equation [2] (Grigoryants, Shyganov and Misurov, 2006):

$$d_k = d_w + d_a \quad [2]$$

where the component  $d_w$  is conditioned by the divergence of the beam, and  $d_a$  is conditioned by aberrations (Equations [3] and [4]).

$$d_w = FW \quad [3]$$

$$d_a = \delta q'/2 \quad [4]$$

where  $F$  is a focusing distance,  $W$  (Equation [5]) is a divergence of the beam and  $\delta q'$  is a transverse spherical aberration.

$$W = 1.22 \varepsilon \lambda / D \quad [5]$$

where  $\varepsilon$  is an empirical coefficient that takes into account the divergence increasing in the resonator (the value of this coefficient is determined by measuring the true divergence of the laser beam),  $\lambda$  is the wavelength of the radiation and  $D$  is the width of the laser beam that enters in the focusing lens. Consequently, the diameter of the focused spot that is due to the beam divergence can be determined by Equations [6] and [7]:

$$d_w = 1.22 \varepsilon \lambda F / D \quad [6]$$

$$\delta q' = \sum_{k=1}^n \frac{P_k (D/2)^3}{2F^2} \quad [7]$$

where  $n$  is the number of optical surfaces, and  $P_k$  is the parameter, which is calculated according to Equation [8]:

$$P_k = (\Delta \alpha_k / \Delta \mu_k)^2 \Delta \alpha_k \mu_k \quad [8]$$

where  $\Delta\alpha_k = \alpha_{k+1} - \alpha_k$ ,  $\alpha_k$  is a tangent of the angle of a peripheral laser beam after its refraction on the optical surface;  $\Delta\mu_k = \mu_{k+1} - \mu_k$ ;  $\mu_k = 1/n_k$  is a reciprocal of the refractive index.

The formula to determine a focus spot size, taking into account the beam divergence and aberrations, then can be written as Equation [9]:

$$d_k = \frac{1.22\epsilon\lambda F}{D} + \frac{P^* D^3}{32F^2} \quad [9]$$

where  $P^* = \sum_{k=1}^n P_k$

We can increase the width of the laser beam by factor  $V$  by its passing through a telescope, which transfers the input parallel beam of rays with the cross section diameter  $D_1$  into the output parallel beam with a bigger cross section diameter  $D_2$ .

$$V = \frac{F_1}{F_2} = \frac{D_1}{D_2} \quad [10]$$

Radii of lens surface curvature and its focusing distance are related by the following ratio:

$$\frac{n_0}{F} = (n - n_0) \left( \frac{1}{r_1} - \frac{1}{r_2} \right) + \frac{(n - n_0)^2}{nr_1 r_2} d_\ell \quad [11]$$

where  $n$  is refraction index of the lens material,  $n_0$  is refraction index of the medium surrounding,  $d_\ell$  is the thickness of the lens (the distance between the spherical surfaces along the optical axis),  $r_1$  is the curvature radius of the surface, which is closer to the light source (further from the focusing area, hereinafter the first surface),  $r_2$  is the curvature radius of the surface, which is further from the light source (closer to the focusing area, hereinafter the second surface). In Equation [11], for the  $r_1$  radius the sign is taken as plus if the surface is convex, and minus if concave. For  $r_2$  on the contrary, we use plus if it is concave, and minus if it is convex. For a thin lens, when the distance between the vertices of the surfaces (the thickness of the lens)  $d_\ell$  is much smaller than the radius of curvature of the surfaces  $r_1$  and  $r_2$ , we accept the condition  $d_\ell = 0$ .

Using Equation [11] and appropriate mathematical operations, the ratio of radii of curvature  $r_1$  and  $r_2$  for the twin-curved and flat-convex lenses were determined. For a twin-curved lens, the ratio between  $r_1$  and  $r_2$  is (Equation [12]):

$$r_1 = - \frac{(n - 1)r_2 + d_\ell \frac{(n - 1)^2}{n}}{\frac{r_2}{F} + (n - 1)} \quad [12]$$

For a flat-convex lens, the ratio between  $r_1$  and  $r_2$  will look the same but with an opposite sign (Equation [13]):

$$r_1 = \frac{(n - 1)r_2 + d_\ell \frac{(n - 1)^2}{n}}{\frac{r_2}{F} + (n - 1)} \quad [13]$$

To test the performance of the telescopic system, the calculation of the radiation intensity distribution in the focus of the lens for basic and upgraded optical schemes was performed using a specialized ZEMAX optical design program (Zemax, LLC, USA).

The quality of focusing of the optical system before and after modernization was studied by engraving of test-scale No1 on a thermosensitive film. This test scale (Figure 1) consists of a 1-pixel line image (1 pixel = 10  $\mu\text{m}$  at the imaging resolution of 2540 dpi) and it allows determining the caustic shape of the beam waist after focusing it by the optical system. The test scale was engraved on a black mask layer of thermosensitive polyethylene terephthalate / poly l-lysine (PET/PLL) film at different values of the lens focus position relatively to the material surface ( $z_f$ ).



Figure 1: Test scale No1 to determine the shape of beam waist

The images of the test scale No1 received on the PET/PLL film were analyzed with the help of Flexometer software-hardware complex equipped with an optical microscope and the width of lines  $s$  was measured.

The optical system of LaserGraver equipment shown in Figure 2, selected for the modernization, consists of ytterbium fiber laser, modulator, optical trap, lens, and beam focusing mechanism. The laser beam focuses on the printing form, using the tele-centric lens and beam focusing mechanism. For convenience, we will call this optical system as “basic”.

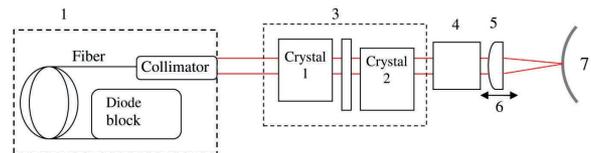


Figure 2: Schematic diagram of the basic optical system: (1) laser, (3) modulator, (4) optical trap, (5) lens, (6) movement mechanism, (7) printing form

### 3. Improvement of engraving system

Taking into account that the design parameters of the laser resonator and the laser collimator are determined by the equipment manufacturer, their initial characteristics are unaltered. Obviously, there are two ways to reduce the focusing spot – decrease the focus-

ing distance of the lens and increase the input aperture of the beam (see Equation [10]). It is not advisable to reduce the focusing distance of the lens as it causes the structural changes of the focusing system, the system of output of combustion products, etc. Therefore, it is optimal to increase the input aperture of the laser beam by installing a telescope that will provide a small diameter of the focusing spot, and hence the higher resolution of the system. Since the input and output beams of the telescope are parallel, it is possible to place the telescope between the collimator and the modulator, the distance between which will determine the maximum overall dimensions of the telescope.

LaserGraver resolution is 2540 dpi. To achieve the value of 5080 dpi, the size of the pixel should be twice smaller during engraving. This can be achieved by halving the diameter of the beam in the focusing area. Consequently, according to Equation [6], it is necessary to double the diameter of the cross section beam in the lens, using the telescopic system with magnification  $V = 2$  according to Equation [10].

It should be noted that increasing of beam aperture results in decreasing of the length of the longitudinal spherical aberration  $\Delta F$  and, accordingly, in decreasing of the constriction length (see Equation [7]), so the depth of engraving is reduced.

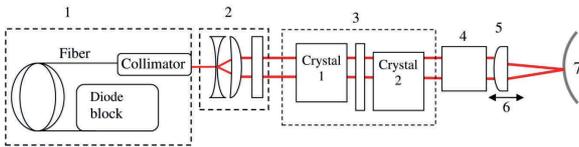


Figure 3: Schematic diagram of modernized optical system: (1) laser, (2) telescope with compensator, (3) modulator, (4) optical trap, (5) lens, (6) movement mechanism, (7) printing form

Figure 3 shows a schematic diagram of the optical system, which, unlike the basic optical system, includes telescope with compensator. For convenience, we will call this optical system as “modernized”. As the telescope is located between the laser and the modulator, its maximum length is 30 mm.

The magnification of the telescopic system should be 2. Taking into account the tolerances on the body, we set the distance between the lenses of the telescope at about 18 mm. In this case, the focusing distance of the lenses should be as large as possible in order to reduce the effect of the transverse spherical aberration (see Equation [7]). It is possible to fulfill this condition by using, instead of twin-convex lenses, a biconcave and flat-convex lens, whose focuses will be approximately 17.5 mm and 35.0 mm, respectively. In addition, twin-convex (cumulative) lenses create a spherical

aberration  $\delta S < 0$  for all areas. In contrast, the biconcave (dispersive) lenses have a spherical aberration of the opposite sign,  $\delta S > 0$ . The flat-convex lenses have very small aberrations. Combining such lenses, it is possible to significantly reduce the spherical aberration of the telescope.

From the limitation of the maximum thickness and height of the collimator, we will determine the maximum diameter of the lens  $D_{max}$ , which, taking into account the tolerances on the body, will be  $D_{max} = 15$  mm. Taking into account Equations [7] and [8], it is not feasible to reduce the diameter without the need. Since the elements of LaserGraver laser system are made from quartz, to manufacture the lenses of the telescope, we also used quartz, whose refraction index is  $n = 1.4584$ . In addition, quartz glass is characterized by high thermal resistance, which is essential for working with laser radiation.

The basic scheme of the telescope and the calculation of the beams are shown in Figure 4. The laser beam, whose cross section diameter is  $D_1$ , falls on the Lens 1, whose focusing distance is  $F_1$ . Refracted by the Lens 1, the beam falls onto the Lens 2, which forms a beam with the cross section diameter  $D_2$ . The Lens 1 is a twin-curved lens with first surface radius  $r_1$  and second surface radius  $r_2$ . The Lens 2 is a flat-convex lens with first surface radius  $r'_1$  and second surface radius  $r'_2$ . The focuses of the Lenses 1 and 2 are aligned at point A.

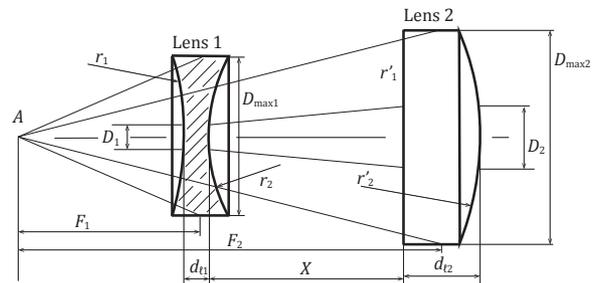


Figure 4: Schematic diagram of the telescope

Since the telescope operates in an air environment, the refraction index is  $n_0 = 1$ . The refraction index of quartz glass for the wavelength  $\lambda = 1.064 \mu\text{m}$  is  $n = 1.450$ . Using the Equation [11], by means of appropriate mathematical operations, the ratio of the radii of curvatures  $r_1$  and  $r_2$  for the twin-curved and  $r'_1$  and  $r'_2$  flat-convex lens (Equations [12] and [13], respectively) has been calculated, the results of which are presented in the graphs in Figure 5.

When calculating for the twin-curved lens, the value of the focusing distance is given as  $F_1 = -17.54$  mm, and the value of the thickness of the lens  $d_{t1} = 1.8$  mm. The thickness of the lens should not be set too thin, since during polishing the lens is deformed, which makes it

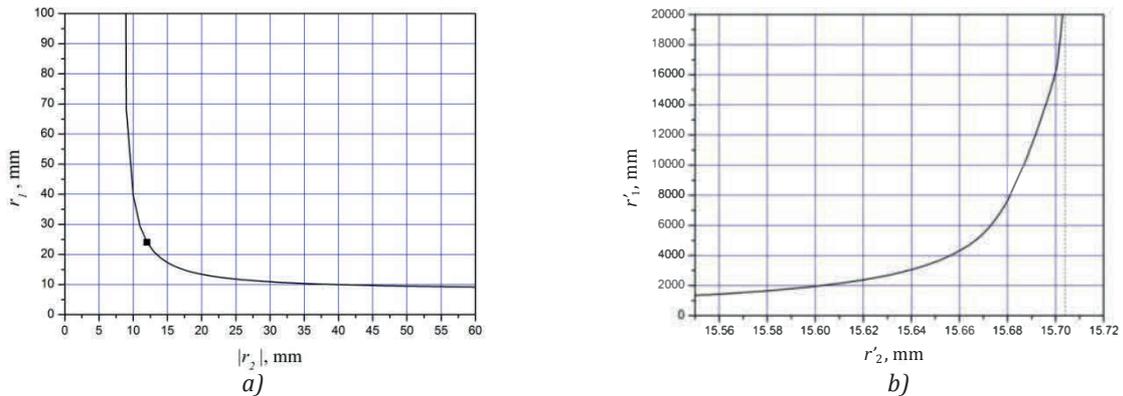


Figure 5: Ratio of the radii of the surface curvature for the twin-curved (a) and the flat-convex (b) lens

impossible to obtain precise surfaces and centering. For a twin-curved lens, the minimum permissible value of  $d_{l1}$  is determined by the ratio between the diameter and  $1.5 D_{max1}$ .

An increase in the thickness of the lens leads to decrease in the intensity of the beam as a result of the weakening of the light flux in the environment. In Figure 5a the values of the surface curvature radii specified for manufacturing the twin-curved lens are denoted by the dot.

When calculating a flat-convex lens, the value of the focusing distance is given as  $F_2 = 34.92$  mm, and the value of the thickness of the lens  $d_{l2} = 5.2$  mm. According to the calculations, a graph of the dependence  $r'_1(r'_2)$  has been constructed (see Figure 5b). The value of  $r'_2$  goes to infinity. Under these conditions, the first surface of Lens 2 can be considered as a plane, and the radius of curvature of the second surface is  $r'_2 = 15.70$  mm.

Thus, based on the conducted calculations of the surface curvature, an optical calculation of the beam passing through the telescope has been done, the data of which are presented in Table 1.

Table 1: Parameters of the telescopic system

Parameter	Lens 1	Lens 2
Lens focus	$F_1 = -17.54$ mm	$F_2 = 34.92$ mm
First surface radius	$r_1 = 24.32$ mm	$r'_1 = 22141.35$ mm
Second surface radius	$r_2 = 11.94$ mm	$r'_2 = 15.70$ mm
Lens thickness	$d_{l1} = 1.8$ mm	$d_{l2} = 5.2$ mm
Focal segment $S_E$	18.34 mm	-31.34 mm
Focal segment $S'_E$	-17.94 mm	34.92 mm
Maximum diameter	11.0 mm	15.0 mm

Verification of the telescope performance was carried out by calculation of the radiation intensity distribution in the focus of the lens for basic and modernized optical systems, using ZEMAX specialized program for optical designing (Figure 6). As it can be seen from Figure 6, the intensity distribution in the focusing area corresponds to Gauss's law. The focusing spot radius ( $R$ ), defined by level  $1/e^2$ , for a basic optical system is about  $12.5 \mu\text{m}$  (Figure 6a), and for the modernized system it is about  $6 \mu\text{m}$  (Figure 6b). Consequently, the suggested telescope corresponds to its functional purpose.

According to the calculations, the drawing of the telescope details has been done using SolidWorks design program. The 3D model of the telescope, which consists

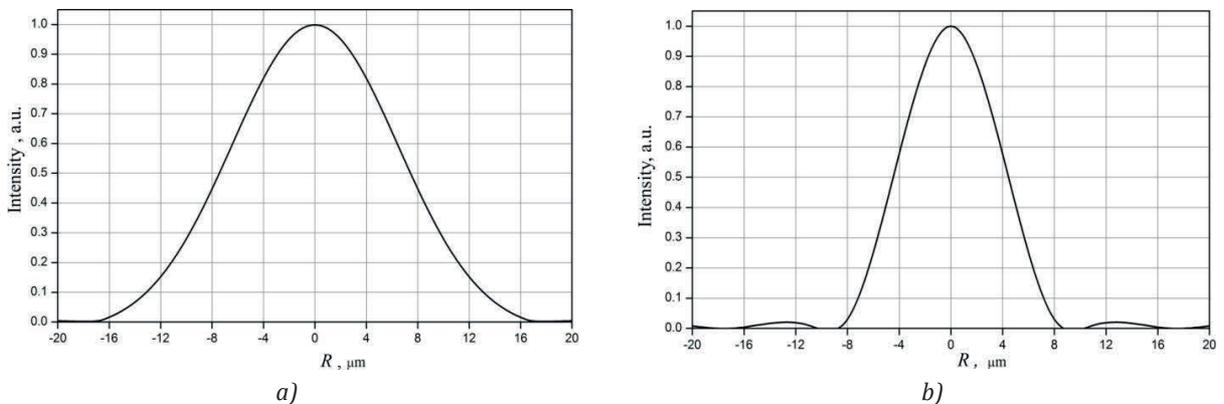


Figure 6: The radiation intensity distribution in the lens focus for basic (a) and modernized (b) optical system

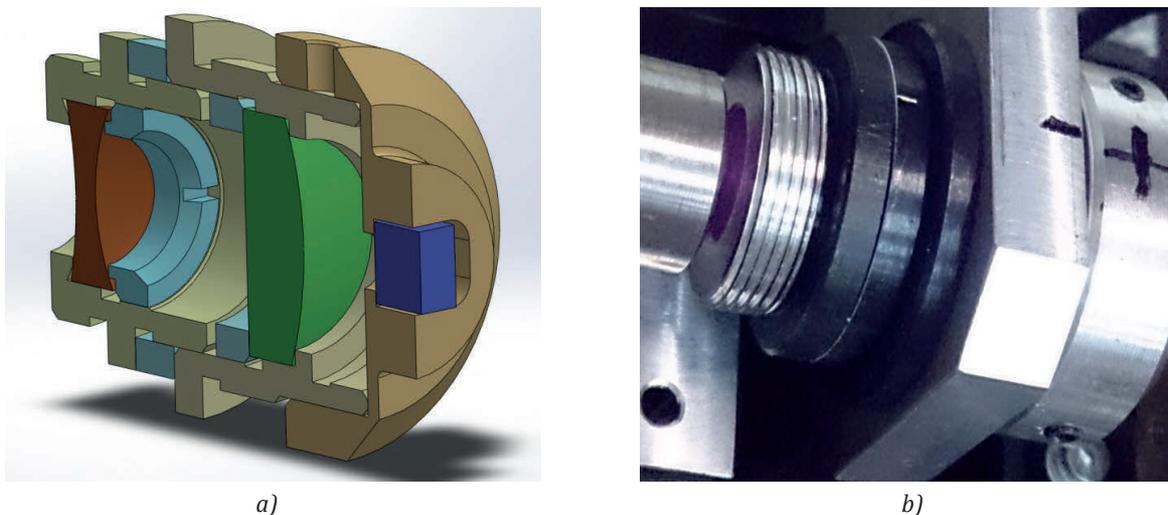


Figure 7: Section of a 3D model (a), and a photo of the telescope installed into LaserGraver optical system (b)

of body parts and two lenses, is shown in Figure 7a. The details were manufactured and the assemblage and alignment of the telescope was completed according to the drawings. Figure 7b shows a photo of the finished telescope.

The telescope was installed into the optical system of LaserGraver equipment in accordance with the schematic diagram of modernized optical system shown in Figure 3. The modernized optical system of the equipment was tested to verify the deviation from the pre-

vious parameters and to check the correctness of the telescope position. After the test completing, control records have been made on a thermosensitive film.

#### 4. Results and discussion

To experimentally determine the parameters of the beam waist in the focus of the lens, the test scale No1 (Figure 1) was engraved on the thermosensitive film at different values of the lens focus position relative to

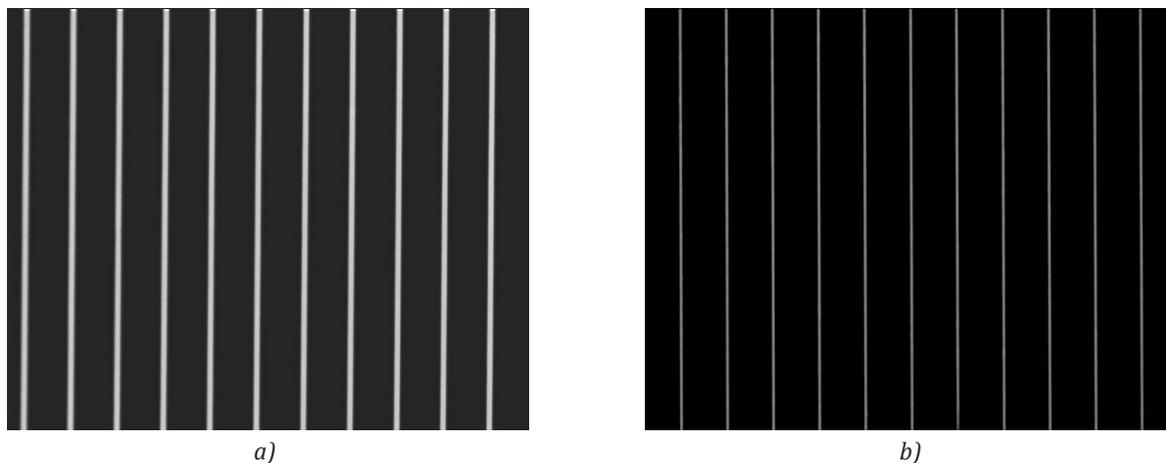


Figure 8: Photos of test scale No1, engraved on the film using basic (a) and modernized (b) optical system

Table 2: Results of the test scale analysis obtained by Flexometer

Parameter	Basic optical system	Modernized optical system
Number of analyzed lines	11	11
Average width of the line	12.57 $\mu\text{m}$	6.32 $\mu\text{m}$
Average squared deviation of line width	0.15 $\mu\text{m}$	0.17 $\mu\text{m}$
Minimal width of the line, $s_{\text{min}}$	12.45 $\mu\text{m}$	5.95 $\mu\text{m}$
Maximal width of the line, $s_{\text{max}}$	12.80 $\mu\text{m}$	7.18 $\mu\text{m}$

the film surface ( $z_F$ ). The test scale was engraved using both (basic and modernized) optical systems. The laser radiation power during the test image engraving was about 15 W. The photos of the engraved tests are presented in Figure 8. Each of engraved lines was analyzed using Flexometer application and the results are presented in Table 2. As can be seen, the average width  $s$  of the line in the focus of the basic optical system is 12.57  $\mu\text{m}$ , whereas of the modernized optical system the width is 6.32  $\mu\text{m}$ . So, the lines are twice as narrow for the case of a modernized optical system.

Figure 9 presents schematic laser beam waist (caustic surface of the laser beam) for basic and modernized optical systems constructed on the basis of dependencies  $s(z_F)$  (Nykyrui and Maik, 2016a).

According to the results of the testing, the hardware parameters for the material being engraved for test

were determined. The modernization of the optical system of the laser engraving device allowed reducing the discrete volume that is removed during DLE process. By changing parameters such as the beam power, the number of passes forming the profile, the lens focus position for each passage and the drum rotation speed of each passage gave us the opportunity:

- to develop the technology for the modification of geometric profile of printing elements on the printing plate made from DLE (Figure 10) and to conduct the studies on the influence of the geometric shape of the profile on the reproduction process and print characteristics (modification of the shape of small print element and single print element, modification of the deformation of print plates under pressure, and study of optical dot gain, elastic properties of print elements, etc.) (Nykyrui and Maik, 2012);

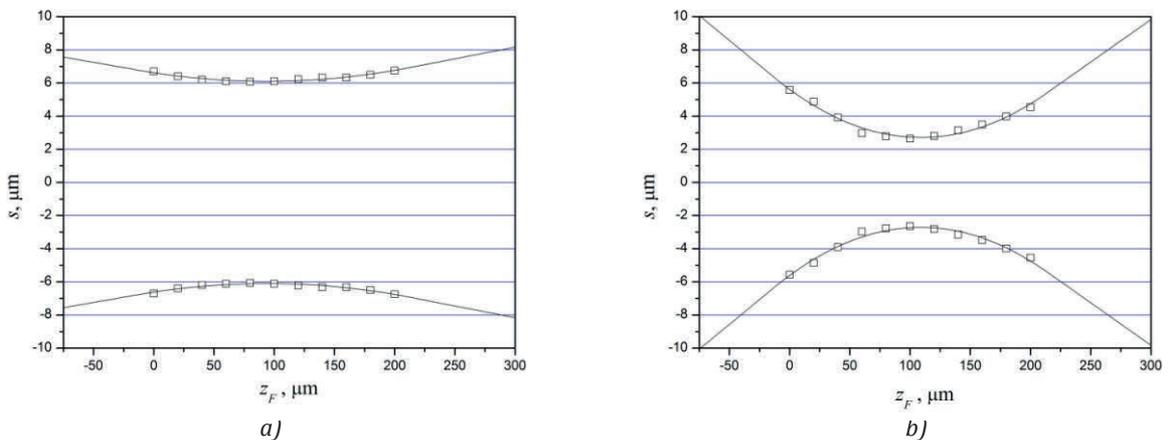
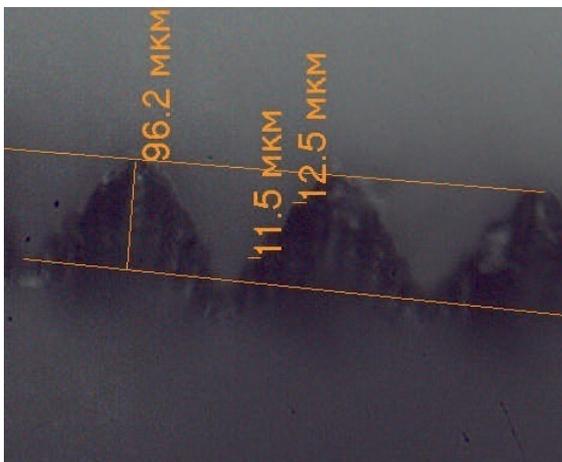
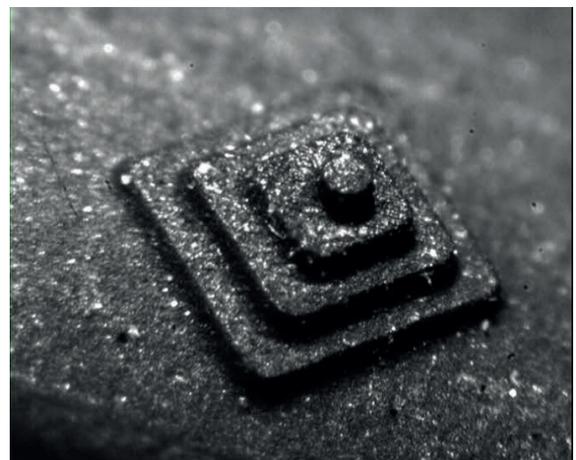


Figure 9: Caustic surface of the laser beam for basic (a) and the modernized (b) optical systems



a)



b)

Figure 10: Micro-photo of printing elements with modified profile in the shape of a pyramid with the step of 10  $\mu\text{m}$  (note: MKM in picture stands for  $\mu\text{m}$ ) (a), and single print element in the shape of a pyramid (dot width = 20  $\mu\text{m}$ ) with the step of 25  $\mu\text{m}$  (b)

- to develop the technology of micro-screening of printing elements on the DLE materials and design different types of micro-screens, which allows to find the optimal type of micro-screen suitable for different types of inks and printing substrates that allows increasing of optical density of the imprints (Nykyrui and Maik, 2016b);
- to develop the technology for the production of flexographic printing plates with the height of printing elements below the level of the printing nip, which avoids excessive tone value increase of small dots of design with reduced pressure on the plate to print different tone values more evenly (Nykyrui and Mayik, 2017).

## 5. Conclusions

The method of increasing the resolution of the laser engraving equipment by modernizing its optical system was described. The calculation and the design of an optical telescope for reducing the laser spot size in the focus of the optical system were carried out. The telescope was produced according to the drawings and incorporated into the optical system of the laser engraving equipment. The increase in the resolution of the equipment was confirmed by the results of testing. Increasing the resolution of the laser engraving equipment allows not only improvement of the quality of material engraving, but also an opportunity for improvement of the flexographic printing plates by engraving.

## References

- Böttcher systems, 2011. *Flexography: flexo printing plate for direct laser engraving*. [online] Böttcher systems. Available at: <[https://www.boettcher.de/fileadmin/web/docs/pdf/en/Flexo\\_787\\_engl.pdf](https://www.boettcher.de/fileadmin/web/docs/pdf/en/Flexo_787_engl.pdf)> [Accessed 24 July 2018].
- Bukwaits, J., 2006. Izgotovlenie flexografskih form: tendencii i novye tehnologii. *Flexo Plus*, 5(1), pp. 16–19. (in English: Production of flexographic forms: trends and new technologies).
- ContiTech, 2017. *CONTI Laserline CSX*. [online] ContiTech. Available at: <[http://www.conti-laserline.com/pages/produkte/csx/docs/Datasheet\\_CONTI\\_Laserline\\_CSX.pdf](http://www.conti-laserline.com/pages/produkte/csx/docs/Datasheet_CONTI_Laserline_CSX.pdf)> [Accessed 24 July 2018]
- Graßler, R., 2011. Auch im Flexodruck sollten die Flanken (der Rasterpunkte) präzise sein. *Deutscher Drucker*, 6, pp. 16–17. (in English: Also in the flexographic printing, the flanks (the halftone dots) should be precise).
- Grigoryants, A.G., Shyganov, I.N. and Misurov, A.I., 2006. *Tehnologicheskie procesy lazernoi obrabotki: uchebnoe posobie*. Moscow, Russia: Bauman MSTU. (in English: *Technological processes of laser treatment: training manual*).
- Kodak, 2013. *Flexcel Direct Media*. [online] Kodak. Available at: <[http://www.kodak.com.cn/Product\\_Pdf/Flexcel\\_Direct\\_Media.pdf](http://www.kodak.com.cn/Product_Pdf/Flexcel_Direct_Media.pdf)> [Accessed 24 July 2018].
- Laskin, A.V., Minin, P.V., Maik, V.Z. and Sorokin, B.A., 2001. *Computer-to-Plate dlya flexografii: klyucheveye aspekty tehnologii*. Moscow: Kursiv. (in English: *Computer-to-Plate for flexography: key aspects of technology*).
- Nykyrui, V., 2009. Lazernye tehnologii v proizvodstve pechatnykh plat i ne tolko. *Pечатный Montazh*, 5(2–3), pp. 25–28. (in English: Laser technologies in the production of printed circuit boards and not only).
- Nykyrui, V.E. and Maik, V.Z., 2012. Stvorennaya profilyu drukuvalnykh elementiv pryamym lazernym graviyuvannym. *Kvalilogia knygy / Book Qualilogy*, 21(1), pp. 128–131. (in English: Element printing profile creating by direct laser engraving).
- Nykyrui, V.E. and Maik, V.Z., 2016a. Doslidzhennya kaustychnoyi poverkhni lazernoho promeny u fokusi optychnoyi systemy. *Naukovi zapiski / Scientific Papers*, 53(2), pp. 66–71. (in English: Research of caustic surface of laser beam in focus of optical system).
- Nykyrui, V.E. and Maik, V.Z., 2016b. Doslidzhennya optychnoi schilnosti vidbytkiv plashok z mikrostrukturoyu. *Kvalilogia knygy / Book Qualilogy*, (29)1, pp. 14–22. (in English: Investigation of fingerprints optical density of dies with microstructure).
- Nykyrui, V.E. and Mayik, V.Z., 2017. Vyhotovlennya fleksohrafichnykh drukars'kykh form iz vysotoyu drukars'kykh elementiv nyzhche rivnya plashky, metodom pryamoho lazernoho hraviyuvannya. *Polihrafiya i vydavnycha sprava / Printing and Publishing*, 73(1), pp. 32–37. (in English: Manufacturing flexographic printing plates with printing elements height below the die level by direct laser engraving).
- Ready, J.F., 1971. *Effects of high-power laser radiation*. New York, London: Academic Press.
- Vefers, L. and Apps, H., 2006. Priamoe lazernoe gravirovaniye – povysheniye kachestva i uproshcheniye procesa dopechatnoi podgotovki. *Flexo Plus*, 5(1), pp. 20–24. (in English: Direct laser engraving – improving the quality and simplifying the prepress process).

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# Canadian magazine digital editions: affordances and engagement

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## Abstract

This paper is an analysis of print based Canadian consumer magazines, studying a selection of titles and their equivalent digital issues. It investigates how publishers are currently integrating a variety of digital platforms, and interactive approaches. These digital affordances are categorized as those that ‘extend’ the use of content, similar to navigation tools, such as searching for text within the issue, links to other articles, as well as the ability to learn more, or to save an article. Features used to ‘enhance’ the content include multimedia such as image slideshows, videos, and audio. Overall, the use of interactive elements in digital editorial content is relatively low, appearing in less than half of the issues. Video is leveraged in just over a third of these interactive examples. The use of interactivity affordances in advertisements is significantly lower. Publishers also support their digital and print editions by leveraging a variety of digital engagement tools. These include social media accounts for the magazine’s brand, as well as supporting the ability for their audience to share some level of content through social media. Other engagement tools such as the production of a digital newsletter, the availability of digital archives (back copies), editorial updates, commentary sections, and ‘email the editors’ are also investigated. These affordances and engagement approaches are compared with available circulation data in an effort to identify trends and patterns. This study forms a useful benchmark for how Canadian publishers are currently leveraging digital infrastructure. It highlights how publishers today may be focusing their efforts on specific devices and platforms, native apps for tablets and the iOS, while their readers and potential audience have shifted to mobile smartphones.

**Keywords:** content analysis, market analysis, mobile media, native app

## 1. Introduction and background

This paper is a media content analysis undertaken on a selection of print based Canadian magazines, showing how they are currently integrating a variety of different digital edition formats. It reviews the different platforms used, as well as the use of interactive affordances in editorial and advertising content. In addition, it also captures the use of different digital engagement techniques publishers are using to help build their audiences. These approaches are considered along with current market trends for devices and platforms, as well as the title’s overall digital and print circulation rates.

### 1.1 Background

Apple first introduced the iPad tablet in April 2010 (Ritchie, 2017), and the resulting market for tablet devices shifted the way readers explore and consume

media content. This shift presented a fresh opportunity for conventional print-based publishers to re-engage with their audiences, which had been moving online for some time, through leveraging a familiar magazine format within a new framework for the digital economy.

However recent industry reports have indicated that, as an overall industry, publishers may not have capitalized on this opportunity (Malyarov, 2017). Today’s rise in the use of smartphone devices (mobiles) may present a renewed opportunity for consumer magazines to engage their readers, and monetize their content.

Note that tablets, in general, are not considered ‘mobile’ devices. In North America, the majority of tablets sold connect to the Internet via Wi-Fi. They do not have SIM (Subscriber Identity Module) cards installed (Heine, 2014), which are required to connect to cellular service

providers. As such in this paper ‘mobile’ is used to refer to smartphones, and does not include tablet devices.

Also for the purposes of this paper, a magazine, either print or digital, is being defined as something that has a clear beginning, middle and an end. It is a structure that contains curated content, which has been through an editorial review, and has an enhanced aesthetic treatment applied. They are date stamped, and are issued on a weekly, monthly, or quarterly basis (Santos Silva, 2011). Reader focused websites hosted and produced by a magazine are generally not considered digital editions, as they lack the same structure.

## 1.2 Canadian magazine market overview

The magazine market can broadly be separated into three main categories: consumer, business-to-business (B2B, or trade), and custom publishing. Consumer magazines target the general reading public, appealing to special interest groups, or niche markets. These publications are often obtained through paid newsstand purchases or subscriptions.

Trade magazines target professionals, and provide industry-specific topics. Custom publishing titles are generally brand magazines, also known as content marketing, which contain editorials that indirectly introduce a product or service to the reader.

The Canadian magazine industry total revenues in 2017 were CND\$ 2 billion, and have experienced an annual negative growth of 5 % since 2012 (Ibisworld, 2017). In general, Canadian print magazine circulations have been in decline, however the overall industry is expected to fare better than both the global and North American markets. The Canadian market is predicted to grow at a compound annual growth rate (CAGR) of 1.2 % through 2016–2021 (PwC, 2017). It is anticipated that digital advertising will provide the growth for consumer magazines.

In Canada, consumer magazine issue sales are driven primarily by subscriptions, which represent 88 % of the copies sold (FIPP, 2014). The majority of a Canadian consumer magazine’s revenue, however, comes through advertising and other print related products; subscription and newsstand sales combined represent an average total of 26 % of revenue.

Typically, a magazine is focused on one specific or broad topic, for example, fashion, gardening, or automobiles. However there can be many different titles produced by one publishing company; leading publishers in Canada include TVA ([groupepva.ca/legroupe/publications](http://groupepva.ca/legroupe/publications)), Rogers Media Publishing ([www.rogersmedia.com](http://www.rogersmedia.com)), and St Joseph Communications ([stjoseph.com](http://stjoseph.com)).

The focus of this research project is on consumer publications, because of their wider audience, and their relative importance to media and culture. The initial objective was to identify which different platforms consumer publishers in Canada currently use for digital distribution – whether Canadian publishers are focusing on devices and approaches that have the greatest potential to reach audiences.

One concern is the wide variety of devices available, with different operating systems, screen sizes and aspect ratios, creating a barrier for publishers “seeking a broader distribution footprint” (Guenther, 2011). As well, there has been discussion in the publishing industries about specific digital formats, and whether to invest in downloadable native apps (Tomas, 2013).

This investigation of the current state of magazine digital platforms is useful to help identify and benchmark trends, which could provide valuable insights for publishers considering a shift in their platform strategy.

## 2. Methods

### 2.1 Content analysis

A content analysis is an established technique used to systematically investigate a particular type of communication (Macnamara, 2005). When applied to mass media, it provides a useful methodology to categorize and summarize both content and format (Neuendorf, 2002). It is applicable for this research project, as it provides a suitable framework to review magazine print and digital editions.

For the purposes of this analysis, content relates to the magazines overall editorial category or theme (for example, lifestyle, or business). Format relates to identifying the different digital edition types and platforms supported, as well as the affordances and engagement tactics used.

Affordances are defined here as ‘possible actions available in the environment’ (digital issue) to an individual, independent of the individual’s ability to recognize this as a possibility offered to him or her as a reader (McGrenere and Ho, 2000; Miric, 2015). These affordances include features to ‘extend’ the use of content: search, learn more, save, as well as links to additional content. They also include additional multimedia to ‘enhance’ content – images, video and audio. This content analysis also investigates different digital engagement tools that publishers use to build relationships with their audiences; social media, as well as other techniques such as newsletters, archives, content updates, comment sections, and email.

## 2.2 Applied methodology

There are approximately 975 English language consumer magazine titles published in Canada (Magazines Canada, 2015), covering a wide range of themes, and of varying circulation levels. An in-depth analysis of each title was impractical due to the volume of titles and options.

To select which titles to analyse, 19 leading consumer editorial categories were identified; the selection within each of them was then based on published circulation data (copies sold or distributed). This data was obtained through a variety of sources; the Canadian Advertising Rates and Data (CARD) online portal for media buyers, published data from the International Federation of the Periodical Press (FIPP, 2014), or from a publisher's claim available in their media and advertising rate cards. Preference was given to CARD and then FIPP, when possible, as these circulation numbers are audited by third parties, and therefore more reliable.

From each editorial category, sample titles were then selected representing lower, moderate, and higher print issue circulation rates. This was done in an effort to capture information from a variety of differently 'sized' magazines (not every editorial category had titles in each circulation tier). Lower circulation is defined as 1 to 99 999; moderate circulation is defined as 100 000 to 499 999; higher circulation is defined as 500 000 to 1 million plus (Magazines Canada, 2015).

When more than one title option was available, the criteria was to have as many different publishers included in the research as possible. This was done in an effort to analyse a range of different publishing organization's digital strategies as wide as practical. A total of 35 titles were selected, representing 26 different Canadian publishers. Please see Appendix for a list of editorial categories, publishers, their titles, and their respective circulation numbers (Smyth and Fan, 2017).

From this sample set, a media content analysis was conducted. The availability of different formats of digital editions, platforms and device support were documented. This was accomplished through first identifying consumer-focused websites related to each title, and reviewing these for the availability of 'digital issues'. The different platforms, types of devices (tablet or mobile), and operating systems (Apple iOS or Google Android) available were noted.

Next, the edition format of these digital issues were classified according to accepted industry definitions, as either a 'digital replica', an 'extended PDF', or as a 'native app' edition (Idealliance, 2013). A digital replica is an electronic version of the print edition, usually

derived from the Adobe Portable Document Format files (PDF) that were created to transfer content for the final production of the print issue. A reader swipes right to left in order to read left to right and pages appear as they would in the print version, downsized to fit the device screen. There are no additional interactive features built into this digital edition type (Nicolas, et al., 2014). Extended PDF editions are based on replica editions, however with some basic interactive elements incorporated for enhanced usability (such as a link to another relevant article).

A native app edition refers to a magazine that is designed and created specifically for a specific type of digital device. It is generally considered as providing a superior user experience, compared to other options. Native apps typically have added features; multimedia content, connectivity through social media channels, as well as additional content when compared to the print issue. As a result, they are generally the most costly to produce (Nordicity, 2009).

Print and digital versions of the same title and issue were obtained for analysis. Print issues were acquired from newsstands when possible, or directly from the publisher. Digital issues were purchased as App Store downloads through Apple's iTunes Canadian store. Print issues were physically compared on a page-by-page basis to the digital edition, using Apple iPad tablets. The relative number and type of 'extend' and 'enhance' affordances in the native app digital editions were identified, and catalogued for both editorial and advertising content. The type and availability of the audience engagement tools utilized by the title were also identified and catalogued.

Advertisements were identified using accepted industry standard classifications for digital editions (Idealliance, 2013): Straight from Print (SFP) ads are repurposed directly from the referenced print version, and can include a single link to an external website. Designed for Tablet (DFT) ads have been designed to fit devices – users do not need to tap and zoom to read content. These can also include multiple external links. Enhanced for Tablet (EFT) ads are also designed for tablets, however also include multimedia such as animations, slideshows, video, or audio, as well as multiple external links.

The data and findings were catalogued in a master spreadsheet, according to editorial category, publisher, and title. The availability of specific issue formats, affordances, and engagement tactics were recorded in separate worksheets. The results were tabulated using Boolean pair yes/no entries. Total positive and negative responses were determined, with ratios and proportions calculated as required.

Previous research related to these topics investigated North American magazine titles available through a particular distribution platform, and found no direct link between affordances and digital edition circulation levels (Miric and Lumby, 2015). Their work analysed Next Issue (now known as Texture), which is magazine digital edition subscription service. This content platform operates with a model similar to Netflix for video, or Spotify for music, customers pay for unlimited access to magazines that publishers make available through the service.

The objectives of this research differ in that it is focused specifically on Canadian magazines, and the leading commercial editorial categories (as measured by number of titles and circulation numbers). It investigates the collection of different platforms and edition types offered by these publishers, as well as the affordances available. In addition, it seeks to separately quantify the use of different audience engagement tactics, used by publishers in an effort to build their digital communities.

These results are then analysed using the magazines' available digital and print edition circulation rates. A ratio of Digital to Print circulation (DtpP) is used to better compare and contrast results between titles, and across circulation tiers.

### 3. Results

#### 3.1 Website availability

To start, it was determined if the magazines published a website for their reading audience (not purely a business to business site to support advertising sales). Readers could use a magazine's site to discover the availability of any digital issues. Figure 1 shows this ratio.

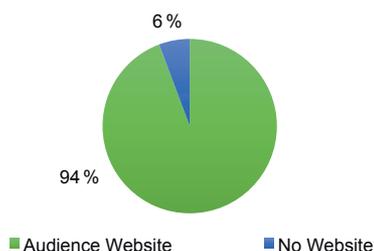


Figure 1: 33 of the 35 magazines researched published a reader focused website

#### 3.2 Digital editions and formats

Secondly, all of the magazines were checked if they offered digital editions. The majority of the magazines analyzed offered some version of a digital issue based on their print issues – 86 % (30 of 35 titles).

Of the titles offering digital editions, 73 % offer a native app version, with 67 % offering a replica edition. The extended PDF edition is least popular, at 47 %. Many publishers opt to offer digital editions in more than one format, offering a native app version, but also a replica (often delivered through a third party digital newsstand platform such as Magzter, Texture, or Zinio). Figure 2 shows this breakdown.

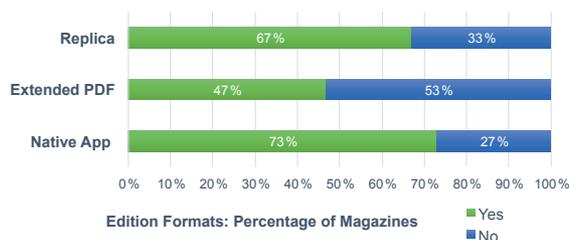


Figure 2: Different formats of digital editions of the 30 titles offering digital editions

Note that 63 % of the magazines offer multiple formats for their digital editions – 19 titles offer more than one digital format, 10 offer only a replica edition, and 1 provides only an extended PDF. No title limits their digital publishing to a single native app digital edition.

#### 3.3 Native app platforms

As shown in Figure 3, the majority of the 22 titles offering a native app edition support both tablet and mobile (smartphone) devices, however 9 % (2 titles) publish for tablets only.

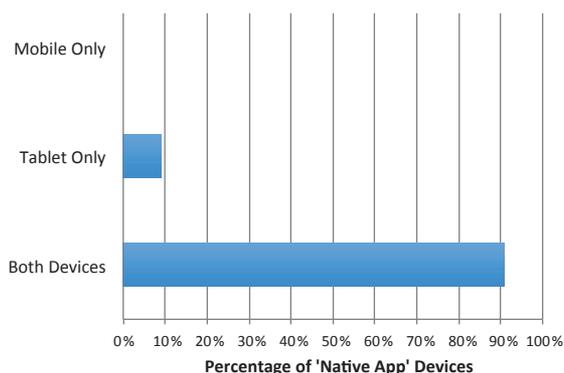


Figure 3: Device support for native app editions

##### 3.3.1 Tablet operating systems

Android and iOS are the two primary operating systems for tablets. Apple's iOS is used primarily in the devices the company produces (iPad and iPhone), while Google's Android operating system is used in tablets and smartphones from a variety of manufacturers (Huawei, LG, Samsung, and others). In the North American market, Apple has the majority of the tablet market share, with over 65 % of tablets running iOS

(Statista, 2018). Publishers appear to understand this; 100 % of the titles offer native apps for iOS enabled tablets. Almost 75 % of titles support both iOS and Android, however no publisher produces titles exclusively for Android OS based tablets.

### 3.3.2 Mobile operating systems

In Canada, the leading operating system for mobile is Apple’s iOS, with 53.99 % of the market, followed by Android with 44.92 % (Statcounter, 2018).

As with tablets, 100 % of the titles with mobile native apps support the iOS, with 75 % supporting iOS as well as Android – no title publishes exclusively for Android devices.

Understanding the significant market share for Android, publishers may wish to consider a shift to supporting both platforms, with a specific focus on mobile.

## 3.4 Affordances

From the set of magazines offering both print and native app editions (22 titles), a specific print issue was compared with its digital counterpart, to examine a variety of affordances. These have been sorted into two groups, those that ‘extend’ the reader’s use of the content and those that ‘enhance’ the content. These are considered for two content subcategories – editorial and advertising.

### 3.4.1 Editorial ‘extend’ affordances

For the purposes of this research project, the functions that allow a user to increase their use of the editorial content are grouped together as affordances that ‘extend’ the reader’s use of the content, designed to make it easier to navigate through the content. These include search, url links to additional content, learn more, and save article functions. Figure 4 shows the levels of ‘extend’ affordances found.

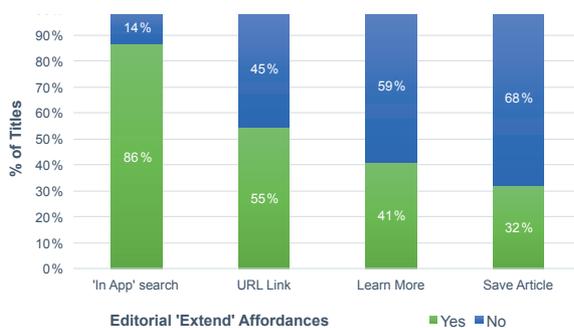


Figure 4: Native app editorial ‘extend’ content interactivity

The ability to search within the native app benefits readers looking for specific topics or keyword phrases within an issue. This feature is important to support a continuing trend in digital publishing – presenting organized and searchable content (Martin, 2017).

The majority of titles offer ‘in app’ search. Note that the device operating systems generally offer some level of manual search functions, outside of the magazine’s application.

Additional links to other stories and content were the most common interactive element, used in 55 % of native app issues. Options for readers to interact with the content, to learn more or to save the article for future reference, were also popular, used in approx. 40 % and 30 % of the issues, respectively.

### 3.4.2 Editorial ‘enhance’ affordances

Multimedia that supports editorial content are organized as ‘enhance’ affordances for this research. This includes image slideshows, video, and audio content types. Figure 5 shows the rates of ‘enhance’ affordances.

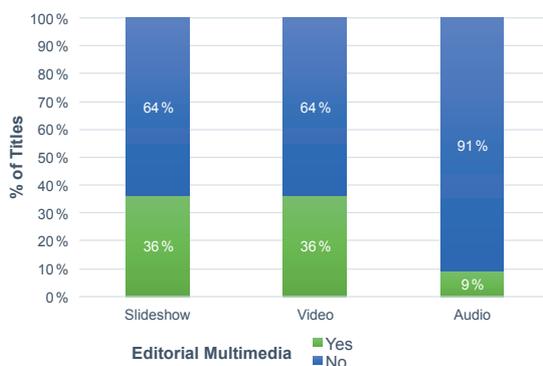


Figure 5: Native app editorial multimedia content

For enhanced content, just over one third of issues offered additional editorial images (for example, through a slideshow) or video. Stand alone audio files were least popular, with 9 % offering recordings of interviews, or similar content.

### 3.4.3 Advertising ‘enhance’ affordances

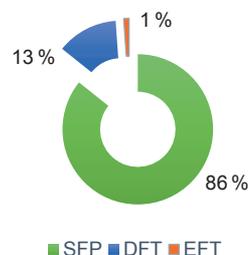


Figure 6: Advertisement formats in digital editions

A total of 540 full page and half page ads were analyzed from the 22 native app issues, with 1 % being identified as EFT, meaning they included interactive features beyond links to additional content, and 13 % were identified as being DFT, meaning the layout and content fit the screen of the device. Figure 6 shows this breakdown.

Examples of the interactive features found included video tutorials for applying beauty products, as well as multiple links to external social media sites. In some cases the EFT ads took a measurable amount of time to load (more than four seconds), or caused the application to freeze.

### 3.5 Digital audience engagement tactics

Some print based consumer magazine publishers in today’s marketplace are making efforts to build digital communities, to increase engagement with their audiences outside of their regular editions.

#### 3.5.1 Social media accounts

Publishers are looking to extend their brand awareness through a larger digital presence. One approach for this is through directly contributing to a variety of social media communities (MacArthur, 2018). Figure 7 shows the breakdown of channels.

Of the 35 titles checked, 32 had a social media presence, defined here as an account on an established social platform (91 %). Two of the 35 titles had neither a website or social media presence that could readily be discovered (Award and Westworld). One title, Kayak, had an online presence, however no social media presence.

Of the different social media platforms publishers leveraged, Facebook and Twitter are the clear leaders. The pattern for Facebook and Twitter is similar to

overall social media usage trends. According to industry reports (U.S. results, November 2016), Facebook is the number one social site, followed by YouTube and Twitter, with Reddit, Pinterest and Instagram trailing (Statista, 2016).

All of the titles with a social media presence are active on more than one social channel, and all these titles have accounts on both Facebook and Twitter. The next most common combinations include either Instagram or Pinterest, with 84 % of the titles having accounts on all four channels.

Other social channels are utilized to a lesser extent, perhaps according to editorial theme. For example YouTube is used for interviews (Maclean’s) or for how to tutorials and reviews (Motorcycle Mojo).

#### 3.5.2 Social media sharing

Providing readers with the option(s) to easily share content they have read in a particular issue of a magazine is considered another valuable approach to building overall awareness of a magazine’s brand and content (Bilton, 2016).

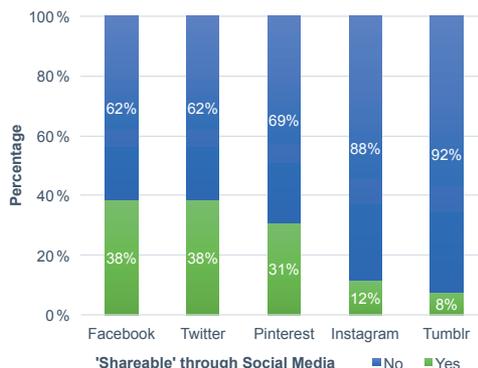


Figure 8: Magazine support for social media sharing

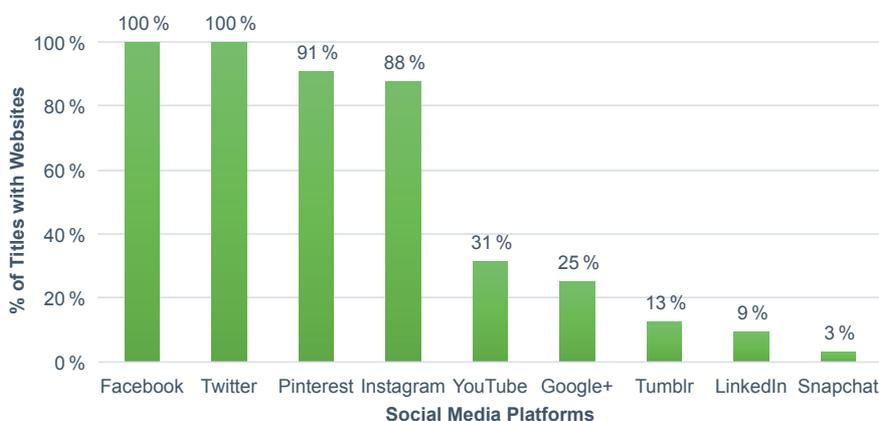


Figure 7: Social media platforms share of magazine brand accounts

Figure 8 shows the top four social media channels that publishers support for their readers to share content on are the same as the top channels leveraged for their own social media presence. However, the overall number of titles supporting shareability is markedly lower.

### 3.5.3 Additional engagement approaches

An additional approach publishers use to help build and maintain audience engagement is through digital newsletters, delivered via email between regular issues (Moses, 2017). Magazines were reviewed for a ‘subscribe to newsletter option’ through two channels, their magazine website as well as through their native app digital issues.

Figure 9 shows the majority of titles (70 %) with websites presented viewers with the opportunity to sign up for a digital newsletter.

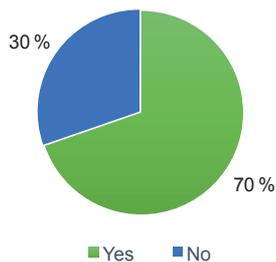


Figure 9: Magazine websites: newsletter subscription option

The native app digital editions were also checked for newsletter options, usually offered as an interactive feature that encourages readers to sign up for a newsletter. Known as ‘overlays’ or ‘modals’, these elements appear as a box or window overtop of the content, and contain a ‘call to action’ for the reader to subscribe to the magazine’s newsletter. Figure 10 shows the number of native app editions offering newsletters.

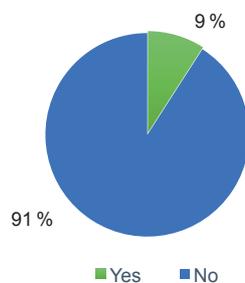


Figure 10: Magazine native app editions: newsletter subscription option

Considering the native app magazines, 2 titles (9 %) appeared to be using interactive elements in an effort to build their newsletter subscriber list. This lower

number compared to the website may be a conscious effort on the part of the publishers not to distract their readers from the experience of reading the digital issue.

Another engagement tool publisher’s leverage for their audience is access to a catalog, or archive, of non-current issues. Figure 11 shows a combined 91 % of titles offer some level of digital access to back copies of their issues, while 9 % of magazines do not offer any kind of access to their archive.

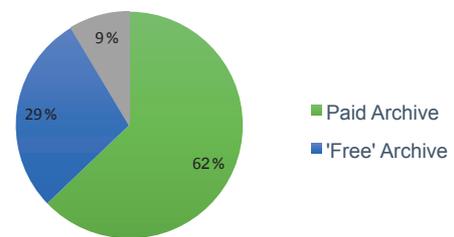


Figure 11: 91 % of magazines offer access to past issues

Access to archived copies can be considered both an engagement approach, and a monetization tactic, offering readers further access to paid content. The value to publishers offering unpaid archived content to readers is, in part, from requesting readers data – their name and contact information – which can be used to help encourage future subscriptions (Spencer, 2007).

Content updates are the ability for a native app to receive new editorial content outside of regularly published issues. They are used in an effort to keep readers coming back to a digital edition between editions. Of the 22 titles with native apps, 2 titles (9 %) supported content updates outside of regular publishing cycles. The two titles, Maclean’s, a business magazine, and Flare, a fashion title, are both owned by Rogers Media Publishing, which could suggest an overall corporate strategy.

In the past, a comments section was seen as valuable tool to build media companies engagement with readers. An in-app comments section supports the ability for a reader to post questions, thoughts, and interact directly with the magazine and contributors through the native app. This was available in just one of the digital editions, Chatelaine.

This could be the result of challenges surrounding the technology to support this within native apps, however several media outlets have also closed or restructured their comments sections in recent years (The Toronto Star, CBC, CNN). This was due in part to the increased use of social media for conversations (Finley, 2015), as well as to the questionable merit of some of the content (Valenti, 2015).

Finally, the ability for readers to email the magazine directly in the app (for example, ‘letters to the editor’) was supported in 21 of the 22 title’s (95 %) native app digital editions.

#### 4. Discussion

A consumer magazine’s economic success is, in large part, contingent on circulation – a measure of how many copies of an issue are sold and/or viewed, calculated over a period of several consecutive editions. The cost for advertising space is generally tied to the level of circulation.

Verified circulation reports (audited readership numbers), are available from a variety of different companies that specialize in audience measurement for media buyers. Sources and vendors vary depending on region and market strategy; Vividata in Canada, or the Alliance for Audited Media in the U.S.

Measurement companies, and magazine industry organizations such as Magazine’s Canada and The Association of Magazine Media (MPA), advocate for reports that capture and communicate a title’s complete audience across multiple channels (for example, PC/laptop, mobile web, video) for media buyers, such as the MPA’s Magazine Media 360°.

##### 4.1 Digital and print circulation

Many audience reports do not break out digital edition circulation separately from print based editions. Figure 12 shows that of the 33 titles in this research that are publishing digital editions, 14 reported separate circulation numbers for their digital issues.

The reported circulation numbers for the digital editions are relatively lower compared to print circulation. A ratio comparing a title’s Digital to Print circulation (DtoP) is used here to better contrast results between titles, and across circulation tiers.

Of the 14 titles listed in this set, 13 offer a native app edition, the remaining one, Windsor Body Magazine, offers only replica version. It is also the only one of the set that does not publish audited circulation reports, meaning its publisher claims are unverified. As a result of both of these, it is considered an outlier, and is therefore not included in the following calculations and discussions.

The median DtoP ratio of the remaining 13 titles is 11.87, while the mean is 17.24. Four of the six titles with DtoP ratios above the median are published by the same parent company, Rogers Media Publishing (Chatelaine, Hello Canada, Maclean’s, and Today’s Parent). This could indicate an overall corporate strategy emphasizing digital readership. Note, however, that Canadian Business and Flare are also published by Rogers, and have relatively lower digital edition circulation ratios of 7.08 % and 11.87 %, respectively.

##### 4.2 Circulation and affordances

The group of seven titles publishing native app editions below or at the DtoP median had a slightly higher average number of ‘extend’ affordances per issue than those above the median (average of 2.0 per issue compared to 1.67). However, with regards to ‘enhance’ affordances, titles above the DtoP median had an average of 2.0 examples per issue, while titles below had an average of 0.71 examples per issue. Offering the ability to extend the use of content through links and saving

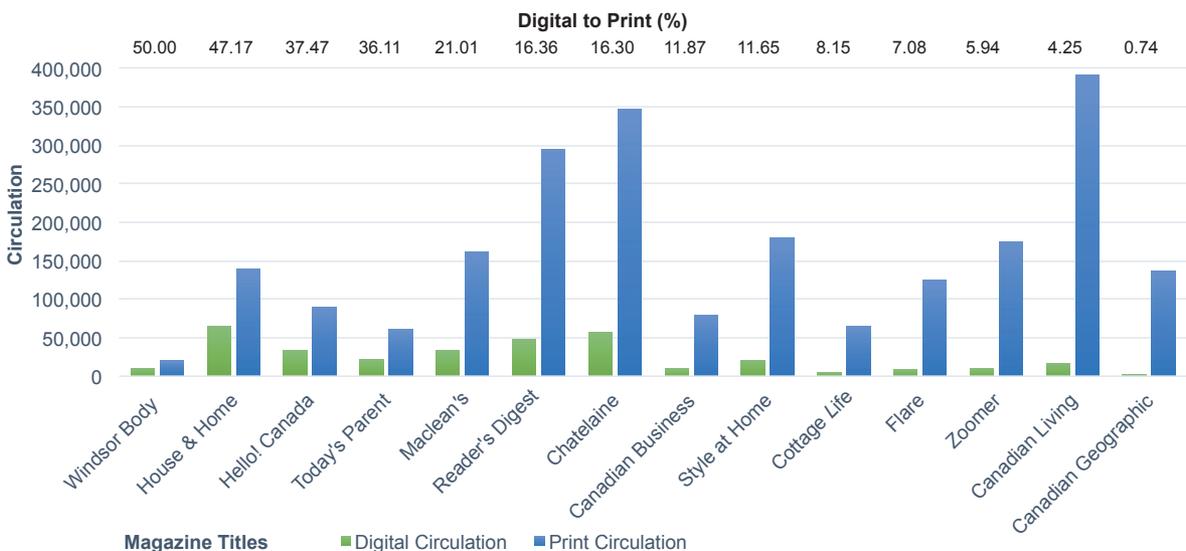


Figure 12: Canadian Magazines: digital to print circulation ratios

articles did not correlate well with a larger percentage of digital edition sales, while offering multimedia content to readers did.

A publication's strategy for offering content extensions and enhancements may be led by their theme or category – business titles are presumably read for professional reasons and not necessarily for entertainment or leisure; Canadian Business had a high level of technical support for sharing articles, but offered no multimedia content. House & Home also offered full support for sharing articles, however they also utilized each type of multimedia content as well. Perhaps the publisher understands that a home interest category reader may wish to share articles and images for inspiration, and extend their reading through different multimedia content formats.

Higher ratios of DFT or EFT advertisements do not appear to have a strong direct relationship with higher digital circulation ratios.

The seven titles below the median DtoP had an average number of DFT and EFT advertisements per issue of 2.86 and 0.43, respectively, while the six titles above the median DtoP had an average per issue of 3.0 and 0.5.

Given the very low numbers of DFT and EFT ads found in the sample set, small differences have a measurable impact. For example, from the subset above the median, the digital issue of Today's Parent had 11 DFT ads, while Reader's Digest, Maclean's, and Hello! Canada each had none. Without the DFT ad count from Today's Parent, the titles above the median would have a lower average of DFT ads than the subset below the median.

### 4.3 Circulation and social engagement

Online traffic from a magazine's social media accounts is often treated separately from audience measurement perspective, perhaps reflecting the difficulty publishers have monetizing engagement on social media.

For a magazine brand, social audience numbers (likes, retweets, or shares) do not necessarily translate directly to issue sales, and as a result don't necessarily provide an increase (lift) in response for advertisers. Editors are addressing this by partnering with established social media influencers, to help promote their titles (Milne, 2018).

Each of the 13 titles with reported digital circulation numbers had a presence on a variety of different social medial channels. The number of different channels the title was active on did not appear to have a direct relationship with their DtoP ratio. The average for the 13 titles was 5.08 channels per title; Canadian

Geographic was active on 7 channels, with a DtoP of 0.74 %, House & Home was active on one channel less, but had a DtoP of 47.17. The average for the 7 titles at or below the median DtoP was 5.14 channels per title, slightly higher than the 5.0 channels average for the titles above the median.

It is interesting to note, however, that increased ability for a reader to share content through a personal social media account did have some relationship with higher DtoP circulation ratios. The average for the 13 titles was 1.54 channels per title; the average for the 7 titles at or below the median DtoP was 1.0 channel per title. The average for the 6 titles above the median was higher at 2.17 channels per title.

It would be understandable that a title's social media strategy would follow the demographics of their target audience – titles that appeal to groups who are active social media users would perhaps be expected to be more active themselves.

#### 4.3.1 Circulation and additional engagement approaches

Newsletters are used in an effort to keep readers involved with the brand between regular issues, as well as for additional advertising sales opportunities. Almost 2/3 (65.7 %) of the complete set of 35 titles analysed here also published digital newsletters. Of the titles publishing native app digital editions, 77 % also produced newsletters. All of the 13 titles reporting audited digital circulation numbers published a newsletter.

As for archives, 92 % (28/30) of the titles publishing any format of a digital edition offered access to their archive of past issues. Two thirds of these require paid access; the remainder offered free access, usually requiring a basic contact information form to be completed.

All of the 13 titles that publish audited digital edition circulation results offered digital archives of past issues. Of these, 12 required payment for access (usually included with subscriptions), while one offered free access to their back issues.

Other engagement approaches either had too few examples, or were universal in the set. Two titles offered content updates through a native app, outside of a regular issue – a business title Maclean's, with a DtoP above the median, and a fashion magazine, Flare, which was below the median. One title offered a comments section, a woman's magazine Chatelaine, which had a DtoP above the median. All of the titles in the sample set offered an in-app email alternative.

## 5. Conclusions

Print based publishing companies continue to work through a period of ‘creative destruction’, competing with other medias for attention, as well as against titles started by publishers that may have been quicker to adapt to newer digital technologies.

This content analysis determined that the majority of leading print-based Canadian consumer magazines offered digital editions of their issues (86 % of the titles investigated). These editions are available in a variety of formats, with 73 % of publishers supporting digital issues producing a native app version. As well, publishers also offered either a digital replica (41 %), or extended PDF (47 %) version, with 18 % offering all three versions. Publishers appear to be exploring multiple formats for extended reach; it is relatively economical to create a replica version for distribution through a newsstand platform such as Texture, or Zinio.

From a platform perspective, it was determined that Canadian publishers appeared to favour tablets slightly over mobile, along with full support for the iOS platform, with partial support for Android. The on-going availability of different devices, screen resolutions and aspect ratios, as well as operating systems, acts as a further set of technical constraints on publishers. Each of these different combinations could require a dedicated native app.

The overall market for tablets in Canada has stabilized, with some reports predicting a decrease in sales. In contrast, the mobile market is expected to continue to grow through 2020, with Apple’s iOS continuing to have the largest market share (Rody-Mantha, 2017).

There are also recent reports highlighting the overall growing importance of mobile as a platform for digital media consumption. In her latest annual Internet Trends report, respected Industry Analyst Mary Meeker outlined that while device sales are slowing due to market penetration, mobile’s actual share of time spent online is increasing (Meeker, 2018). On mobile, Internet browser usage is increasing, while individual app usage is generally decreasing; however media subscription apps are “predicted to grow 20 %” in Canada through 2020 (Rody-Mantha, 2018). Eric Schmidt, former CEO and executive chair of Google, has previously encouraged publishers and advertisers to adopt a “mobile first” strategy, citing that mobile will be a key driver for the digital display advertising market (O’Regan, 2011 cited in Tomas, 2013).

Overall, the native app editions studied generally presented relatively moderate to low use of the digital

affordances available, aside from in-app search that was found in 86 % of the issues. The other interactive elements related to ‘extending’ content use were links (55 %), learn more (41 %) and save article (32 %). The multimedia formats used to ‘enhance’ content were generally less common, with interactive images and video found in 36 % of native app issues, and audio in 9 %. While there did not appear to be a direct relationship between higher rates of digital circulation and ‘extend’ affordances, there did appear to be relationships between higher rates of ‘enhance’ affordances and higher rates of digital circulation.

In the native app editions, publishers do not appear to be taking full advantage of the affordances available to them to enhance their content. The relatively lower levels of interactive editorial content are presumably related to the constraints of higher costs required to produce this material, as well as the resources to deliver it across multiple devices and platforms (Guenther, 2011).

Overall, the use of interactivity in advertising content is minimal, again presumably related to the resources required to produce the content, as well as demonstrable efficacy for the advertiser (lower circulation levels for digital editions of print based magazines).

With regards to digital engagement with the magazine’s audience, there did not appear to be a direct relationship between the numbers of social media channels a title was active on and digital circulation rates. There did, however, appear to be a relationship between increased abilities for a magazine’s readers to share some level of content through their personal social media accounts and higher circulation rates.

Publishers may wish to (re)consider their strategies for supporting some form of content sharing on social media. It is understood that sharing could be a constraint for publishers of paid content, with some readers effectively republishing copyright protected content through social media sites. Overall, it appears that the publishing industry may still have yet to develop a viable business model to sustain the costs of producing a digital magazine, which appears to continue to contribute to publishers earlier reported overall “poor exploitation of digital tools” (Santos Silva, 2011).

The growth for the consumer magazine market in Canada is expected to depend on digitally delivered titles. Considering the patterns discussed here Canadian publishers who wish to grow their digital audience should further consider a shift in platform focus to mobile devices, with additional operating systems, as well as additional resources for multimedia affordances and digital engagement.

## 6. Future research

An area of further study could include evaluating the use of social networks by magazines to allow readers to easily share some form of access to a magazine's content. Providing content to mobile devices, via a website, may provide greater potential readership network effects than on a tablet. This work could also include the various technologies that support these deep links into an issue. In addition, this could be considered with an analysis of the use of different forms

of paywalls (access to website content restricted to subscribers), which is reportedly increasing with newspapers (FIPP, 2018). This could include a review of the availability of 'micropayments' in magazine publishing, a monetization approach in which readers can purchase access to specific articles.

Lastly, a similar analysis of competitive titles and categories in the United States publishing market could serve an additional useful benchmark, to evaluate strategies in a similar market.

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## References

- Bilton, R., 2016. In search of Facebook love, publishers form link-sharing pacts with each other. *Digiday*, [online] 4 February. Available at: <<https://digiday.com/media/social-world-publishers-taking-link-sharing-facebook/>> [Accessed 16 June, 2018].
- Finley, K., 2015. A Brief History of the end of the comments. *Wired*, [online] 8 October. Available at: <<https://www.wired.com/2015/10/brief-history-of-the-demise-of-the-comments-timeline/>> [Accessed 12 June, 2018].
- FIPP, 2014. *FIPP world magazine trends 2014/2015*. London: Fédération Internationale de la Presse Périodique (International Federation of the Periodical Press).
- FIPP, 2018. 2018 global digital subscription snapshot. *FIPP – Fédération Internationale de la Presse Périodique (International Federation of the Periodical Press)*, [online] Available at: <<https://fipp.s3.amazonaws.com/media/documents/2018%20Digital%20Subscription%20Snapshot.pdf>> [Accessed 9 June 2018].
- Guenther, M., 2011. Magazine publishing in transition: unique challenges for multi-media platforms. *Publishing Research Quarterly*, 27(4), pp. 327–331. <https://doi.org/10.1007/s12109-011-9244-1>.
- Heine, C., 2014. Are tablets just as 'mobile' as smartphones? *Adweek*, [online] 1 October. Available at: <<http://www.adweek.com/brand-marketing/are-tablets-just-mobile-smartphones-160457/>> [Accessed 5 February, 2017].
- Ibisworld, 2017. Magazine & periodical publishing – Canada market research report. *IBISWorld*, [online] Available at: <<https://www.ibisworld.ca/industry-trends/market-research-reports/information/magazine-periodical-publishing.html>> [Accessed 23 June, 2018].
- Idealliance, 2013. OpenEFT (enhanced for tablet) designed for tablet magazine guide. *Idealliance*, [online] Available at: <[http://www.primstandard.org/openeft/draft3/guides/OpenEFT\\_DFT\\_Guide\\_Draft3.htm](http://www.primstandard.org/openeft/draft3/guides/OpenEFT_DFT_Guide_Draft3.htm)> [Accessed 4 December, 2016].
- MacArthur, A., 2018. Social media marketing for magazines: how top publishers get seen. *Mequoda*, [online] Available at: <<https://www.mequoda.com/articles/audience-development/social-media-marketing-magazines-top-publishers-get-seen/>> [Accessed 13 June, 2018].
- Macnamara, J., 2005. Media content analysis: its uses, benefits and best practice methodology. *Asia Pacific Public Relations Journal*, 6(1), pp. 1–34.
- Magazines Canada, 2015. Consumer magazine media: fact book 2015. *Magazines Canada*, [online] Available at: <[https://magazinescanada.ca/wp-content/uploads/2016/11/consumer\\_fact\\_book\\_2015\\_english\\_final.pdf](https://magazinescanada.ca/wp-content/uploads/2016/11/consumer_fact_book_2015_english_final.pdf)> [Accessed 20 June, 2016].
- Malyarov, N., 2017. Are digital editions dead?. *FIPP – Fédération Internationale de la Presse Périodique (International Federation of the Periodical Press)*, [online] Available at: <<https://www.fipp.com/news/opinion/are-digital-editions-dead>> [Accessed 9 June 2018].
- Martin, N., 2017. Digital publishing trends to watch for in 2018. *MagLoft*, [online] Available at: <<https://www.magloft.com/blog/digital-publishing-trend-watch-2018/>> [Accessed 1 June, 2018].
- McGrenere, J. and Ho, W., 2000. Affordances: clarifying and evolving a concept. In: *Proceedings of Graphics Interface 2000*. Montreal, Quebec, 15–17 May 2000. Toronto: Canadian Information Processing Society.

- Meeker, M., 2018. Internet trends report 2018. *Kleiner Perkins Partners*, [online] Available at: <<http://www.kpcb.com/internet-trends>> [Accessed 18 June, 2018].
- Milne, N., 2018. How to tap into the power of influencers. In: *MagNet 2018 Canada's Magazine Conference*. Toronto, Canada, 25–26 April 2018. Toronto, Canada: Magazines Canada.
- Miric, M., 2015. *Exploration of affordances in subscription-based digital magazines*. Master of Digital Media Thesis. Ryerson University.
- Miric, M. and Lumby, N., 2015. Exploration of affordances in subscription-based digital magazines. *International Circular of Graphic Education and Research*, 8, pp. 54–63.
- Moses, L., 2017. The struggle with the importance of newsletters. *What's New in Publishing*, [online] 16 January. Available at: <<https://whatsnewinpublishing.com/2017/01/17/the-struggle-with-the-importance-of-newsletters/>> [Accessed 3 June, 2018].
- Neuendorf, K., 2002. *The content analysis guidebook*. Thousand Oaks, CA: Sage Publications.
- Nicolas, D., Coburn, E., Van Doren, M. and MacArthur, A., 2014. Digital magazine publishing: digital publishing tips for creating digital magazines in a tablet publishing world. *Mequoda*, [online] Available at: <<https://issuu.com/kimprints/docs/digital-magazine-publishing-handboo/7>> [Accessed 22 May, 2018].
- Nordicity, 2009. Study of digital magazine and newspaper publishing in Canada. *Nordicity for Ontario Media Development Corporation*, [online] Available at: <<http://www.nordicity.com/media/20121112ghttxgyq.pdf>> [Accessed 18 August, 2016].
- PwC, 2017. Perspectives from the global entertainment and media outlook 2017–2021. *PricewaterhouseCoopers*, [online] Available at: <<https://www.pwc.com/gx/en/entertainment-media/pdf/outlook-2017-curtain-up.pdf>> [Accessed 8 June, 2018].
- Ritchie, R., 2017. Happy 7<sup>th</sup> anniversary iPad! *iMore*, [online] Available at: <<http://www.imore.com/history-ipad-2010>> [Accessed 3 February, 2017].
- Rody-Mantha, B., 2017. Television advertising to remain flat, tablets to tank: study. *Media in Canada*, [online] 11 January. Available at: <<http://mediaincanada.com/2017/01/11/television-advertising-to-remain-flat-tablets-to-tank-study/>> [Accessed 16 June, 2018].
- Rody-Mantha, B., 2018. Canada's prolific smartphone market skews to iOS. *Media in Canada*, [online] 23 January. Available at: <[mediaincanada.com/2018/01/23/canadas-prolific-smartphone-market-skews-to-ios-study/](http://mediaincanada.com/2018/01/23/canadas-prolific-smartphone-market-skews-to-ios-study/)> [Accessed 16 June, 2018].
- Santos Silva, D., 2011. The future of digital magazine publishing. *Information Services and Use*, 31(3–4), pp. 301–310.
- Smyth, C. and Fan, C., 2017. Canadian magazine publishers – state of the 'App'. In: P. Gane, ed. *Advances in Printing and Media Technology: Proceedings of the 44<sup>th</sup> International Iarigai Conference*. Fribourg, Switzerland, 10–13 September 2017. Darmstadt, Germany: iarigai, pp. 97–108.
- Spencer, J., 2007. *Small magazine circulation: management and accounting*. Toronto, Canada: Magazines Canada.
- Statcounter, 2018. Mobile operating system market share in Canada – April 2018. *Statcounter*, [online] Available at: <<http://gs.statcounter.com/os-market-share/mobile/canada/2018>> [Accessed 31 May, 2018].
- Statista, 2016. Most popular social network websites in the United States in November 2016, based on share of visits. *Statista*, [online] Available at: <<https://www.statista.com/statistics/265773/market-share-of-the-most-popular-social-media-websites-in-the-us/>> [Accessed 5 June, 2018].
- Statista, 2018. Market share of tablets in North America by device from 2Q'15 to 1Q'18. *Statista*, [online] Available at: <<https://www.statista.com/statistics/629385/tablet-market-share-by-device-in-north-america/>> [Accessed 31 May, 2018].
- Tomas, K., 2013. Virtual reality: why magazines should adopt a mobile-first publishing strategy. *Publishing Research Quarterly*, 29(4), pp. 301–317. <https://doi.org/10.1007/s12109-013-9330-7>.
- Valenti, J., 2015. Not all comments are created equal: the case for ending online comments. *The Guardian*, [online] 10 September. Available at: <<https://www.theguardian.com/commentisfree/2015/sep/10/end-online-comments>> [Accessed 12 June, 2018].

## Appendix

A list of Magazine Categories, Publishers, Titles, and their Circulation, with sources.

Note: Digital Edition Circulation where available – not all titles reported circulation numbers for their digital editions.

Category	Publisher	Title	Circulation		
			Print	Digital	Source*
Architecture / Design	Canada Wide Media	Award	10,000		Publisher's claim
Automotive	Performance Publications Media Group	PRN Ignition	250,430		FIPP
Automotive	Riptide Resources Inc.	Motorcycle Mojo	11,705		CARD
Beauty	St. Joseph Media	Glow	370,000		CARD
Business	Rogers	Maclean's	161,183	33,870	CARD
Business	Business Edge News Media	Business Edge	157,200		Publisher's claim
Business	Rogers	Canadian Business	79,705	9,460	CARD
Children	Bayard	ChickaDEE	58,643		CARD
Children	Bayard	Chirp	55,277		CARD
Children	Bayard	Owl	47,427		CARD
Children	Canada's History Society	Kayak	6,088		CARD
Family	Family Communications	Parents Canada	50,000		Publisher's claim
Family/Parenting	Rogers	Today's Parent	60,760	21,939	CARD
Fashion	Rogers	Flare	125,111	8,852	CARD
Fitness	Impact Productions	Impact Magazine	90,000		Publisher's claim
Fitness	Myndlogic Publishing	Windsor Body Magazines	20,000	10,000	CARD
Food & Drink	Liquor Control Board of Ontario	Food & Drink	531,333		CARD
Gen. Interest	Reader's Digest	Reader's Digest	294,697	48,211	CARD
Gen. Interest	Canadian Geographic	Canadian Geographic	137,071	1,012	CARD
Gen. Interest	Moongate Publishing Inc.	Harrowsmith's (Almanac)	91,000		FIPP
Health	Alive Publishing Group	Alive	172,661		CARD
Health	The Town Crier of Markham Inc.	Healthy Living	140,000		Publisher's claim
Home Interest	TVA Group	Style at Home	180,430	21,015	CARD
Home Interest	House & Home Media	Canadian House & Home	138,861	65,496	CARD
Lifestyle	TVA publications (Transcontinental)	Canadian Living	391,539	16,651	CARD
Men's Lifestyle	Contempo Media	Sharp	140,000		CARD
Men's Monthly	Chill Media Inc.	Chill	196,683		Publisher's claim
Other Special interest	Zoomer Media Limited	Zoomer	174,816	10,382	CARD
Other Special interest	Rogers	Hello! Canada	89,173	33,409	CARD
Other Special Interest	Cottage Life Media	Cottage life	65,117	5,307	CARD
Sport	ScoreGolf Canada	SCOREGolf	120,381		CARD
Sport	Solstice Publishing	Ski Canada	28,835		Publisher's claim
Travel	Canada Wide Media	Westworld	1,327,818		FIPP
Wedding	Family Communications	Today's Bride	92,666		CARD
Women's	Rogers	Chatelaine	347,560	56,651	CARD

\* CARD: Canadian Advertising Rates and Data card online  
FIPP: International Federation of the Periodical Press  
Publisher's claim: media kit ratecards for advertising sales



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# Assessing the effectiveness of community radio during the 2015 floods in Tamil Nadu

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## Abstract

Flooding due to the unusual excessive rainfall during the month of December in 2015 was one of the recent calamities that turned the state of Tamil Nadu upside down. The arterial districts of the state were reeling under water due to the intense flooding and the coastal district of Cuddalore was one among the severely impacted. People residing in Cuddalore district were extremely traumatised and were clueless about the ongoing situation due to a major power outage and subsequent communication blackout. The advent of an emergency community radio in the post disaster phase of the 2015 floods in Tamil Nadu in the coastal district of Cuddalore carved a place for itself in history by becoming the country's first ever emergency radio station and emerged as a timely disaster communication medium for the affected community. The present study aims to analyse the consumption of an emergency community radio *Peridar Kaala Vaanoli* (Tamil words meaning radio in times of extreme calamity) established for disaster communication in the context of a coastal district in a rapidly developing nation like India. The study is attempting to identify the predictors that envision the effective consumption of an exclusive community radio dedicated for emergency communication in the post disaster phase of the Tamil Nadu Floods, 2015, apart from a comprehensively analysing the socio-economic conditions and the extent of media technology diffusion with respect to the Cuddalore community through survey method. The empirical evidences from the current study state that the extent of media technology diffusion among the respondents is in line with their economic background and the emergency community radio *Peridar Kaala Vaanoli* has been effective through community empowerment, community resilience, needs gratification and inclusive communication design.

**Keywords:** disaster, emergency, communication, Peridar Kaala Vaanoli

## 1. Introduction

### 1.1 Community radio – then and now

The formal models of radio broadcasting in India include commercial radio and public radio. The country witnessed the emergence of community radio stations as the third formal tier of radio broadcasting when the government promulgated a policy to institute the community radio stations by well-established educational institutions in the year 2002. Later the government extended the scope of establishment of these community radio stations to non-profit and voluntary civil society organizations that sowed the seed for the growth of community radio stations in India. Community radio stations operate on a low output frequency that extends its coverage over a small geographical area. Community radio stations intended to

echo and subsequently met out the needs of communities that are usually neglected by the mainstream media agenda (Jayaprakash, 2000). Community radio stations facilitate two-way communication by bridging the information providers and information receivers. The active civic participation in the community radio programming establishes a sense of connection with the audience which is one of the fine aspects of community radio (Gaynor and O'Brien, 2017, p. 39). The South Indian state of Tamil Nadu holds the pride of possessing the highest number of operational community radio stations in the country (Prabhakar, 2012) apart from being a forerunner in respect of exclusive community radio establishments in the wake of disasters and other community development ventures. Nirmala (2015, p. 44) states that the first campus community radio in country, Anna FM (Frequency Modulation) was established in the state of Tamil Nadu with a view

to achieve community development through education and subsequently carved a place for itself in the history of radio broadcasting in India. The community radio station operates on the frequency of 90.4 MHz and is stationed at Anna University, Chennai. Prabakar (2009, p. 7) stated that the programming schedule of the community radio station was designed in a way that focused on community-centered programming. And the same was achieved by the radio station by considering the community as an intrinsic part at every stage of the communication process. The researcher also points out that Anna FM community radio station reached out to the affected communities of the Indian Ocean tsunami in 2004 by providing an opportunity to voice out their fears and anxieties apart from disseminating critical communication pertaining to voluntary support, recovery and rehabilitation and proved that community radio can be effectively used as an inclusive community disaster communication medium especially for the vulnerable population. The establishment of Anna FM community radio was a successful community development venture therefore the Government of India was inquisitive to explore the feasibility to establish a network of community radio-based disaster warning systems in the Andaman and Nicobar Islands with monitoring and support from Anna FM community radio station (Prabakar, 2009, p. 11).

Radio is considered as a powerful tool that has the potential to bridge infrastructural impediments like digital divide that is widely prevalent in India (Rao, 2005, pp. 361–366) and thereby drives the relevance and necessity of its usage. According to a recent study, it is found that radio is the second most accessed media platform (Ahluwalia, 2018). The radio usage statistics concedes the fact that radio has the capability of bridging the communication technology disparities in the near future paving way for the emergence of a technologically empowered nation.

Community radio specifically aids in improving the access to communication networks in developing regions of India (Rao, 2005, p. 371). Currently, there are about 217 operational community radio stations in the country according to the reports by the Ministry of Information and Broadcasting, Government of India (Ministry of Information and Broadcasting, 2018).

Some of the operational community radio stations in the state of Tamil Nadu include Anna FM community radio, Loyola community radio, *Kongu* community radio, *Ilanthilir* community radio, *Muthucharam* community radio *Periyar* community radio, *Sivanthi* community radio and many more (Community Radio Facilitation Centre, n.d.a). These community radio stations are run by established educational institutions in the state.

## 1.2 Need for community disaster communication in Tamil Nadu

The World Health Organization defines disaster as an occurrence that can disrupt the normal conditions for existence that causes suffering that extends beyond the capacity of the affected community (World Health Organization, 2002, p. 3). The effects of disasters become dire when they strike a region occupied by human settlements.

Among the 35 states and union territories (combined) in India, 27 are prone to various disasters and more specifically the state of Tamil Nadu is increasingly prone to multiple natural hazards in comparison to other states in the country in terms of various nature and intensities of the calamities (Government of Tamil Nadu, 2012, p. 1). The state of Tamil Nadu accounts for 15 % of the country's coastline where 40 % of the fishing community lives within 1 kilometer from the coast and about another 50 % live within 2 kilometers from the coast. The state witnesses flooding like flash floods, monsoon floods, cyclonic floods, cloud bursts, and dam failures almost every year and about 8 % of the state is affected by cyclones of which some are very intense in nature (ENVIS Centre: Tamil Nadu, 2018).

Year on year several thousands of people in the state of Tamil Nadu are affected by these disasters and subsequently the damage inflicted on their settlements, environment, and vegetation is very evident which eventually deteriorates the quality of life of the disaster affected communities.

The disaster vulnerability profile of the state of Tamil Nadu speaks in volumes for a fact that the disaster risk is high for the people and that the risk is inflated with the existence of poverty and poor socio-economic conditions that diminish the coping capacities of the vulnerable communities (ENVIS Centre: Tamil Nadu, 2018). Added to this is a growing concern pertaining to climate change and variability that accentuate as well as underscore the need for disaster risk reduction practices that paves way for a sustainable and a resilient nation (ENVIS Centre: Tamil Nadu, 2018).

According to Thattai, et al. (2017, p. 4) these growing hazards are considered alarming since they pose serious threats to India's vast coastline that experiences frequent disasters accounting for 10 % of the tropical cyclones that surge across the world. The role of community radio stations particularly in the wake of disasters is manifold. According to van Kessel, MacDougall and Gibbs (2014, p. 459) and Fombad and Jiyane (2016, p. 1), community radio stations not only inform but also empower the vulnerable population to face the wrath of disasters by overcoming the socio-economic issues.

### 1.3 Community radio and coastal disasters, Tamil Nadu

The gigantic tsunami of 26<sup>th</sup> December 2004 shook the coast line of the Indian Ocean and the adjoining land masses to a grave extent that massacred *lakhs* (hundred thousands) of people living in 14 different countries across the Indian Ocean region (International tsunami Information Center, UNESCO, n.d.). The Indian Ocean tsunami of 2004 left deep scars in the coastal community of the state of Tamil Nadu in India by washing off the dense settlements along the coastline and leaving them massively inundated. The Indian Ocean tsunami of 2004 was considered one of the deadliest disasters in the history of mankind (Taylor, 2014). The communities that fell as a prey to such a deadly disaster were not prepared enough to manage them and hence the impact was very dire. The Indian states of Tamil Nadu, Andhra Pradesh, Kerala and the union territories of Puducherry and Andaman and Nicobar Islands were deeply impacted by the deadly wave, tsunami (National Disaster Management Authority, Government of India, n.d.). The affected areas of tsunami in the state of Tamil Nadu include Nagapattinam, Chennai, Cuddalore, Kancheepuram, Thanjavur, Thiruvavur, Thoothukudi, Kanyakumari, Tiruvallur, Villupuram, Pudukottai, Ramanathapuram and Tirunelveli where several thousands of people were washed away by the giant tidal waves and eventually lost their lives (Tamilnadu State Disaster Management Agency, n.d.). The intensity of disaster vulnerability of the coastal community of India became obvious only when the Indian Ocean tsunami surged (Government of Tamil Nadu, 2012, p. 1).

Ilamparithi (2011, p. 11) reported that years after the tsunami devastation, a non-profit organization named DHAN Foundation extended a helping hand to severely affected fishing and farming communities in the coastal district of Nagapattinam in the state of Tamil Nadu through a community-centered approach. The community radio station was christened *Kalanjiam Saamuga Vaanoli* (Tamil words meaning *Kalanjiam* Community Radio) and the station operated on the frequency of 90.8 MHz. The community radio was backed by the joint efforts of the United Nations' tsunami recovery support programme. Quinn (2008) points out that the broadcasts of the community radio stations aim at capacity building towards effective disaster management for the affected community. According to Kuppuswamy and Rajarathnam (2009, p. 210), Ewart and Dekker (2013, p. 378), and van Kessel, MacDougall and Gibbs (2014, p. 459) community radio stations have the potential to develop disaster resilient communities for the future. Disasters of the past often reiterate the importance of building resilient communities for the future and the same is emphasized in the Sendai Framework

for Disaster Risk Reduction 2015–2030 through a community centered approach (UNISDR, 2015).

Community radio specifically aids the affected communities by addressing the local concerns through grassroots communication (UNESCO, 2007). In the context of a rapidly developing nation like India community disaster communications tools like community radio stations possess an elevated need and relevance during pressing situations like disasters. According to Al-hassan, Andani and Abdul-Malik (2011), and Fombad and Jiyane (2016), community radio stations recognise the importance of social inclusion in developing nations through participatory communication that paves way for not only reaching out to the remotest, most vulnerable and the socially underprivileged but also empowers them with the necessary knowledge and skills. Coile (1997) states that the community radio stations act as mediators coordinating various rescue and relief activities, collecting and reporting information about the status of the disaster affected communities and aid in swift recovery from the trauma caused by the disaster. These activities aid the disaster vulnerable communities by training and preparing them to face the fury of grave disasters by strengthening their coping capacities and life-saving skills with a long-term focus. A deep-rooted legacy of community radio in the state speaks volumes particularly in the context of being an inclusive medium that allows the most vulnerable communities to be an intrinsic part of development through participatory communication. A handful of community radio stations have been established in the state of Tamil Nadu in the wake of coastal disasters for emergency communication. One such community radio established recently was *Peridar Kaala Vaanoli* (Tamil words meaning radio in times of extreme calamity) in the coastal district of Cuddalore in Tamil Nadu, India.

#### 1.4 *Peridar Kaala Vaanoli* 107.8 MHz

With frequent instances of disasters, the state of Tamil Nadu has become a disaster-stricken region particularly in the months of November and December in the recent times. It was floods in 2015 and cyclones in the subsequent years. But the 2015 floods were the first-time experience for many residing in the state for whom the beginning days of December in 2015 were nightmarish. People living in the flood vulnerable areas of the state woke up to see their surroundings and nearby localities drowning due to heavy downpours and subsequent breakage of a major water body, the *Chembarambakkam* lake, in the wee hours of December 1, 2015. The people were experiencing the ferocity of the unusual torrential rains caused by the North-East monsoon that eventually ended up in severe flooding in the major coastal districts of Tamil Nadu apart from the neighboring union territory –

Pondicherry, and state – Andhra Pradesh. The continuous heavy rains that lashed the state of Tamil Nadu resulted in the transport systems coming to a standstill, power supply being suspended, drains ceasing to function, communication lines failing to operate and overall the daily routine in the flood affected areas came to a complete deadlock. Flooding and its subsequent impact pushed the affected communities to undergo a large-scale blackout. The intensity of flooding was high enough to submerge vehicles like bikes and cars that were parked in the ground level. The flooding eventually became a declared national disaster that claimed around 470 lives and severely impacted the livestock and agricultural crops and the adjoining land masses (Press Trust of India, 2016). People who underwent the trauma caused by the intense flooding became clueless of the ongoing situation and were desperate for information and communication since the disaster devastated the communication infrastructure altogether, washed away people's hope, their hard-earned property, darkened their living and drove many homeless. The coastal stretch beginning from Chennai till Cuddalore was intensely inundated. It was amidst all these startling events that the emergency community radio *Peridar Kaala Vaanoli* made a record of sorts in the history of Indian radio by becoming the country's first ever radio station exclusively established for emergency communication (Ramakrishnan, 2015) that operated on the frequency of 107.8 MHz. The community media stationed at the Office of the District Collector, Cuddalore redefined the scope, need and sustainability of media during emergencies like disasters and was inaugurated by the district collector. The reach of the radio was approximately 20 kilometers radius from the district collector office, Cuddalore. The establishment of the emergency community media *Peridar Kaala Vaanoli* is a clear-cut evidence of the combined efforts of radio practitioners, social activists, and government bodies along with the local administration (Ramakrishnan, 2015). A capital amount of Rs. 500 000 is required to setup a community radio station in India (Community Radio Facilitation Centre, n.d.b). In the case of establishing *Peridar Kaala Vaanoli*, the Wireless Planning and Coordination (WPC) wing of the Ministry of Communications issued swift license to run the community radio, organizations such as the Broadcast Engineering Consultants India Ltd. (BECIL) rendered support by providing assistance to setup the equipment for broadcasting, the National Informatics Centre provided technical resources such as computers and internet connectivity and the government owned Bharat Sanchar Nigam Limited (BSNL) provided a dedicated contact number for helpline and other necessary resources were harnessed by volunteers and supporting organizations (Manzar, 2015). Volunteers including the then district collector came forward to be announcers of the community radio to broadcast notifications

from the district administration on the flood relief measures (Ramakrishnan, 2015) and subsequently drove the popularity of the community radio to the Cuddalore community. The emergency community radio service was the one that was an affordable and accessible medium that broadcast timely, situational, local and relevant information to the flood affected Cuddalore coastal community. The radio service chalked out issue focused programming plan and broadcast programmes on relief and rehabilitation activities carried out in the region apart from news, educational and phone-in programs that allowed the flood affected community to be a part of the disaster communication process. The intent of the community media like *Peridar Kaala Vaanoli* for instance was to reach out to the people living in the geographically remote areas who are otherwise not reached by the local administration (Manzar, 2015) and heal the nightmarish experience after the disaster incidence by guiding the community towards recovery and reconstruction.

### 1.5 Deep-rooted dependence on community media during disasters

During grave events like disasters, the communication infrastructure is impacted that it ceases to function. Failure of the communication infrastructure indicates a flat line in information dissemination that in turn instigates a sense of fear and anxiety among those experiencing the unpredictable disruptions. During untoward circumstances, local medium like community radio service becomes the primary source of situational information and people exhibit a heightened dependence on such communication medium due to want of crucial crisis information (Hindman and Coyle, 1999, p. 8). The emergence of the only viable source of information and communication *Peridar Kaala Vaanoli* for the coastal district Cuddalore in the post disaster phase of the 2015 floods in Tamil Nadu raised hopes for the disaster affected community. Incidences of disasters instigate the realization that the basic needs for human beings need to be redefined. Birowo (2010) states that during emergencies like disasters people need, not just food, water, clothing and shelter but also a medium for communication to get to know the ongoing situation and bounce back to normalcy. Ewart and Dekker (2013, p. 370) say community radio service has envisioned the same by being an accessible, affordable and interactive communication medium. According to Romo-Murphy, James and Adams (2011) community radio stations operate with a view to disseminate crucial communication to the information-thirsty community. Not just that, disasters are always discriminative in nature in the sense that their impact is disproportionate to the people who experience its fury. It is mostly the socially underprivileged and poverty-stricken who reside in the disaster vulnerable areas where the impact

is very dire. The coping capacities of those communities are poor and are often left with lack of resources that drive them to pose an increased risk to face and recover from deadly disasters. According to Banjade (2007) and Nirmala (2015) decentralised medium like community radio service empower the powerless with informational and other resources that prepare them to face the wrath of disasters. *Mandakini-ki-Awaaz*, *Kumaon Vani* and *Henvalvani* are decentralised community radio services established in the wake of Uttarakhand floods, 2013 in the *Rudraprayag*, *Muktheswar* and *Chamba* Valley region in India (Talwar, 2016). The community radio services aimed at playing a cardinal role in keeping the communities residing in the flood prone regions of Uttarakhand informed and alert for momentous disaster communication. An added advantage with the community radio stations is that they closely work with various disaster management agencies as well as the local government bodies to ensure that trustworthy information is passed on to the affected communities. The role of community radio stations established in the wake of disasters has been observed to be vital with respect to timely information dissemination to the disaster affected communities that satiate their thirst for information.

## 2. Theoretical foundation

### 2.1 Factors driving community radio usage during disasters

Community radio leverages the disaster affected communities by prioritizing the first level responders, the communities themselves, by providing the necessary information in the local dialect that paves way for better understanding of the situation, its intensity and impact (ICT Post Media Action Bureau, 2015). Doing so, the community radio services become pathways for accessing time-sensitive information that strengthens the fragility of the vulnerable communities to face disasters and aid in preventing such events in becoming intense humanitarian crisis. According to Wei, et al. (2010, pp. 1013–1014) timely information dissemination and the subsequent dynamic knowledge derived during

emergencies from information hubs help in achieving effective disaster risk reduction. Community radio stations stand as valuable information hubs during emergencies like disasters. These researchers also state that the content of these emergency community radio services have been designed in such a way that it sensitises the communities, satiates their informational needs and discusses crucial community-specific issues.

Hibino and Shaw (2014, pp. 386–387) manifest that a community radio service in an emergency like disaster stands as the immediate and accessible source of information that establishes situational awareness to the communities, routes emergency response, evacuation and recovery information from the local administrative bodies apart from providing backing to safeguard the physical as well as mental health of the disaster impacted. King (2002) and Wei, et al. (2010) state that when a community lags in disaster preparedness and awareness, an instance of a disaster will shock them enough and throw them out of gear.

A community radio indeed recognises the informational gap that accelerates community vulnerability and offers pertinent information and knowledge dissemination. Coyer (2011, p. 166) states that there are frequent instances of disasters in the global context and for the nations that are disaster vulnerable; radio is a major source of information for millions. Karanja (2016) highlights that there is a dire call for an escalated need for community radio stations that work tirelessly for reducing community vulnerability and eventually achieve effective disaster risk reduction. Previous studies in the area of enquiry are found to focus less on the immediacy aspect of disaster needs of the affected community which has been taken up in the current study. However, the studies throw light on the factors to be analysed for the current study (see Table 1).

Based on the factors derived from literature, the role and utility of community radio services in the post disaster phase for the coastal community is studied. The current research aspires to examine the diffusion of a community radio service *Peridar Kaala Vaanoli* established in the coastal district of Cuddalore in Tamil

Table 1: Factors considered in the current study

Factors	Quinn (2008)	Wei, et al. (2010)	Coyer (2011)	Al-hassan, Andani and Abdul-Malik (2011)	Ewart and Dekker (2013)	van Kessel, MacDougall and Gibbs (2014)	Nirmala (2015)	Fombad and Jiyane (2016)
Inclusive communication	✓		✓	✓	✓			✓
Needs gratification	✓	✓	✓	✓			✓	✓
Resilience building	✓	✓			✓	✓		
Community empowerment			✓	✓	✓	✓	✓	✓

Nadu, India during the aftermath of the 2015 floods in the state of Tamil Nadu and aims to supplement the deficiency in the area of enquiry.

## 2.2 The media dependency theory

The current research is grounded on the dependency model of mass media proposed by Sandra Ball-Rokeach and Melvin DeFleur in 1976. Ball-Rokeach and DeFleur (1976) in their dependency model of mass media, state that there is an internal link that exists among the audience, media and the social system. The nature of this tripartite relationship ascertains the effects of media on people and the social system. The model lays focus on the degree of dependence people have on media that eventually throws light on understanding the influence of the media messages on the audience. The dependency increases manifold when media gratifies the informational needs of the audiences. Ball-Rokeach and DeFleur (1976) state that there are pervasive needs like gathering information that serves to establish a sense of familiarity and connectedness with the social world. Other informational needs include the need to act meaningfully and effectively in real world situations, the fantasy need that allows people to escape from their daily issues and problems and so on. Centrality of the media information function is also a key player in the dependency model. When a medium provides greater amount of information that is socially central to the prevailing situations, that too at appropriate frequencies, the dependency on the medium by the audience and the social system is heightened. During situations of high degree conflict and change, the dependency on the medium for want of information becomes manifold since the situational information disseminated in media during such emergencies aims to establish a sense of social stability. At such grave junctures, information is manifested as knowledge and knowledge as power for the affected lot.

## 2.3 Research questions

The theory gains relevance for the current research as the relationship among the community disaster communication medium – *Peridar Kaala Vaanoli*, the audience and their social system are studied in the context of the 2015 floods in Tamil Nadu to understand the extent of dependency the disaster affected Cuddalore community had on the community medium. The study considers the coastal community of Cuddalore as intrinsic active participants of the community disaster communication process in the post disaster context of the 2015 floods in Tamil Nadu, India. According to the theoretical framework adopted in the current study, the community media – *Peridar Kaala Vaanoli*, audience (flood affected population in Cuddalore) and the social system (coastal community) are hypothesised to be well

connected. The dependency of the flood affected community on the emergency community radio depends on the extent to which the community radio fulfills the emergency needs of the disaster affected communities. Also, during an unpredictable grave event like disaster, affected people tend to reconsider their beliefs, practices and behavior for decision making for dire want of information, support and guidance. At that time social stability is established through timely provision of information and necessary support. By studying the extent to which the community medium *Peridar Kaala Vaanoli* gratified the informational needs of the audience the effectiveness of the communication medium can be ascertained. Economic conditions, social structure and culture also influence the choice of media and the dependence relied on it for gratifying the informational needs.

Based on the adopted theoretical framework, the research questions framed for the current research include:

Research Question 1: What is the extent of media technology diffusion in the disaster stricken coastal community of Cuddalore district in Tamil Nadu, India?

Research Question 2: What are the predictor variables that influence the effective consumption of the content disseminated in the emergency community radio *Peridar Kaala Vaanoli* during the post disaster phase of the 2015 floods in Tamil Nadu?

## 3. Methodology

A comprehensive survey among the 2015 flood affected coastal communities of Cuddalore district in Tamil Nadu, India was conducted for the present research. The map below clearly represents the geographical location of the district in the state of Tamil Nadu, India (see Figure 1).

The state of Tamil Nadu was chosen for the study (area sampling) since it was the area where the disaster took place. In Tamil Nadu a majorly affected district due to the 2015 floods – Cuddalore – was chosen (purposive sampling). The coastal district of Cuddalore was chosen for the study since it possesses a higher vulnerability towards natural disasters apart from a fact that the emergency community radio *Peridar Kaala Vaanoli* was established in the same district.

The coastal district of Cuddalore in Tamil Nadu predominantly has plain terrains sans any high relief zone except in a very few places and witnesses surplus rainfall during the North East Monsoon season and is a Cyclone prone zone in the east coast of India. The aver-

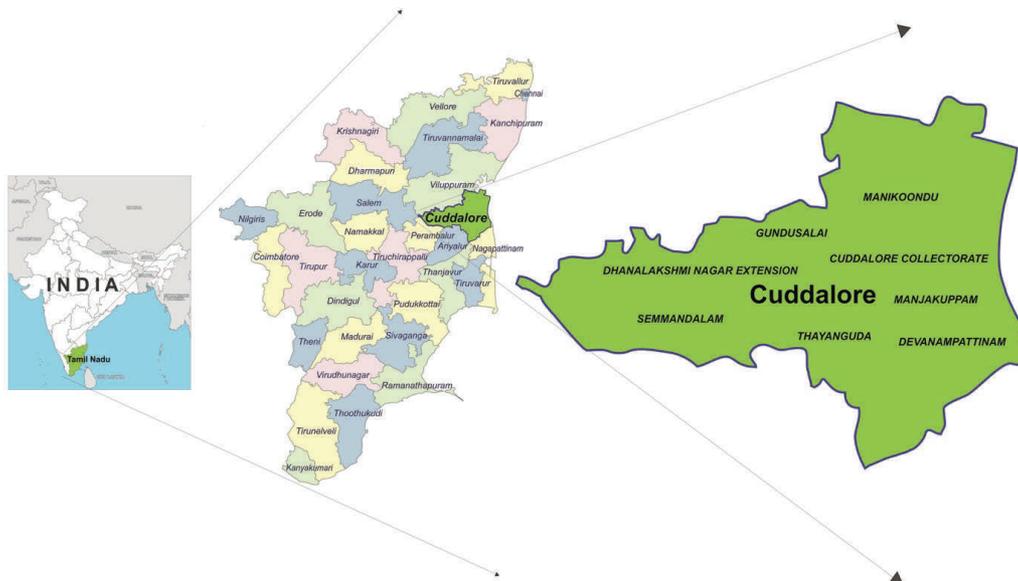


Figure 1: Study regions in Cuddalore District, Tamil Nadu, India (adapted from d-maps.com, 2018)

age rainfall recorded in the year 2015 at Cuddalore was at a colossal 1748.14 millimeter – a highest record in the past decade (Government of Tamil Nadu, 2017, p. 25).

In the chosen coastal district, people who were listeners of the emergency radio *Peridar Kaala Vaanoli* during the post disaster phase of the 2015 floods in Tamil Nadu were included in the sample (purposive sampling), in multiple stages. Hence a multistage purposive sampling technique was adopted for the current research. According to Lavrakas (2008, p. 645) the adoption of the purposive sampling technique logically allows for a sample inclusion that is representative of the population considered for the study. Through the sampling technique adopted in the current study, the responses from the listeners of the emergency community radio residing in the areas of station's coverage had been recorded for the study. Respondents were sampled in the areas surrounding the Office of the District Collector, Cuddalore. The areas include *Dhanalakshmi Nagar*, *Devanampattinam*, *Thayanguda*, *Gundu Salai*, *Manikoondi*, *Semmandalam* and *Manjakuppam*.

### 3.1 Research instrument

The literacy rate of the respondents in the current study is 71.85 % – as stated in the Cuddalore District Disaster Management Plan, 2017 (Government of Tamil Nadu, 2017, p. 6). The prevailing literacy rate is lesser than the state's average, and hence an interview schedule method was found appropriate to record the survey responses of the flood affected Cuddalore community. Enumerators were employed for data collection. A questionnaire was designed to record the survey responses. The questionnaire design aims to assess the prevailing status with respect to access to

media of the Cuddalore coastal community based on their socio-economic profile apart from identifying the factors that drive the Cuddalore coastal community in getting hooked to the radio station during the 2015 floods in Tamil Nadu. These factors help in assessing the effectiveness of the content as well as the importance of the community radio during coastal emergencies. The questionnaire design for the proposed survey methodology aims to collect the information from people identified as sample for the research. A data driven approach that begins with observations of the sample and progress further with explanatory variables is found appropriate for the study, as cited in de Leeuw, Hox and Dillman (2008, p. 6). The responses for the questionnaire designed for the study were recorded from a total of 250 respondents residing in the geographical area of study. The questionnaires having incomplete responses were excluded from analysis. The responses from the remaining 203 questionnaires were taken up for the study. The sample consisted of a greater number of males and the minimum level of their education.

## 4. Results

### 4.1 Respondents' socio-economic profile

The respondents of the current study were found to be residing in areas that are highly vulnerable to disasters. The coastal district has witnessed the onslaught of the tsunami in 2004, cyclones almost every year apart from the recent floods in December 2015. From the analysis it is inferred that the share of the male respondents is 15.28 % more than the female respondents that is indicative of a male dominated population (see Table 2). The

penetration of education among the respondents has attained grass roots level with an equal chunk of the respondents having pursued primary and high school education, respectively. Progression towards education and enhanced literacy is evident through the presence of graduate respondents who are 1.97 % more than primary and high school respondents, respectively (see Table 2). The age of the respondents is varied in which the age group of 36–45 is dense, followed by the 26–35 age group. The former group is 5.91 % more than the latter (see Table 2). The respondents are majorly self-employed (35.96 %), followed by homemakers (30.05 %). The respondents are not found to be financially sound and the same is evident through their status of income that falls majorly under the categories of low income and middle income. Also, the respondents are found to be residing in dense settlements that are dominantly four members and more (34.98 %) residing in: huts (8.87 %), thatched roofs (16.26 %), semi pucca (34.48 %) and pucca houses (40.39 %).

*Table 2: Percentage analysis of the socio-economic profile of the respondents*

<b>Socio-economic profile</b>		
<b>Gender</b>	Male	57.64 %
	Female	42.36 %
<b>Level of education</b>	Primary	19.21 %
	Secondary	22.17 %
	High school	19.21 %
	Higher secondary	7.88 %
	Lacking proper schooling	10.34 %
	Graduation and above	21.18 %
	<b>Age</b>	
	15–25	18.72 %
	26–35	21.18 %
	46–55	27.09 %
	56 and above	17.73 %
<b>Occupation</b>	Employed	10.34 %
	Self-employed	35.96 %
	Daily wage worker	10.34 %
	Homemaker	30.05 %
	Others	13.00 %
<b>Income group</b>	Below poverty line	16.26 %
	Low income group	41.87 %
	Middle income group	41.87 %
	High income group	–
<b>Family size</b>	1 member	2.46 %
	2 members	9.36 %
	3 members	13.30 %
	4 members	34.98 %
	5 members	21.67 %
	6 members	18.23 %
<b>Type of house</b>	Hut	2.46 %
	Thatched roof	9.36 %
	Semi pucca	13.30 %
	Pucca	34.98 %

The overall socio-economic profile of the respondents clearly demonstrates the evidence of posing an increased risk and vulnerability towards disasters.

#### **4.2 Respondents' extent of media technology diffusion**

A major crux of the survey respondents is found to be starved of communication technology sophistication that is evident through the possession of mobile phones with primitive communication features sans internet and associated breakthrough communication facilities and a diminutive group does not have access to mobile phones owing to their diminished financial status. The share of respondents possessing a mobile phone with primitive communication options is 52.71 % and those having zero access to such communication devices is 19.70 %. The empirical evidence reveals a fact that there exists an inequality with respect to gaining access to information and communication technology such as mobile phone among the respondents under study. The consumption of media content disseminated through various mass communication outlets are displayed in the bar chart (see Figure 2). The usage of media platforms was recorded as a multiple response question owing to the extensive media consumption of the respondents. The multiple responses have been clubbed into three categories: electronic media, traditional media and all media. Traditional media category refers to platforms such as newspaper, television and radio (Chan and Fang, 2007); electronic media category refers to television and radio.

Among the various mass communication media outlets, television medium holds supremacy (28.57 %) pertaining to consumption as a stand-alone medium indicative of a deep-rooted penetration into the households of the respondents. The respondents in the coastal district are found to prefer a visually appealing medium of information, communication and entertainment. Collective mass media consumption profile of the respondents signifies a fact that the respondents prefer traditional mass media outlets (29.56 %) over other media owing to accessibility and availability in the study area. The share of respondents having access to all media such as newspaper, radio, television and mobile phone is at a mere 17.24 %. Even with the advent of a range of advance media technologies their penetration in the study area is still at a very nascent stage. The respondents' exposure to such advance media technologies is very small and hence bases their dependence on the traditional mass media outlets for delivering information and communication.

The frequency of media usage was measured using a five-point scale (see Appendix); it was high in the case of television with a mean of 3.47 followed by radio with

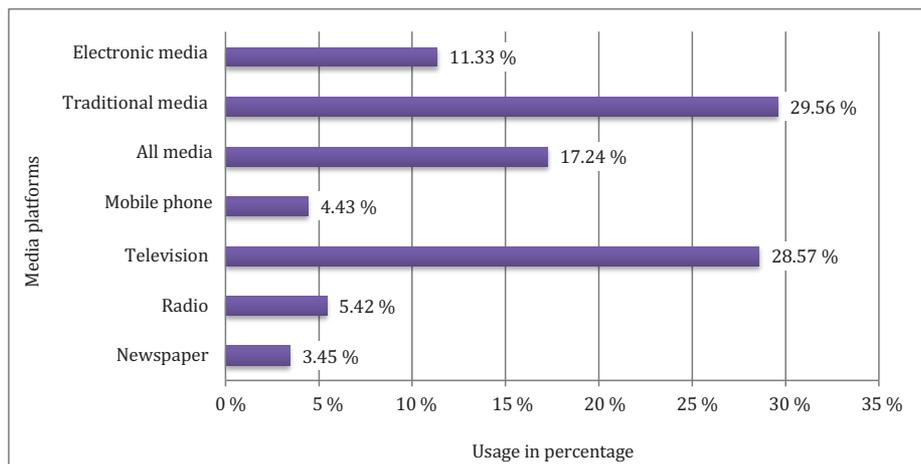


Figure 2: Respondents' media platforms usage

a mean value of 3.19 indicating that television takes the lead with respect to preference and duration of usage when compared with other media during normal times. But with the incidence of floods in the study area, the respondents' preferences for media for information and communication are found to have been altered from the usual. The preference for television medium has witnessed a dip of 0.98 % (preference altered from 28.57 % to 27.59 %) and the preference for radio witnessed a large increase of 18.72 % (preference altered from 5.42 % to a massive 23.15 %). Apart from a change in preference for communication medium, the frequency of using radio has apparently surged after the instance of the 2015 floods particularly in the study region. Radio medium has sustained the onslaught of intense flooding in the study area to serve the information and communication function to the disaster affected communities. Doing so the radio medium *Peridar Kaala Vaanoli* has captivated as well as driven the flood affected Cuddalore community to look up to it through sheer sustenance during unpredictable disastrous events.

### 4.3 Predictors of the effectiveness of *Peridar Kaala Vaanoli*

The variables viz. inclusive communication design, needs gratification, community resilience and community empowerment were identified to be vital predictors that influence the effective consumption of the content disseminated in the emergency community radio *Peridar Kaala Vaanoli* in the post disaster phase of the 2015 floods in Tamil Nadu based on the review of literature on the subject of the research and the number of statements used to measure them were eight, six, four and six, respectively. The predictors were measured through statements that used the five-point Likert scale response measure. Reliability coefficients were computed using Cronbach's Alpha which eval-

uates the internal consistency among the statements that are used to measure the predictors. The results of the reliability analysis are stated in Table 3.

Table 3: Reliability coefficients – predictors of the effectiveness of *Peridar Kaala Vaanoli*

Factors	$\alpha$ Value
Inclusive communication design	0.707
Needs gratification	0.871
Community resilience	0.906
Community empowerment	0.912

The reliability coefficients of the factors considered in the study range from 0.707 to 0.912 all falling under the acceptable range as cited in Clark and Watson (1995). It implies that the statements used to measure each of the predictors have a good internal consistency. Regression analysis was employed for predicting the effectiveness of the emergency community radio in the context of the 2015 floods in Tamil Nadu. The predictors considered in the study were individually analysed to know the extent to which those factors determined the effectiveness of the emergency community radio *Peridar Kaala Vaanoli* in the post disaster phase of the 2015 floods in Tamil Nadu among the coastal community of Cuddalore. The values of the regression analysis conducted for each of the factors are displayed in Table 4. All the factors considered for analysis in the current research are found to be indicating a good level of prediction with respect to determining the effectiveness of the emergency community radio *Peridar Kaala Vaanoli* (regression is significant at 0.000 level).

Community empowerment ( $R^2 = 0.429$  and adjusted  $R^2 = 0.411$ ) associated with skills building of the coastal community through radio programming explains 41.1 % of variance in the effective consumption of the content disseminated in *Peridar Kaala Vaanoli* during

Table 4: Regression values of the predictors of the effectiveness of *Peridar Kaala Vaanoli*

Predictors of the Effectiveness of <i>Peridar Kaala Vaanoli</i>	R <sup>2</sup> (adjusted R <sup>2</sup> )	F-ratio	Significance
Inclusive communication design	0.246 (0.215)	7.921	0.000
Needs gratification	0.224 (0.200)	9.436	0.000
Community resilience	0.410 (0.398)	34.344	0.000
Community empowerment	0.429 (0.411)	24.504	0.000

the post disaster phase of the 2015 floods in Tamil Nadu. Also, community empowerment indicates that the regression model offers a good fit for the data analysed by explaining a significant amount of variance ( $F = 24.504$ ) in influencing the effective consumption of the content disseminated in the emergency community radio *Peridar Kaala Vaanoli* in the post disaster phase of the 2015 floods in Tamil Nadu. The regression statistics confirm that the strongest predictor is community empowerment followed by community resilience, needs gratification and inclusive communication design with respect to significant determination of content effectiveness of the emergency community radio *Peridar Kaala Vaanoli* in the post disaster phase of the 2015 floods in the study area (see Table 4).

## 5. Discussion

The study attempted to evaluate the role and the impact of an emergency community radio *Peridar Kaala Vaanoli* in the post disaster phase of 2015 floods in Tamil Nadu as a community disaster communication medium by studying the prevailing diffusion of media technologies among the coastal community of Cuddalore. The research instrument adopted for the current study allowed the researchers to obtain comprehensive information in the context of the study with which the effectiveness of *Peridar Kaala Vaanoli* for the 2015 flood affected Cuddalore community was ascertained. The respondents were reflective of the population intended for the study in terms of their characteristics, experience with respect to disasters, as well as usage of the medium under study (*Peridar Kaala Vaanoli*). The context of the study is in line with the theoretical framework adopted.

The diffusion of media technology is deep-rooted with respect to the traditional media platforms such as newspaper, radio and television indicating a fact that the access, availability and usage of these media platforms are high. The respondents are found to have increased exposure to traditional media platforms for provision of information and communication. In the case of media platforms like mobile phones and smart mobile phones the access, availability and usage are low owing to their impoverished socio-economic background. Prior to the incidence of the disaster under current study –

the 2015 floods in Tamil Nadu, the assimilations of the audience particularly towards television is evident. The assimilations eventually altered with the incidence of the 2015 floods in Tamil Nadu which implies a fact that more than accessibility and preference for a communication medium, the sustainability and availability of a medium for provision of information and communication particularly during emergency situations like natural disasters is very crucial. This indicates that the community radio *Peridar Kaala Vaanoli* has pervasively served the emergency informational needs of the flood affected Cuddalore community. The dip in usage of television and surge in usage of radio indicate that sustainability of a communication medium has proved to be very influential in driving the viewers to become listeners apart from catering tailor-made content for the flood affected coastal community in the post disaster phase of the 2015 floods.

The community radio *Peridar Kaala Vaanoli* has stood as the primary signalling system during dire emergencies like disasters apart from delivering socially-central communication to the flood affected Cuddalore community. *Peridar Kaala Vaanoli's* socially central information dissemination through an inclusive lens that fixates the vulnerable population in the disaster communication model has proven to be very effective.

The emergency community radio *Peridar Kaala Vaanoli* has leveraged for community empowerment and resilience building apart from gratifying their emergency needs. The coastal community of Cuddalore and the emergency community radio *Peridar Kaala Vaanoli* are found to be well-connected during times of distress which is in accordance with the media dependency theory. Disastrous events like the 2015 floods in Tamil Nadu cause social instability and the community radio has played an effective role in restoring the stability and in turn has driven the flood affected community to have heightened dependence on the community radio and yet again seconds the media dependency theory.

The prevailing economic conditions and social system along with the predictors of the effectiveness of *Peridar Kaala Vaanoli* have influenced the choice, preference and dependence on the emergency community radio and thereby reinstate that the study conforms with the media dependency theory.

## 6. Conclusion

The emergency message dissemination in the community radio *Peridar Kaala Vaanoli* has been appropriate and consecutively has left no scope for ambiguity in the information disseminated. The community radio has established its focus towards ambiguity resolution during the 2015 floods in Tamil Nadu through a clear and tailored communication design that limited the range of interpretations people can arrive at and therefore restrict any possible confusion over the information communicated. Ambiguity resolution clubbed with sustainability of media during instable conditions has made the community radio *Peridar Kaala Vaanoli* to become the stand-alone communication resource for the flood affected Cuddalore community to look up for crisis information. The communication design of *Peridar Kaala Vaanoli* has been found to be inclusive and appropriate in the context of the study and subsequently paved way for the medium to gain effectiveness. Social crisis events like the 2015 floods in Tamil Nadu posed serious threats to established institutions, beliefs and practices. The intensity of the event was so severe that it can alter the adequacy of the established practices with which people cope with the life situations. At such instances, media like *Peridar Kaala Vaanoli* rose to the occasion by disseminating appropriate information resources to the flood affected Cuddalore community and thus intensified the dependency on the medium. The ability of the community disaster communication medium *Peridar Kaala Vaanoli* has been proven by way of being able to acquire and disseminate crucial information that was capable enough in the reconstruction the normal life of the 2015 flood affected Cuddalore community. The community radio *Peridar Kaala Vaanoli* has facilitated the enhancement of coping capacities of the people through its effective programming that intended to build community resilience reinforcing a fact that community resilience is a predictor of the effectiveness *Peridar Kaala Vaanoli*.

Nirmala (2015) clearly pointed out that community radio stations are popularly known for giving voice to the voiceless and in the case of the current study it has empowered the powerless with necessary skills and informed citizenry. The mainstream media adopts a broader perspective in its emergency communication agenda whereas a community disaster communication medium is more focused and in turn gains effectivity

during dire situations like disasters. It implies that communication becomes effective only when there is deep-rooted recognition of the process of communication at the community level. The emergency community radio *Peridar Kaala Vaanoli* has gratified the emergency needs of the Cuddalore community and has driven the community to solely depend on the medium for provision of information, support, and guidance during the aftermath of the 2015 floods in Tamil Nadu and subsequently alleviated the pain caused by the disaster. Needs gratification is also found to be a predictor of the effectiveness of *Peridar Kaala Vaanoli*. The community media *Peridar Kaala Vaanoli* has empowered the coastal Cuddalore community with the necessary knowledge on managing disasters, facilitated to build resilience and advocated the use of radio for emergency communication. Community empowerment is a factor to be considered for predicting the effectiveness of community radio in the context of a disaster. The emergency community radio has set the path for building sustainable societies that can withstand the wrath of the imminent hazards in the future.

The findings of the current study suggest that radio is a resilient medium that is unaffected by dire events like disasters and can effectively be used as a critical communication resource especially for the remotest places in a disaster vulnerable country like India. The study gains prominence by having increased relevance as well as a dire need for community disaster communication medium in a rapidly developing nation like India. The rural communities are deprived of access to digital technologies and the information superhighway and they are the ones who face the wrath of nature's fury during every other instance of disasters.

Overall, the current research has proved a positive fact that community media like *Peridar Kaala Vaanoli* can be utilised as an effective disaster communication medium. The study suggests that the research can be extended to a larger level to explore the possibilities of utilizing community media like *Peridar Kaala Vaanoli* to instil a sense of awareness pertaining to various phases of disasters such as mitigation, preparedness, response and recovery through effective communication and pave way for building resilient and responsible societies that will work hard to reduce the imminent disaster risk and conserve both natural and human resources for a better future and a better world.

## References

- Ahluwalia, H., 2018. *Radio emerges as second most accessed media, outpaces social networking: report*. [online] Available at: <<https://www.livemint.com/Consumer/vBLB4xcdPUMEHCzafXUUoI/Radio-emerges-as-second-most-accessed-media-outpaces-social.html>> [Accessed 19 September 2018].

- Al-hassan, S., Andani, A. and Abdul-Malik, A., 2011. The role of community radio in livelihood improvement: the case of Simli radio. *The Journal of Field Actions – Field Actions Science Reports*, 5. [online] Available at: <<https://journals.openedition.org/factsreports/869>> [Accessed 7 June 2018].
- Ball-Rokeach, S.J. and DeFleur, M.L., 1976. A dependency model of mass-media effects. *Communication Research*, [e-journal] 3(1), pp. 3–21. <https://doi.org/10.1177/009365027600300101>.
- Banjade, A., 2007. *Community radio in Nepal: a case study of community radio Madanpokhara*. Ph.D. dissertation. Ohio University.
- Birowo, M.A., 2010. The use of community radio in managing natural disaster in Indonesia. *Bulletin of the American Society for Information Science and Technology*, [e-journal] 36(5), pp. 18–21. <https://doi.org/10.1002/bult.2010.1720360506>.
- Chan, K. and Fang, W. 2007. Use of internet and traditional media among young people. *Young Consumers*, [e-journal] 8(4), pp. 244–256. <https://doi.org/10.1108/17473610710838608>.
- Clark, L.A. and Watson, D., 1995. Constructing validity: basic issues in objective scale development. *Psychological Assessment*, [e-journal] 7(3), pp. 309–319. <https://doi.org/10.1037/1040-3590.7.3.309>.
- Coile, R.C., 1997. The role of amateur radio in providing emergency electronic communication for disaster management. *Disaster Prevention and Management: an International Journal*, [e-journal] 6(3), pp. 176–185. <https://doi.org/10.1108/09653569710172946>.
- Community Radio Facilitation Centre, n.d.a. *Searchable database of CR stations*. [online] Available at: <<http://crfc.in/list-of-cr-station/>> [Accessed 19 September 2018].
- Community Radio Facilitation Centre, n.d.b. *What is the estimate cost to start up a Community Radio Station?*. [online] Available at: <<http://crfc.in/what-is-the-estimate-cost-to-start-up-a-community-radio-station/>> [Accessed 24 September 2018].
- Coyer, K., 2011. Community media in a globalized world: the relevance and resilience of local radio. In: R. Mansell and M. Raboy, eds. *The handbook of global media and communication policy*. Chichester, West Sussex; Malden, MA: Wiley-Blackwell Publishing, pp. 166–179.
- d-maps.com, 2018. *Maps Tamil Nadu (India)*. [online] Available at: <[https://www.d-maps.com/pays.php?num\\_pay=437&lang=en](https://www.d-maps.com/pays.php?num_pay=437&lang=en)> [Accessed November 2018].
- ENVIS Centre: Tamil Nadu, 2018. *Disaster management in Tamil Nadu*. [online] Available at: <[http://tnenvis.nic.in/Database/TN-ENVIS\\_898.aspx#ctl00\\_Internalcontent](http://tnenvis.nic.in/Database/TN-ENVIS_898.aspx#ctl00_Internalcontent)> [Accessed 25 June 2018].
- Ewart, J. and Dekker, S., 2013. Radio, someone still loves you! Talkback radio and community emergence during disasters. *Continuum: Journal of Media and Cultural Studies*, [e-journal] 27(3), pp. 365–381. <https://doi.org/10.1080/10304312.2013.772106>.
- Fombad, M.C. and Jiyane, G.V., 2016. The role of community radios in information dissemination to rural women in South Africa. *Journal of Librarianship and Information Science*, [e-journal]. <https://doi.org/10.1177/0961000616668960>.
- Gaynor, N. and O'Brien, A., 2017. Community radio, democratic participation and the public sphere. *Irish Journal of Sociology*, 25(1), pp. 29–47. <https://doi.org/10.7227/IJS.0002>.
- Government of Tamil Nadu, 2012. 15.5. *Disaster management in Tamil Nadu: twelfth five year plan Tamil Nadu*. [pdf] Tamil Nadu. Available at: <[http://agritech.tnau.ac.in/12th\\_fyp\\_tn/5.%20Natural%20Resource%20Management/5\\_5.pdf](http://agritech.tnau.ac.in/12th_fyp_tn/5.%20Natural%20Resource%20Management/5_5.pdf)> [Accessed 30 May 2018].
- Government of Tamil Nadu, 2017. *Cuddalore District disaster management plan*. [pdf] Government of Tamil Nadu. Available at: <<https://cdn.s3waas.gov.in/s3a96b65a721e561e1e3de768ac819ffbb/uploads/2018/07/2018070974.pdf>> [Accessed 9 August 2018].
- Hibino, J. and Shaw, R., 2014. Role of community radio in post disaster recovery: comparative analysis of Japan and Indonesia. In: R. Shaw, ed. *Disaster recovery: used or misused development opportunity*. Tokyo: Springer Japan. pp. 385–410.
- Hindman, D.B. and Coyle, K., 1999. Audience orientations to local radio coverage of a natural disaster. *Journal of Radio Studies*, [e-journal] 6(1), pp. 8–26. <https://doi.org/10.1080/19376529909391705>.
- ICT Post Media Action Bureau, 2015. *Disaster management through community radio: for the community, by the community and of the community*. [online] Available at: <<http://ictpost.com/disaster-management-through-community-radio-for-the-community-by-the-community-and-of-the-community-2/>> [Accessed 30 May 2018].
- Ilamparithi, V., 2011. *Community radio for rural development: a social capital perspective of the role of NGO initiatives in Tamil Nadu*. Ph.D. thesis. Manonmaniam Sundaranar University.
- International Tsunami Information Center, UNESCO, n.d. *Indian Ocean tsunami 2004*. [online] Available at: <[http://itic.ioc-unesco.org/index.php?option=com\\_content&view=category&id=1136&Itemid=1373](http://itic.ioc-unesco.org/index.php?option=com_content&view=category&id=1136&Itemid=1373)> [Accessed 8 June 2018].
- Jayaprakash, Y.T., 2000. Remote audiences beyond 2000: radio, everyday life and development in South India. *International Journal of Cultural Studies*, [e-journal] 3(2), pp. 227–239. <https://doi.org/10.1177/136787790000300211>.
- Karanja, E., 2016. *Radio in times of disaster*. [online] Available at: <<https://www.unisdr.org/archive/47813>> [Accessed 30 May 2018].

- van Kessel, G., MacDougall, C. and Gibbs, L., 2014. Resilience-rhetoric to reality: a systematic review of intervention studies after disasters. *Disaster Medicine and Public Health Preparedness*, [e-journal] 8(05), pp. 452–460. <https://doi.org/10.1017/dmp.2014.104>.
- King, D., 2002. You're on your own: community vulnerability and the need for awareness and education for predictable natural disasters. *Journal of Contingencies and Crisis Management*, [e-journal] 8(4), pp. 223–228. <https://doi.org/10.1111/1468-5973.00143>.
- Kuppuswamy, S. and Rajarathnam, S., 2009. Women, information technology and disaster management: tsunami affected districts of Tamil Nadu. *International Journal of Innovation and Sustainable Development*, [e-journal] 4(2–3), pp. 206–215. <https://doi.org/10.1504/IJISD.2009.028074>.
- Lavrakas, P.J. ed., 2008. *Encyclopaedia of survey research methods*. Thousand Oaks, CA: SAGE Publications.
- de Leeuw, E.D., Hox, J.J. and Dillman, D.A. eds., 2008. *International handbook of survey methodology*. New York: Taylor & Francis Group.
- Manzar, O., 2015. *Why community radio matters*. [online] Available at: <<https://www.livemint.com/Opinion/ekmMJYK3Ij6KyZtB0knBiP/Why-community-radio-matters.html>> [Accessed 26 June 2018].
- Ministry of Information and Broadcasting, 2018. *Community radio stations*. [online] Available at: <<http://mib.gov.in/broadcasting/community-radio-stations-0>> [Accessed 24 June 2018].
- National Disaster Management Authority, Government of India, n.d. *Some major disasters in India*. [online]. Available at: <<https://ndma.gov.in/en/disaster-data-statistics.html>> [Accessed 8 June 2018].
- Nirmala, Y., 2015. The role of community radio in empowering women in India. *Media Asia*, [e-journal] 42(1–2), pp. 41–46. <https://doi.org/10.1080/01296612.2015.1072335>.
- Prabakar, N., 2009. *A study on the role of campus community radio (Anna FM) in inculcating everyday science awareness among marginalized women*. Ph.D. thesis. Anna University.
- Prabhakar, V.P., 2012. Community radio stations – success stories. *Media: A Bilingual Monthly Journal of the Kerala Media Academy*, [online] Available at: <<http://mediamagazine.in/content/community-radio-stations---success-stories>> [Accessed 10 June 2018].
- Press Trust of India, 2016. *Northeast monsoon claimed 470 lives in Tamil Nadu: Jayalalithaa*. [online] Available at: <<https://www.thehindubusinessline.com/news/national/northeast-monsoon-claimed-470-lives-in-tamil-nadu-jayalalithaa/article8064661.ece>> [Accessed 26 June 2018].
- Quinn, S.C., 2008. Crisis and emergency risk communication in a pandemic: a model for building capacity and resilience of minority communities. *Health Promotion Practice*, [e-journal] 9(4\_suppl), pp. 18S–25S. <https://doi.org/10.1177/1524839908324022>.
- Ramakrishnan, N., 2015. How the deluge in Tamil Nadu became a historic occasion for Indian radio. *The Wire*. [online] Available at: <<https://thewire.in/17338/how-the-deluge-in-tamil-nadu-became-a-historic-occasion-for-indian-radio/>> [Accessed 26 June 2018].
- Rao, S.S., 2005. Bridging digital divide: efforts in India. *Telematics and Informatics*, [e-journal] 22, pp. 361–375. <https://doi.org/10.1016/j.tele.2005.01.007>.
- Romo-Murphy, E., James, R. and Adams, M., 2011. Facilitating disaster preparedness through local radio broadcasting. *Disasters*, [e-journal] 35(4), pp. 801–815. <https://doi.org/10.1111/j.1467-7717.2011.01234.x>.
- Talwar, G., 2016. Community radio stations to empower people in five disaster prone districts in Uttarakhand. *The Times of India*, [online] Available at: <<https://timesofindia.indiatimes.com/city/dehradun/Community-radio-stations-to-empower-people-in-five-disaster-prone-districts-in-Uttarakhand/articleshow/52467456.cms>> [Accessed 30 May 2018].
- Tamilnadu State Disaster Management Agency, n.d. *Tsunami 2004 – Affected Districts*. [online] Available at: <<http://www.tn.gov.in/tsunami/Tsunami2004/AffectedDistrict.html#menu>> [Accessed 29 May 2018].
- Taylor, A., 2014. Ten years since the 2004 Indian Ocean tsunami. *The Atlantic*, [online] Available at: <<https://www.theatlantic.com/photo/2014/12/ten-years-since-the-2004-indian-ocean-tsunami/100878/>> [Accessed 19 September 2018].
- Thattai, D.V., Sathyanathan, R., Dinesh, R. and Harshit Kumar, L., 2017. Natural disaster management in India with focus on floods and cyclones. In: *IOP Conference Series: Earth and Environmental Science – International Conference on Civil Engineering and Infrastructural Issues in Emerging Economies*. Thanjavur, India, 17–18 March 2017. United Kingdom: IOP Publishing. <https://doi.org/10.1088/1755-1315/80/1/012054>.
- UNESCO, 2007. *Community radio in India: a guide for civil society*. [pdf] UNESCO. Available at: <<http://unesdoc.unesco.org/images/0015/001568/156854eo.pdf>> [Accessed 9 June 2018].
- UNISDR, 2015. *Sendai framework for disaster risk reduction 2015–2030*. [pdf] UNISDR. Available at: <[https://www.unisdr.org/files/43291\\_sendaiframeworkfordrren.pdf](https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf)> [Accessed 2 July 2018].
- World Health Organization, 2002. *Disasters and emergencies: definitions*. [pdf] WHO/EHA Panafrican Emergency Training Centre. Available at: <<http://apps.who.int/disasters/rep0/7656.pdf>> [Accessed 5 June 2018].
- Wei, J., Zhao, D., Yang, F., Du, S. and Marinova, D., 2010. Timing crisis information release via television. *Disasters*, [e-journal] 34(4), pp. 1013–1030. <https://doi.org/10.1111/j.0361-3666.2010.01180.x>.

## Appendix

<b>Socio-Economic Profile</b>		
<b>Variable</b>	<b>Response</b>	<b>Code</b>
Age	15–25	1
	26–35	2
	36–45	3
	46–55	4
	56 and above	5
Gender	Male	1
	Female	2
	Others	3
Level of Education	Primary	1
	Secondary	2
	High School	3
	Higher Secondary	4
	Lack Proper Schooling	5
	Graduation and above	6
Occupation	Employed	1
	Self Employed	2
	Daily Wage Worker	3
	Home Maker	4
	Others	5
Annual Income	Below Poverty Line	1
	Low Income Group	2
	Middle Income Group	3
	High Income Group	4
Family Size	1 member	1
	2 members	2
	3 members	3
	4 members	4
	5 members	5
	6 members and more	6
Type of Residence	Hut	1
	Thatched Roof	2
	Semi Pucca	3
	Pucca	4
	Others	5
Media Usage	Newspaper	1
	Radio	2
	Television	3
	Mobile Phone	4
Frequency of Media Usage	Newspaper	1–5
	Radio	1–5
	Television	1–5
	Mobile Phone	1–5
Media Preference post floods	Newspaper	1
	Radio	2
	Television	3
	Mobile Phone	4
Frequency of Media Usage post floods	Newspaper	1–5
	Radio	1–5
	Television	1–5
	Mobile Phone	1–5

Inclusive Communication Design*		
Communication Language	Scale	1-5
Communication Style	Scale	1-5
Community Centred Strategy	Scale	1-5
Dialogic Communication	Scale	1-5
Tailored Communication Design	Scale	1-5
Needs Gratification*		
Information Source	Scale	1-5
Accessibility	Scale	1-5
Disaster Recovery Guidance	Scale	1-5
Sustainability	Scale	1-5
Distress Helpline	Scale	1-5
Situational Awareness	Scale	1-5
Community Resilience*		
Disaster Education	Scale	1-5
Aiding for Resilience	Scale	1-5
Expedite Disaster Recovery	Scale	1-5
Risk Association Awareness	Scale	1-5
Community Empowerment*		
Knowledge Enhancement	Scale	1-5
Volunteered Participation – Programming	Scale	1-5
Health Awareness	Scale	1-5
Comprehensive Information Dissemination	Scale	1-5
Community Activism	Scale	1-5
Rehabilitation Assistance	Scale	1-5
Expert Advice	Scale	1-5
Skill Development	Scale	1-5
Effectiveness of <i>Peridar Kaala Vaanoli</i> (Overall Rating on a Five Point Scale): 1-5		

\*Multiple dimensions of predictors were measured on a five-point scale.



# TOPICALITIES

*Edited by Markéta Držková*

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# News & more

## The activities of CIE in 2018



This year, the International Commission on Illumination, CIE, and its national committees organised the CIE Expert Tutorial and Workshop on Research Methods for Human Factors in Lighting (August, Copenhagen, Denmark), the 7<sup>th</sup> Conference on Lighting, BalkanLight 2018 (September, Varna, Bulgaria), the 5<sup>th</sup> International Lighting Design Workshop (September, Makrinitza, Greece), and the CIE Tutorial and Practical Workshop on CIE S 025: LED lamps, LED luminaires and LED modules (November, Moscow, Russia). In April, the CIE 2018 Topical Conference on Smart Lighting was held in Taipei, Chinese Taipei. In addition, CIE was part of the Steering Committee for the inaugural International Day of Light in May and technically co-sponsored the 16<sup>th</sup> International Symposium on the Science and Technology of Lighting that took place in June in Sheffield, UK. Currently, the CIE Joint Technical Committee JTC 12 is looking for visual data to be used as the input for the definition of sparkle and graininess measurement scales.

Besides the proceedings of the above-mentioned Topical Conference on Smart Lighting (CIE x045:2018), CIE this year published the standard describing the optical radiation effects on humans and several technical reports, as usually. In addition to those presented in the following text, the report dealing with the measurement of the effective intensity of flashing lights, CIE 229:2018, was released.

### CIE 228:2018 – Grey-Scale Calculation for Self-Luminous Devices

This technical report elaborated by the corresponding committee of Division 1, Vision and Colour, recommends a method to calculate a neutral scale fulfilling specific requirements connected to self-luminous devices such as computer displays and advertising media, which often exhibit high luminance, high spatial resolution and high contrast. Unlike the CIE lightness  $L^*$  commonly used a neutral component in colour-difference calculations for reflective materials, the self-luminous neutral scale recommended in this report is a function of the background luminance of the visual target measured in  $\text{cd m}^{-2}$  and lacks the upper limit. The reference white is thus not required. The presented self-luminous neutral scale enables the calculation of colour differences between self-luminous image segments, including consideration of a neutral point. The scale also accounts for intraocular scattering for the cases when high contrast over a small visual angle is involved.

The Whittle's logarithmic formula is recommended and calculation of CIE self-luminous neutral scale using this formula is shown, including the examples of both positive and negative contrast from background and differences between two visual targets. Among colour-difference formulae for self-luminous stimuli, the use of the self-luminous neutral-scale calculation is presented for CIELAB colour difference, CIEDE2000 and in OSA-UCS (Uniform Colour Space) system. The report also explains the meaning of self-luminous neutral and defines the scope for future research to further improve the recommended calculation, considering e.g. the mesopic light levels, effects of stimulus geometry and post-retinal effects.

## The news from the Ghent Workgroup in 2018



Ghent Workgroup

In January and February, the Ghent Workgroup

(GWG) Webinar Programme offered at the turn of the year 2017/2018 concluded with the last three webinars from the series, dealing with the Ghent PDF Output Suite, the Processing Steps Specification and PDF for Packaging (see also the News & more section of 6(2017)4).

In May, GWG provided the Graphic Arts Workshop on PDF2.0, PDF/X Plus and PDF for Packaging in Washington. In the course of 2018, two White Papers were published. First, it was the one on 'Transparency Best Practices' by Jason Lisi in April, providing the fundamentals of native transparency, design considerations regarding opacity, blending mode and feathering and efficient, trouble-free design. Then came the second one on 'Packaging & Labels' by David L. Zwang in October, discussing future outlook for this market segment and the expected consequences connected to the requirements on prepress data defining the job content, colours and processing steps, as well as on the tools for PDF production, optimising and use in automated workflows.

This year, GWG celebrated 25 years of PDF, continuing the work on specifications and sharing best practices for PDF exchange – with the current goal to extend and create specifications for packaging, wide-format and industrial print processes. All existing GWG settings for the common prepress applications are now more easily accessible for download and installation.

Among the organisations that joined GWG during 2018 are another two universities providing education in the field of graphic arts and printing, the University of Ljubljana and the University of Novi Sad.

### Selected recent projects and publications by Fogra

The new version of PSD (ProcessStandard Digital) Handbook



is available since spring 2018. It recommends to prefer M1 over M0 measurement mode for all use cases and the related chapter on migrating from F39 to F51 was updated. Further, FOGRA53 is introduced and together with FOGRA54 added to the overview of characterisation datasets. Also, the tolerances for Grey Balance patches of OK-sheets were included.

During 2018, Fogra MediaWedge Multicolor V1.0 was released and the work on multicolour printing process standardisation (FOGRA55) started.

There are a number of research projects ongoing, with the new one on 'Test system for evaluating surface wettability and cleanness'.

Among the finished projects, the report on graphic standardisation for the production of plastic cards was published. The colouring recommendation for solid colours in waterless UV offset printing on white films was updated, based on the data for 42 material combinations.

The significant influencing factor is lamination, which caused a shift in colour coordinates – in most cases to darker and more chromatic colours.

The effect is connected with the lateral spread of light that constantly increases with the overlay layer thickness. It was possible to simulate the lateral light spread for differing overlay thicknesses. The material of the lamination film also has a certain influence. When comparing colour measurements by devices with the aperture size of 11 mm and 4 mm, respectively, the brighter and more chromatic colours resulted from the measurement with the former one.

The visual comparison between laminated originals and digital proof prints based on data measured by both types of devices shown good agreement, irrespective of the aperture, in the case of laminates with an overlay thickness of 100 µm. However, if the thickness is 200 µm or more, it is recommended to produce proof prints based on 11 mm colour measurement data.

### CIE 015:2018 – Colorimetry

The 4<sup>th</sup> edition of CIE recommendations concerning colorimetry was again prepared by the committee established under Division 1, Colour and Vision. In addition to the standard physical data of illuminants and sources, the reflectance standard, geometric conditions for colorimetry, standard observer data, calculation of tristimulus values and chromaticity coordinates, uniform colour spacing and colour differences, dominant wavelength and purity, special metamerism indices, assessment of the quality of a daylight simulator, whiteness evaluation and calculation of correlated colour temperature, covered in the 3<sup>rd</sup> edition from 2004, the current document includes CIE recommendations concerning colour appearance models, new illuminants for different LED types and new findings on cone-fundamental-based tristimulus functions.

### CIE 198-SP2:2018 – Determination of Measurement Uncertainties in Photometry Supplement 2: Spectral measurements and derivative quantities

This report is a second supplement to the CIE 198:2011 technical report and was prepared under Division 2, Physical Measurement of Light and Radiation, by the appointed committee (The Evaluation of Uncertainties in Measurement of the Optical Properties of Solid State Lighting Devices, including coloured LEDs). This supplement gives advice on how to identify sources of correlation in spectral measurements when dealing with combinations of measured spectral distributions, especially with the effect of correlations between the measured spectral values and calibration processes. The document provides uncertainties in a number of important radiometric and photometric quantities determined from spectral measurements. The examples of treating correlations introduced by various processes of interpolation and correction that may be applied to measured spectral values before they are combined are included. The examples cover photometric response, the mismatch index quantifying the spectral mismatch between the relative spectral responsivity of a photometer and the luminous efficiency function for photopic vision, the spectral mismatch factor, dominant wavelength, correlated colour temperature and blue-light hazard measurements, with the emphasis on LED sources.

### CIE S 026/E:2018 – CIE System for Metrology of Optical Radiation for ipRGC-Influenced Responses to Light

This document was prepared by the dedicated Joint Technical Committee, CIE JTC 9, of Division 1, Vision and Colour; Division 2, Physical Measurement of Light and Radiation; Division 3, Interior Environment and Lighting Design; and Division 6, Photobiology and Photochemistry, and focuses on the non-image-forming effects of light originating in the eye. The abbreviation ipRGC in the name of this standard stands for intrinsically-photosensitive retinal ganglion cell and the standard defines spectral sensitivity functions, quantities and metrics to describe the ability of visible optical radiation (380–780 nm) to stimulate each of the five photoreceptor types that can contribute to retina-mediated non-visual effects of light in humans via these cells, containing the melanopsin. The document provides action spectra for human photoreception and considers the effects of age and field of view; on the other hand, it does not give complete information for particular lighting applications, or for the quantitative prediction of ipRGC-influenced responses to light. Also, it is not intended for colorimetric contexts and does not address health or safety issues.

# Bookshelf

## Understanding Color Management

The book *Understanding Color Management* written by Abhay Sharma, first published in 2004 by Thomson Delmar, is known but relatively outdated source of information regarding colour management. The second, rewritten edition was published in 2018 by JohnWiley & Sons in its Series in Imaging Science and Technology. It has to be said that it is a well-done publication.

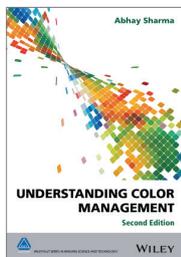
Author introduces himself as capable to explain “complicated concepts using simple analogies”. For experienced user some of the analogies might seem a bit humorous. However, from the educator’s point of view, this book is an excellent textbook for any student, professional, or even non-professional who would like to gain insight into colour management. I find the language very intelligible to wide audience.

The book starts with an introductory part where the reader is briefly acquainted with basic terms, concepts and approaches in colour management that are broadened in further chapters. Basics of colorimetry are explained just enough, without too many equations. Description of measuring devices and measuring conditions contains all necessary information, even though the reference to ISO 13655:2009 could be updated to version 2017, since the update was published one year before the publication of the book. Further chapters on camera, display and printer profiling provide in-depth description of practical colour management of these devices. Chapters about profiles’ structure, spot colours, extended gamut and connection with mark-up language can be useful to more advanced users of colour management. The last chapter dedicated to colour management in Adobe Photoshop serves as a ‘cook book’.

Each chapter contains a short summary at the end, which I find particularly useful, because it is beneficial from the educational point of view. The author also included examples and references to a variety of commercial software and devices of various vendors. The text contains many hints and tips and explains colour management for different platforms such as PCs (personal computers with the Windows operating system), Macs and mobile devices. Here, one reproof regarding readability of some images has to be mentioned. Many times the areas marked in screenshots of software applications and devices firmware are not readable due to the size of the image in the publication. This might the readers find annoying, especially if they are inexperienced users.

To conclude, the book is a comprehensive, up-to-date publication about colour management that can be recommended to everyone who wants to gain new or extended knowledge on the topic. Reading of this book is a true pleasure.

*Review by Ondrej Panák, University of Pardubice*



*Author: Abhay Sharma*

Publisher: Wiley

2<sup>nd</sup> ed., September 2018

ISBN: 978-1-119-22363-4

376 pages

Hardcover

Available also as an eBook



### Mixed Raster Content: Segmentation, Compression, Transmission

Author: *George Pavlidis*

Publisher: Springer  
1<sup>st</sup> ed., June 2018  
ISBN: 978-9811097164  
354 pages, 260 images  
Softcover  
Also as an eBook



The main concern of this book is the optimisation of segmentation and compression for efficient storage of digitised documents with mixed visual content, including text, graphics and images in shades of grey or various colours, which is usually referenced as mixed raster content.

In the first two chapters, the author provides a brief overview of vision and colour theory and presents current approaches used for data coding and image compression.

Here the book deals in depth especially with the structure of a basic compression system, going through the steps of transformation, quantization and encoding, and also compares JPEG and JPEG2000 compression standards. The remaining three chapters are then focused on segmentation of digital images with mixed raster content and optimisation of their compression and transmission, utilising a set of approaches proposed by the author. The softcover reprint of the original edition from 2016 is now available.

### The Image-Interface: Graphical Supports for Visual Information

Author: *Everardo Reyes-Garcia*

Publisher: Wiley-ISTE  
1<sup>st</sup> ed., November 2017  
ISBN: 978-1786300621  
288 pages  
Hardcover  
Also as an eBook



In this book, the author relates graphical user interfaces, seen as visual supports of digital information, to images – in order to discover

### Human Color Vision

This book presenting many recent advances in the understanding of human colour vision was published in the Springer Series in Vision Research two years ago and now it is available in paperback edition. The book is contributed by 25 experts in respective fields and covers different aspects studied with a range of methods including genetics, morphology, imaging techniques, electrophysiology, psychophysics and computational neuroscience. In order to make the text comprehensible for a broader audience, the authors were asked to keep it as simple and understandable as possible but without compromising on the scientific content. Readers can learn about the genetics of colour vision and congenital colour deficiencies, the retinal processing of photoreceptor signals and the value of the electroretinographic studies in the intact visual system, functional imaging of cone photoreceptors and cone opponency as an efficient way of transmitting chromatic information. Further, the book deals with psychophysical correlates of retinal processing, colour constancy and contextual effects on colour appearance, colour in the cortex and interactions of colour vision with other visual modalities. Finally, there are also the chapters presenting computational modelling of colour vision, introducing the colour vision tests used in clinical practice and presenting the evolution of colour vision, considering results from a wide range of different species.



Editors: *Jan Kremers, Rigmor C. Baraas, N. Justin Marshall*

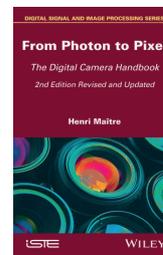
Publisher: Springer  
1<sup>st</sup> ed., July 2018  
ISBN: 978-3-319-83177-0  
361 pages, 82 images  
Softcover  
Available also as an eBook

### From Photon to Pixel: The Digital Camera Handbook

The second edition is a fully revised and slightly extended version of this comprehensive guide that explains how the digital camera works and examines in detail all its components. The author first provides the background and introduces the basic principles and terms. Then the book explores the two main parts of digital cameras – photographic objective lens and the digital sensor. Next, it deals with definitions and practical aspects connected to radiometry and photometry, colour, image quality (including a new section discussing aesthetics) and noise in digital photography. The last three chapters then describe coding and formats used for image representation, elements of camera hardware and photographic software.

Author: *Henri Maître*

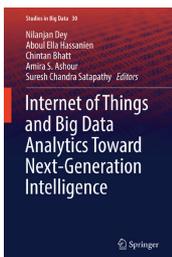
Publisher: Wiley-ISTE  
2<sup>nd</sup> ed., March 2017  
ISBN: 978-1-786-30137-6  
466 pages  
Hardcover  
Available also as an eBook



## Internet of Things and Big Data Analytics Toward Next-Generation Intelligence

This volume published in the Studies in Big Data series deals with the massive datasets generated due to the increasing extent of connecting the physical objects to the Internet and with the software computational intelligence techniques for analysis of these data, as well as for their keeping, retrieving, storing and sending. According to the editors, the main objective of the book is to prove the significant valuable role of the big data along with the Internet of Things (IoT) based on intelligence for smart life in several domains.

The first part describes IoT-based wireless body area network in healthcare and then the relationship between mobile sensor networks and robotics. The second part is focused on big data analytics – the utilisation of machine learning tools, real-time applications for a manufacturing industry, benefits of the big data Learning Management System and performance evaluation of open source tools for big data and business intelligence. The third part presents several examples of IoT-based smart life, employing IoT as a gateway for smart devices, in smart manufacturing and industry in general, in home automation and for smart cities, including the prototype real-time smart street parking system. Also, the agricultural application for smart irrigation is included, and two chapters deal with the so-called green IoT and its cloud-based architecture for smart cities. Finally, the fourth part discusses IoT security both in the particular case of healthcare systems and in general, and then it explores three selected technologies and applications connected to data mining and communication within the topic.



*Editors: Nilanjan Dey, Aboul E. Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Ch. Satapathy*

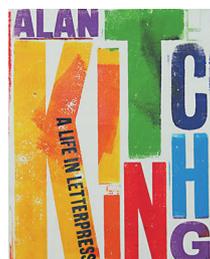
Publisher: Springer  
1<sup>st</sup> ed., August 2017  
ISBN: 978-3-319-60434-3  
549 pages, 236 images  
Hardcover  
Available also as an eBook

## Alan Kitching: A Life in Letterpress

This monograph presents the fifty years' work of Alan Kitching and features images selected from his own archive. It starts with the first typographical experiments and then documents his rich career in design, including the creations at The Typography Workshop, and also the years of teaching letterpress at the college. The Collector's Edition and Special Edition of this volume were published a year earlier, in 2016.

*Author: John L. Walters*

Publisher: Laurence King Publishing  
1<sup>st</sup> ed., April 2017  
ISBN: 978-1-78067-772-9  
408 pages, 350 images  
Hardcover



the best strategies to design and implement graphical information. As the visual properties of any digital image rendered on screen are affected by a series of layers, the approach is based on the investigation of software, graphical user interfaces, programming code and data types. The chapters go through describing images and graphical information over practising, designing and prototyping image-interfaces to the conclusion. The appendices provide an overview of available software applications, web-based tools and resources, as well as the exploratory online data visualization projects.

## Visual Communication Design: An Introduction to Design Concepts in Everyday Experience

*Authors: Meredith Davis, Jamer Hunt*



Publisher: Bloomsbury  
1<sup>st</sup> ed., September 2017  
ISBN: 978-1474221573  
208 pages, 254 images  
Softcover  
Also as an eBook

This introductory textbook deals with the principles of graphic design from the perspective of audiences and users. The content is organised into chapters presenting related design concepts, which are discussed and illustrated by several examples.

## What is the History of the Book?

*Author: James Raven*



Publisher: Polity  
1<sup>st</sup> ed., February 2018  
ISBN: 978-0745641614  
196 pages  
Hardcover  
Also as an eBook

James Raven builds on his expertise and offers a guide to the discipline of book history from ancient to modern times, across the world. The text presents the scope of the field, its early history and the methods of book studies, reviews the influences on production and circulation and finally it deals with reading.

### Photochromic Materials: Preparation, Properties and Applications

Editor: He Tian, Junji Zhang

Publisher: Wiley-VCH  
1<sup>st</sup> ed., September 2016  
ISBN: 978-3527337798  
440 pages  
Hardcover  
Also as an eBook



Contributed by the international team of authors, this book is a comprehensive summary presenting current knowledge on photochromic materials, including the recent trends and topics. After the introduction to organic photochromic molecules in general, the book describes photochromic transitional metal complexes for photosensitisation, multi-addressable photochromic materials and photoswitchable supramolecular systems. Then it presents light-gated chemical reactions and catalytic processes, surface and interfacial photoswitches and hybrid approaches to generate multifunctional materials, interfaces, and devices. The bulk photochromic materials are also covered, as well as those used in biochemistry. The last chapter discusses current industrial applications of these materials and their future perspectives.

### Additive Manufacturing: Materials, Processes, Quantifications and Applications

Editors: Jing Zhang, Yeon-Gil Jung

Publisher: Butterworth-Heinemann  
1<sup>st</sup> ed., May 2018  
ISBN: 978-0128121559  
362 pages, Softcover  
Also as an eBook



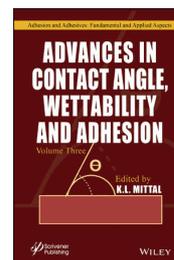
This book reviews the recent developments of available additive manufacturing technologies with the aim to explain their engineering aspects and physical principles, discussing the criteria to consider for selection of a proper technology for particular design and presenting applications in various industries.

### Advances in Contact Angle, Wettability and Adhesion Volume Three

This volume follows up the first two, published in 2013 and 2015, respectively (see also Bookshelf in 5(2016)1), and brings the updates on the noticeable developments in the field, covered in 16 articles. The first part is focused on contact angle measurement and analysis, dealing with a more appropriate procedure to investigate contact angles and drop shapes, measurement considering spreading, evaporation and reactive substrate, method for measuring contact angles of a particular liquid on a substrate of the same liquid film, evolution of the axisymmetric droplet shape parameters to characterise the interfacial physicochemical processes, and the interfacial modulus of a solid surface. The second part on wettability behaviour presents patterned functionalisation of textiles using UV-based techniques, the behaviour of nanorough surfaces in air or in water, the effect of particle loading and stability on the wetting behaviour of nanofluids, and dielectrowetting for digital microfluidics. The third part offers the articles studying superhydrophobic surfaces – their development by selective micropatterning and electron beam irradiation and their applications in fouling prevention in sea environment and for anti-corrosion treatment of aluminium. Finally, the fourth part is dedicated to wettability, surface free energy and adhesion, covering the advanced approaches to determination of the surface free energy, bioadhesion to reference polymers, metals, ceramics and tissues, as well as enhancing stem cell adhesion and growth on different materials.

Editor: Kashmiri L. Mittal

Publisher: Wiley-Scrivener  
1<sup>st</sup> ed., March 2018  
ISBN: 978-1-119-45994-1  
426 pages  
Hardcover  
Available also as an eBook

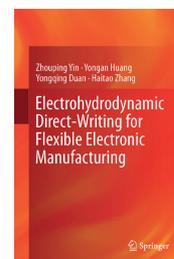


### Electrohydrodynamic Direct-Writing for Flexible Electronic Manufacturing

The authors of this book introduce the electrohydrodynamic printing as a highly promising fabrication technique for flexible electronics thanks to its ultra-high resolution and compatibility with highly viscous inks and summarise the progress of the groundbreaking research in this field. After explaining the fundamentals, the book covers the mechano-electrospinning, helix electrohydrodynamic printing, inks and nozzles for electrohydrodynamic printing, the possibilities of its control, as well as the available equipment and existing applications.

Authors: Zhouping Yin, YongAn Huang,  
Yongqing Duan, Haitao Zhang

Publisher: Springer  
1<sup>st</sup> ed., December 2017  
ISBN: 978-981-10-4758-9  
194 pages, 108 images  
Hardcover  
Available also as an eBook



# Bookshelf

## Academic dissertations

### Printing of Organic Field-Effect Transistors: Process-Related Analysis of the Charge Carrier Transport

The research done in this thesis aimed towards the optimisation of printing processes used to produce organic field-effect transistors with respect to their electrical performance and also to answering the question whether the commonly used methods of optical characterisation and electrical characteristic analysis are sufficient to optimise printing processes in terms of electrical quality. The printed bottom-contact top-gate organic field-effect transistors based on two different amorphous polymeric semiconductors and the polymer dielectric were chosen for the experiments. Besides spin coating as a reference process, flexographic and gravure printing were employed. For dynamic characterisation, the electronic time-of-flight method with charge carrier velocity distribution analysis was tested. Among the input parameters, the author examined the influence of resistance, gate voltage, pulse height and photonic injection of charge carriers. The attention was paid also to process variations and the interpretation of characteristic values evaluated for charge carrier velocity distribution curve for quantification and comparison purposes. For the resulting transistors, the study explored the influence of the semiconductor layer thickness, printing technique and print parameters used for semiconductor layer deposition as well as dielectric layer processing on their dynamic and static behaviour. It was shown that besides the semiconductor layer thickness the electrical performance of the printed transistors depends also on the manufacturing process. Further, it was proved that static and optical characterisation methods are not sufficient to optimise the printing speed and printing form parameters and the use of the tested dynamic method is beneficial and time-efficient. The findings also confirm the impact of the flexographic printing plate contamination on transistor performance and the improvement of its behaviour for thin and homogeneous dielectric layers.

### Printed and Coated Functionality on Natural Fibre-Based Substrates

The objective of this thesis was to enhance the control over the electric and wetting performance of natural fibre-based substrates by adding special functionality to the substrate. This creates new possibilities in various printed electronics applications and supports a shift towards more sustainable production. In the course of the research, several surface engineering approaches were tested in order to control surface chemistry and structure of the substrates, including nanofibrillar cellulose (NFC) thin films.

In the first study, a paperboard was treated with liquid flame spray (LFS) TiO<sub>2</sub> nanoparticles; this allows reversible switching of the paperboard surface between highly hydrophilic and superhydrophobic wetting states through exposition to UV radiation or thermal energy, respectively. Untreated paperboard and LFS TiO<sub>2</sub> treated paperboard without and after UV radiation, as well as plastic and multilayer coated paper, were printed by water-based poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS) ink using flexography, where different amounts were applied using successive prints. The TiO<sub>2</sub> nanoparticle coated paperboard enabled to control the ink

Doctoral thesis – Summary

Author:

*Simone Ganz*

Speciality field:

*Printed Electronics*

Supervisors:

*Edgar Dörsam*

*Klaus Hofmann*

Defended:

*18 October 2017, Technical University of Darmstadt, Department of Mechanical Engineering, Institute of Printing Science and Technology Darmstadt, Germany*

Language:

*German*

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Doctoral thesis – Summary

Author:

*Dimitar Valtakari*

Speciality field:

*Functional Materials*

Supervisors:

*Jarkko J. Saarinen*

*Martti Toivakka*

Defended:

*12 January 2018, Åbo Akademi University, Laboratory of Paper Coating and Converting Turku, Finland*

Contact:

*dimitar.valtakari@ri.se*

setting on the surface (see also JPMTR 2(2013)1). The second study dealt with the effect of polyelectrolytes on PEDOT:PSS conductivity. Polyelectrolytes are used as dispersing agents and additives in paper coating formulations. Their concentration can increase at the interface of PEDOT:PSS and paper coating, and thus have an impact on the conductivity of PEDOT:PSS, as mineral pigment coating particles are fully covered by these polyelectrolytes. The study showed that while the cationic polyelectrolyte at higher concentrations induced an increase in conductivity corresponding to 2–3 successive applications of PEDOT:PSS without polyelectrolytes, the anionic polyelectrolyte resulted in a lower conductivity. In the third study, PEDOT:PSS was spin-coated on either drop-cast or spin-coated NFC-glycerol thin transparent films. Glycerol was used to ensure crease-free adhesion between the glass substrate and the NFC layer and as a secondary dopant for PEDOT:PSS. In the case of the drop-cast substrates, a three-order-of-magnitude increase in the PEDOT:PSS conductivity was observed thanks to water and glycerol stored in the NFC layer. Finally, the fourth study utilised the controlled and localised wetting of paperboard with LFS TiO<sub>2</sub> nanoparticle coating to create low-cost permanent planar fluidic channels, which can be potentially used for disposable and biodegradable point-of-care diagnostics. A permanent change in the wetting characteristics that normally can be switched reversibly was achieved by simple water treatment following the UV irradiation, partially removing the nanoparticles from the wetted areas and thus forming a permanent channel.

#### Doctoral thesis – Summary

Author:  
*Ivana Jurič*

Speciality field:  
*Graphic engineering and design*

Supervisors:  
*Dragoljub Novaković*  
*Sunčica Zdravković*

Defended:  
*25 May 2018, University of Novi Sad,*  
*Faculty of Technical Sciences*  
*Novi Sad, Republic of Serbia*

Language:  
*Serbian*

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#### Print Uniformity Model for Digital Prints

This thesis was focused on print uniformity as the important attribute of the perceived quality. Better understanding of various factors that cause irregularities is necessary for further development of printing machines and their control especially in the case of digital printing. The aim of the research was to define a model for the quantification of digital print non-uniformity allowing to characterise it using parameters which are well-correlated with the visual assessment. Four existing methods for measurement of print surface non-uniformity were selected – the Gray-Level Co-Occurrence Matrix (GLCM), the method according ISO/IEC 13660 standard, the Integration Model and the M-Score method, with a total of ten parameters evaluated and compared. The analysed samples were prepared to simulate two types of print non-uniformity – systematic and random variation. The amplitude of strikes (systematic variation) was varied in the first sample set and the amplitude and size of the noise pattern (random variation) were varied in the second and third set, respectively. The work also compared three types of print sample digitalisation (scanner, digital camera and mobile phone, with three different devices of each type). The presented findings are based on the comparison of values expressing the non-uniformity as determined by the objective methods with the results of psychophysical experiment in which the samples were visually assessed by 23 respondents. Regardless the type of variation, GLCM Entropy, GLCM Energy and GLCM Sum-Entropy were found as appropriate for print uniformity characterisation. Further, the Improved Integration Model can be recommended for systematic variations. In the case of random variations, ISO Mottle is suitable only for mottle and M-Score only for graininess, while ISO Graininess can be used for both. With respect to the type of device used for image digitisation, the digital camera was shown as unsuitable for given application, while the mobile phone proved to be the best choice for all three sets of samples. The scanner can also be used, however, for graininess, it is better to use a mobile phone. In all cases, the procedure, conditions and appropriate settings were defined. In addition, the possible industrial applications were proposed.

# Events

## Color 2019

San Diego, California, USA  
12–15 January 2019



This conference that is hosted by Printing Industries of America and SGIA (Specialty Graphic Imaging Association) aims to cover all facets of colour and present

how the colour-related quality can be achieved throughout the entire production cycle. Participants can learn about best practices and standards as well as get in touch with the experts in the field.

Traditionally, the conference attendees can gain or refresh knowledge of colour management principles and processes in a free half-day pre-conference seminar combining presentations with hardware and software demonstrations. The main 2019 programme opens the keynote by Mike Scrutton '2020: a print Odyssey' discussing the perspectives of colour, workflow, and printing. The other talks at the main stage are 'Color excellence: it's a journey, not a destination' by Mike Graff, 'End-to-end publishing with PDF 2.0 and PDF/X-6' by Dov Isaacs, and 'Case study: are you for the orange team or the red team' by Erica Walker, followed by a panel discussion on today's trends, technologies, and standards development. On Sunday and Monday, two tracks of breakout sessions are reserved for topics related to print production and brand & design, respectively; the third one is dedicated first to colour management for wide-format inkjet and then to standards, research and emerging technologies.

## EI 2019 – IS&T International Symposium on Electronic Imaging



Burlingame, California, USA  
13–17 January 2019

In 2019, this event joins 16 conferences and offers 25 technical short courses. In the programme, three theme days are highlighted. The focus of the first one is on autonomous vehicle imaging, with a plenary speech of Amnon Shashua dealing with the challenges connected to autonomous driving technology and presenting the OrCam MyEye, a device designed to assist people who are blind or visually impaired. A topic of the related panel is sensing and perceiving for autonomous driving, while the short course covers the development of corresponding enabling technologies. The second theme day on 3D imaging features a plenary speech of Hong Hua focused on head-mounted light field displays capable of rendering true 3D scenes for virtual and augmented reality, a joint session on computational models for human optics and two short courses. The third theme day, dealing with augmented/virtual reality and light-field imaging, offers a plenary of Paul Debevec on the technology and production processes for light fields and light stages, a joint session on light-field imaging and display, as well as a short course teaching how to build a head-mounted display.

## 3D Printing Electronics Conference

Eindhoven, The Netherlands  
23 January 2019



The programme in 2019 opens Corné Rentrop with a keynote providing

an overview of the fundamentals and equipment for printed electronics and showing the latest, large-scale applications. The other announced topics include printing of metal structures on 3D-printed polymer parts, a semiconductor characterisation and manufacturing view as means of characterising both the dielectric and conductive layers of printed electronics, printed stretchable circuits, manufacture of 3D mechatronic systems, 3D-printed stereolithography products with integrated electronic functionalities, and practical challenges for printed electronics production.

A few days earlier, on 18 January, the related Intelligent Sensor Networks Conference takes place in Rotterdam, The Netherlands.

## Converting Technology Exhibition

Tokyo, Japan  
30 January to 1 February 2019



This large event features 2019 editions of five exhibitions – Converttech Japan, Neo Functional Material (including paper/fibre zone), JFlex presenting technologies and materials for flexible devices, 3Decotech Expo, and Advanced Printing Technology Exhibition – and is held concurrently with eight more events, which cover, among others, the field of 3D printing and additive manufacturing, advanced surface technologies, smart energy, and nanotechnologies.

## Packaging, Labelling & Printing Events by EasyFairs



The ADF&PCD Paris 2019 combines the Aerosol & Dispensing Forum with the Packaging of Perfume Cosmetics & Design and takes place in Paris, France on 30–31 January. A week later, two events are held in Sweden – Sign & Print 2019 in Stockholm (5–7 February), and Empack Malmö 2019 in Malmö (6–7 February). Another week later, the Pentawards Live event is organised in Amsterdam, The Netherlands on 13 February. Four events are co-located in Birmingham, UK on 27–28 February 2019. These include Packaging Innovations, Empack, Label&Print and Industrial Pack. At the end of March, Sign & Print Expo takes place in Gorinchem, The Netherlands (26–28 March), the Asian 2019 edition of ADF&PCD is held in Shanghai, China (27–28 March), and Industrial Pack 2019 in Atlanta, Georgia, USA (27–28 March).

## C!Print

Lyon, France  
5–7 February 2019 

The visitors of C!Print tradeshow can again take part in technical training and workshops and see live production and demonstrations in the Plug&Play area to unlock new ideas.

## VISIGRAPP 2019 14<sup>th</sup> International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications

Prague, Czech Republic  
25–27 February 2019



Besides technical sessions and five keynotes, the 2019 edition of this established joint event features e.g. tutorials and the Doctoral Consortium.

## EFI Connect 2019



Las Vegas, Nevada, USA  
22–25 January 2019

The annual EFI worldwide users' conference celebrates in 2019 the 20<sup>th</sup> anniversary and adds more educational breakout sessions in tracks covering the various areas encompassed by the EFI portfolio. These include business management, quoting and estimating, customer and order management, scheduling, reporting, finance and accounting, sales and marketing, web-to-print, cross-media, prepress, production management, shipping and logistics, information technologies and integration, three tracks on inkjet, and also the G7 track offering a special two-day training on colour theory, the G7 methodology, ISO standards, process control and press/proof alignment to achieve G7 certification by Idealliance.

The topics within the three inkjet tracks range from the opportunities in soft signage and other markets, over the advanced capabilities of inkjet printers, efficient automation, newly released PDF 2.0 standard, coming PDF/X-6 standard and Ghent Workgroup best practices, up to the employer brand building to attract new and younger selling talents.

## IMI Events

### Inkjet Winter Workshop

 Valencia, Spain  
21–25 January 2019

In 2019, the participants can choose from six courses and the timetable allows to attend up to three of them. The week starts with the Inkjet Academy covering the basic theory of current inkjet technologies and the concurrent course on inkjet printing software, providing an in-depth overview of the fundamental aspects of digital imaging applications and the software functions. The second set of courses deals with inkjet inks – one course is focused on their characterisation in terms of rheology and surface tension measurements, particle and dispersion assessment, as well as drop visualisation and print quality analysis, and the other one covers the selection and optimisation of materials used for ink formulations. Finally, there is a course dedicated to the issues of inkjet ink design, development and testing, scale-up for manufacture and manufacturing itself, and a course dealing with single-pass inkjet printer design and process development.

### Digital Print Week

 Orlando, Florida, USA  
5–8 February 2019

The IMI Digital Print Week 2019 starts with three concurrent digital print conference programs on 5–6 February – Digital Manufacturing Conference, Future Packaging Conference and Security Printing Conference, complemented by the IMI Inkjet Academy where the attendees can learn about the types of inkjet printing technology and inks, including UV curable inks, different drop-on-demand printhead technologies, inkjet ink design, materials and dispersions, issues connected to printhead operation and system design, print quality, inkjet applications and emerging technologies.

The Inkjet Printing Conference 2019 takes place on 6–8 February. The presented topics include the progress in technology, such as printhead developments, inkjet defect control, drying and curing, functional materials applying and patented inkjet innovations, and also the markets and applications, discussing e.g. the specific requirements of transactional print and challenges of inkjet dye transfer technology for hard surfaces, among others. There are also short suppliers' presentations related to technology, capabilities, services and new product introductions.

## SPIE Events

### SPIE Applications of 3D Printing 2019

**SPIE. PHOTONICS WEST 3D PRINTING** San Francisco, California, USA  
2–7 February 2019

In 2019, the Photonics West event again offers the special application track on 3D printing. Similarly to previous years, a number of invited papers as well as regular contributions present optics and microfluidic devices or their combinations, such as the one on fabrication of optics-integrated microfluidics using 3D printing for biosensing applications. There is also a variety of 3D-printed components utilised in orthodontics, for photobiomodulation delivery, or acne treatment, and as probes for atomic force microscopy, ultrasound imaging phantoms, or optical sensor devices, to name a few examples. In the session focused on large-area fabrication, e.g. printed optoelectronics and inkjet printing of microlens arrays are listed. The other presented applications include 3D printing of metals, metamaterials or multiple materials, a lab-on-a-chip system with integrated ink-jet printed organic semiconductor detection elements, polymer light-emitting diodes with inkjet-printed electrodes for all solution-processed display application, and more. Several papers also deal with the investigation of optical and mechanical properties of 3D-printed parts. One of the plenary presentations demonstrates deep learning optics employing 3D-printed diffractive networks that implement the classification of images of handwritten digits and fashion products, as well as the function of an imaging lens at the terahertz spectrum. In addition, an industry perspective on 3D printing and Industry 4.0 is a topic of one of the panel discussions.

### SPIE Smart Structures / Nondestructive Evaluation 2019

**SPIE. SMART STRUCTURES NDE** Denver, Colorado, USA  
3–7 March 2019

The programme of this SPIE event also features many applications of printing technology. These include 3D printing of functional ceramics for multifunctional materials (invited paper), 3D printing of soft microactuators, printed time-temperature indicators for vaccines, and ink-jet printed conductive and semiconductive rubber for dielectric elastomer devices. Other papers deal with the investigation of inkjet- and screen-printed silver electrodes for ionic polymer–metal composites, optimisation and characterisation of inkjet-printed ferroelectric capacitor for human body detection, development of smart gear system by conductive-ink print, temperature-compensation of printed polymer-based strain gauge, 4D printing of programmable shape memory structures for biomedical applications, etc. The demonstration of 4D printing technique based on the 3D-printable filaments with a shape memory effect is scheduled as well.

## WAN-IFRA Events



For the first quarter of the year 2019, the WAN-IFRA calendar features two events. The 8<sup>th</sup> edition of Digital Media India takes place in Mumbai on 19–20 February together with Newsroom Summit India. The topics of the former are digital transformation, revenue strategies, native advertising, Indian language web and online video, while for the latter the focus is on newsroom transformation, journalism in the digital world, fake news, artificial intelligence and machine learning and audience engagement. Then, on 6–7 March, the 14<sup>th</sup> Middle East Conference is organised in Dubai, UAE. Its topics were identified as increasing revenues through native advertising, engagement and personalisation, paid content models, transformation and business models, innovation in print and the future newsroom.

## PIA President's Conference

Phoenix, Arizona, USA  
3–5 March 2019



The conference schedule for 2019 features, among others, employer strategies to engage the Millennials, employee stock ownership plans, data breach prevention, efficient management of high-performance printers, building the problem-solving capabilities, fostering the everyday culture of innovation, and also what the production of ballots and other election-related material is about.

## LOPEC 2019

Munich, Germany  
19–21 March 2019



The 2019 edition of this event for printed electronics industry keeps the proven format with business, technical and scientific conferences, complemented by short courses.

### FESPA Events

The series of 2019 events organised by



FESPA around the world begins in Bangkok, Thailand on 21-23 February with the Asia Print Expo 2019 focused especially on wide-format digital printing, screen printing and textile printing. The visitors can also attend seminars covering sustainability, environmental issues and standards, as well as the sessions on colour management, market opportunities, etc. A month later, on 20-23 March, FESPA Brasil 2019 takes place in São Paulo together with the ExpoPrint Digital 2019, a focused narrow-format printing event for Latin America organised by Brazilian company APS.

### Graphispag 2019

Barcelona, Spain  
26-29 March 2019

This packaging, commercial printing, visual



communication and design event has changed the format, and in 2019 it offers four areas called Graphispag process, village, talks and experience.

### Digiday Publishing Summit

Vail, Colorado, USA  
27-29 March 2019

Having sustainability as the main theme again, the summit agenda for 2019



features the talks exploring how publishers are keeping up with changes in the advertising landscape and how they are diversifying their revenues, e.g. by attracting younger audiences or creating and handling a subscription product. The presentations and networking are combined with working in groups to solve one of three key challenges in the publishing industry. Earlier in 2019, the Digiday Publishing Summit Japan takes place in Kyoto (12-13 February) and the European edition in Milan, Italy (5-7 March).

### TAGA 2019 Annual Technical Conference



Minneapolis, Minnesota, USA  
17-20 March 2019

In 2019, the Technical Association of the Graphic Arts organises its recognised conference in association with ISCC (Inter-Society Color Council). The keynotes announced for 2019 include 'Immersive media: the new language of enchantment' by Jeff Gomez, presenting case studies in story world development and narrative design while sharing new techniques and a new language for immersive media, 'This is your brain on paper' by Daniel Dejan, discussing various aspects relevant when comparing ink-on-paper communication with its digital counterpart, 'Imaging cultural heritage in 3D' by Dan Dennehy, reviewing the opportunities and challenges involved in employing new methods of documentation, and 'Interacting with color: the art and teaching of Josef Albers' by Fritz Horstman, revealing the artist's influences, aspects of his pedagogy and his fascination with colour.

The papers selected for the conference deal with a variety of topics, as usual. To date, the contributions related to colour range from those focused on colour reproduction, which include challenges and solutions in characterisation of multicolour printing, key factors affecting colour reproduction on corrugated board using UV wide-format inkjet printer, colour management for digital textile printing, chroma optimisation for expanded colour gamut and colour accuracy of corporate colours in expanded gamut print reproduction, over presentations focused on educational issues, such as the initiative led by the ISCC to identify misinformation about colour in education and promote updated colour competencies, to studies investigating categorical effects in printed colour under different color temperature of lighting, identifying best printing process and substrate for newly developed colour vision deficiency diagnosing tool, revealing factors impacting consistent color appearance prediction, etc. Of course, many other areas are covered as well. The accepted papers present, for example, common milkweed as an alternative cellulose fibre source, printability analysis of flexography on compostable films, digital enhancement on a narrow web press, a scalable 'self-serve' augmented reality platform and the importance of cyber security awareness in the variable data and direct mail printing industries.

### Advanced Functional and Industrial Printing



Düsseldorf, Germany  
27-28 March 2019

This conference was first held in 2013 and evolved from former events organised by ESMA, the European association for printing manufacturers in screen, digital and flexo technology. The 2019 keynotes scheduled to date are 'Fine line printing of functional inks for automotive applications' by Tim Claypole, 'Goodbye, membrane keyboard?' by Martin Gehrig, 'Radiopaque 3D printing of patient specific phantoms: an inkjet application for patient safety in radiology and radiation therapy' by Paul Jahnke, 'Inkjet printing: drawing its success story in electronic and bio-printing fields' by Jérôme Mouly, and 'How to utilise printed inks and electronics in healthcare - a case study' by Jesper Hassel. The other presentations deal with the evaluation of NIR-technology according to the specific application requirements for functional and industrial printing/coating processes, advanced finishing solutions, inks for smart surfaces and in-mould electronics, and much more.

## 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 Emerging Sources Citation Index, Scopus, Index Copernicus International, PiraBase (by Smithers Pira), Paperbase (by Innventia and Centre Technique du Papier), NSD – Norwegian Register for Scientific Journals, Series and Publishers.

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, batteries, sensors and other printed functionality; Printing on biomaterials; Textile and fabric printing; Printed decorations; 3D printing; Material science; Process control
- ⊕ **Premedia technology and processes**  
Colour reproduction and colour 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 relevant scientific competence, carefully evaluated, selected and edited. Once accepted and edited, the papers will be 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).

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Submissions and queries should be directed to: [journal@iarigai.org](mailto:journal@iarigai.org)



Vol. 8, 2019

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

When preparing a manuscript for JPMTR, please strictly comply with the journal guidelines. 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.

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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 communications. 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. Literal translations are often wrong. Terms that do not have a commonly known English translation should be explicitly defined in the manuscript. Acronyms and abbreviations used must also be explicitly defined. Generally, sentences should not be very long and their structure should be relatively simple, with the subject located close to its verb. Do not overuse passive constructions.

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**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), although some overlap is unavoidable.

**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 number, and E-mail. Editors will communicate only with the corresponding author.

**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, relationships), and your interpretation and main consequences of your findings (discussion, conclusions). The abstract must reflect the content of the article, including all 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.

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**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.

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# 4-2018

# Journal of Print and Media Technology Research

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- ⊕ Printing technology and related processes
- ⊕ Premedia technology and processes
- ⊕ Emerging media and future trends
- ⊕ Social impacts

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