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Modeling optically induced halftone mottle from the variability of lateral light scattering by the unprinted paper surface

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Abstract

Mottle in halftone prints reduces the perceived quality of printed images. One of the sources of mottle in halftone print is the variation in apparent area of printed dots. Inhomogeneous lateral light scattering within the paper surface in between the printed dots leads to optical dot gain variation which is perceived as halftone mottle. Absence of a reliable model that can predict the paper surface's susceptibility to halftone mottle before printing poses serious challenges in controlling factors in papermaking that contribute to lateral light scattering variability and hence to optically induced halftone mottle. In this work, the variability in the paper surface's lateral light scattering is modeled from the variability in spatial distances between colorimetric coordinates obtained from high resolution microscopic imaging of a knife edge shadow projection on the unprinted paper surface. We present a new model based upon multivariate paired T^2 statistic for characterizing the variability in knife edge shadow response of the paper surface in order to estimate its lateral light scattering variability. The proposed model has been found to effectively predict the visual perception of halftone mottle that arises from inhomogeneous optical interactions between the printed dots and the paper surface.

Keywords: Halftone mottle, optical dot gain, light scattering, multivariate paired T^2

1. Introduction and background

Print mottle is sometimes observed only in halftone areas of the print and is not seen in the full tone areas of the print on the same sample. This can be explained from the fact that although ink absorption may be uniform on the paper surface, inhomogeneous optical interactions between the fine printed dots and the paper surface lead to optical dot gain variation and observed halftone mottle.

This can happen due to the variability of lateral light scattering in the spatial domain on the unprinted portion of the paper surface in between printed dots (Masayuki and Masaya, 2009; Namedanian, 2013).

Although there exists a number of models that characterize the extent of optical dot gain from lateral light scattering on the surface of a paper, the treatment of modeling halftone mottle from spatial variability of paper surface's lateral light scattering is sparsely represented in the literature. And secondly, although there exists a wide range of instrumental mottle measurement techniques which can objectively characterize mottle from image analysis of printed samples, these methods find limited use in applications where it is required to predict the mottle tendency from unprinted paper samples. The motivation for this work has been to construct a reliable model that can be used for predicting the unprinted paper samples' propensity for optically induced halftone mottle before actually performing any printing. Such a model can find wide acceptance in applications such as quality control and development at the papermaking stage.

2. Previous work

The characteristic lateral scattering of the paper is often described by either the Point Spread Function (PSF) or the Modulation Transfer Function (MTF). The PSF is a probability density function that describes the probability of a photon returning to the surface of the paper at the location (x,y) away from the point of entry into the paper (Rogers, 1998). The discrete Fourier transform of the PSF is the modulation transfer function (MTF). Measurement of the MTF of paper has taken two approaches, direct and indirect. Direct methods involve projecting a knife edge shadow and pencil light projection on the paper surface. Yule, Howe and Altman (1967) were among the first to demonstrate a direct measure of the lateral light scattering of paper surface using a line spread function which is derived from micro reflectance measurements across the edge of a sharply defined knife edge shadow on the paper surface. Masayuki (2010) proposed a method to directly measure the MTF of paper using pencil light projection on the paper surface. Inoue, Tsumura and Miyake (1998) proposed an indirect method for MTF measurement by contacting a sinusoidal test target printed on film. This method is experimentally simpler than the projecting method but it requires measuring several patterns iteratively. Rogers (1998) proposed a bar-target image projection method. He calculated the ratio between the series-expansion coefficients of the Fourier transform of measured data and that of ideal bar-target data in order to find the MTF of paper. This method is also experimentally efficient since only one bar-target image needs to be measured. However, it is not easy to produce an ideal bar-target image having sufficiently sharp edges like a knife. Engeldrum and Pridham (1995) proposed a method using the histogram of the image obtained by the contacted bar-target on paper.

A Monte Carlo simulation proposed by Hainzl et al. (2000), which is also known as the GRACE model, is yet another indirect MTF measurement method. This model contributes to the understanding of the physical processes of light scattering in paper. Since it involves substantially more parameters, many of which are difficult to determine, the practical application of the GRACE model is limited. Monte Carlo simulations with isotropic single scattering have recently been found to explain a greater extent of lateral light scattering and directional inhomogeneity of scattering in uncoated papers (Coppel, 2011).

The measurement accuracy of indirect methods for characterizing the MTF of paper is not high enough and therefore direct methods are more widely used (Masayuki, 2010). For modeling variability in optical dot gain, Arney et al. (2003) analyzed the standard deviation of the MTF constant k_p, although they did not evaluate this approach in discriminating mottle and non-mottle samples. Smith et al. (2010) recently proposed a method for characterizing halftone mottle from the standard deviation in intensity of reflected light across the knife edge shadow response. They concluded that the standard deviation of intensity for mottle and non-mottle samples did not correlate with the visual estimation of mottle. A possible explanation could be that the visual perception of mottle is not accurately modeled from the magnitude of variation in intensity of reflectance alone, and that both the magnitude and the coarseness of variation in reflectance at different wavelengths in the spatial domain need to be considered, (Fahlcrantz and Johansson, 2004). In the present work, optically induced halftone mottle is characterized from variability in lateral light scattering on unprinted paper surface. The degree of lateral light scattering is estimated from the spatial distance between clusters of vector matrices comprised of device independent XYZ tristimulus responses, obtained by transforming the RGB responses from the microscopic image of knife edge shadow projection on the paper surface.

The multivariate paired Hotelling T^2 statistic is used to calculate the spatial distance between vector matrices comprised of colorimetric responses, since it is a more appropriate measure for characterizing spatial distances where the variables are highly correlated and also it takes into account variance and covariance among the multiple coordinates (Rancher, 2002).

3. Methods and materials

3.1 Measurement of lateral light scattering variability

A large number of printed samples, with substances ranging between 200 and 350 $g\,m^2$, were categorized as either good or bad depending upon the visual perception of mottle on initial inspection. The mottle was observed only in the halftones areas of the print whereas the full tone areas did not demonstrate any mottle on the same samples. Each set constituted ten samples. For the set of good samples, negligible halftone mottle could be detected visually and for the set of bad samples a varying degree of halftone mottle was detected visually. Corresponding unprinted paperboard samples were then used for microscopic image analysis of knife edge shadow for estimation of lateral light scattering variability. A sharp knife was placed perpendicularly to the paper surface and was illuminated at an angle of 45 degrees from the normal. The knife edge shadow projection was obtained on the side opposite to that of illumination onto the paper surface. A microscopic image of this knife edge shadow was captured using a reflection based optical microscope equipped with a CCD digital camera.

The schematic view of the digital microscope used for imaging the knife edge shadow projection and subsequent data acquisition of image elements around the boundary of shadow is shown in Figure 1.

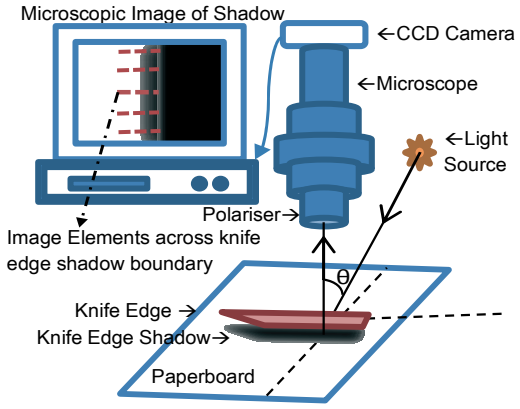

Figure 1: Schematic view of the imaging system used for capturing knife edge shadow response of the paper surface

Since the variability of lateral light scattering on the paper surface is expected to be high near the boundary of knife edge shadow, we therefore analyzed the variability of microscopic image elements across the boundary of the knife edge shadow. Data acquisition was done for a large number of pixels across the boundary of the shadow along a set of five parallel lines as shown in Figure 1. Each line is comprised of R, G, and B values for 498 pixels and in the resulting data matrix, the R, G, and B data are ordered column-wise and each row represents one pixel.

Different feature sizes in a mottled image are known to have different impacts on the viewer, even if their amplitudes and variations are the same (Johansson, 1993). The detection threshold of the human visual system has a maximum sensitivity to variations in the wavelength range of 0.9-2.6 mm in the spatial domain, depending upon the luminance level at a viewing distance of 30 cm (De Valois and De Valois, 1988). Considering these factors, the lateral light scattering variability of the paper surface was evaluated from the variability of image elements within a span ranging from 1 mm to 5 mm by the acquisition of image elements across the boundary of the knife edge shadow for the set of five parallel lines, where the length of each line was 5 mm and the distance between any two consecutive pairs of lines was 1 mm. For each line, the three image components R, G, and B were captured for 498 pixels. In this manner, data was collected for 5 lines which were parallel to each other. In the resulting data matrix, the R, G, and B data were distributed column-wise and the rows represent points on one line from the first to the 498th pixel. Data acquisition was performed in this manner for each of the ten good and bad samples. The RGB data were transformed to device independent XYZ colorimetric values using the characterization coefficients derived from the device characterization. Multivariate paired T^2 statistic was used to model the variation of the three image elements among the pair of lines, since correlation analysis between the X, Y and Z variables revealed that the correlation between these three variables was greater than 90 %. The multivariate paired T^2 statistic gives a measure of standardized spatial distance between a pair of mean vectors, which can be found in equation [1].

$$T^2 = n\,(\bar{L}_1 - \bar{L}_2)^T\, S^{-1}\, (\bar{L}_1 - \bar{L}_2) \qquad [1]$$

where n = 498.

$(\bar{L}_1 - \bar{L}_2)$ is the mean difference matrix which can be computed from the mean of differences between two line matrices. Each line matrix is comprised of 3 columns representing X, Y and Z respectively and 498 rows representing the points for which the three image elements were captured for one line.

$$(\bar{L}_1 - \bar{L}_2) = \begin{pmatrix} \Delta\bar{X} \\ \Delta\bar{Y} \\ \Delta\bar{Z} \end{pmatrix} \qquad [2]$$

$(\bar{L}_1 - \bar{L}_2)^T$ denotes the transpose of the mean difference matrix [Equation 2] and S is the covariance matrix, which can be found by computing the variance and covariance between the three variables (ΔX, ΔY & ΔZ) of the difference matrix [Equation 3]

$$S = \begin{pmatrix} \sigma^2_{dX} & \sigma_{dX,dY} & \sigma_{dX,dZ} \\ \sigma_{dY,dX} & \sigma^2_{dY} & \sigma_{dY,dZ} \\ \sigma_{dZ,dX} & \sigma_{dZ,dY} & \sigma^2_{dZ} \end{pmatrix} \qquad [3]$$

where, σ^2_{dX}, σ^2_{dY} and σ^2_{dZ} are the variances and $\sigma_{dX,dY}$, $\sigma_{dY,dX}$ and $\sigma_{dZ,dX}$ are the covariances of the columns in the difference matrix. As the data acquisition was done for 5 lines for each microscopic image of knife edge shadow, we need to calculate multivariate paired T^2 values for 10 such line pairs. The lateral light scattering variability was estimated from the variability of these 10 T^2 values which is represented by an index that was derived by dividing the standard deviation with the square root of the mean T^2 value. The T^2 index was deduced in this manner for each of the ten good and bad samples, respectively.

3.2 Halftone printing

Since our aim was to study the contribution of the paper surface alone towards optically induced halftone mottle, precise control over the printing variables was very important. On a commercial offset machine, there are a number of printing variables which may introduce their own impacts upon mottle and could make it difficult to discriminate paper induced mottle from print related mottle. This issue has been overcome in the current study by using a Prüfbau printability tester where a

limited set of printing variables are involved and it is relatively easier to control them so as to make better judgment of the paper surfaces contribution towards optically induced halftone mottle. Halftone dots of 133 LPI and 40 % screen area were printed using the Prüfbau printability tester at the same location where an estimation of lateral light scattering variability was made from the knife edge shadow response of the paper surface.

3.3 Instrumental mottle assessment of printed halftone samples

Mottle values have been calculated for the same set of Prüfbau printed halftone samples using a range of standard instrumental mottle estimation approaches for which high resolution images (a resolution of 1 024 x 1 024) of the Prüfbau printed samples of size 50 x 50 mm² were taken at 45/0 geometry, using the same optical digital microscope used for imaging the knife edge shadow. Subsequently, image analysis was performed in order to arrive at the mottle values, employing the following methods:

ISO Mottle (ISO/IEC 13660:2001-1): The image was divided into 100 non-overlapping square tiles of 1.61 mm² area. For each tile, 900 non-overlapping measurements of print density were made and the average print density m_i was calculated. The standard deviation of m_i over the 100 tiles is denoted as the ISO Mottle Index [Equation 4].

$$\text{ISO Mottle} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(m_i - \left(\frac{1}{n}\sum_{i=1}^{n} m_i\right)\right)^2} \qquad [4]$$

where $n = 100$.

Multiscale Mottle (Fahlcrantz and Johansson, 2004): The images were subjected to band pass filtration through image analysis software in order to separate the micro-reflectance variations of the images at different spatial scales. Subsequently, the reflectance variation was categorized into different spatial wavelength bands and was used to calculate the multiscale mottle index by equation [5].

$$\text{Multiscale Mottle} = \frac{1}{\sqrt{R}}\sqrt{\sum_{ij=1}^{5}\frac{\sigma_{ij}^2\, w_{ij}^2}{u_{ij}^{mid}}} \qquad [5]$$

where,

R is the mean reflectance,

$\sigma_{ij} = \sigma_i - \sigma_j$, is the subtraction of the coefficient of reflectance variations at different spatial scales or wavelength intervals,

$(_{ij})$ are the wavelength intervals: 0.25-0.5, 0.5-1.0, 1-2, 2-4, 4-8 mm,

u^{mid} is the frequency at the middle of the octave (ij),

w_{ij} is the relative contrast sensitivity at frequency u_{mid}.

Wavelet Multiscale Mottle (Fahlcrantz and Johansson, 2004): This is calculated in same way as multiscale mottle index except that the σ_{ij} are obtained by the summation of coefficient of reflectance variations at different intervals.

Band Pass Image Analysis (Johansson, 2003): The images were subjected to band pass filtration through image analysis software in order to separate the micro-reflectance variations of the images at different spatial scales. The summation of the coefficient of reflectance variations at different wavelength intervals (0.25-0.5, 0.5-1, 1-2, 2-4 and 4-8 mm) is made to obtain the band pass mottle index [Equation 6].

$$\text{Band Pass Mottle} = \sum_{i=1}^{n}\frac{S_i}{R_i} \qquad [6]$$

Here

$n = 5$,

i is the wavelength interval: 0.25-0.5, 0.5-1.0, 1-2, 2-4, 4-8 mm,

S_i is the standard deviation of reflectance at different wavelength intervals,

R_i is the mean reflectance at different wavelength intervals.

3.4 Visual mottle assessment of the printed halftone samples

Visual estimation of print mottle for the same set of Prüfbau printed samples was subsequently performed by two separate panels of observers, using two different approaches, viz. visual ranking and category judgment methods, respectively. For both visual mottle assessment exercises, the Prüfbau print strips were placed inside a standard viewing chamber under D50 standard illumination. The observers were presented with samples of 50 x 50 mm² size and assessment was done at a viewing distance of 30 cm. The first panel of judges was comprised of 12 members who performed the visual estimation of mottle through a visual ranking exercise (Sharma, 2003), also known as the no-preference approach. In this approach each panel member was asked to arrange the sample sets in ascending order of mottle severity, from best (no mottle) to worst (severe mottle) and to assign a value of 100 to the sample exhibiting a middle level of mottle among the set of mottled samples. A value proportional to the mid-level of severity of mottle was then assigned to all the other samples by the observer. Higher numbers thus indicate a higher degree of mottle, and vice versa. The geometric mean of the visual ratings assigned by the panel of judges to each sample was taken as a visual index of mottle, as the arithmetic mean is sensitive to outlier evaluation.

The second panel of judges consisted of another nine members who performed the visual estimation of mottle through a category judgment exercise on an interval

scale (Sharma, 2003). In this, each panel member was provided with a category scale for mottle as a reference.

The visual category scale for mottle was made prior to conducting the psychophysical experiments, by performing paired comparisons of a separate set of printed mottle samples by an independent group of expert jury members. Visually perceptible mottle limits were determined based on the psychophysical theory of just noticeable difference (JND), or the smallest difference in the sensory input (Eerola et al., 2010). The basic assumption behind JNDs is that visual perceptions are probabilistic in nature (Keelan, 2002). The visual mottle scale for category judgment was constructed by sorting the samples in ascending order of mottle severity in such a manner that 75% of the jury members noticed a JND between any two consecutive pairs of mottled samples.

In this manner, a visual mottle reference scale was constructed that comprised of five different levels of mottle severity.

In the current experiment, the panel members were asked to assign visual scores on a scale of 1-5 for each of the Prüfbau halftone print strips by comparing against the mottle category sample references. When the visual score approaches 5, it indicates a higher degree of mottle. Similarly, the extent of mottle is considered to be the least when the score approaches 1. As in the visual rating exercise, the geometric mean of visual scores assigned by the panel of judges to each sample was taken as the visual mottle index for the respective sample.

Finally, a correlation analysis was performed between the visual scores of the printed samples and the coefficient of variation of multivariate T^2 statistics calculated from the knife edge shadow image on unprinted samples.

The correlation was also calculated between the visual scores and the mottle values obtained from the different instrumental mottle measurement methods on the Püefbau halftone strips, namely ISO Mottle, Multiscale Mottle, Wavelet Multiscale Mottle and Band Pass Image Analysis.

4. Results

The correlation between the T^2 index and the visual scores obtained from the two independent visual mottle assessment methods is presented in figures 2 and 3 respectively.

The mottle index of halftone print strips obtained from the various image analysis techniques were also correlated independently to the visual scores obtained by the ranking and category judgment methods.

The correlation coefficient between the visual scores and each of the different instrumental mottle measurement methods is presented together with the proposed T^2 method in Table 1.

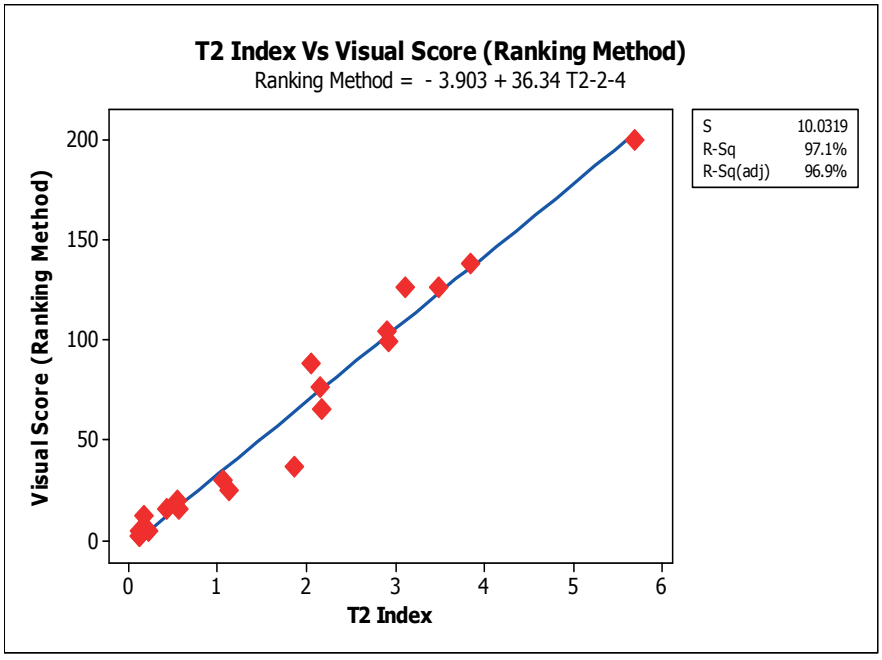

Figure 2: Correlation between the T^2 index and visual score obtained by the ranking method

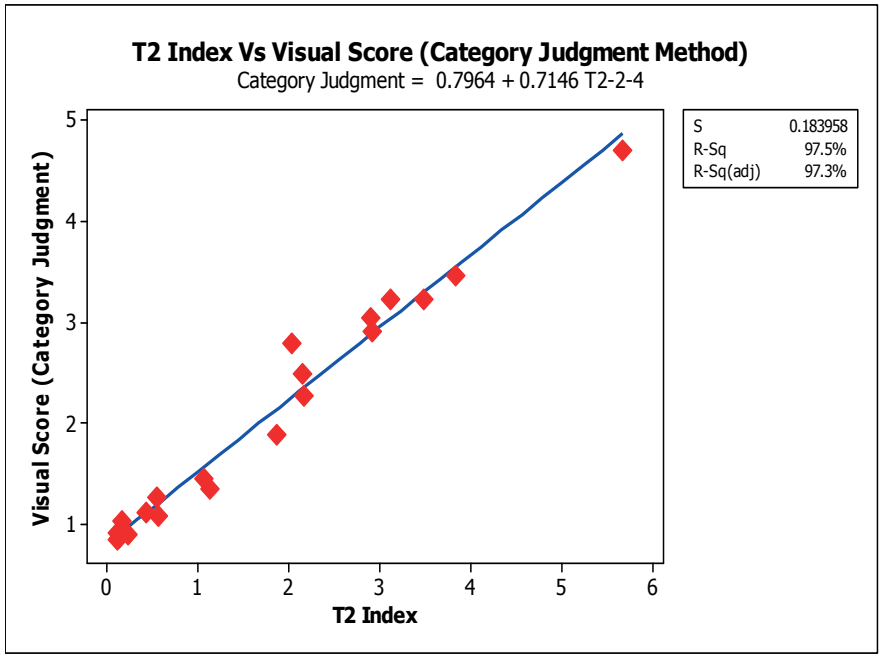

Figure 3: Correlation between the T² index and the visual score obtained by the category judgment method

Table 1: Comparison between the prevailing mottle measurement models and the proposed model

Visual estimation method	**Correlation coefficient (R^2)**				
	ISO mottle	*Multiscale mottle*	*Wavelet multiscale mottle*	*Band pass mottle*	*T² index*
Ranking method	*90.3*	*94.7*	*81.9*	*88.6*	*96.9*
Category judgment method	*88.9*	*95.1*	*84.2*	*91.8*	*97.3*

5. Discussion

Substantial agreement can be observed between the visual perception of halftone mottle over the printed samples and the T² index that has been deduced from the knife edge response of unprinted paperboard samples.

The results imply that the paper surfaces variability in lateral light scattering is affecting the spatial distance between the collinearly paired colorimetric coordinates which consequently leads to optically induced halftone mottle.

6. Conclusions

The proposed method of predicting optically induced halftone mottle from unprinted samples using multivariate T² analysis of variability in microscopic measurements of knife edge shadow projections on unprinted samples performs well across the entire scale of halftone mottle. The results also show that the proposed T² method delivers better results than the scanning based mottle measurements of printed halftone mottle samples.

The proposed T² method is shown to provide a very good prediction of optically induced halftone mottle without requiring any printing at all on the paper surface. Therefore this model can provide a robust method for predicting the propensity of unprinted plain samples to halftone mottle before printing, which is useful in applications such as quality control and product development in the paper manufacturing process.

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Life cycle oriented analysis of laminating films for the printing and packaging industry using a multi-level approach

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Abstract

The gloss coatings of printed products in the packaging industry have become increasingly important through adding some additional properties. These coating materials are commonly made from crude oil. The world-wide scarcity of oil resources generates a need to develop product alternatives based on renewable materials, e.g., cellulosic films.

In this paper, a comparative life cycle oriented analysis of two different laminating films is presented: (a) one film type is based on crude oil, viz. polypropylene and (b) one laminating film manufactured from wood. The analysis is focused on the cellulosic film type and aims to give information about the environmental impact of this product alternative in comparison to the polypropylene film. The resource consumption of the main materials is included in the study. Furthermore, the global warming potential, which is one of the best investigated and most reliable impact categories, is calculated.

The interpretation of the LCA results was conducted in accordance to a so-called 'multi-level approach' developed by the authors. This approach analyzes the LCA results level-by-level and hence generates a high degree of information in the LCA study. The LCA results show savings in the impact category 'oil consumption' and a higher global warming potential for the cellulosic film than for the polypropylene based one. However, a reversed product ranking is possible considering the uncertainty analysis for this impact category. The manufacturing of the cellulosic film is energy consuming and requires a certain amount of chemicals. Hence, these process types are the main contributors, in addition to the transports.

We conclude that the use of renewable material in the cellulosic film type preserves the world-wide oil resources. The benefit of this film type is also apparent in the end-of-life phase: CO_2 emissions occurring in the incineration of the glossy cardboard are biogenic for the cellulosic film and fossil for the polypropylene based film. This loop approach is common in LCAs and has a great influence on the comparative LCA in the impact category 'global warming potential' in this study. However, there are no advantages of this product alternative concerning the global warming potential. In further work, the LCA study on the film types will be extended including further impact categories to reach a complete LCA.

Keywords: life cycle assessment, renewable resources, global warming potential, coatings, laminating film

1. Introduction

Coatings have become increasingly important in the printing and packaging industry, generating added value to printed products. Due to the minor contribution to the overall impact of printed products, coatings of cardboard packages, e.g., laminating films, are not considered in LCA studies (e.g., Larsen, Hauschild and Hansen, 2006) whereas studies on printed products are numerous (eg., Borggren, Moberg and Finnveden, 2011; Enroth, 2009; Hermann, Blok and Patel, 2010; Larsen, 2004; Mourad, da Silva and Nogueira, 2012).

However, the environmental impact of different coating materials, which are commonly made from crude oil, is of special interest for actors in the packaging industry acting in compliance with their environmental objectives.

A report by Plastics Europe (2013) shows a continuous growth of the worldwide plastics production, reaching 288 million tons in 2012. This high demand for plastic materials had led to a demand for alternative materials in order to reduce the impact on non-renewable resources. One of the alternatives is cellulosic plastics.

The environmental benefits of renewable plastic alternatives will be discussed in this paper. The study presents results for specific impact categories, aiming to give a first impression of the product differences. The categories are the resource consumption of oil and wood and the global warming potential (carbon footprint).

A study initiated by the Federal Environmental Agency of Germany (Detzel, Kauertz and Derreza-Greeven, 2012) as well as previous work by the authors (Radermacher, Jung and Marzinkowski, 2013a) show savings of oil reserves but no advantages in other impact categories.

In this paper, a comparative analysis of two specific laminating film types - used in the printing and packaging industry for the application on cardboard packages - is presented. A life cycle assessment method was chosen to provide a life cycle oriented analysis of the environmental performance of the two film types.

2. Goal and scope of the LCA study

Two specific laminating films are compared with regard to their environmental impact: (a) petrochemical polypropylene-based (PP) laminating film (18.2 gsm) and (b) laminating film from renewable material (29.5 gsm), viz. cellulose derivates. These two plastic alternatives are typically used in the printing and packaging industry for applying to cardboard packages. The functional unit is therefore defined as '1 sqm laminating film (20 µm) adding gloss and protection properties to a cardboard package'. Both films are high-glossy materials in accordance to DIN (1999). The durability of both film types exceeds the life time of a cardboard package, hence their protection properties are assumed to be similar.

The study is focused on the cellulosic film type which is intended to be an alternative to the petrochemical one in order to reduce the environmental impact. The main contributors of the cellulosic film to the environmental impact were identified, determining the advantages and drawbacks in the different impact categories in comparison to the conventional PP-based film. The inventory analysis is based on secondary data taken from the international database ecoinvent v2. These data were analyzed and verified according to their usability in this comparative analysis.

A cradle-to-grave approach was chosen to describe the environmental performance of the different laminating film types (cf. Figure 1). The use phase was excluded because packages are short-term products having their main impact in the production and disposal phase.

Both laminating film types are two-side coated. It is assumed that the coating is nearly similar in both cases and could be ignored in this comparative analysis because of the low percentage to the total coating weight.

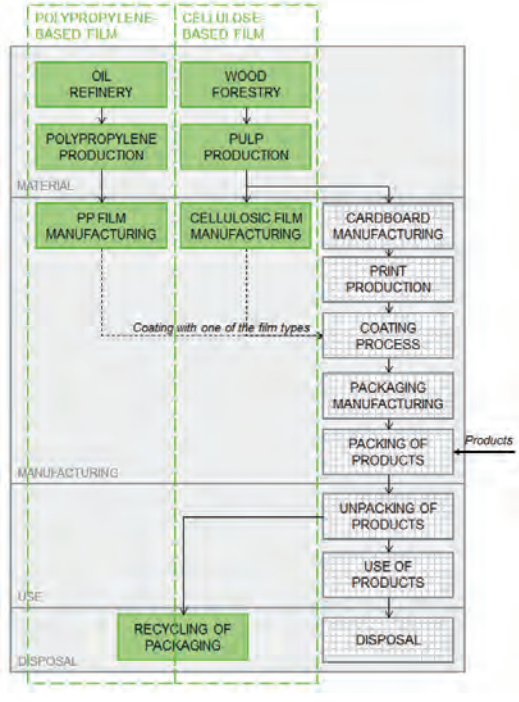

Figure 1:
Life cycle of a film coated cardboard package and the system boundary of the product systems of PP film and cellulosic film; the hatched boxes are not included in the LCA study

In the end-of-life phase, the laminating film applied to a cardboard package is assumed to be recycled. This scenario is a common option for paper-made products in Germany and other European countries.

2.1 Life Cycle Inventory

The PP-based film is converted from polypropylene granules. The process steps are described by Radermacher, Jung and Marzinkowski (2013a), according to Habersatter and Fecker (1998). The assessment of the polypropylene based laminating film is based on average European data including two different extrusion processes: 'bubble process' and 'stenter frame process' (Hischier, 2007; Boustead, 1997). In this product system, the propylene granules are produced and manufactured in European countries. The origin of the crude oil is not known. However, the oil can be supposed to be from outside Europe. The production of propylene and co-products from naphtha were allocated based on the mass ratio of the outputs. The process data are highly aggregated. Thus, the life cycle stages of material extraction and production are handled as a black box (cf. Figure 1). Details about the data collection and methods for aggregation are available in Hischier (2007).

The cellulosic film in question is a viscose based product manufactured from eucalyptus. There is a similarity to the viscose production in the textile industry. According to Crump (2000), the raw material and the manufacturing process involved are very similar for all viscose based products, irrespective of the industrial application. Thus, process data were taken from the viscose production process of the textile industry (Althaus, Werner and Stettler, 2007). A verification of the included data from the ecoinvent database concerning their agreement with the manufacturing process modeled in Crump (2000) shows that this proceeding is suitable. Eucalyptus pulp was included as raw material from Thailand. The pulp was transported to Europe to be manufactured into a cellulosic film. An average transport distance of 15000 km (overseas) and 400 km (lorry) was assumed (Althaus, Werner and Stettler, 2007).

The data input of both product systems are of high age. Significant technological improvements or disruptive technology steps in this industry are not known. Thus, the data are assumed to be up-to-date.

The environmental burden of the waste materials accrued within the material extraction, processing and film manufacturing were completely allocated to the product system in question (the '100 % rule'). The co-products 'electricity' and 'heat' were ignored. In the sensitivity analysis, different allocation methods were investigated. The effect of the allocation methods '50-50-partioning method', 'partitioning upon economic criteria' and 'system expansion with the avoided impact approach' (Baumann and Tillman, 2004; Klöpffer and Grahl, 2009) were analyzed. The influence on the over-all impact is lower than 1 % and is negligible in this case.

At the end of life, the cardboard package is assumed to be recycled. The coating materials (the coated laminating film and the adhesive) are disconnected from the pulp in the deinking process and remain as non-paper components (Müller et al., 2014). It is assumed that the coatings are completely split from the pulp and energetically recovered in the combustion.

The laminating films are disposed by municipal incineration concerning their main materials: plastic for the PP film and paper for the cellulosic film. The energy recovery, which is credited to the product systems, depends on the heat value of these different materials. According to Doka (2007), polypropylene produces 3.74 MJ/kg energy and 7.54 MJ/kg heat. Wooden material has an energy recovery rate of 1.32 MJ/kg energy and 2.77 MJ/kg heat. In this study, the energy recovered is calculated by defining the avoided burden in the heat production with natural gas and in the electricity production with hard coal, based on the heat values. The statistics of the International Energy Agency illustrate that in the OECD countries, heat is mainly produced with gas and electricity is mainly produced with coal (IEA, 2014).

2.2 Assessment of data uncertainty

To quantify the data uncertainty and error propagation, the Monte Carlo simulation method was utilized. This statistical approach is one of the most common methods in the LCA community (Heijungs and Huijbregts, 2004).

The uncertainty in the input data is quantified by the predigree matrix of Weidema and Wesnaes (1996). This approximation of the 'real' scores is suitable if the number of samples for the uncertainty estimation is small. The uncertainty approximation by Weidema and Wesnaes (1996) could not be investigated for cumulative data sets, e.g., upstream processes of the polypropylene granulate and energy related processes because of their aggregated nature and are not considered in the study.

10000 iterations were performed in the Monte Carlo simulation for each investigation. This amount of iterations reaches reliable results (Heijungs and Kleijn, 2001; Ciroth, 2001; Feck, 2007).

2.3 Impact assessment

According to the goal of this LCA study, the environmental impact of the cellulosic film type is assessed in comparison to the petrochemical one. To do so, the resource consumption of oil and wood was investigated. These two categories are focused on the origin of the two film types. The material origin has an important

influence on the structure of the upstream chain of the product systems. The global warming potential (GWP) is also considered. It is a commonly reported impact category in the context of the environmental sustainability of products. The GWP is an energy-related impact category (Larsen, 2004) and will include indirectly every kind of fossil resources.

The EDIP2003 method was chosen for the impact assessment (Laurent, Olsen and Hauschild, 2011). For the preparation of the categories for resource consumption, this method enables us to present the specific categories of the resource consumption of wood and oil.

The characterized LCA results are reported in this paper. The inclusion of the weighting step in a comparative analysis does not fulfill the requirements of the ISO standard.

2.4 Interpretation

The authors developed a 'multi-level approach' for the interpretation step (cf. Figure 2). The main contributors to the overall impact in the cellulose based product alternative can be identified in a comfortable way. The special feature of this approach is that three different levels of detail are strictly distinguished: (1) the life cycle stages (here: material extraction, raw material production, film manufacturing, end-of-life treatment), (2) the process types including the upstream chain (here: auxiliaries, infrastructure, process energy, process emissions, transport, transport packaging, waste treatment) for each life cycle stage and (3) the grouping by the use targets oriented towards the process types (here: providing of materials (chemicals, metals, others), infrastructure, transportation, energy, water, waste treatment).

The levels are described in Figure 2. From the authors' viewpoint, a differentiation of these levels is useful in order to give a consistent and enlarged interpretation of the LCA results.

The LCA results of level 1 for the cellulosic film are presented in comparison with the results for the petrochemical film. Investigations of levels 2 and 3 show the key factors giving detailed information. Levels 2 and 3 are applied to the cellulosic film in the detailed analysis in section 3.2.

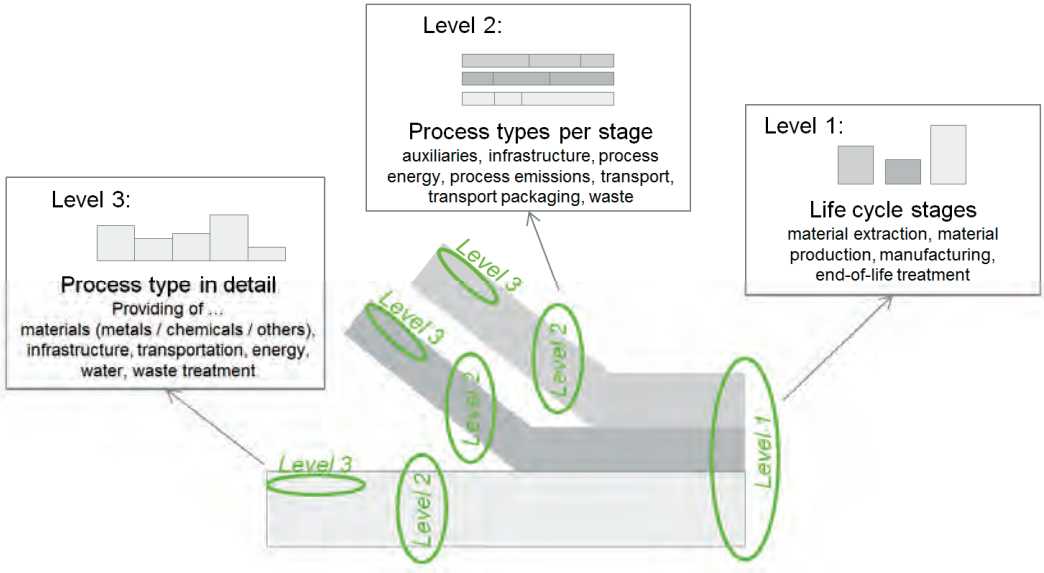

Figure 2: 'Multi-level' approach for life cycle analysis; Level 1: Calculation of the impact per life cycle stage; Level 2: Calculation of process types and their upstream processes; Level 3: Calculation of process types in more detail

3. Comparative analysis of polypropylene based and cellulose based laminating films used for coatings

3.1 Sensitivity analysis

In Figure 3, the overall impact of the two laminating film types is presented for the life cycle stages 'material extraction', 'material production', 'film manufacturing' and 'end-of-life treatment'. The results are shown as percentages in reference to the product system with the highest score, in analog with Radermacher, Jung and Marzinkowski (2013a). The life cycle stages material extraction and production were summed up into one score for both product alternatives, because the data of the polypropylene based film are only available in a cumulative form.

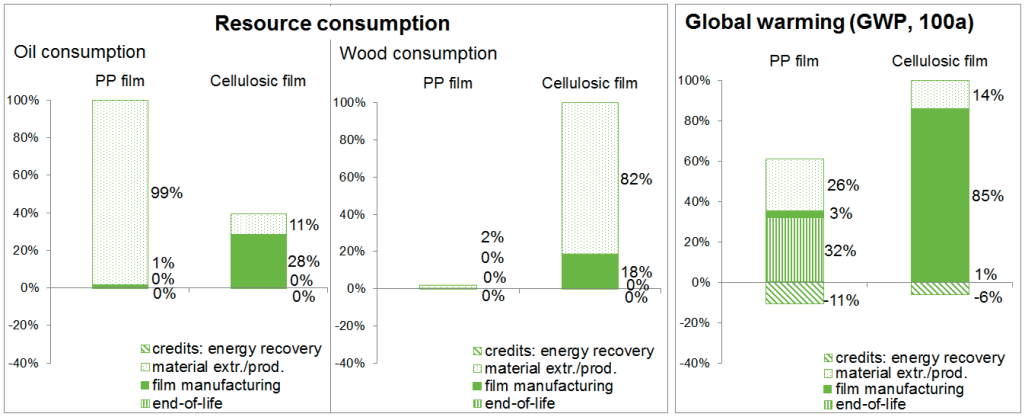

Figure 3: Overall impact of the product systems cellulose based and polypropylene based laminating films in percentage resource consumption (oil and wood) and global warming potential

The product comparison shows that the cellulosic film is a preferable alternative when trying to reduce the oil consumption. About 60% of the oil could be saved. However, a certain amount is used in the renewable film type.

The wood consumption is high for the cellulose based product system. The raw material contributes to the overall wood consumption by 82%. For the petrochemical film type, this renewable resource is of little interest. Here, wood is mainly used in the raw material stage for the packaging of the polypropylene granules (2%).

The global warming potential, GWP, is about 40% higher for the cellulosic film type. In comparison to the impact of the upstream processes (14%), the manufacturing stage contributes to the global warming potential by about 85%. Contrarily, the manufacturing stage of the PP laminating film has a smaller influence on the global warming potential (3%) than the material extraction and production. The material extraction and production (26%) and the disposal (32%) are the main contributors.

The end-of-life phase shows great differences in the impact category 'global warming potential'. The disposal of the petrochemical film material contributes to the overall impact of this film type by 32%. The disposal is lower than 1%, for the cellulosic film type. The reason for this is that a low amount of fossil carbons but a high amount of biogenic carbons occur in the waste disposal of the cellulosic material. The incineration of disposed material has two co-products: electricity and heat. The level of energy outcome depends on the material to be disposed (Doka, 2007). Hence, the PP film type reaches a higher credit than the pulp-based material.

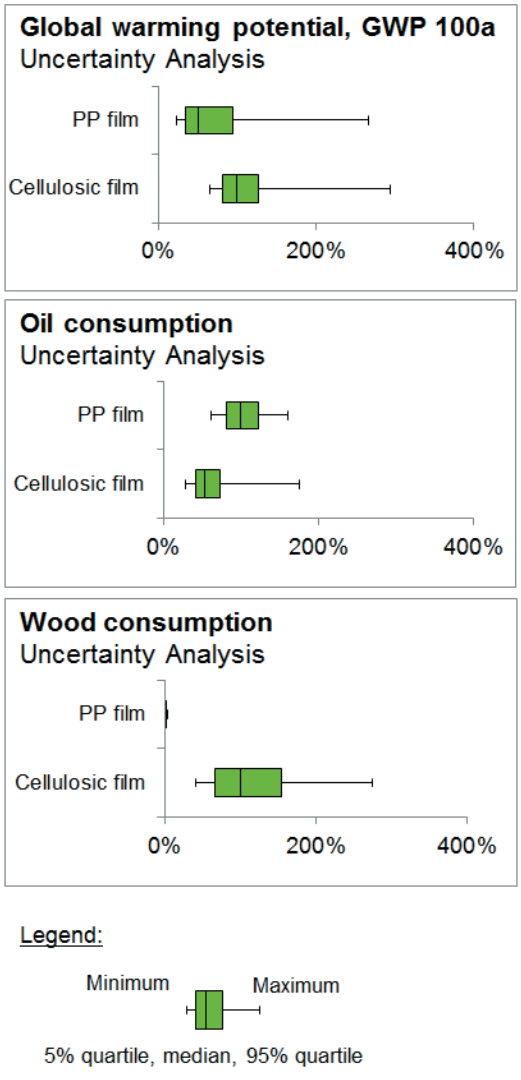

Figure 4:

Comparative uncertainty analysis (Monte Carlo simulation: 10 000 iterations) in box-plot diagrams for cellulose based and polypropylene based laminating films; resource consumption (oil and wood) and global warming potential

The Monte Carlo simulation of both film types is presented in box-plot diagrams for the impact categories 'global warming potential', 'oil consumption' and 'wood consumption' in Figure 4, similar to Feck (2007). The 100% value corresponds with the median value of the dominating product system. The box describes the 'true' value lying within a 90% range of probability concerning the specific uncertainty procedure of 10000 iterations. The vertical line in the box represents the position of the median value of the log-normal distribution. The horizontal lines describe the range between the minimum and maximum value in the simulation.

In the results of the Monte Carlo simulation, the global warming potential tends to be greater for the cellulosic laminating film (median: 100%) than for the polypropylene based type (median: 51%). However, there is a probability of a reversed product ranking. The product ranking is unambiguous for the resource consumption of oil and wood in the 90% confidence range.

3.2 Detailed analysis of the cellulose based laminating film

The detailed analysis presented in the following subsections is concentrated on the cellulosic laminating film type. Therefore, Figure 5 shows the percentage of the different life cycle stages contributing to the impact of the cellulosic film type. Here, the material extraction and production are depicted separately, in contrast to Figure 3.

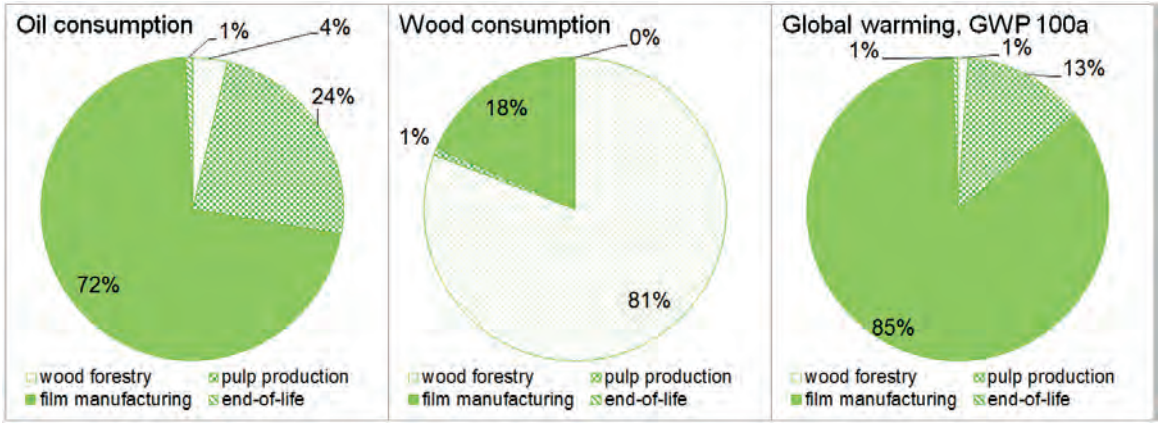

Figure 5:
Life cycle stages contributing to the overall impact of the cellulose based laminating films in percentage; resource consumption (oil and wood) and global warming potential

3.2.1 Material extraction

The main material of the cellulosic film is wood. Hence, the wood foresty contributes mainly to the wood consumption category. Small amounts of fossil resources are used for cultivating and harvesting. Furthermore, this life cycle stage has a small effect on the global warming potential.

3.2.2 Material production

In this LCA study, the sulfate pulp is extracted from the eucalyptus in Thailand. The oil consumption is mainly caused by the process energy and transportation of the raw material. Direct process emissions, the energy consumption and the transportation are relevant in the GWP category.

For further information of the reliability of the inventory data, the pulp production from eucalyptus was compared with results of other LCA studies (Gonzalez-Garcia et al., 2009; Gonzalez, Vega and Zaror, 2011). Gonzalez-Garcia et al. (2009) and Gonzalez, Vega and Zaror (2011) investigated the life cycle inventories of the eucalyptus pulp production in Spain and Chile. One ton pulp produced in Chile is bleached elementary chlorine free (ECF); the pulp from Spain is bleached totally chlorine free (TCF). Two scenarios considering the bleaching of pulp were created: (a) elementary chlorine free (ECF) bleached pulp and (b) totally chlorine free (TCF) bleached pulp. Therefore, the influence of the TCF and ECF bleaching processes were extracted from process data estimated for the production of a sulfate pulp mix (Hischier, 2007) and added to the reference scenario.

The infrastructure is not included in either Gonzalez-Garcia et al. (2009) or Gonzalez, Vega and Zaror (2011). In order to fill the data gaps, the impact of the infrastructure included in the reference scenario was transferred to the other estimates.

The global warming impact in Gonzalez-Garcia et al. (2009) is reported in CO_2-eq. calculated with the CML2001 method. As presented by Radermacher, Jung and Marzinkowski (2013b), results characterized by EDIP and CML will lead to similar results and could be compared in this impact category. Gonzalez, Vega and

Zaror (2011) show different air emissions which were used to calculate the GWP using the effect factors of the EDIP method.

The comparison shows about one fifth greater GWP in the reference scenario compared to the other data sources. Considering the contribution to the overall impact of the cellulosic film, this difference will influence the result by 3% and will not significantly cause the product ranking. Technological differences regarding to the geographical dimension between Spain, Chile and Thailand could not be expected.

3.2.3 Film manufacturing

In the manufacturing process of the cellulosic film, the pulp is dissolved, viscose is produced and a thin, transparent film is manufactured (see Radermacher, Jung and Marzinkowski, 2013a). The manufacturing stage of this type is energy consuming and requires specific chemicals for the processing shown in the GWP. These process types are also dominant in the category of oil consumption. Furthermore, the transportation is not negligible. Small amounts of wooden material are used in this life cycle stage for energy production.

The values for input and output data is caused by the allocation method between product and co-products chosen. In the following, different allocation methods and their influence on the impact categories are analyzed.

In the manufacturing process of the cellulosic film, the chemicals used could be recycled and re-used in the manufacturing process. However, small amounts of sulfuric acid and sodium sulfate are produced as co-products. These co-products were economically allocated in this LCA study, except for the raw material input. The sulfate pulp was not allocated and completely assigned to the product 'cellulosic film' (see Althaus, Werner and Stettler, 2007). The pulp is the main material of the cellulosic film and is not directly necessary for the production of these co-products.

Figure 6 shows differences in the LCA results when applying different allocation methods for the viscose production and its co-products. The overall impact would be higher if the system expansion by avoided production of the co-products were used. The results applying the 100% rule present similar ratios for the wood consumption and the GWP. Here, the oil consumption is 11% higher. The greatest difference to the reference scenario occurs in the allocation by mass ratio. The overall impact of the cellulosic film type would be 9% (wood consumption), 34% (oil consumption) or 41% (global warming potential) lower.

However, the mass ratio scenario as used in the polypropylene based system seems not to be appropriate in this case, because materials and chemicals are not comparable by their weight. The system expansion for chemicals is related to a high effort in the data analysis. Chemicals are often produced as co-products of other chemicals; also in this product system.

Further uncertainties in the data inventory could be expected (see section 3.2.5). Hence, the economic partitioning was chosen as reference scenario.

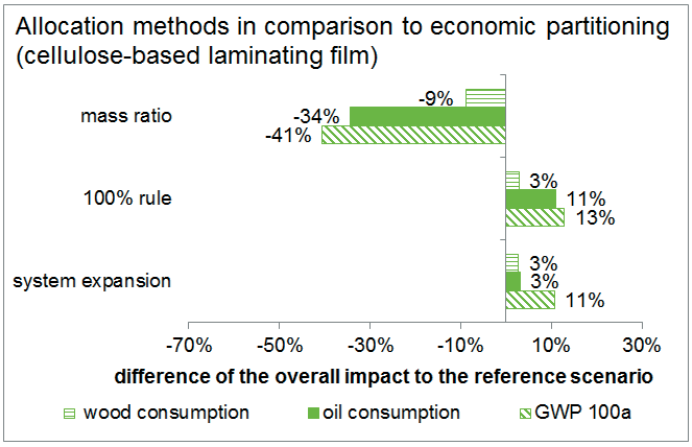

Figure 6:
Different allocation procedures applied to the film manufacturing stage in comparison to the economic partitioning (reference scenario) and the credits to the overall impact in the categories 'global warming potential', 'oil consumption' and 'wood consumption'

As mentioned before, the main contributors to the impact categories 'oil consumption' and 'global warming potential' are the process energy, chemicals and transportation. These process types are analyzed in the sensitivity analysis.

In this study, the electricity is a mix of European electricity. Because of significant differences in the electricity production also within Europe, a concentration onto specific strategies of one European country seems not to be suitable. A discussion about the different energy sources should not be the focus of this LCA study. Hence, an investigation of scenarios of energy sources for electricity is not part of the sensitivity analysis. Considering the probability to reduce the usage of electricity by 10%, the global warming potential changes by -1.5% and the

oil consumption by <-1%. The heat for the manufacturing process is assumed to be from a mix of gas, oil, wood and coal. The variation of the mix of sources for the heat production show higher global warming potential using coal (+5%) and oil (+2%) slightly reduced emissions in the heating process with gas (-1%). The increased usage of oil for heating in scenario 3 has a great influence on the LCA results in the impact category 'oil consumption' (+58%). The results of the scenarios are presented in Figure 7.

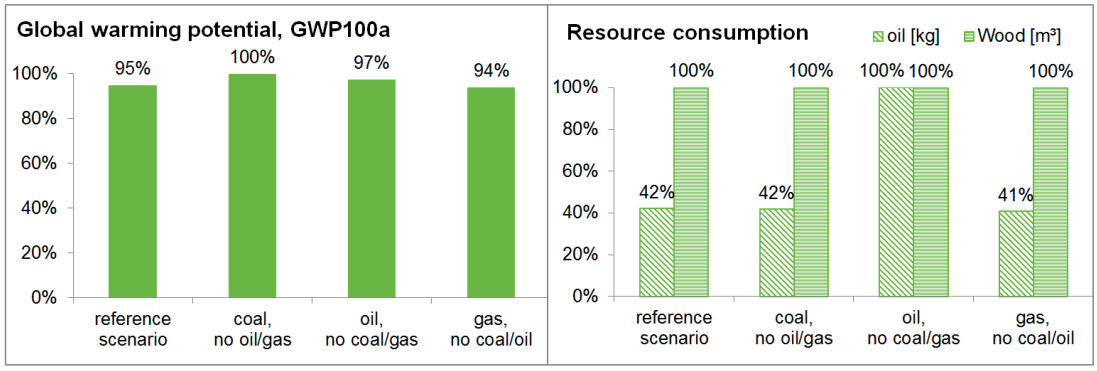

Figure 7: Scenario analysis using mainly coal, oil or gas for the heat production in the film manufacturing process in the categories 'global warming potential', 'oil consumption' and 'wood consumption'

The impact of chemicals is the second contributor to the oil consumption and global warming potential. If an improvement of the manufacturing is possible and the amount of chemicals could be reduced by, e.g., 10%, the global warming potential and the oil consumption will decrease by around 3%.

The transportation was also identified as one of the main contributors. In the reference scenario, the pulp is assumed to be from Thailand. The pulp of eucalyptus could also be produced in an European country, as presented by Gonzalez-Garcia et al. (2009). Transport route is assumed to be from Spain to Germany (~2000 km).

The LCA results of different scenarios in comparison to the reference scenario are shown in Figure 8.

The transportation by lorry will lead to a higher GWP value (+2%) and an increase of the oil consumption (+13%). Transport by train is a preferable alternative.

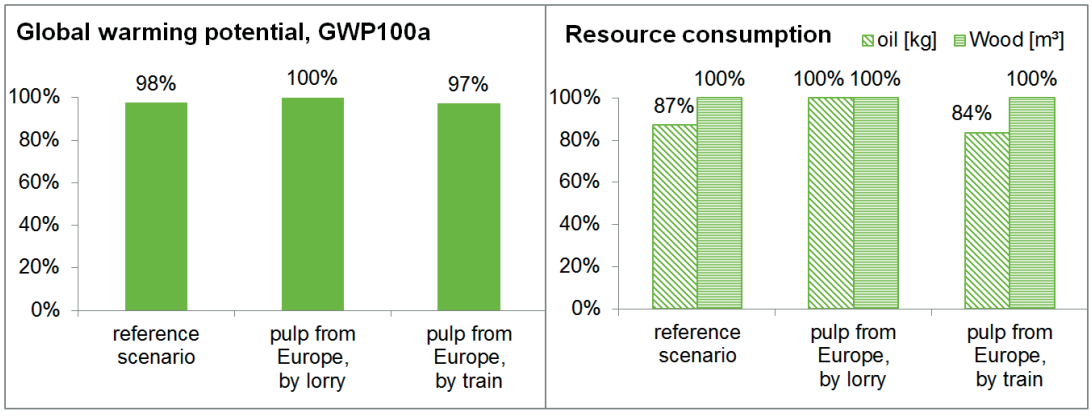

Figure 8: Scenario analysis of the transport route from Thailand (reference scenario) and from Spain to Germany (~2000 km) in the categories 'global warming potential', 'oil consumption' and 'wood consumption'

3.2.4 End-of-life treatment

The laminating film is assumed to be incinerated as paper based material. Emissions of the incineration process and auxiliaries are the main contributors to the impact categories. However, the contribution of the end-of-life phase to the overall impact is small in this product alternative (cf. Figure 5) and will not be investigated in more detail.

3.2.5 Uncertainty of life cycle stages

In this section the main influence of the life cycle stages and process types of the cellulosic film type on the uncertainty analysis was analyzed. This visualization should identify the location of uncertainties. Therefore, the uncertainty in one stage was calculated and those of the other stages were fixed. Figure 9 shows the results in the impact category 'global warming potential'. 100% re-

presents the overall impact of the product system. The confidence range of 90% is broader for the manufacturing stage than for the others. Thus, the uncertainty in the film manufacturing contributes mainly to the uncertainty of the whole product system. In further investigations, it was found that the greatest uncertainty of the film manufacturing stages is located in the production chain of the auxiliaries.

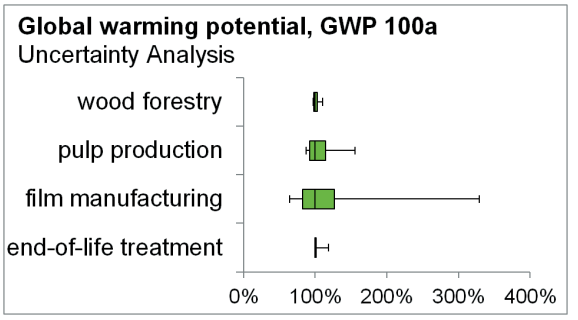

Figure 9: Uncertainty analysis (Monte Carlo simulations with 10 000 runs) for the life cycle stages for the impact categories 'global warming potential', 'oil consumption' and 'wood consumption'

4. Results

This paper presents a comparative analysis of the environmental burden of two laminating film types in Europe. One is based on petrochemical material and the other is manufactured from cellulose. A cradle-to-grave approach was chosen, which includes the life cycle stages from the material extraction to the film manufacturing and the end-of-life treatment of the laminating film applied to cardboard packages. Secondary data from the ecoinvent database were used for the LCA study. These data are mainly average data from industry. The impact assessment is focused on the resource consumption of oil and wood and the global warming potential (GWP100a) using the EDIP2003 method.

The LCA results and their data uncertainties were analyzed in this paper. The results show that the petrochemical film tends to consume a higher amount of oil: 60% more than the cellulosic film (minimum: 33%, maximum: 71%). However, the cellulosic film type also uses oil for example for auxiliaries and transports. The wood consumption is high for the cellulosic film type but negligible in the product system of the polypropylene film. The global warming potential tends to be higher for the cellulosic film type. The film manufacturing is the main contributor to this impact category. The dissolving and preparing of the pulp for the film manufacturing require great amounts of energy and auxiliaries. These factors also influence mainly the oil consumption. The Monte Carlo simulation shows similar results regarding the median values for all impact categories. However, in the case of the global warming potential, a reversal of the product ranking is possible.

In a detailed analysis of the cellulosic film in the manufacturing stage, the process types 'energy', 'chemicals' and 'transportation' were identified as the main contributors to the overall impact. The impact induced by the energy related processes, e.g., heat production and transportation, has slight effects on the GWP; the influence on the oil consumption is great. The data uncertainty is high in the film manufacturing, caused by the auxiliaries used.

5. Discussion and conclusions

This paper presents an environmental analysis of two different laminating films used in the coating process in the printing and packaging industry. Plastics are relevant in the discussion concerning the use of renewable vs. non-renewable materials in industrial applications, due to the shrinking supply of, e.g., oil. This topic is addressed in this paper. Are renewable materials an alternative for the packaging industry if oil reserves are exhausted? In addition to this, the global warming potential is also considered by presenting the carbon footprint of the film types. The changes in the climate conditions is one pressing topic worldwide. The global warming potential (GWP) is commonly calculated in the context of the environmental sustainability of products. It is the best investigated impact category and hence generates reliable impact results. For the calculation of the GWP, the choice of assessment method is of limited interest. The LCA results using different assessment methods, e.g., EDIP and CML, are similar. Results in other impact categories, such as human and eco toxicity can differ fundamentally (Radermacher, Jung and Marzinkowski, 2013b). Here, depending on the choice of assessment method different results can be obtained. Thus, the inclusion of other impact categories requires

consistent decisions about appropriate assessment methods for the product system in question. However, the GWP results only allow a restricted view of the environmental performance of products. For example, the quality of chemicals and their toxic properties were completely excluded from this study. In further work, the authors will take additional impact categories into account in order to extend the knowledge of the environmental burden of laminating films.

Due to the lack of detailed inventory data, the polypropylene (PP) film type was investigated in a cumulative way. The material extraction and the production of the PP granules were aggregated. This could be a decisive lack of information because a detailed analysis and the sensitivity analysis of the PP-based film type could not be conducted. The comparability of the LCA results of the two product alternatives was based on the documentation of inventory data. The detailed analysis in this paper is concentrated on the cellulosic film. To achieve this, the authors developed a 'multi-level approach' for the interpretation step. This approach distinguishes between different levels of detail and gives comprehensive information about the life cycle stages and process types. The information generated helps to provide a consistent contribution analysis in the comparative LCA of the laminating films in question. This approach will be pursued in further work.

This paper shows that the inclusion of the disposal in a cradle-to-grave approach is an essential factor for the LCA results of this study. According to Radermacher, Jung and Marzinkowski (2013a), a cradle-to-gate approach leads to the conclusion that the global warming potential is higher for the cellulosic film than for the petrochemical one, considering the median of the Monte Carlo simulation. The cradle-to-grave approach also includes the end-of-life phase of the films. In this paper, the disposal of the oil based plastics produces about 30% of the overall impact of this film type. As a consequence, the median values of the two film types come closer to each other. However, an advantage of the cellulosic film type, related to the global warming potential, could still not be shown. This conclusion agrees with Hermann, Blok and Patel (2010) as cited by Detzel, Kauertz and Derreza-Greeven (2012).

The sensitivity analysis of the main contributors in the manufacturing stage shows that the oil consumption category is crucially influenced by the assumptions made in the cellulosic product system for energy processes such as heat production and transportation. The product ranking could be influenced depending on the choice of energy sources. The overall oil consumption would be around 10% lower if no oil resources were used in the heat production. The variations in the country of origin for the pulp shows that the transport from inside Europe by lorry will heighten the oil consumption (+13%). Train will be a preferable alternative. The global warming potential is slightly affected by all these assumptions. Therefore, the product ranking seems not to be decisively influenced neither by the transport method nor by the energy source.

The difference between the two film types concerning the disposal phase is mainly caused by the biogenic carbons calculated for the cellulosic film. In the loop approach in the case of renewable materials, it is assumed that carbons occurring in the disposal of paper based materials will be consumed by trees used as raw material for further paper products. This approach leads to a difference in the almost similar disposal process of the two film types because of biogenic carbons for the cellulosic film and fossil carbons for the polypropylene-based film type. If the carbon emissions of the cellulosic film are also calculated as fossil carbons, the gap between the two film types in this study will increase by 13% in the GWP.

The use of the loop approach in the case of renewable materials is a common procedure in the life cycle assessment. However, account should be taken of that the results of the global warming potential could be influenced crucially.

In conclusion, the LCA study on laminating films shows that the cellulosic film type tends to save oil reserves; there are no advantages concerning the global warming potential. The resource categories are directly affected by the assumptions chosen and have high data uncertainty. However, the categories 'oil' and 'wood' introduce the origin of the main material of the cellulosic and plastic film and visualize aspects relevant to the discussion of renewable and non-renewable materials. Furthermore, the global warming potential was investigated. The LCA results show that the cellulose based film tends to have a higher global warming potential than the propylene based film. The sensitivity analysis and the data uncertainty analysis confirm this result. The GWP seems not to be mainly influenced by specific assumptions concerning the main contributing process types.

The LCA study discusses one important impact category, but the product ranking of the different laminating film types could not exclusively be based on the GWP. For a comprehensive study, further impact categories should be included. Therefore, further work is needed to perform an impact assessment appropriate for the specific product system.

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An analysis of the motivation, structure and success factors of supply chain co-operation in the Sino-German printing industry

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Abstract

The German and Chinese printing and packaging industries are among the main players in the globalization process within their business sector. As there is not yet much literature available explaining the details of the interactions between the involved enterprises, this paper aims to investigate the motivations and the supply chain structures, explore the key factors of success, establish a framework of supply chain co-operation in the Sino-German printing and packaging industry, and analyze the findings of different case studies. The study is based on literature review, on interviews and on cases studies on transnational co-operations. The findings in this investigation indicate that for the analyzed enterprises there did not exist 'The One' key factor for successful co-operations. It shows that there are various drivers to be considered more in detail. This paper aims to become a starting point for deeper understanding of and further investigations and research into the Sino-German globalization process.

Keywords: supply chain co-operation, Sino-German printing industry, key factors of success

1. Introduction

During the past twenty years, the supply chain of enterprises has been extended more and more into international fields (Golini and Kalchschmidt, 2010). The increasing pressure of competition, the diminishing trade barriers and the rapid development of transportation and information technologies have made supply chains go across national borders and proceed with a company's production and sales in the global market through international practices (Hülsmann and Berry, 2004). The globalization of the enterprises' supply chains has promoted the globalization of the industry's supply chains, especially in fields such as the automobile, computer science, clothing and printing industries (Meixell and Gargeya, 2005; Diao, Li and Ross, 2010).

Germany plays a leading role in the international printing industry. Considering printing machines as an example, the exported machines made by German manufacturers take up 42 percent of the global export volume of all printing machinery world-wide (Bünteme-yer, 2009). The two largest German printing machinery manufacturers have always held the first and second places in the international printing and manufacturing Industry. At the same time, Germany is also the largest printing market in Europe, capturing over 20 percent (Büntemeyer, 2009) of the total sales volume. The German printing industry does have its own technological advantage, mainly for the following reasons: first, German printing enterprises have strict quality control systems, secondly, they have accomplished a well-defined market positioning by developing unitary products in small and medium-sized enterprises and promoting them through global marketing activities and, finally, they persist in innovation and control their patents and thereby they play a dominant role in the technology sector. For example, one German group has focused on folding machines since long time and has become the first and the only manufacturer who can offer a varied range of products from standard folding to specialized and complex folding solutions.

China is also a big printing power in the world. Following the United States and Japan, China has become the third largest market, preceding Germany and Great Britain. According to the National Press and Publication Administration (China Printing Industry Annual Re-

port, 2010), China's printing and publishing industry showed a positive growth tendency in 2009 with a gross output of more than 1 000 billion RMB. The gross output of the printing industry has reached 574.62 billions and has increased by 15.25 percent compared to 2008. However, the national printing technology and facilities in China are still on a middle and low level in relation to the entire industry. High-grade technologies and facilities mostly rely on imports. According to the statistics from the German Verband Deutscher Maschinen- und Anlagenbauer (VDMA, n.d.) the import volume of the printing technology and facilities in the year 2008 increased to 75% of the gross national output. Of this, the import from Germany took up 70% of the total import volume. Asia has become the second largest export market for the German printing industry. Regarding the main export destinations in 2006, Mainland China was responsible for 7.2% of the total export share. Germany owns a worldwide advantage in the printing industry and in printing manufacturing, while China, the third largest printing market, has strong market potential and cost advantages. Largely, Germany and China complement each other (Diao, Li and Roos, 2010).

However, no analysis of the supply chain co-operation in the Sino-German printing industry has been reported. What is the motivation and structural features of the co-operation? Which factors are influencing a successful co-operation? These questions should be analyzed and explored.

Based on literature review, research and case studies, this paper aims to explore the motivation and structural features of the supply chain co-operation in the Sino-German printing industry and to identify the necessary key elements for a successful result. At Hochschule der Medien Stuttgart and TU Xi'an, a research study was conducted in the year 2011. 32 German and Chinese companies were interviewed. The initial results are summarized and analyzed in this paper**.**

2. Literature review

2.1 Motivations for trans-national co-operation

(1) Market motivation

Most of the literature attributes the reason for co-operation between trans-national companies and host nations to the supply relationship. The trans-national companies believe that co-operation could increase the opportunities in their local market (Yaprak and Karademir, 2010).

The theory of 'Monopoly Advantage' indicates that a market structure whose demand exceeds supply will drive the overseas enterprises to transfer their tangible assets, such as technology, or intangible assets, such as brands, to the local market in order to obtain profit (Erdilek, 2008). Kreutzberger (2000) states that the exploration and the enhancement of their market share are the key factors for German companies to enter the Chinese market.

(2) Cost motivation

The theory of 'Transaction Costs' indicates that, by extending its business into the overseas market, an enterprise can take some actions to reduce their costs, such as the costs of direct exports, stock control, indirect investments and the costs on their agreed contracts (Buckley et al., 2008). Ghemawat and Ghadar (2006) claim that the cost pressure from customers and suppliers push the companies to seek help in the overseas market in order to cut down production costs. Chen and Reger (2006) point out that the motivation for German enterprises for investing in the Chinese market is to enter the market as well as to reduce the production costs.

(3) Resource acquisition

Huang, Hu and Cheng (2008) argue that, under competitive circumstances, enterprises could maintain their competitiveness through global co-operation, which could integrate information, knowledge and human capital as a whole. Mathews and Zander (2007) believe that specialized resources in the global emerging market will become a magnet to attract external companies.

According to the research of Yaprak and Karademir (2010), the motivation for overseas investments is to obtain resources, from initial natural resources to knowledge resources and other ability resources.

2.2 The structure of supply chain co-operation

Barratt (2004) has made an in-depth study of supply chain co-operation by dividing the structure into horizontal and vertical types (Figure 1). This model is widely accepted by the academic community.

However, Barratt has only seriously studied the horizontal type. Later on, Bahinipati, Kanda and Deshmukh (2009) have studied co-operation from the perspective of the horizontal type by taking the supply chain of the semiconductor industry as the target object.

(1) Vertical Type

The vertical type of supply chain co-operation includes the co-operation between downstream users and upstream suppliers. This is mainly achieved by purchasing and promotion. Under the global condition, the main practices are to establish branch offices, subsidiary companies or agencies in overseas areas.

(2) Horizontal Type

The horizontal type of co-operation is considered as the co-operation between two or more companies that are at the same position in the supply chain and that wish to seek common goals and benefits (Bahinipati, Kanda and Deshmukh, 2009). Bahinipati, Kanda and Deshmukh, 2009) argue that the horizontal types of co-operations in the semiconductor industry are the following: fundamental co-operation to seek more information about the industry; contract-based co-operation to seek common goals by two or more partners in joint investments; R&D co-operation to share a common ability and possibly exchangeable technology.

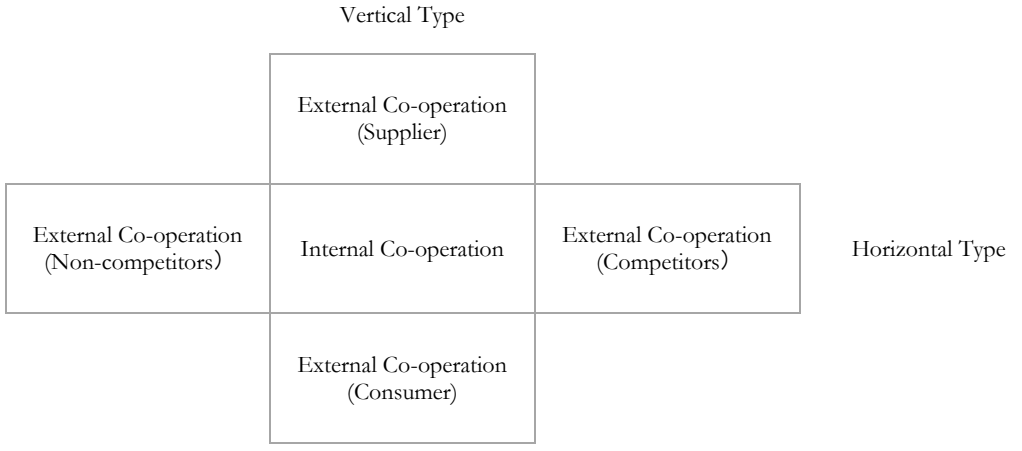

Figure 1: Structures of supply chain co-operation (Barratt, 2004)

Referring to the forms of realization based on a study of the stability and complexity of the co-operation, Bidault and Salgado (2001) have summarized it into three forms.

The first is a contract-based co-operation in which companies do not have any economic relationship with each other and the co-operation is based on a contract. The second is a joint-venture-based co-operation in which companies achieve their co-operation totally through a subsidiary company. The third is equity-linked co-operation in which cross holding of the equity is involved or at least one side holds the equity of the other side.

2.3 Key success factors in trans-national co-operation

Based on the literature review, our exploration of theory has mainly focused on three levels: the Theory of Resource (Yang and Lee, 2002), the Theory of Ability (Beamish and Kachra, 2004; Gale and Luo, 2004) and the Theory of Relationship (Muthusamy, White and Carr, 2007; Kiessling and Harvey, 2004).

The Theory of Resource emphasizes the importance of the enterprise's resource. This kind of resource, tangible or intangible, is defined as the one that offers valuable resources for an efficient production and market innovation (Hunt and Morgan, 1995). Based on the current literature reviews on the Theory of Resource, the key success factors of trans-national co-operations are technology (Yang and Lee, 2002), market (Isobe, Makino and Montgomery, 2000), brand image (Nippa, Beechler and Klossek, 2007), government policy (Yang and Lee, 2002), the information access from the partners (Gale and Luo, 2004) and others.

According to current literature reviews on the Theory of Ability, the key success factors of trans-national co-operation is the support provided by the high-level management (Wittmann, Hunt and Arnett, 2009; Hemeriks and Duyster, 2007), the selection of business partners (Gale and Luo, 2004), clear agreements and targets (Gale and Luo, 2004), culture-friendly management (Isobel, Makino and Montgomery, 2000), organizing ability (Beamish and Kachra, 2004; Nippa, Beechler and Klossek, 2007) and other factors. In the study of China's circumstances, some scholars are emphasizing the strategic importance of management ability (Heimeriks and Duyster, 2007).

In the Theory of Relationship, some experts have explored key factors from a relationship perspective and divided the key factors into trust (Demirbag and Mirza, 2000; Gale and Luo, 2004), long-term commitment (Gale and Luo, 2004; Demirbag and Mirza, 2000; Nippa, Beechler and Klossek, 2007), conflict management (Yang, 1998) and ownership control (Das and Teng, 1998; Meschi and Cheng, 2002).

In addition, the management in China and abroad both believe that ownership control is the key factor for the success of a joint-venture enterprise. Chinese management pays more attention to the proportion of the equity share, while the foreign management wants to be sure that Chinese enterprises are willing to have long-term co-operation with them (Gale and Luo, 2004).

3. Implementation of the study

3.1 Study method

Compared with single-case studies, cross-case studies tend to be more convincing in their generalized result. In this paper we adopt the method of cross-case studies (Larsson, 1993) in order to generalize the motivation, structure and key success factors of the supply chain co-operation in the Sino-German printing industry. In general, a case study selects samples based on two aspects. One is the feature of the sample. The selected example must be highly related to the theme of the study. The second is the quantity of the example. The quantity of the example will not be taken into consideration, but the depth and characterization of the selected example will be.

3.2 Selection of the cases

In order to make the study more efficient, two competitive points should be considered. The first is the industrial features of the enterprise (the position in the supply chain, the position in the industry and its own technical features); the second point is the organizational features of the enterprise (the scale and the age of the organization). Therefore, 14 typical cases have been chosen, see Table 1.

Table 1: Typical enterprises of co-operation in the Sino-German printing industry

No.	Name/type of company	Industry
1	Chinese packaging group	Packaging, printing, printing material
2	German printing equipment manufacturer	Printing machinery, manufacturing
3	German post-press company	Folding equipment, manufacturing
4	German printing ink group	Tobacco packaging ink, flexible packaging ink, label/sheetfed ink, food packaging ink and paper and board ink
5	Sino-German supplier company	Surface treatment agent, cleaning agent, sealant, LOCTITE, adhesive etc.
6	German printing equipment manufacturer	High-tech equipment of pre-press services, printing and post-press services, manufacturing
7	Sino-German printing equipment company	Auxiliary equipment, cooling and temperature control equipment for printing machines, printing ink systems and components
8	Sino-German printing ink company	Silk screen printing ink, printing ink and other unique chemical auxiliaries
9	German paper group	Paper making, energy sources, motive power, industrial service standard, paper-making machines
10	German printing equipment company	Control systems for paper-making and printing equipment machines
11	German Digital Printing Equipment Company	Digital printing and other printing plates
12	German printing ink group	Printing ink, printing varnish, fountain solution, printing auxiliaries
13	Sino-German industrial machinery company	Paper-making industry, surface treatment technology, exhaust-gas treatment equipment
14	Chinese printing group	Combination of pre-press services, printing and post-press processing

Among the typical international enterprises listed in Table 1 we have selected companies for cross-case analysis. These have been chosen specifically to avoid the influence from competitive explanations, using the following rules-of-thumb.

(1) Avoid the influence brought by industry features

Motivation, structure and key success factors are typical factors in analyzing the co-operation between enterprises in different positions of the supply chain. These aspects of co-operation should be studied also in different types of multinational co-operation in the printing industry. In order to avoid the influence brought by industry features, typical enterprises such as upstream printing equipment and printing material have been selected for this study.

(2) Avoid the influence brought by organization features, widen the scope

We have selected large companies such as German print press manufacturers and Chinese print press manufacturers as well as small and medium-sized companies such as German post-press companies and German printing equipment manufacturer, aiming to overcome the feature practical limitations.

The five companies selected for cross-case study are presented in Table 2.

Table 2: The basic conditions of the selected companies. (The companies are anonymized in this study)

Company type	German post-press company GPostC	German printing equipment manufacturer GPrintM	German printing equipment company GPrintEC	Chinese packaging group CPackG	Chinese printing group CPrintG
Size	medium	large	medium	large	large
Start of Sino-German co-operation	2003	1925	2003	1996	1976
Type of business co-operation	Post-press equipment	Printing machinery	Paper making, paper film processing	Flexo-printing, plate making, printing ink	All kinds of printing products
Industry features	The first and only post-printing manufacturer with full coverage service (from standard page to special page)	The largest web-fed printing machine manufacturer; the second largest sheet paper printing machine	The leading pioneer in control systems for the paper making and paper film processing industry	The largest blown-film printing & packaging company in Asia; the first company for plate-making, aqueous based alcoholic ink technology in China and Asia	A well-known packing and printing group in China, having a complete industry chain of pre-press services, printing and post-press processing

4. Results of the study

4.1 Medium-sized German post-press company GPostC

The GPostC company was founded in the 1960's and the headquarter is located in Germany. Being the leader in folding machines, the GPostC company technology service network has spread all over Germany, France, the United States, China and other parts of the world. In the year 2000, through a merger with another German company, a manufacturer of specialized folding machines, the GPostC company has become a comprehensive single-source provider of folding equipment and technology. The company has established a fully owned subsidiary company in China, a post-press company that is responsible for sales in the Chinese market. At the same time, branch offices were also established in Shanghai and Shenzhen.

In 2003, the GPostC company chose Beijing as the starting point of its development in China and was much welcomed by the market.

On this basis, the GPostC company has established a comparatively small fully owned subsidiary in Beijing, responsible mainly for sales and post-sale service. Since 2006, the GPostC company has begun to fabricate all German-made parts in China and this practice is still ongoing.

In China, the post-press enterprises can be classified into three groups:

- a group with high technology and a low market share, represented by the GPostC company
- a group with high market share and fair technology, represented by a Chinese post-press company
- a group with fair behavior in both technology and market share, represented by a German printing machinery manufacturer

Figure 2 illustrates the positions and the differences between German and Chinese enterprises.

(1) Motivation for the co-operation: Market expansion

In the 1990's, the GPostC company considered entering the Shenzhen market in China. However, the top-level management knew little about China and did not have much expectations for the Chinese market. Therefore, they turned to the United States market where they now have a market share of 70 to 75%. Later on in 2003, with the assistance of an appropriate "middle-man", the GPostC company successfully entered the Chinese market and made good results based on its unique technology.

(2) Structure of co-operation: Vertical type

Before the GPostC company entered China, it had contacted a large Chinese group in the hope to enter the Chinese market by establishing a joint-venture enterprise. However, this plan was rejected since the two sides did not reach common agreement on, e.g. such is-

sues as intellectual property. In conversations with the GPostC company's top management, we found that small and medium-sized companies such as the GPostC company fully rely on their advanced technology and they worry about the possible loss of their core technology. Thus, the GPostC company did not establish a joint-venture enterprise to enter the Chinese market. In the very beginning, The GpostC company tentatively established just a branch office since they knew little about the social and industrial structure in China. Through a process of continuing learning and improved understanding, the company gradually expanded its business scale. They started to hire local employees and established a wholly owned subsidiary in Beijing. The strategy of the GPostC company in China is to produce and sell their equipment themselves.

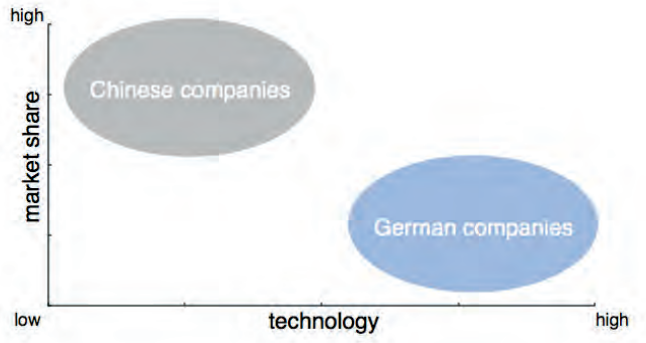

Figure 2: The positions of Chinese and German enterprises in China

(3) Key success factors

a. An appropriate "middleman"

The "middleman" played an important role in promoting and advising entry into the Chinese printing industry. It is difficult for small and medium-sized companies such as GPostC to enter the Chinese market directly.

The GpostC company needed a "middleman" who is very familiar with the language, the culture and the mentality in both China and in Germany.

b. Technology transfer agreement between the two sides

Like many small and medium-sized companies in Germany, the GPostC company relies totally on its core technology. During its co-operation with the Chinese company, GPostC company paid great attention on protecting its intellectual property and core technology. Therefore, a technology transfer agreement was necessary for both sides.

c. Stable supply chain and good monitoring system

Hoping to better meet the requirements of the local market and to achieve a higher market share, the GPostC company purchased great numbers of spare parts in China; the GPostC Company worked in close relationships with Chinese companies and maintained its original quality advantage. A long-term and stable supply chain and a good monitoring system were required by the GPostC company to ensure the long-lasting stability of the product quality.

d. Sufficient access to information

Before the GPostC company entered the Chinese market, it had limited access to the domestic market and limited knowledge of government policies. Consequently, with the assistance of the middleman, they gradually learned about Chinese culture, mentality and the ways of doing business. With the development of their business in China, the GPostC company improved their access to information about the Chinese market, mastered the operation system and achieved great success.

e. Mode of operation for market adaptation

Because of the lack of knowledge about the Chinese market, the GPostC company and their Chinese counterpart did not reach an agreement on co-operation when they first made contacted with each other. This was not satisfactory. In this regard, the GPostC company should adjust its product structure and business strategy to better suit the Chinese market.

4.2 Large German manufacturer of printing machinery (GPrintM)

The GPrintM company is a pioneering industrial group in Europe and is one of the world's top 500 companies. The company was founded in the mid-18th century. Its business extends into 120 countries all over the world. As a large web-fed printing machine manufacturer and one of the larger sheet paper printing machine manufacturers, the GPrintM company has formed a solid foundation in the worldwide printing industry during its development. Web-fed printing machines, sheet-fed printing machines and digital printing systems are the

main products for printing and publication, commercial printing and packaging printing.

(1) Motivation for the co-operation: Market development

The entry of the GPrintM company into China dates back to the 1920's when *Shanghai Daily* introduced their first rotary printing press in 1925. In the 1950's, the GPrintM company imported a large number of letterpress rotary printing presses into China; in the 1980's, they provided high-tech rotary printing machines to large-scale newspaper printing enterprises; and in the 1990's, they entered the Chinese market with great expectations.

(2) Structure of co-operation: Vertical co-operation

After years of efforts, the GPrintM company has established good relationships with their Chinese customers. The strategy of establishing branch offices in China is not only to offer equipment, but also to build close cooperative relationships with Chinese printing enterprises. Nowadays, the GPrintM company branch offices have covered most parts of China and there are permanent employees for sales and service in places such as Hong Kong, Shanghai, Beijing, Shenzhen, Chengdu, Guangzhou and Taiwan.

(3) Key success factors

a. Management adapting to cultural differences

The China headquarters of the GPrintM company is located in Hong Kong and is mainly dealing with sales and post-sales services.

They have a German management and the employees are Chinese. Considering the cultural differences between China and Germany, the management uses a managerial combination of Chinese and German cultures.

b. Mode of operation adapting to market demands

The main customers of the GPrintM company in China are newspapers, publishing and printing plants. The GPrintM company is welcomed by the market because their quality and technology advantage largely exceeds the level of their competitors. However, these advantages also increase costs, resulting in a 50% higher sales price than that of their Japanese competitors.

Chinese customers pay more attention to the performance/price ratio and appreciate a lower price as long as the quality meets their requirements.

In this regard, if the GPrintM company could design more affordable (suitable) products according to the Chinese market requirements, which means offering equipment with a lower sales price but still ensuring product quality, the GPrintM company definitely could have a larger market share than they currently have.

c. Support from the top management

Most of the members of the top management in the GPrintM company is engineers. They pay very much attention to the quality of the products and do not wish to decrease the quality. Thus, a transfer in mode of operation requires support from the top management.

4.3 Medium sized German printing equipment company GPrintEC

The GPrintEC company was established in the 1920'es in southern Germany. The GPrintEC company ranks among the worldwide leading suppliers of control, guiding, and inspection systems for the textile, paper, corrugating, film, tire, rubber, non-woven, and printing industries. Today, the GPrintEC company has established subsidiaries in countries such as the United States, Great Britain, France and China and has formed a worldwide network for production and sales. With the increasing demand in Asia and mainland China, GPrintEC company has established subsidiaries in Hangzhou and branch offices in Foshan in the Guangzhou province and Qingdao in the Shandong province, mainly responsible for sales and post-sales services for the Chinese market.

(1) Motivation for the co-operation: Market development

The GPrintEC company began to pay close attention to the Far Eastern market thirty years ago and has established a subsidiary in Taiwan. They consequently established agents and branch offices in mainland China. With the increasing demand in Asia and in mainland China and for better management and expansion purposes, the GPrintEC company established a subsidiary in Hangzhou in September, 2003. This replaced the strong influential position of Taiwan and led to a much more sound supply chain.

(2) Structure of the co-operation: Vertical co-operation

The GPrintEC company provided printing materials and services to the market in Asia and China and a development path of "agent to branch office to subsidiary". At the beginning stage in China, the GPrintEC company sold their products and services by offering commission to the agents. With increased knowledge of the market and the expansion of co-operations as well as for quick and convenient business operations, the GPrintEC company later on established their branch offices in China and subsidiaries responsible for the Chinese and the Asian market.

(3) Key success factors

a. Sufficient access to information

When choosing the location of the subsidiary in China, people from the GPrintEC company researched and analyzed the investment situation in the Chinese

market, developed a positioning strategy and finally decided to establish the subsidiary in Hangzhou. Considering related factors such as recruitment of employees, product storage, fund allocation and future development, it was reasonable to choose Hangzhou, which is located very close to Shanghai.

b. Management adapting to cultural differences

The predecessor of the Hangzhou subsidiary was a subsidiary in Taiwan. The establishment of the Hangzhou subsidiary followed the management mode of Taiwan. Later on, with increasing attention paid from Germany, the subsidiary was taken over directly by the German headquarter in 2009 and the entire management is now German based. The GPrintEC company reflected much on the cultural differences between China and Germany and therefore adapted a management policy of combining each other's cultural uniquenesses.

Compared with the local R&D department in Germany, the internal atmosphere of the Hangzhou subsidiary is more flexible and the employees are optimistic about the future.

c. Communication with local government and customers

The General Manager of the GPrintEC company reveals that the critical problems relating to cultural and managerial differences require the application of the principle "do in Rome as the Romans do" in the daily work. The company management is also working actively with the government and other customers in order to the solutions. Today, business runs quite smoothly.

4.4 Large Chinese packaging group (CPackG)

The CPackG group was founded in the beginning of the 1980's and has today grown to more than 2000 employees and total assets amounting to 2.5 billion RMB per year. The main products are plastic-film and color-printed packaging paper, color-printed packaging material, glass packaging material, crystal products, PE film, aqueous-based alcoholic ink, BOPP film, gravure plate making, flexible printing plate making and ticket printing. In 1996, the group invested 200 million RMB and established three German-Chinese joint-venture companies (packaging, prepress, ink production) in the packaging market. Both the Chinese and German sides hold a 50 percent share.

(1) Motivation for the co-operation: Market development, resource acquisition

As a result of the joint investment, one of the three joint ventures became the first world-class plate-making center in the Chinese and Asian market. The second joint venture also reached a leading position in ink manufacturing through its aqueous-based alcoholic ink. For the Chinese partner group, the co-operation brought not only the foreign investment support but also advanced technology and a managerial mentality. In addition, the third joint venture used the Chinese group's local advantages to popularize their brand images and to rapidly enter into the China market.

(2) Structure of the co-operation: Horizontal co-operation

As a prepress specialist, the German partner has rich experience in plate making; a second partner is also a well-known printing ink manufacturer in Germany. They both have overlapping business with the Chinese partner group. In this regard, they could have become competitors in the same Chinese market. However, through horizontal co-operation, the Chinese group not only acquired advanced technology and equipment, and obtained a great number of professional talents with good technical skills, but also established a strict and efficient management system. By now, it has become an leading flexible plate-making center in China and its ink products are widely used in gravure and flexography printing. At the same time, the German partners also benefited from the co-operation through a successfully ability in entering the Chinese market.

(3) Key success factors

a. Choice of management mode

In general, there are three types of management modes (Glaister et al., 2003) between joint venture enterprises: common management, one-sided management and third-party management. The choice of management mode is critical for both sides and requires a joint agreement. When the CPackG group co-operated with German companies, it considered both internal and external factors and adopted a management mode mainly focusing on China, which did satisfy both sides. A correct choice of management mode will help both sides to use their advantages and to complement each other.

b. Trans-cultural coordination

Different parties in the joint-venture enterprise come from various geographical environments and have different cultural backgrounds. In this regard, different value concepts and diverse behavior are inevitable and trans-cultural coordination is critical to the success of a joint-venture enterprise.

c. Common strategic objectives

The Chinese group has strategic objectives in common with the two German companies. Since 1996, they have settled the conflicts in their co-operation for the sake of long-term benefit and tried to promote their successful co-operation.

4.5 Large Chinese printing group (CprintG)

The CPrintG group is a well-known printing and packing group in China, with twenty wholly financed joint-venture companies and total assets amounting to 2 billion RMB. It has formed a complete printing supply chain with pre-press service, printing and post-press processing.

(1) Motivation for the co-operation: Cost-driven market development

German companies are mostly small and medium-size. With increasing printing costs, more and more production activities are transferred to places outside of Germany if the deadline is not too tight. The printing enterprises in the Chinese market have obvious cost advantages; among others, the CPrintG group has actively explored the overseas market for business opportunities. In 2007, the group achieved a total output value of 1.3 billion RMB, with printing trade orders taking up 90% of the output value.

(2) Structure of the co-operation: Vertical co-operation

The first co-operation between the CPrintG group and a German enterprise was in the year 1976 when CPrintG group was still a very small printing factory. The CPrintG group received an order for the design, printing and packing of 100000 sets of handkerchiefs from a German company, by which it earned 220000 US dollars. The CPrintG group then began to explore the international operations field and received a great number of printing orders from all over the world. Today, the group enjoys a world reputation, with an annual growth rate of 20% and the overseas trade volume has increased by 250 times compared to the volume in 1976.

(3) Key success factors

a. Quality control

Germans printing industry is very strong and German customers are extremely demanding when it comes to the quality of the product. To meet the standards of overseas business, the CPrintG group has increased its quality control levels. All of the affiliated companies are ISO9000 certified while most of them also have the environmental certificate ISO14000. Meanwhile, the group has also obtained special certifications according to their customers' requirements. To ensure that the quality control meets international standards, overseas orders are strictly monitored by a professional trading service team.

b. Communication

By participating in international exhibitions such as the Frankfurt Book Exhibition and by improving communication with customers, the CPrintG group has increased its popularity; they have established subsidiaries to break geographical limitations, and has borrowed the experience of the Hong Kong printing industry by strengthening communication with its agents.

5. Comparison and discussion of the cross-case study

5.1 Comparison of the cases

Through the analysis of typical cases of Sino-German co-operation's, this paper aims to explore the motivation, structure and key success factors of supply chain co-operation in the Sino-German printing industry. Five companies were selected for the cross-case study. Table 3 shows a comparison of the five single cases, in which different motivations, structures and key success factors can be discerned.

Table 3: Comparison of the studied cases

Variables	Post press company GPostC	German printing manufacturer GPrintM	German printing equipment company GPrintEC	Chinese packaging group CPackG	Chinese printing group CPrintG
Motivation	Market development	Market development	Market development	Market development, Resource acquisition	Market development, cost-driven
Structure	Vertical	Vertical	Vertical	Horizontal	Vertical
Key success factors	"Middleman" Technology transfer agreement Stable supply chain and complete monitoring system Sufficient access to information Market adaptation	Cultural adaptation Market adaptation Support from the management	Sufficient access to information Cultural adaptation Contact with government and customers	Choice of management mode Cross-culture coordination Common strategic objectives	Quality control Communcation

From the five cases, we can see that the main motivations for co-operation in the Sino-German printing industry are market development, resource acquisition and cost-driven practice. The structures of the co-operation are both horizontal and vertical; different motivations will imply different structures, thus leading to different key factors for success.

5.2 Discussion of co-operation structures

The type of co-operation that is based on market development and cost-driven factors belongs to the vertical type. It can be regarded as a co-operation through plain supply in the Sino-German printing industry supply chain (mainly the co-operation between upstream suppliers and downstream customers). Another type of co-operation, based on resource acquisition, is a co-operation between companies that are on the same level in the supply chain. However, there are also companies that are focused on market development and conduct horizontal co-operation with companies from the same production scope, e.g., the co-operation of the Chinese packaging group CPackG with a German ink company and a German prepress company. To realize the cooperative structures, the Chinese and German companies usually take measures such as establishing co-operation teams, branch offices, wholly funded subsidiaries, joint-venture companies as well as working together with agents. Based on the above analysis, a framework of Sino-German supply chain co-operation is shown in Figure 3.

1. Co-operation in the upstream part of the supply chain in the Sino-German printing industry, mainly co-operation between printing equipment manufacturers and printing material manufacturers.

2. Co-operation between Chinese printing companies and companies from the upstream part of the supply chain in the German printing industry, mainly the co-operation between German printing equipment and printing material manufacturers with Chinese printing companies. This is the most frequent type of co-operation between China and Germany.

3. Co-operation between Chinese and German printing enterprises

4. Direct co-operation between Chinese printing companies and companies from the downstream part of the supply chain in the German printing industry, mainly co-operation between German publishers, packers and agents with Chinese printing companies;

5. Indirect co-operation between Chinese printing companies and companies from the downstream part of the supply chain in the German printing industry, mainly co-operation between German publishers, packers and agents with Chinese printing companies, through the assistance of middlemen or agents.

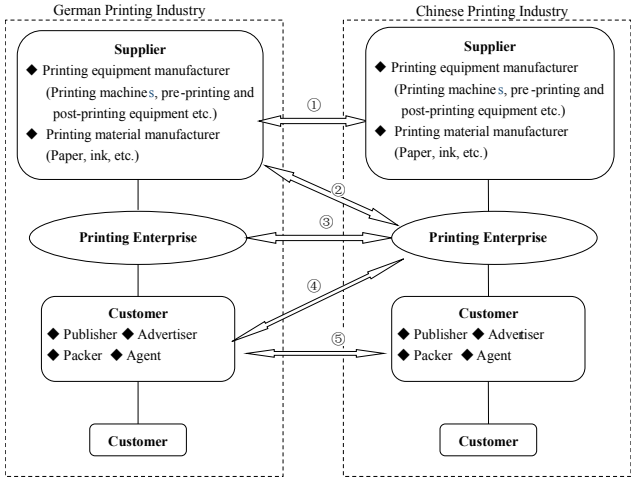

Figure 3: Framework for supply chain co-operation in the Sino-German printing industry

The co-operation types, indicated by the numbered arrows in Figure 3, are described above.

Through comparison and analysis, we have found that there is a difference in the key success factors in supply chain co-operation in the Sino-German printing Industry. In the vertical structures, the key factor is the link of supply parts. Thus, the main factors to ensure a successful corporation are "adapting the business mode to the market", "a stable supply system", "appropriate middleman or agent", "sufficient access to information" and "communication with governments". In the horizontal structures, the key factor is the co-operation between enterprises that are at the same level. Thus, the main factors are "the choice of management mode", "trans-culture coordination" and "common strategic objectives".

6. Conclusions

Germany plays a leading role in the international printing industry while China has become one of the largest printing markets in the world. They are complementary to each other and co-operation between China and Germany has gained increasing attention.

In the 2009, China was the guest of honor at the Frankfurt Book Exhibition while Germany was the guest of honor at the Beijing International Book Exhibition.

Through the analysis of the five cross-case studies, this paper has discussed the motivation and structure of supply chain co-operation, in order to explore the key success factors and to build a framework for the co-operation. The study shows that, due to different motivations and structures, the key success factors also differ from each other. A follow-up study would use empirical research methods to further explore the key success factors and to produce more well-founded conclusions.

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Narrative engagement and reading performance on digital and printed platforms

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Abstract

Narrative transportation theory proposes that when people lose themselves in a story, their attitudes and intentions change to reflect that story. Travel can be used as a metaphor for reading to conceptualize narrative transportation as a state of detachment from the world of origin that the story receiver experiences because of his or her engrossment in the story. The state of narrative transportation makes the world of origin partially inaccessible to the story receiver, thus marking a clear separation in terms of here/there and now/before, or narrative world/world of origin.

Narrative engagement is part of narrative transportation and it consists of four dimensions: narrative understanding, attentional focus, emotional engagement and narrative presence.

This study compares the narrative engagement that reading novel-type texts evokes using either a printed book or an eBook as the reading platform. A reading test in controlled laboratory conditions was conducted and the results show that there were no statistically significant differences in narrative engagement. This result was verified in more natural reading environments through a qualitative study.

Keywords: eBooks and printed books, narrative engagement, reading speed, comprehension

1. Introduction

Most people recognize the instance in which a book totally captivates and absorbs them, while hindering distractions from other sources of influence. In other words, a heightened focus, obtained through deep concentration, pushes aside any other thoughts obstructing a focal interaction. Accordingly, the physicality of the book vanishes to a degree, leading to a sensation of unity with the content, amplifying the message it conveys. Such possible engagement excites the reader, making a previously encountered deep mental involvement a goal when trying to encapsulate a reading experience in want of immersion. The mechanical act of reading is not sufficient to create such narrative engagement with the content. The individual needs to invoke an image by herself - in accordance with the meaning of the text - which will transcend her previous situation and widen her personal horizon. According to Mangen (2008), phenomenological immersive reading depends on our abilities to create a virtual world from the symbolic representations displayed by means of any technological platform.

A requirement for positive reader engagement and satisfaction is that the reading platform, either printed or digital, offers minimal disturbances to the user; that it becomes more or less transparent. As an example, readers should not get distracted by the clicking of the next page button and the time lag in page turning. The purpose of this study is to compare the narrative engagement when reading a printed book with reading an eBook on a tablet device. Two reading performance measures, reading speed and comprehension, were also compared. Both laboratory experiments and real life reading studies were carried out.

2. Narrative engagement

Reading does have different levels of involvement, indicated by the many words for reading: to leaf, flick or thumb through, to look over, to browse and skim, to study, scrutinize and peruse, to decipher and interpret. Reading of novels is usually continuous from beginning to end and the goal is usually to reach an emotionally

satisfying engaging reading experience. In many cases, the engagement is for the greater part created by internal processes in the user's mind since novels are usually presented as non-illustrated text, offering no options but to read.

Ryan (2001) has examined the many metaphors used in describing engaged reading, which is usually associated with movement, saturation or depth, often in combinations. We talk of being carried away or lost in reading, to be deeply involved or to be immersed, deeply absorbed or engrossed in reading.

In immersive imaginative reading, readers get involved in a story, conjuring up vivid images of persons and places, living through situations, empathising with characters. In this process, readers are carried away into imagined worlds, anxious to know what is going to happen. Becoming immersed in reading is usually emotionally satisfying and some people consciously use novel reading as a form of escape. Immersive imaginative reading is often associated with narratives and requires reading to be fairly fluent (Hillesund, 2010).

All readers experience that text involvement is relative; that immersion is a matter of degree. Much fictional literature, both classical and modern, requires a high degree of reflection in order to make sense and arouse interest. Thrillers, westerns, and mysteries immerse us in their characters and plots, making us temporarily oblivious of the world around us. Texts by "difficult" writers engage us by challenging and subverting our schemas, reminding us of our role as readers and sensemakers. Busselle and Bilandzi (2009) describe four dimensions of narrative engagement which can be interpreted as representing unique but interrelated engagement processes. The components are narrative understanding, attentional focus, emotional engagement and narrative presence (Bal and Veltkamp, 2013).

Narrative understanding can be described as ease in comprehending a narrative or, from a mental models perspective, ease in constructing models of meaning.

Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things. *Focused attention* is the task of actively paying attention to only one task. A truly engaged reader should be unaware of focused attention and should become aware only if attention drifts or must be refocused.

Emotional engagement (feeling for and with characters) appears to be specific to the emotional arousal component of narrative engagement, but not necessarily to any specific emotion. Readers of a fictional narrative can identify with the main characters, and such identification and sympathizing with the main characters can be expected to be stronger as the reader becomes more familiar with them, in other words, when one reads more of a novel. Thus, the effects of fictional narrative experiences may be stronger as one has a more prolonged exposure.

Narrative presence is the sensation that one has left the actual world and entered the story. This can be conceived as a twofold phenomenon. One is an intense focus resulting in a loss of awareness of self and surroundings. The second is the sensation of entering another space and time, which should be unique to narratives.

A slightly different perspective on narrative engagement is presented by Enlund (2000) who argues that a sense of presence and reality can be produced through a combination of sensory environment (the technical characteristics of the delivery platform), content characteristics and various individual preconditions such as emotional state, associative context and the active suspension of disbelief (Figure 1).

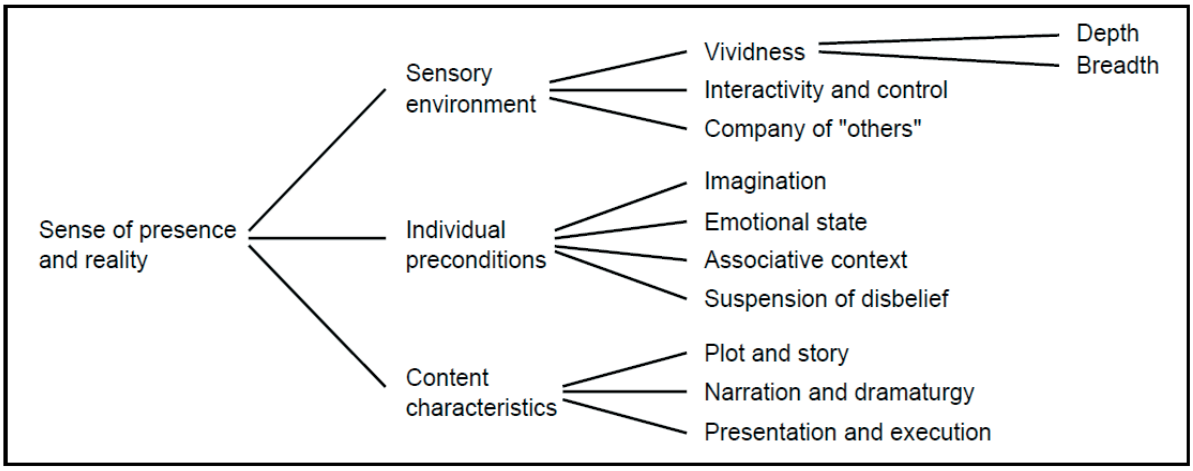

Figure 1:
A framework for creating a sense of presence and reality (Enlund, 2000)

3. Experiments

40 persons participated in our laboratory experiments. The participants were recruited by various means: by contacting people who expressed their interest when answering a web survey aimed at the library patrons using a new eBook loaning system, by e-mailing and directly contacting people working in various positions at the same research centre as the authors, as well as their family members and other acquaintances, and through other contacts.

This convenient group of participants was comprised of persons with relatively varying backgrounds (but was not a random sample and cannot be assumed to represent a general population). 25 of the participants (62.5 %) were women and 15 (37.5 %) were men. The ages of the participants ranged from 15 to 64 years old.

Each participant read two texts from a printed edition and two texts from a digital edition. Three of the texts were selected from three different novels and one from a nonfiction book. The novels can be characterized as a humorous autobiographical novel (text 1), a historical romantic drama (text 2), and a psychological novel (text 3). The nonfictional book (text 4) can be characterized as a social commentary.

The texts lengths varied from three to eight pages consisting an entire chapter or just the beginning of a chapter. The order of the texts was randomized and each text was read by 20 persons from a printed edition and by 20 persons from a digital edition. The digital edition was read using BlueFire Reader software on an Apple iPad 4 (Bluefire Productions, 2014). The tests were conducted under controlled viewing conditions approximating the viewing conditions P2 defined in ISO 3664:2000 for practical evaluation of printed products, with chromaticity coordinates approximating those of the CIE standard illuminant D50 and with the illuminance of approximately 500 lx at the table level (International Standards Office, 2000). Indirect illumination from fluorescent tubes reflected from the ceiling of the room was used. Selected light sources were turned off when reading book sections from the tablet device. Otherwise the lighting conditions were similar between the cases of reading a printed book and a digital book from a tablet, with the same chromaticity and similar levels of ambient illumination. Difficulties with glare, such as may occur with tablets when reading in direct sunlight, were eliminated through this arrangement. The brightness adjustment slider on the iPad was manually set to the middle of the scale (automatic brightness adjustment was turned off).

After reading the text, each participant answered a set of reading comprehension and reading experience questions. This procedure was repeated four times. Finally, at the end of the test session, the readers were asked to associate different properties with the digital and printed books.

The reading experience questionnaire assessed different aspects of the narrative engagement using a ten-point Likert scale. The following four dimensions were evaluated: narrative understanding (eight questions), attentional focus (seven questions), emotional engagement (eleven questions) and narrative presence (nine questions). Examples of the questionnaire are presented in Table 1.

Table 1: Examples of questions in the reading questionnaire. Items marked with asterisk are reverse-worded

Dimension	Item indicator
Narrative understanding	I had a hard time recognizing the thread of story. *
	At times, I had a hard time making sense of what was going on in the story.*
	The story was easy to understand.
Attention	I found my mind wandering while reading the story.*
	While reading my mind was concentrated.
Emotional engagement	The story affected me emotionally
	The events in the story felt meaningful.
Narrative presence	While reading, the story's world was closer to me than the real world.
	I could easily picture the events of the story taking place.

Reading comprehension was assessed using reading quiz questions. Multiple-choice questions whose answers could be found in the passages read were developed. Four questions per story were presented to the participants. Reading speed was simply measured as the time needed to read the presented chapter of the book. After completing the reading experience questionnaires and answering the reading comprehension multiple choice questions, the participants were instructed to think of and compare their general impressions, feelings and thoughts concerning reading printed books and reading digital books on a tablet device, based on this experiment as well as on their earlier real-life experiences.

They were then presented with a questionnaire containing 40 statements or mental associations such as "Read-

ing demands concentration", "Reading to relax", or "Text appears tangible". They were instructed to move a pointer on a 9-point scale from the midpoint towards either end ("Printed book" on left, "Digital book" on right) to indicate the platform with which they more strongly associated the given statement or aspect, and to indicated stronger association by moving the slider farther in that direction.

4. Results of the laboratory experiments

The readers experienced similar narrative engagement when reading either a printed or an eBook version of the four texts. The differences in the engagement dimensions were statistically insignificant. The four dimensions narrative understanding (UND), attentional focus (ATT), emotional engagement (EMO) and narrative presence (PRE) are shown for both the printed (P) and the digital (D) books in Figure 2. The different dimensions are scaled to allow comparison.

All four texts evoked similar narrative engagement.

The only exception was text 4 which produced lower emotional engagement in the readers.

This is quite natural because this non-fictional text did not offer main characters with whom the reader could identify and sympathize. The emotional engagement of the different texts is show in Figure 3.

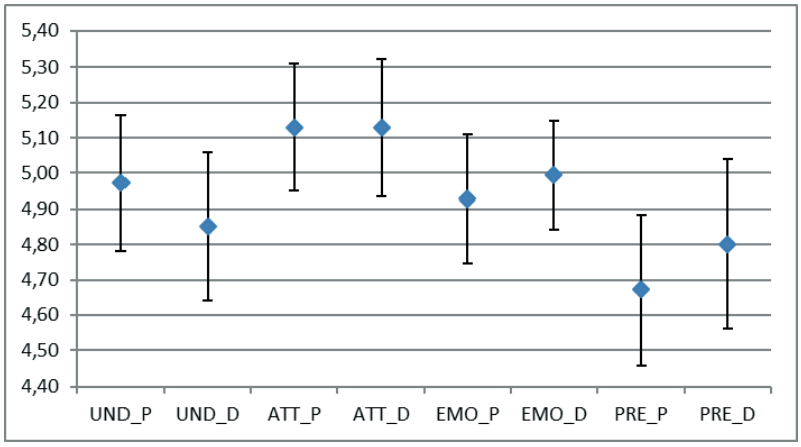

Figure 2: Different narrative engagement dimensions of the four texts in printed (P) and digital (D) form. 95% confidence intervals are also shown

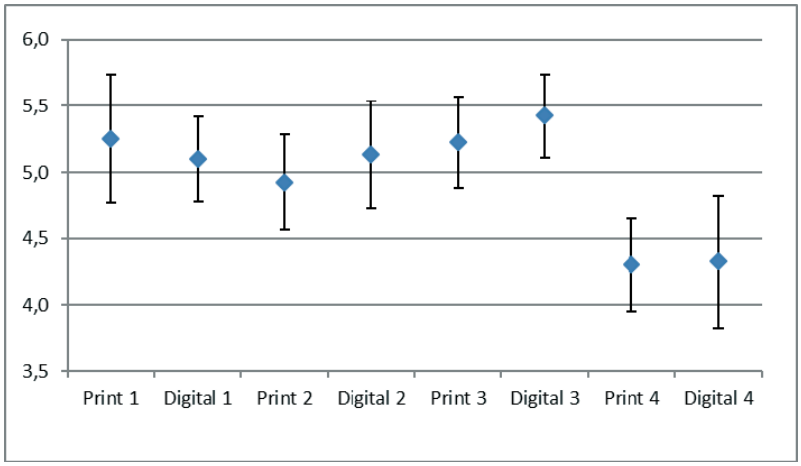

Figure 3: The emotional engagement of the texts 1-4 in printed and in digital form. Texts 1-3 are from novels and text 4 is from a non-fictional book

Figure 4 depicts the distribution of reading times between the participants for the printed and digital versions of texts 1 to 4. The horizontal red line on each column of the graph indicates the median reading time in that case. The thick bars extending below and above the median value indicate the 25% lower quartiles and 75% upper quartiles of reading times among participants. The horizontal extent of the bar thus indicates the interquartile range containing half of the reading times for that particular text and reading platform. The

notches around the median value indicate the 95% confidence intervals for the median. The confidence intervals were calculated assuming normal distributions, but provide reasonable estimates of confidence intervals even in the cases when the values are not normally distributed. The whiskers plotted with broken lines extend to the shortest and longest reading times among the main group of participants and the red crosses indicate the reading times of observers that can be considered outliers.

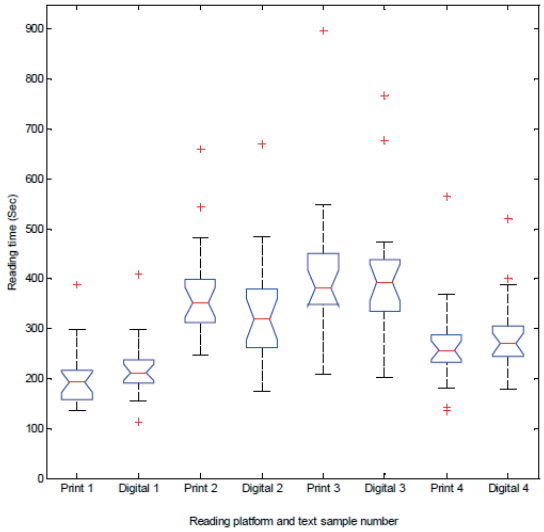

Figure 4: A box-plot depicting the reading time distributions of the printed and digital versions of the four texts among the participants

As expected, there are significant differences between the median (and mean) reading times between different texts. However, the difference in the median or mean reading time between the printed and digital version is not statistically significant at the 95% confidence level for any of the texts.

There were mostly no significant differences in text comprehension between the printed and digital versions. In the statistical analysis, the mean reading comprehension score was found to be slightly higher for the printed version of Text 3 than for the digital version of the same text (significant difference at 95% confidence level).

For Texts 1, 2, and 4, no statistically significant differences were found in reading comprehension scores between the printed and digital versions (Table 2).

Table 2: The mean values and standard deviations of reading comprehension scores among participants for printed and digital versions of the texts

	Text 1		Text 2		Text 3		Text 4	
	Print	Digital	Print	Digital	Print	Digital	Print	Digital
Mean	2.8	3.0	3.0	2.9	3.5	2.8	2.3	2.5
Standard deviation	0.9	0.9	1.1	0.9	0.6	0.8	1.1	0.8

The readers were also asked to link different mental associations with the reading platforms. The mental associations that the readers have with the printed and digital book were different. Printed books were associated with long, luxurious, inspiring and relaxing reading sessions where the reader feels to be in control of the reading situation. In contrast, the digital reading device was associated with work related reading situations where information finding is of importance. Tables 3 and 4 list the statements and aspects that had a significantly stronger association with either reading digital books on a tablet device (Table 3) or printed books (Table 4) at 95% confidence level, as indicated by Student's t-test for the mean of each scale value.

Table 3: Statements that had a significantly stronger association with reading digital books on a tablet device (at 95% confidence level) than with reading printed books. The statements are arranged in order of increasing p-value (roughly corresponding to decreasing statistical significance) from left to right

Reading is tiresome	Work-related reading	Disturbing gloss or glare	Finding information

Table 4: Statements that had a significantly stronger association with printed books (at 95% confidence level) than with digital books read on a tablet device. The statements are arranged in order of increasing p-value (roughly corresponding to decreasing statistical significance) from left to right and from top to bottom

Suitable for long reading sessions	Suitable for luxurious reading sessions	Perceiving the whole content available within a title	Comfortable posture for reading
Suitable for inspiring reading sessions	Pleasant platform for reading books in general	Text appears tangible	Blocking the surrounding real world out of one's mind
Reading to relax	Pleasant platform for reading novels and other fiction	Reading in a pleasant ambience	Returning to a previously read part of a text
Immersing oneself in the world of the story	Reading to acquire and adopt new information and points of view	Fast reading	Entertaining reading
Being in control of the reading situation	Ease of comprehending a text	Reading demands concentration	Hobby-related reading

5. Real life reading - a qualitative study

In addition to the laboratory experiment, a real-life reading experiment was carried out in order to get information from everyday life situations. The study focused on leisure time book reading, thus newspapers were excluded. The goal was to find out the participants' response to reading on tablets and how the reading experience using a tablet differs from reading print. The participants were given freedom to describe the reading experience from their own perspective, not focusing only on, e.g., narrative engagement.

Altogether eight persons (four male and four female, aged 30 - 46) participated in the experiment. The participants were expected to have their own tablet device for reading and to possess not more than little previous experience with eBooks.

The experiment group was instructed to read an eBook of own choice on a tablet during a period of approximately one week. The focus was on leisure time reading, thus work-related content was not recommended. Non-fiction was allowed, however. Furthermore, the participants were instructed to use library services[1] for providing a free eBook. The use of any other (commercial) services was allowed as well. As a result, seven out of eight participants used library services.

Each experiment group participant was interviewed after the test period. The interview focused on following themes:

1. Background
   - general leisure time reading habits
   - attitude toward eBook reading before the test period
2. Overall impression of the test period
   - free description of the reading experience
   - good and bad sides of reading on a tablet
3. Reading situations
   - reading places, styles, time
4. Content and reading on a tablet
   - suitability of the chosen content for reading on a tablet
5. Technology
   - suitability of the tablet device for reading
   - suitability of other mobile technologies for reading
6. Conclusion
   - attitude toward eBook reading after the test period
   - willingness to read eBooks in the future.

6. Results of the qualitative study

6.1 Reading places and styles

According to the interview results, most of the reading on tablet was done at home, exactly in the same places where the experiment participants would usually read print: in a sofa, in an armchair, in bed. The situations were also the same as with print; the usual time for reading was in the evening, often just before going to sleep. Some interviewees mentioned that they also read while commuting and during breakfast, as they do with print as well. One person additionally mentioned that her reading was depending on the sleeping rhythm of her child. Generally, the tablet device did not have any major effect on the reading place and situation.

[1] Recommended library service: http://www.helmet.fi/en-US

However, one person mentioned that she read in a cafeteria, which is unusual for her. At least for her, the tablet had the potential to change her habits.

No major differences in reading styles between print and eBook were mentioned. The experience of reading the text and the story was basically the same. Many emphasized that they want a certain minimum amount of time and a peaceful moment for leisure reading, thus reading, for example, in shorter periods on the move (as possibly expected with mobile devices) is not desired.

Some experienced that reading an eBook was possibly a bit faster than reading print and some felt it was a bit slower, but no significant or definite differences were mentioned. In terms of narrative engagement, no significant differences between print and eBooks were experienced. One person mentioned that the new reading situation with the new device somehow disturbed her attention on the content, but she could not describe it more profoundly. Light reading was experienced as especially suitable for reading on a tablet. For some, classic novels were not very suitable as eBooks, since classic literature and paper are strongly associated.

6.2 Tablets as devices for reading

Five participants used Apple iPads and three used Samsung tablets for reading. In this study, no comparison was made between the devices from the two manufacturers. Table 5 indicates the experienced advantages and weaknesses of tablet reading.

Table 5: Experienced advantages and weaknesses of tablets for reading.

Advantages of tablet reading	**Weaknesses of tablet reading**
turning the page is easy and handy	brightness must be adjusted
holding the tablet is comfortable	the tablet is heavy
adjusting the font size, brightness and column width is possible	one might hit the wrong buttons accidentally
carrying loads of books is possible	the tablet is fragile
	starting to read is slower compared to print
	need for electricity and internet connection

Adjusting the brightness, font size and column width was experienced as both a positive and a negative feature. It took some time understand it first but after performing the adjustments, the reading experience clearly became better. Some felt that the eBook's column width helps in reading faster, and some thought that there is less browsing through the pages than in print, thus reading might be faster. Starting and finishing the reading on a tablet were experienced as slower, and the screen saver sometimes disturbed reading (before disabling it). The other functions of tablet, such as access to internet and email, disturbed the reading experience as well, compared with print reading. Generally, reading on tablet was experienced as functional and pleasant. The tablet was also unanimously considered as the most suitable device for reading eBooks, when compared to a mobile phone or a laptop computer.

6.3 Changes in attitude

The interviewees were asked about their attitude toward reading eBooks before and after the test period. Before the experiment, all the participants had either a neutral or slightly negative attitude toward eBooks, meaning that generally no one had been especially eager to read on them. One reason behind these attitudes was the assumption that reading from a screen is not good for your eyes. Furthermore, reading on a tablet was considered as difficult for two reasons: starting to read is complicated and eBooks lack the physical features of print. Seven out of eight interviewees reported that their attitude had changed after the experiment. The reading experience with tablets had been positive for all seven participants. For one person, print was still the superior platform and digitalization in general was not to be praised, thus his negative attitude had not been changed during the experiment.

For the majority of the experiment participants, the overall experience was that tablet reading was easier and more pleasant than they had thought before. Reading from a screen was not a problem and the tablet was generally considered as a suitable device for reading. Additionally, the access to eBooks via online library services was easy and thus made the experience better.

Finally, two persons stated that eBooks could completely replace reading of printed books. The remaining six persons thought that they could partly replace print in the future.

7. Conclusions and discussion

This study shows that the narrative engagement was similar on both of the reading platforms. Also, the reading pace and comprehension were almost identical when reading a printed books and an eBook on a modern digital tablet device. The results indicates that the reading platform does not affect how the readers comprehend

the narrative, how they focus their attention, how they experience emotional arousal or how they develop the sensation that they have left the actual world and entered into the story. One of the reasons for the identical results in the laboratory experiment was the controlled reading environment where there was no gloss or glare. In a more natural setting, these effects may disturb the reading engagement of an eBook.

The only difference between the two reading platforms found in this study was in the mental associations that the readers have regarding printed and digital books. Printed books were associated with long, luxurious, inspiring and relaxing reading sessions where the reader feels to be in control of the reading situation. In contrast, the digital reading devices were associated with work related reading situations where information finding is of importance.

In the real life experiment it was found out that there did not exist major differences in reading styles between print and eBook. For the majority of the experiment participants, the overall experience was that reading an eBook was easier and more pleasant than they had thought before. No significant differences in narrative engagement between eBooks and print were reported. eBooks could either partly or wholly replace print in the future.

Fiction is intended to be read linearly in contrast to nonfiction, which may require the reader to repeatedly look for specific information in a text. This study did not investigate the effects of eBook devices on the readers' ability to locate and report material in a text, when compared to other text presentation formats.

Further research should include experiments with longer reading times and a variety of reading settings to truly test the participants' desire to use a tablet for long periods of pleasure reading.

Further research should also investigate conditions that the present study did not control. For example, the contrast between the text and the background was fixed by device constraints.

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Explorative scenarios of emerging media trends

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Abstract

Dealing with the on-going structural changes in the media landscape is one of the most urgent challenges in today's society, both for people working in the media industry and for consumers trying to adapt to a large and increasing number of new media technologies and services. In this article, we present and discuss a number of current media trends, outline possible future scenarios and evaluate and discuss these scenarios in terms of future media consumption, mainly focusing on the Nordic media market. The research questions are: What are the main media consumption trends today, and what could be the most important characteristics of media consumption in different future scenarios? We have used a combination of a future studies approach, semi-structured expert interviews and design fiction methodology. We have organized two reference group workshops and then interviewed 11 media experts, both from the media industry and the academic world, and combined the results of these interviews and workshops with the significant media trends generated through design fiction methodology in the project course "The Future of Media" at the KTH Royal Institute of Technology in Stockholm.

One of the conclusions drawn is that the mobile phone (smartphone) and other mobile devices such as tablets, etc., are playing an increasingly important role in current media consumption trends. We can see this through an increased number of mobile devices, an increased use of multiple devices (often used simultaneously) and in the fact that users tend to be "always connected and always synchronized". Another conclusion drawn is that there is an increased focus on personalized and individualized news with more co-creation and sharing of media content. The amount of non-text formats for news, e.g., video, is increasing, as well as the need for a high-speed, high-quality infrastructure/network. The news consumers are increasingly time-pressed, and commute more, which creates new and different demands on the media content, such as being easily accessible at all times and places. Finally, more data is collected by media companies about the consumption habits of media users and more surveillance is performed on citizens by governments and corporations. When interviewed about the scenarios and trends in this study, the experts considered the most desirable future society to have a balanced mix of governmental control and commercial powers. As an example, public service media was considered an important counterbalance to commercially oriented media companies. According to the experts that were interviewed, aspects of all four proposed scenarios could however become true in the future, depending on choices made both on an individual level and on a societal level.

Keywords: media consumption, media trends, scenarios, future, design fiction

1. Introduction and background

1.1 Introduction

What will the future of media in general and news in particular look like? Which of the major trends that exist today can give us a hint of tomorrow's media landscape? In this article, an attempt is made to answer these questions by first outlining possible scenarios and then evaluating them.

Dealing with the ongoing structural changes of the current media landscape is one of the most urgent challenges in today's society for people working in the media industry trying to understand the ongoing processes. Consumers are also trying to adapt to a barrage of new media technologies and services. Dealing with the ongoing changes implies finding ways to grasp and understand the processes as well as learning more about what may be expected of the future of media.

In this article, we present results from a study of media consumption trends and future scenarios, performed at the KTH Royal Institute of Technology in Stockholm,

Sweden. The study builds on empirical results from workshops and interviews as well as on the results from a project course on "The Future of News" for fifth-year master level students. Several different methods have been used, and the results present a spectrum of thoughts and ideas centered on the future of media, but with special focus on the future of news. In this study, we mainly focus on the present trends and future scenarios of the Nordic media market.

By presenting the results of this study, we hope to elucidate what is happening in today's society in terms of media development, and to provide researchers and media content producers alike with useful input with regards to the ongoing structural changes.

1.2 Background

The media industry is a worldwide, multi-billion dollar industry comprising production and distribution of content in newspapers, internet portals, magazines, radio, TV, movies, books, online games and other related channels within the news and entertainment sector (Hadenius, Weibull and Wadbring, 2008). However, the development of the media landscape is today closely connected to the transformation of the ICT (information and communication technology) society (Kaye and Quinn, 2010). The business environment in which media companies exist today is rapidly evolving. "*For at least these past couple of decades, traditional media industries have been deeply engaged in a relentless process of change and adaptation*" (Hultén, Tjernström and Melesko, 2010, p. 9). According to Hultén, Tjernström and Melesko (2010), this process consists of responses to new technologies and to changes in the business operations of media companies, of which the most important are ownership consolidations and changes concerning the economic market. Examples of these responses include new media services for consumers (e.g., websites and mobile services), and the consolidation of media companies.

During the past 10 to 20 years, most media companies have worked hard to position themselves in relation to this ongoing change and to find (or create) their place in this evolving new media landscape (cf. McChesney and Pickard, 2011). In the media industry in particular, there is an uncertainty when it comes to what the future system of channels, platforms, media consumption, media content, and work methods will look like (Nygren and Wadbring, 2013). Consequently, it is important to deepen our general knowledge and understanding within this area.

According to Dannemand Andersen and Rasmussen (2012), there are changes in society that in the course of just a few years can cause dramatic changes in society's development, in enterprises and in our daily lives. They conclude that "*the ability to relate to future changes and possibilities is in many ways crucial.*" To them, the goal of foresight is to "*discover the perspectives of many different futures and make decisions today*" - rather than to predict the future (Dannemand Andersen and Rasmussen, 2012, p.3). Future studies pioneer Bertrand de Jouvenel has pointed out that the faster the pace of change is, the stronger is the need for future studies (de Jouvenel, 1967). If we accept de Jouvenel's statement, the need for future studies is indeed strong and pressing today.

The research field of future studies consists of a vast array of studies and approaches (Börjeson et al., 2006). According to Bell (2003), future studies involve systematic and explicit thinking about alternative futures, aiming to uncover future possibilities, to help prepare for the "unpredictable", and to increase human control over the future. According to Bell and Olick (1989, based on Amara, 1981), the aim of future studies is to discover and propose *possible*, *probable* and *preferable* futures, and to examine and evaluate these futures. Future studies can be described as studies aiming at analytically exploring different possible futures and preparing for them, or exploring possible and/or desirable alternatives attempting to suggest how such alternative futures can be reached.

A large number of research reports take current changes in the media landscape as their starting point (Carlsson and Facht, 2014; Sundin, 2013; Nygren and Wadbring, 2013; Kaye and Quinn 2010). Carlsson and Facht (2014) and Sundin (2013) present a detailed overview of the current media market in Sweden. Nygren and Wadbring (2013) relate today's trends and developments to future possibilities, and Kay and Quinn (2010) discuss how journalism can be funded in the digital age. As technology shapes society in complex ways, there are frequently multiple effects of technological change and these effects can also pull in different directions as well as contradict each other (Fuchs, 2011).

Digitalization is one important aspect of the transformation of the ICT society. According to Åkesson (2009), digital innovation has transformed the structure, processes and boundaries of the business landscape. "*A constant introduction of new digital technology, increased mobility, changing media consumption and advertising patterns as well as digital convergence are radically changing the media industry*" (Åkesson, 2009, p. 3). According to Hultén, Tjernström and Melesko (2010), old media industries are affected by digitalization in all their aspects: production, storage, distribution, audiences' mode of reception, and patterns of use. The digitalization of content and services affect all media companies, independent of their size. It also affects the consumers, both on a short and a long term basis. The ongoing shift in the Nordic media landscape primarily depends on two factors; the development of technology, and the development of journalism. The development of technology is closely linked to innova-

tion. "*Innovation is the motor of technological advance, and organisations must innovate in order to respond to this advance*," (Küng, in Storsul and Krumsvik, 2013, p.9).

"*In large part, media firms' current pressing imperative to innovate stems from the unceasing technological advance that has become a permanent element of their strategic environment. As a result, technology and innovation have leap-frogged up the strategic agenda in media organisations - creating in the process strategic challenges that are not always perfectly mastered*" (Ibid, p.9).

Schudson (2011) mentions a number of ways in which journalism has broadly developed. Some examples are that:

- the dividing line between reader and writer has blurred,
- the distinction among tweets, blog posts, newspaper stories, magazine articles, and books has blurred,
- the line between professionals and amateurs has blurred,
- the line between the newsroom and the business office within commercial news organizations has blurred,
- the line between old media and new media has blurred.

Westlund (2011) writes that "*journalism has always been intertwined with technology, from the invention of the printing press to the digitalization of the tools used to produce and distribute news*" (p.5). As Jenkins (2006, p.13) expresses it: "*History teaches us that old media never die. /…/ What dies are simply the tools we use to access media content. /…/ Delivery technologies become obsolete and get replaced; media, on the other hand, evolve.*"

Exploring the ongoing digitalization process, the shift in technology use and what this means for the future of journalism is an urgent task, to which we hope this article will contribute.

1.3 Definition of scope and research questions

The scope of this study is first to present and discuss a number of media consumption trends, then to outline a number of possible future scenarios and finally to evaluate and discuss these scenarios in terms of future media consumption with special focus on news consumption. The method used in this study is a combination of a future studies approach, semi-structured interviews and design fiction methodology. The scope includes media consumption in a Nordic perspective. The research questions are: What are the main media consumption trends of today? What could be the characteristics of media consumption in relation to different future scenarios?

2. Theory and methods

2.1 Theory

We have, during the last few decades, moved from scarcity to abundance in area after area; texts, photos, music and moving images (Hylland Eriksen, 2001). Nothing in particular implies that we have reached the end state of such developments; it might be that when we look back on the present from a distance of 10 or 20 years from now, what we today perceive as a hectic pace will by then seem like a leisurely stroll in the park, much like the "heavy"[1] users of e-mail yesteryear received a middling daily load of e-mail by today's standards.

Where we were once limited in acquiring media products of various kinds primarily by our economic means, we now live in an age of information overload and we are instead increasingly limited by the *time* we have at our disposal to consume media products. We live, in the words of business strategists Davenport and Beck (2001), in an "attention economy" - an economy where time and attention are the most important limiting factors instead of (for example) money or the volume of content produced. What we here characterize as a shift from "scarcity" to "abundance" does strictly speaking not mean that we once and for all have "done away" with scarcity of all kinds, but rather that scarcity has moved from a relative paucity in terms of media products and in our abilities to acquire them to limitations on the time and attention needed to consume them, i.e., time and attention have replaced money as the most important bottlenecks. Still, the *effect* for media in general and for news in particular is indeed that it is hard to charge premium dollars (or Swedish kronor) for content in an increasingly saturated media market (cf. Picard, 2010).

Traditional print media products (newspapers, magazines, books) were structured and limited by the abilities and the characteristics of the machines that were used in the production process. A line-casting machine such as Linotype was immensely powerful compared to earlier technologies as it allowed a small number of operators to typeset a newspaper on a daily basis (Adams et al., 1988). Despite this, absolute physical limitations in terms of time and space and volume (a newspaper cannot be infinitely large or thick) determined the limits of the kind of products that the mechanical machines of the recent past produced. Above all, the daily output of such a machine was finite, as was the consumption of

[1] "Heavy" users of electronic mail were in an article from 1998 defined as people who either receive 20 or more, or who sent 9 or more email messages per day (Lantz, 1998).

the resulting product(s). It was easy to clearly discern a beginning (first page), a middle and an end for each newspaper, magazine or book.

Many of these limitations have disappeared with the arrival of digital technologies and the internet. Your internet newsfeed never "ends" and one link will inexorably lead to another - wherever your brand (in-)fidelity leads you.

The technology is infinitely flexible and the limitations that matter have less and less to do with characteristics or the ability of the technology in question and much more to do with business models, financial endurance and/or reader/consumer behaviour. Anything is possible as long as someone is willing to experiment and someone else is (perhaps) willing to pay for the resulting media product or service. Do note that these developments do not necessarily mean that the largest media conglomerates, with the deepest pockets and the most skilled staff, will be the ones who will ultimately stand victorious.

The Achilles' heel of such companies is that they also have very high fixed costs (Shirky, 2010). It might thus be the case that lone amateurs, working out of their homes and with tiny overhead costs, manage to explore and find business models that prove to be a better "fit" to this new media environment.

Again, the faster the pace of change is, the stronger the need for future studies (de Jouvenel, 1967) and there are many suggestions and predictions about what the future of journalism, newspapers, books or social media will be like (McChesney and Pickard, 2011; Kaye and Quinn, 2010; Nygren and Wadbring, 2013).

Perhaps unsurprisingly, the suggestions that come closest to the perspective represented in this article come from researchers, journalists, authors and pundits who point at the shift from scarcity to abundance and who examine a variety of ramifications of such trends.

Shirky (2008) notes that the price of coordination and organization has decreased and is continuing to do so, with the arrival of social media and the internet.

This quantitative change has also led to qualitative changes where things that were costly, hard or impossible to accomplish before can easily be solved today (e.g., to find a large number of pictures of a parade by searching for tagged photos on a photo-sharing service such as Flickr).

Benkler (2006) has looked at how alternative internet-based models of production ("commons-based peer production") harbour the promise (and the threat) of transforming both our economies and our societies (in his opinion mostly for the better) in the age of "the networked information economy".

Fleischer (2009) assumes that we will all soon have an infinite amount of music always available and asks the intriguing question of what happens then? How do you choose the next song to listen to when you could hit "random" and never hear the same song twice until the day you die? In fact, how do you even acquire a taste for a specific musical genre or manage to imbue certain artists or songs with meaning in an age of infinite abundance of music?

Sunstein (2002; 2007) worries that internet-induced information overload will make us *less* rather than *more* open to opinions that differ from the ones we already possess; we run the risk of constructing cyberspace "echo chambers" where our opinions are always affirmed/never challenged. This could then lead to a weakening of our ability to understand and sympathize with other opinions and could mean that democracy might be weakened as a system of governance.

Turkle (2011) is concerned about the effects of always-connected technologies on our relationships with other people, including with our nearest and dearest (spouses, children, parents). She also questions our ability to grow up and develop into independent human beings, able to make decisions and have opinions of our own in an age where your social network is never further away than your smartphone, but where people paradoxically prefer to "handle" other people (including friends and family members) from a distance rather than engage in more time consuming and demanding forms of face-to-face interaction.

Carr was concerned about his own seemingly deteriorating ability to concentrate and take in long texts and complicated arguments after years of skimming, skipping and jumping from one text to the next on the internet. His initial text, "Is Google making us stoopid?" (Carr, 2008), was later expanded into a book-length treatment (Carr, 2010) of the possible detrimental effects of abundance and information overload on cognition - including how the brain adapts and comes to expect fast-paced bit-sized vacuous news (or "news") on the internet.

Our intention in this article is not to "endorse" any specific trend or prediction, but rather to insist on the necessity of entertaining several parallel visions of the future of media, i.e., of exploring different scenarios of emerging media trends. In this respect, we believe the methods expounded on below are appropriately chosen.

2.2 Methods

Despite its name, the most important outcome of future studies is not knowledge and images of the future, but learning about today and what can be done now, for example in order to reach a desired future (Svenfelt and Höjer, 2012). According to Börjeson et al. (2006, p.

723), *"one of the most basic, although contested, concepts in this field is 'scenario'. It can denote both descriptions of possible future states and descriptions of developments."* Kosow and Gassner (2008, p.1) describe a scenario as a *"description of a possible future situation, including the path of development leading to that situation. Scenarios are not intended to represent a full description of the future, but rather to highlight central elements of a possible future and to draw attention to the key factors that will drive future developments."*

In this study, we first made a literature study and then used the future studies techniques of workshops and scenario discussions (Kosow and Gassner, 2008) in order to explore possible futures of media. The explorative scenarios used in this study aim at answering the question "What can happen?" as described by Börjeson et al. (2006). Explorative scenarios are considered to be the most appropriate choice here since the focus of the study is in exploring the consequences of alternative developments.

The process of scenario generation in this study was first carried out by a reference group consisting of three senior media experts within the fields of 1) digital media, 2) print media and 3) media technology development, and, in addition, 4) an environmental expert within the field of life cycle assessments of media products. At the first reference group meeting, in August 2013, significant media trends were singled out during a brainstorming session, partly based on parameters identified by Appelgren and Leckner (2013). Next, the trends were grouped into clusters and discussed. At the second reference group meeting, in September 2013, a so-called scenario cross was created to depict the most influential dimensions (based on van der Heijden, 1996), and the list of significant media trends was discussed and further refined.

As the next step, a total of 11 media experts, not including the reference group, were interviewed in this study - ten of the interviews were conducted in Sweden and one in Finland. The group of media experts consisted of a mix of people from the media industry and the academic world. They work at a variety of media companies, such as daily newspapers, business press, and public television, as well as at one media industry organization. The academics participating in this study are all senior researchers within the field of media studies but with different competencies, such as media development, mobile media, and media economics, and they come from different universities.

The media experts participating in this study were first asked to suggest and discuss significant media trends of today, based on a list of media trends presented to them. They were then asked to suggest and discuss a number of parameters which affect possible future media developments. The four scenarios were then presented to them. The experts were asked which of the scenarios they *believe* could become true in the future, which of the scenarios they would *like* to become true in the future, and which of the scenarios they *fear* could become true in the future.

The experts gave their opinions and comments, and these led to some further changes, through a Delphi-like process (Kosow and Gassner, 2008). A Delphi-like process refers to a method where experts comment on research results and suggest improvements, which are then commented upon by the next round of experts, et cetera, in an iterative process.

Semi-structured interviews can be described as an interview situation where the interviewer has an agenda and leads the interview, while at the same time the interviewee is given some freedom to elaborate on the subject and bring up other points that are relevant to the current question, but without leaving the original subject entirely behind (Bryman and Bell, 2007).

When analyzing the result of the semi-structured interviews made with media experts in this study, the extrapolated trends from the design fiction project "The Future of News" were included in the analysis, as described below.

2.3 "The future of media as design fiction"

In the project course "The Future of Media", advanced graduate students in Media Technology and Media Management at KTH Royal Institute of Technology explore the relationships between technology, economy and social factors in processes of technological innovation and development.

This is done by developing different visions of the future of media. In 2013, ten project groups with 5-6 students in each group analyzed, reflected upon, reviewed, refined and further developed visions of the future of news and the news of the future from a media technology perspective.

Part of the work included the creation of practical "design representations", such as for example movies and prototypes of different applications and services.

Design fiction is a method that tries to envision the future through the use of semi-fictional narratives, concepts, prototypes, movies, etc. (Wakkary et al., 2014), and can be seen as a continuation of the use of:

1) simple fictional vignettes to frame research (Carroll, 1999),
2) scenarios that illustrate the use of soon-to-be-developed technologies (Weiser, 1991) and
3) fictive, made up "personas" (prototype users) with designated gender, age, professions and habits (Eriksson, Artman and Swartling, 2013).

During an intense six week long start-up phase (from the beginning of September to mid-October, 2013), the whole class read selected literature about news, worked with news-related issues in seminars, and welcomed around 20 guest lecturers from industry and academia. These guests had a variety of backgrounds and presented the students with a wide variety of perspectives, over-all giving them a well-rounded picture of the history of news, the present state of news, as well as suggestions for trends and possible future developments.

At the end of this start-up phase, ten project groups were formed around the course participants' emerging interests. During the second half of the autumn semester (from mid-October to December), these groups independently explored different aspects of "the future of news" and "news of the future" through the use of design fiction, i.e., "the deliberate use of diegetic prototypes to suspend disbelief about change" (Sterling, 2013).

Despite the fact that these project groups generated widely different ideas and scenarios, there were a number of trends that all ten project groups had to position themselves in relation to. These trends were "extracted" through a Delphi/wisdom of crowds-like process (Surowiecki, 2005), where the ten project groups each suggested a variety of trends that they thought described important premises from which they built their own particular scenario. This process resulted in a list of trends that all groups could relate to. The resulting 11 trends are presented below (see section 3.1).

Each of the ten project groups in the Future of Media course created a scenario that illuminated some aspect of the future of news, including the creation of prototypes of future systems or movies that envisioned the use of their proposed future systems. Some aspects of "the future of news" that were explored include but are not limited to: responsive news that adapts to the changing physical contexts that you move through in the course of a day, geographically anchored news services, collaborative crowd sourced news, automated bias detection software for news stories, and the use of second screens to supplement the main (computer, TV) screen.

The computer science researcher Alan Kay famously said that "the best way to predict the future is to invent it" (Brand, 1988). Design fiction does not live up to Kay's high standards of *actually* inventing and building the systems of the future, but it explores multiple possible futures through the use of fiction and a variety of supporting media products (texts, images, movies and prototypes). We believe that design fiction is a very exciting method to explore and visualize scenarios of emerging media trends.

3. Results

3.1 Current media trends

Based on literature (cf. Schudson, 2011; Carlsson and Facht, 2014; Sundin, 2013; Nygren and Wadbring 2013; Kaye and Quinn 2010), interviews, workshops and the design fiction practices used in this study, we propose the following significant media development trends.

The list does not aim at being complete ("prediction is difficult, especially about the future", as physicist Niels Bohr once joked) but we believe that it addresses some of the most important trends at play in current media development. Below is an attempt to briefly describe these trends and relate them to future developments.

1. More mobile devices

   We are using more mobile devices, such as smartphones, tablets, etc. Just as virtually everyone today owns a mobile phone, people will own a smartphone and/or a tablet in the future, and will to a large extent use these devices for media consumption.

2. Multiple devices used

   People are using and switching between multiple devices depending on their moment-to-moment situation. Even when moving between different rooms at home, people are switching between different devices. This is leading to a high demand for shared or uniform security and "sensible" subscription or other payment plans.

3. Always connected, always synchronized

   As we are using our mobile devices more and switching between different devices, there is a higher demand for seamless connection solutions. Devices need to be always connected and perfectly synchronized with each other. These always-connected, always-synchronized devices will be a natural choice for consuming media.

4. More news channels

   In addition to currently available media channels, there are more alternative channels. These could, for example, include individual channels, such as "ordinary" persons publishing blogs or podcasts, or "non-media" corporations starting a TV-channel (banks, chain stores, etc.), or non-governmental agencies with their own social media channels.

5. More (co-)creation and sharing

   There is an increasing volume and variety in the news landscape, because of more co-creation and sharing of content, for example, via blogs and other social media. "Ordinary" persons who cannot be regarded as fulfledged news channels (see above), will produce news related content that will be shared among smaller or larger groups of people.

6. Personalized/individualized news

   Beyond mass media, there is more individualization of news according to each individual's interests and preferences. While there are some attempts to go in this direction today, we have really only seen the beginning of this development. In the future, you will read well-curated articles on topics which are exactly what you are interested in, but from sources that you have not heard of before.

7. More non-text formats for news

   News is to a larger extent consumed through non-text formats, such as video, images, and audio. Today's popular cat images and YouTube videos hint at this growing trend. In a time-pressed future, short news items will win out over long complicated in-depth stories.

8. Increased need for high-speed, high-quality infrastructure/networks

   In order to cater for higher volumes of data traffic, there is an increased need for a better infrastructure. The amount of traffic is expected to increase and the broadcast network will be at ultra-high speed and ubiquitous.

9. Hurried, time-pressed news consumers

   The future is high-paced, with hectic lifestyles and impatient users. This implies a need for shorter, visual news items and more overviews (rather than in-depth coverage). Multitasking, such as simultaneous consumption of several media channels, is on the rise, which will lead to an increased use of media while simultaneously performing other tasks.

10. More commuting

    People are spending more time commuting, both by car and by public transportation, due to continued urbanization and a continued spatial and geographical expansion of cities (cf. Ax:son Johnson, 2013). This trend implies that we will increasingly access and consume news on the move; in cars, in subways, on buses, etc. This will also be a driver for using more mobile devices in society.

11. Big data and surveillance

    More data is collected and more surveillance is performed - for good and for bad. More data will be collected by media companies about the consumption habits of media users and more surveillance will be performed on citizens by governments and corporations (cf. Karlsten, 2013). This has important and serious implications for issues having to do with integrity, but it also brings about possibilities for more convenience and better service in many different areas of society.

3.2 Scenarios of the future

Appelgren and Leckner (2013) discuss what parameters influence the development of media. They conclude that social, cultural, economic, juridical, political and technical parameters are the most important ones. In this study, these parameters were used at the first workshop when formulating and discussing a list of external factors. The interviews and workshops made in this study support the conclusions made by Appelgren and Leckner. We have further developed and specified these parameters into external factors influencing the media development as the following:

- Laws in the media area, on a national and global level, for example regarding copyright, broadcasting rights, publishing rights, news aggregation, behavioural targeting, integrity laws, censorship, taxes on media content, and advertisement taxes.
- Political developments in the Nordic countries and the rest of the world.
- The development of the world economy, the fundamental technical development and the ability of Nordic and international companies to innovate new products and services.
- Electricity supply, electricity consumption, and energy costs for companies and private citizens.
- (Partly dependent on the bullet points above) Consumer habits, consumers' media consumption and the general demand for emerging and existing media products and services.

Hvitfelt and Nygren (2008) further claim that media consumption in general depends on the consumers' age, where they live, what their household looks like, what personal interests they have, how educated they are and, finally, how much time and money they have at their disposal.

In the scenario generation process described above, a total of four future scenarios were created. A so-called scenario cross was created to map out the most influential dimensions, based on van der Heijden (1996) who discusses scenario creation.

We have made the assumption that the amount of influence from the government in combination with the strength of comercial powers strongly affects the future of media, based on Hultén et al. (2010) who discuss the duality between government regulations and the market.

Thus, the scenario cross presented in Table 1 is not orthogonal with regard to the descriptive parameters, but constructed around the four possible combinations of this duality.

Table 1: The four scenarios, based on the four possible combinations in the scenario cross

	Strong governmental control	**Weak governmental control**
Strong commercial powers	Scenario 2	Scenario 3
Weak commercial powers	Scenario 1	Scenario 4

Below is a short description of each of the four media scenarios developed in this study.

Scenario 1, "Strong governmental control, weak commercial powers"

The government is controlling or monitoring media content producers to an increasing degree, often justifying this control in terms of "defence against terrorism". Foreign companies are controlled by the government, which means that they have limited influence and limited possibilities to expand in the domestic media market. Public service is used for the dissemination of government information (propaganda), and news shows are controlled by government authorities. Public service and printed newspapers receive governmental support to help them survive even though most people are not so interested in watching or reading them. Critical voices in society are controlled and limited by the government. Debates in social media and other types of forums are read and controlled by the government.

Scenario 2, "Strong governmental control, strong commercial powers"

Press freedom is guaranteed by the government, which encourages free and independent media, but stops monopolies and cartels formed by foreign or national media companies. Media companies continue to consolidate, which increases the amount of meetings. The increased amount of meetings leads to more trips for the staff as well as more meetings with online tools. Smart phones become increasingly important in society for media use in general. Moving images/video is consumed on large or small platforms, independent of time and space. The lifecycle of new media devices becomes shorter, and the consumers have an interest in new technology. The amount of e-waste increases every year. Energy prices increase in society. This has the effect that the distribution of printed newspapers become more expensive, and that newspapers consider printing fewer copies per week and with less content (fewer pages). The distribution of morning papers go down/go through radical changes. The increased energy price also leads to the introduction of new technical devices with low energy consumption and an overall low environmental impact becomes increasingly important in society.

Scenario 3, "Weak governmental control, strong commercial powers"

The government has little or no control over media, media content and the organization of media companies. Most of the news media content and societal information is available on the web. The largest sites are run by citizen journalists, or get their content from crowdsourcing of information, and they exist side by side with large multinational media companies. Public service is shut down, and the TV license fee and other media taxes are gone. Multinational media conglomerates dominate the Nordic media market, as they own the majority of the Nordic sites. These companies do not have journalism as their guiding star, but operate strictly according to their economic interests. Foreign companies strive towards a monopoly on the Nordic market. Media content broadcast (on TV and radio) or published on the web becomes increasingly focused on entertainment. Very little documentary or informational material is broadcast as the focus is mainly on entertainment. The level of general knowledge in society decreases while social gaps increase. Moving images, such as video, are becoming increasingly important and more common in relation to text based media content. The consumers' attention span gets shorter - they have little patience with consuming complex media content. The digital market for advertising is dominated by large companies. The media market is increasingly agile.

Scenario 4, "Weak governmental control, weak commercial powers"

In this scenario, news updates with large amounts of user generated content is mainly found online. Most of the traditional media content as well as social forums and societal information can be found online, free of charge and without any restrictions. The largest web sites are run by citizen journalists. Crowdsourcing is an important source for information. Multi-national companies have played out their role in society at large. The government has very little influence over the media market. Bloggers and smaller media players dominate, or work together in network structures. Web sites where consumers sell and buy goods and services from each other dominate the net trade. People like to share resources, often by using social media channels to communicate.

3.3 Reactions to the trends and scenarios

The list of media trends and the four scenarios were presented to the 11 media experts with whom we conducted semi-structured interviews, as described above. The experts were specifically asked:

1. Which of the scenarios do you *believe* could become true in the future?
2. Which of the scenarios would you *like* to become true in the future?
3. Which of the scenarios do you *fear* could become true in the future?

There was a surprisingly strong consensus among the experts regarding the scenarios. Scenario 1 was considered the most improbable. None of the experts could imagine a future where media worked as in scenario 1 - even though this could be a description of the current media situation in some countries outside of (and not so far away from) Scandinavia. The only possibility for scenario 1 to become true in the Nordic region was, according to the experts, if there was a global war, a deep, turbulent and long-lasting economic crisis or some other similar major unexpected global or regional crisis. Such an unexpected crisis was not something that these experts feared.

Scenario 2 was considered the most probable of the four scenarios. The experts agreed that this is what the future would look like if current media trends continue to follow their trajectories. This scenario was also regarded as the most desirable by a majority of the experts.

Scenario 3 was considered probable by some of the experts, but not by all. On the other hand, many of the media experts thought that this scenario was the most frightening, due to the high amount of commercialism and general lack of governmental control. This scenario created a sense of unease among many of the interviewed experts, due to a general uncertainty about what direction this kind of society would take, when commercial powers are free to dominate.

Some experts thought that scenario 4 was the most desirable, especially from an environmental point of view. However, few thought that scenario 4 was very probable, since it entails both weak commercial powers and weak government control and this was deemed very unlikely to happen. Some experts considered scenario 4 to be problematic because it necessitates citizens who are good at exerting source criticism in order for this type of network society to function well. This is usually not the case, according to the experts. In scenario 4, all citizens would also have to work towards everyone else's best interest. The experts were very sceptical as to the probability of this happening, based on the belief that there are strong ideological powers in society that could affect the development negatively.

The conclusion drawn by some of the experts was that the most desirable future society combines a balanced mix of governmental control and commercial powers. The ideal seems to be neither too much governmental control nor too little governmental control. A combination of "healthy" governmental control and "healthy" commercial influence would be the most optimal future, according to the experts. As an example, these experts found it important to keep public service media organizations as a counter-balance to the commercial powers in the media sector. Interestingly enough, the media experts working in the newspaper industry found this particularly important.

In addition to the trends already mentioned in this article, the experts considered the following three media trends to play an important role in relation to future developments:

- Economic interests are increasingly important for media content producers.
- The amount and proportion of entertainment in media content is increasing, except in news media.
- General knowledge in society, for example, what can be assumed that most citizens have general knowledge of, is shifting and the knowledge gap between different groups in society is increasing.

The experts pointed out that we have, historically, seen the same patterns of consumer behaviour as we see today, but now there are new media tools and new technologies that take advantage of this behaviour in new ways (cf. Jenkins, 2006; Nygren and Wadbring, 2013). Some examples of this behaviour are: the sharing of information, and the sense of fellowship and community in social forums and communities of interest. To an increasing extent, information today is shared via social media channels, while it was more common earlier to share information at physical meetings or via the telephone. The same goes for communities of interest which were earlier maintained via physical meetings, and where social media tools today play an increasingly important role. As a result, the geographical location of the community participants is less important today as communities of interest become increasingly global.

The experts agreed that if the main media trends of today follow their current trajectories, we will see a future closest to our scenario 2 (above), or something that is situated between scenarios 2 and 3. However, aspects of all four scenarios could become true in the future, depending on choices made both on an individual and a societal level, according to the experts.

4. Analysis and discussion

In this study, we have presented 11 media consumption trends and outlined four possible future scenarios. By using future studies methodologies combined with semi-structured interviews and design fiction, we believe that we have obtained a good understanding of what media experts today think about the future. However, we must consider that media experts tend to have a certain bias, since they are working within an industry that they naturally would like to see as successful in the future. Despite this, the general impression from the interviews was that the media experts had very "realistic" and sometimes even pessimistic views of the future of traditional media, for example printed newspapers. They were aware of the fact that the media industry they know and have worked in for decades is on the rim of a total transformation (and not necessarily for the better, from their point of view.) We cannot really say that any of the experts had an unrealistically positive view of the future of media.

When it comes to the future of media, we argue that it will most likely entail parts of all the scenarios described above. The future will furthermore play out differently for different people. It will depend on their age, where in the country they live, what their household looks like, what personal interests they have, how well educated they are, as well as how much time and money they have at their disposal (based on Hvitfelt and Nygren, 2008). With this study, we have aimed at increasing our general understanding and awareness of what is happening in our society today. We believe that one of the greatest challenges for media companies today and in the future

is to adapt content and services to consumers' varying demands and needs. Consumers have different needs (wishes), and all consumers take for granted that their demands and needs will be taken into consideration in one way or another - and hopefully as soon as possible.

Another important aspect of the future of media is the question of environmental sustainability. Which of the four scenarios would be the most beneficial (or least harmful) for the environment? Can anything be done to facilitate developments that would decrease the environmental impact of media consumption? That perspective in combination with the results of this study could generate interesting questions to be explored in a future study.

Taking this into consideration, it might be possible to work in a more environmentally beneficial direction by choosing certain paths rather than other paths, also taking into account parameters such as democracy, freedom of expression, etc. This is an important task for future research and a future study of ours.

5. Conclusions

In this study, the aim was to present and discuss a number of media consumption trends, then outline possible future scenarios and finally evaluate and discuss these scenarios in terms of future media consumption. We have tried to answer the following questions: What are the main media consumptions trends today? What could be the characteristics of media consumption in relation to different future scenarios?

One of the conclusions drawn about the main media consumption trends of today is that the mobile phone (smartphone) and other mobile devices are playing an increasingly important role. This can be seen in the quickly increasing number of mobile devices, in the increased use of multiple devices, often used simultaneously, and in the fact that users tend to be "always connected and always synchronized". Other conclusions about media trends are that in addition to current media channels, there are more alternative media channels, such as "ordinary" persons publishing blogs or podcasts, corporations starting a TV-channel, or non-governmental agencies with their own social media channels. There is an increased focus on personalized and individualized news with more co-creation and sharing of media content. The amount of non-text formats for news, for example video, is increasing, as well as the need for a high-speed, high-quality infrastructure/network. The news consumers are increasingly pressed for time and commute more, which creates new and different demands on the media content, such as being easily accessible at all times and places. Finally, more data is collected by media companies about the consumption habits of media users and more surveillance is performed on citizens by governments and corporations.

When it comes to the characteristics of media consumption in relation to different future scenarios, the conclusions drawn from interviewing experts are that scenario 2 (strong governmental control and strong commercial powers) was considered the most probable of the four scenarios.

The experts agreed that this is what the future would most probably look like if current media trends and other trends continue to follow their trajectories. This was also regarded as the most desirable scenario by a majority of the experts. The experts considered the most desirable future society to have a balanced mix of governmental control and commercial powers. Neither too much governmental control nor too little governmental control seems to be the ideal. As an example, public service media was considered an important counterbalance to commercially oriented media companies. A combination of healthy governmental control and healthy commercial influence would be the most optimal future, according to the experts.

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Topicalities

Edited by Mladen Lovreček

Contents

News & more

First drupa Global Trends report

In spring 2014, about 1 100 international key executives from the printing industry took part in the on-line survey and many participants provided very useful examples from their business environment. This first drupa Global Insight report is based on a very detailed survey covering a wide range of topics assessing the impact of the internet on print. The survey dealt with many other issues such as CRM, Digital Asset Management and 'Big Data', as well as the automation of workflows, and the need for companies to have better IT skills. It investigated how the increasing digitization of communications is affecting the demand for conventional print and the demand for different print substrates (paper, board, film, metal or glass)? The "drupa Global Insights" report provides some informative answers. It concludes that printers need to accept the reality of an Internet-driven multi-channel digital future, change their approach and invest accordingly.

The first results of the drupa Global Insights report on "The impact of the internet on print - The digital flood" are now available. They illustrate how many internet-enabled tools such as web-to-print, variable data printing, interactive print such as Augmented Reality and QR codes and smart technologies such as printed electronics, will impact on most areas of the printing industry. Print service providers and the supplier industry on the one hand and their customers on the other are being compelled to deal with new challenges and opportunities. With its detailed analysis of the global markets and the overview of current trends, the drupa Global Insights report is an important contribution to strategic decisions that need to be taken by printers and suppliers alike.

The rise of ecommerce

Ecommerce is growing in most global regions at rapid rates and printers are having to play catch-up, for whilst 51 % of the survey panel had Web-to-Print services, only 14 % reported it transacted more than 25 % of their orders. Nevertheless in the catalogue market, publishers understand that print catalogues drive on-line sales and a majority of 60 % of catalogue printers reported growth in on-demand digital production.

The shift to mass customisation

Whether it is photo books, calendars, stationery, T-shirts or marketing articles, in small or large volumes - the customized large-scale production of digital print articles is catching on. Already, 72 % of all questioned commercial printers worldwide offer variable data printing services; in the US its proportion is even higher (87 %). While the proportion of variable pages remains small, 56 % of participants reported moderate or fast growth. Increasing numbers of commercial printers offer a wide range of print products that can be both sold on the web and personalized. These trends are confirmed by the drupa Global Trends report published in spring 2014: 38 % of commercial printers and 32 % of publishing printers expressed their intention to invest in digital electrophotographic colour sheet printers.

ScanStation for archiving

contex
WHEN IMAGING MATTERS

Big archive tasks need speed. Not just "inches per second" but actual throughput. Contex ScanStation is designed specifically for productivity by reducing scan time with fast scanners and scanning processes. It is intended for professional users with request for the best possible productivity, reliability, quality and versatility - day after day.

With innovative imaging technology, document handling, archiving and productivity-boosting features, best-in-class image quality and the fastest and most efficient way to scan, copy, file and archive wide format images, drawings, documents and records.

Joint venture on CTP market

The combination of ECRM engineering and Holotek technology have propelled the company in developing of laser-based optical systems. Oriented to violet flatbed imaging technology, ECRM in 2006 acquired the polyester CTP business of Esko-Graphics.

ECRM
imaging systems

Now China's largest CTP manufacturer started a joint venture with ECRM Imaging Systems. The new company will serve as a future center for the advanced research and development of new, high-quality prepress equipment that will be distributed worldwide.

CRON

The new venture will be key to completing CRON's global strategy for distribution of high quality CTP solutions in North America and a new line of offset printing plates manufactured in China.

Reforesting for the benefit of the environment

Among the leading reforestation organizations in the world, Reforest'Action is a social action that enables companies to concretely contribut in favor of the environment thanks to an unequalled model.

Reforest'Action offers a unique web platform, where companies, their partners and customers plant trees in Senegal, Peru, Guatemala, India or France. They measure the social and environmental benefits and can share this experience on the social media. One of the partners, CMA Imaging, have recently made a pledge to plant or protect 2 500 trees in Peru to compensate for the next 2 500 rolls of inkjet media that are sold.

Since its creation in 2010, Reforest'Action has in this way planted more than 280 000 trees and generated a positive impact on the livelihood of more than 10 000 people.

LayFlat-Books

LayFlat is a bookbinding term and describes a specific kind of adhesive binding that is also called panorama or flush mount binding. The reverse side of every folded sheet of paper is coated with glue and consecutively attached to the next.

There are two basic advantages of this type of binding: the book stays completely flat when opened and there is no visible central gutter. No visual information is lost. Two-page spreads look especially good with LayFlat binding. There is no unwanted turning over of pages when the book is open.

With conventional adhesive binding, also called Perfect Binding, the book block's individual folded sheets are only glued together at the spine. When you open the book, the pages curve and fall outward. Therefore, important visual information is lost in the gutter. Panoramic images on two-page spreads lose their impact.

Interactive printing on the increase in the publishing and packaging segment

Interactivity is the watchword as print customers are realizing the power of communicating via the Internet and mobile technologies directly with their target audiences on a 1-2-1 basis. Cross-media campaigns, with data acquisition/analysis and the use of several channels (e.g. PURLs, Email, SMS), are increasingly demanded by customers. The range of applied technologies includes QR codes, other smart-print options, augmented reality and near-field communication. One third of the drupa panel of experts already offers interactive print of one form or another, i.e. interactive response elements in publications, business communications, advertisements, packaging and outdoor advertisements. As was to be expected, there are major regional differences: in the US 44 % of printing companies which took part in the survey offer interactive printing, but only 3 % of providers in the Middle East. A substantial proportion of drupa panel members from the packaging sector also use Internet-based tools. 50 % use QR codes, 43 % use variable content, and 41 % of all packaging printers that took part in the survey offer personalized print.

A comprehensive report on "The impact of the internet on print - The digital flood" is expected to be published in October 2014.

Innovative color image printer

The new powerful imagePRESS C800 color light production device incorporates a range of innovative technologies within a small footprint, to reliably deliver outstanding quality, end-to end productivity, flexibility and versatile media handling. Innovative technologies ensure class-leading print quality without affecting productivity. Newly developed Consistently Vivid (CV) toner improves transfer efficiency for enhanced color consistency and accuracy across a wide variety of media. It features a new compact and highly accurate registration technology that assures best-in-class results whether printing one or thousands sheets. Meanwhile the VCSEL laser unit achieves an exceptional 2 400 dpi resolution enabling higher precision in the printing of text and images. It also features several halftone screen patterns for increased flexibility and optimized quality closer to offset.

The imagePRESS C800 consistently delivers impressive production speeds of up to 80 impressions per minute on a wide range of media. It can run at maximum speed on heavy stock up to 220 gsm and quickly and effortlessly produce duplex print jobs on 300 gsm media. Major enhancements in the belt fusing technology allow the imagePRESS C800 to print complex jobs on a wide range of substrates.

Three productive, innovative and intuitive workflows are available including EFI, PRISMAsync and Canon. The Canon solution is powerful and easy to use, allowing the production of high-quality print jobs.

The imagePRESS C800 delivers excellent end-to-end productivity with extensive choice of finishing capabilities including: booklet making with three-knife trimming; in line perfect binding; high capacity stacking; and multiple folding options together with third-party in-line finishing devices.

In spite of problems, a new series of inkjet presses

Experiencing significant shrinking of the traditional web offset press market, German manufacturer KBA decided to cut more than 40 % of jobs in their two subsidiaries - Albert-Frankenthal and KBA-FT Engineering. The company expects that the capacity utilisation will be improved and prolonged losses should soon come to an end.

On the other hand, KBA is devoted to adopting and developing new technologies and positioning the company further into the commercial digital segment.

Result of this efforts is RotaJET L, a new series of inkjet web presses. The entire series is modular, and aimed at markets including book, direct mail, magazine, newspaper, packaging and industrial printing. KBA has also announced a collaboration with HP to develop inkjet solutions for corrugated packaging.

All-purpose camera for press control

Two specialists in the field of print automation have joined forces to launch the latest innovation in quality automation. The precursor had already been presented by Q.I. Press Controls at DRUPA 2012, while the IDS-3D system, which combines register and density control functions, will be introduced at the World Publishing Expo 2014 in Amsterdam.

EAE's takeover by the Q.I. Press Controls has enabled developers in both companies to combine the best of both worlds and produce one full-colour print quality control and regulation system. Algorithms for the LOOP and IDS were implemented in a single new system All functions are now executed with combined intelligence on full-color print lines, without the need for any printed bars, strips or markings.

IDS-3D incorporates the automatic cleaning system. A cassette with a film in front of the lens ensures proper functioning of the system at all times. The camera is able to see whether the film has been smudged and cleans this whenever required. Built-in process algorithms are ensuring simultaneous closed-loop corrections, such as:

- Optimisation of the CMYK colour register, front-to-back register, unit2unit register and likewise the cocking register for heatset rotation presses;
- Optimisation of colours in compliance with ISO 12647-3 and/or ISO 12647-2 by controlling the ink keys, incl. water balance optimisation;
- Immediate recognition and signalling of incorrectly positioned print plates and irregularities and/or printing errors in relation to the virtual TIFF image and/or approved print.

Advanced tile printing

Advanced electronics enabled innovative printing systems that will redefine ceramic tile printing. It offers a newly engineered ink system, new ceramic ink sets, automatic printhead cleaning technology, more compact design and a new vacuum system. EFI ceramic inks, combined with the Cretaprint printer and Fiery color management, produce the best quality ceramic products with low ink consumption.

efi Cretaprint Digital Inkjet Printer

New ceramic inks provide intense color within a wider color gamut. Colors include dark blue, reddish brown, yellow, golden yellow, beige, pink and black. Special effect inks include sinking ink, extra white, matte glaze, glossy glaze and luster.

The new Cretaprint C4 printer. with a width up to 745mm, offers a more compact footprint and is 30% lighter. A new user interface and advanced nozzle plate cleaning system are among its additional features. The easy-to-use product lowers maintenance costs and energy consumption.

The printer includes a number of innovations such as:

- A new vacuum system working with higher pressure for greater efficiency without affecting quality.
- A compact frame holding eight individual bars that can be pulled out if required, making all the components accessible for maintenance tasks.
- Bar separation optimized for a highly efficient steam and mist extraction without compromising printing quality.
- Automatically adjustable height of both the vacuum bars and the jetting distance.New cleaning system ensuring a longer printhead life.
- The ability to detect and correct missing nozzles.
- A newly designed transport system ensuring greater accuracy with precision alignment.

Variable data printing software

At this year's Print Chicago a new advanced software for variable data printing (VDP) will be introduced by Meadows Publishing Publishing Solutions.

DesignMerge is a professional VDP software package that works directly with Adobe InDesign. The software is ideal for data-driven VDP applications, from relatively simple, multi-up consecutive numbering and bar coding jobs, to sophisticated, personalized direct mail pieces.

It provides a straightforward, single-step capability to use the unique Kodak NexPress Fifth Imaging Station inks as variable data directly within the application. This opens up the power of the special Fifth Imaging Station inks for some creative uses of variable data.

Working from within the Adobe InDesign application automatically provides DesignMerge with the features required to achieve such stunning and unique VDP output. The integration between Kodak NexPress press and DesignMerge is a natural fit.

Web-to-Print enhancement

According to the analysis, the worldwide market for web-to-print software is constantly growing. Digital Enhancement package W2P, is a module that helps Scodix users better demonstrate the impact of digital enhancement online. It is engineered to work with the user's web site providing the client the visual impact of enhancements.

The new software package aims to accelerate either overall business or value-added services and drastically increase online profits already generated from typical W2P products (business cards, photo albums, cards, calendars…) by making 3D enhancements easier to access and more attractive within an internet-based workflow.

Simple and effective quality control

An effective and easy-to-use web-based color quality control system complies with CMYK color bars for SWOP, GRACoL, 3DAP, FOGRA and other standards, which can be easily measured and evaluated on any proof or press sheet. In-house printing standards and customizable color bars can be added. To verify spot colors, users can create their own sets of colors by selecting numerous from spot color libraries or entering appropriate Lab values.

ORIS Certified // Web measurement results can be output as a brief summary on a label or as a detailed report. All measurement results for the devices monitored are stored and can be used for analyzing trends and device performance. This allows the user to detect quality variations over a certain period of time. The system provides clear facts and helps avoid lengthy discussions about color issues.

Web monitoring brings all the data to any location that has an internet-connection. Data can be analyzed for overall company performance and trends. View all job information throughout the production process from soft proof to proof to print. An included temperature and humidity probe constantly measures environmental conditions to ease the troubleshooting process.

Direct-to-pack solution

Digital packaging production is an inventive area that is developing rapidly and building on its market share year after year. Printers and converters looking to move into the exciting area of short to medium-run packaging will soon be able to set up a complete start-to-finish business system in no time at all thanks to a new strategic partnership between Caldera and Highcon. By pairing Caldera's new POW! Packaging Online Workflow software suite with the Highcon™ Euclid direct-to-pack digital finishing system, graphic arts printers and converters are able to leap from out-of-the-box to onto-the-box, creating opportunities based on the key trends in packaging: shorter runs, streamlined production and personalization.

The Highcon Euclid digital cutting and creasing system puts finishing in line with pre-press and printing, enabling a purely digital workflow with low overheads, reduced waste or reprint implications and excellent efficiency. POW!, built by Caldera for Highcon, and including Color Alliance technology, opens new business potential for its users, combining a web order portal with an automated software system and taking a job from concept to high-value finished package with a minimum of intervention.

The POW! front end - which the printer can rebrand, customize and deploy either as a B2C or B2B2C portal - allows a brand owner to pick a package design from a broad library of templates and add their own graphics, text, cutting and marking elements. This system could be used in e-shop format for a variety of consumer products, from packaging to shaped folders or giftware, or to streamline customer order processes and simplify the sales process. RIP and workflow suite ensures that true color and raster data reach the printer in the appropriate format, and generates a DXF file for the Euclid engine which indicates the cut and crease paths.

Bookshelf

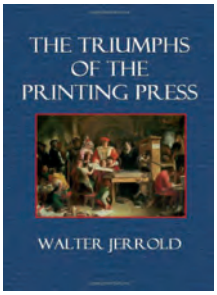
The Triumphs of the Printing Press

Sounds strange, but the only art which can record all others, practically, have forgotten to record its own history. The story of the invention and rise of the most potent factor in the spread of knowledge - one might almost say in the development of civilization - is marked by all too many gaps and surmises. Its origin, although so recent, is yet wrapped more or less in impenetrable mystery. The very name of the man to whom the world owes the art of printing cannot be decided with absolute certainty. It is generally agreed that the evidence is in favor of Johannes Gutenberg (whose real name was Gensfleisch) as the inventor, and Mainz as the city in which his first book was printed.

This book, however, does not pretend to be a full record of the work which has developed from the discovery of the mid-fifteenth century. For, although printing has not troubled properly and connectedly to record its own development, there is yet a great wealth of varied materials concerned with its "triumphs." From among these such portions were chosen as shall show the growth of the art, from the simple types and plain wooden press of the time of Gutenberg, up to the present day, when machinery works many thousand times as quickly as did the old hand-presses; when the very art of printing from movable types appears likely to give way to a later development, in which the printing is almost directly done from the matrices themselves.

It can be noticed how few are the details which have come down to us of the lives of those men who are most intimately connected with the "triumphs" dealt with - Gutenberg, Caxton, Wynkyn de Worde, Aldus, Elzevir. Of these men we would gladly learn much; we would like to know what manner of men they were, what lives they led, and what their contemporaries thought of them. The fifteenth and sixteenth centuries were not, however egotistical as the nineteenth, and no memoirs, reminiscences and recollections were issued either by notable men themselves, or, as nowadays, by those who had merely known them. But if details of how these men lived are missing, they are known to us by their works.

To deal at all fully with the developments of the printing press would require several volumes of this size, and all that has been attempted is to present, so far as is possible, sketches of the lives of some of those most prominently concerned in that development, along with brief mention of the kind of work to which they owe their fame; and also briefly to indicate the extraordinary progress which has been made during the present century, since the invention of the steam printing press. So great has been this progress, that printing is now carried on in quarters of the globe which, within comparatively recent years, were quite untouched by Western civilization. Today, indeed, the printing press may be said to have carried its triumphs into every corner of the world, and to be employed in the service of nearly all languages.



The Triumphs of the Printing Press
Author: Walter Jorrold
Language: English
Publisher: CreateSpace, Independent Publishing Platform, March 2014
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ISBN-13: 978-1496178251
Paperback, 160 pages

On Paper: The Everything of its Two-Thousand-Year History

Author: Nicholas A. Basbanes

Publisher: Vintage
Reprint edition July 2014
ISBN-10: 0307279642
ISBN-13: 978-030727964
Paperback, 448 pages

In these pages, the author shows how paper has been civilization's constant companion. It preserves our history and gives record to our very finest literary, cultural, and scientific accomplishments. Since its invention in China nearly two millennia ago, paper has spread throughout the inhabited world.

With deep knowledge and care, author traces paper's trail from the earliest handmade sheets to the modern-day mills. Paper, yoked to politics, has played a crucial role in the unfolding of landmark events. Without paper, modern hygienic practice would be unimaginable; as currency, people will do almost anything to possess it; and, as a tool of expression, it is inextricable from human culture. Lavishly researched, compellingly written, this masterful guide illuminates paper's endless possibilities.

The Library Beyond the Book

Authors: Jeffrey T. Schnapp and Mathew Battles

Publisher: Harvard University Press, 2014
ISBN-10: 0674725034
ISBN-13: 978-0674725034
Paperback, 176 pages

With textbook readers and digital downloads proliferating, it is easy to imagine a time when printed books will vanish. Such forecasts miss the mark, argue the authors. Future bookshelves will not be wholly virtual, and libraries will thrive - although in a variety of new social, cultural, and architectural forms. Authors combine deep study of the library's history with a record of institutional and technical innovation. They gather these currents in *The Library Beyond the Book*, exploring what libraries have been in the past to speculate on what they will become: hybrid places that intermingle books and ebooks, analog and digital formats, paper and pixels. Libraries have always been mix-and-match spaces and remix is their most plausible future.

Out of Print:

Newspapers, Journalism and the Business of News in the Digital Age

Journalism has never been a fixed term, but has continued to develop and evolve in a fluid manner and has undergone radical periods of change before the development of the internet in the 1990s. *Out of Print* examines the past, present and future for a fragile industry battling a "perfect storm" of falling circulations, reduced advertising revenue, rising print costs and the impact of "citizen journalists" and free news aggregators.

The book provides an insightful and detailed analysis of journalism through history and reviews the effects of the digital age on journalism's current state, as well as its potential future. In his introduction, author discusses the effects of digital media on the world of journalism and highlights the fact that the 21st century is 'only a short period in the history of journalism'. Also, cheap, simple publishing technology has redefined the meaning of the term 'journalist'. However, Brock does not see the influence of digital media as necessarily a death-toll for established, traditional journalism.

Author defines journalism as 'the systematic, independent attempt to establish the truth of events and issues that matter to society in a timely way', and at the end of the book reminds us that 'Journalists should not confuse the platform with the content'. His argument is that the way in which we access news, and the way in which it is reported, is what changes - however there is still, and will continue to be, a very definite place for journalism in society.

One of the greatest advantages that can be noticed with digital media is that although mistakes are made often, they are also quickly corrected. Moreover, with digital media there is a greater readiness to take risks, and to discover by trial and error what style of news reporting is most effective. The book ends with focusing not on what is being lost, but on what will remain of journalism in whatever future media climate.

Out of Print: Newspapers, Journalism and the Business of News in the Digital Age
Author: George Brock
ISBN-10: 0749466510
ISBN-13: 978-0749466510
Publisher: Kogan Page, London, UK, 2013
Paperback, 256 pages

How to Start a Printing of other Security Papers Business

This publication will teach you the basics of how to start a Printing of other Security Papers Business. With step by step guides and instructions, the book offers not only a better understanding, but gains valuable knowledge of how to start a Printing of other Security Papers Business. The publication should be used as just a stepping stone for any beginner, who may not have an idea of how to start the business. It will provide readers with basic information without complex breakdowns about the business concerned. This publication can be used as a guide to determine what to expect when venturing into this specific business.

How to Start a Printing of other Security Papers Business
Author/Publisher: Sam Enrico, 2014
Kindle edition
File size: 428 KB
Print length: 27 pages
ASIN: B00NSJ7H3I

Encyclopedia of Label Technology

In ten years since the first ever Encyclopedia for the label producer and label user sectors was published, it have been substantially updated and extended in the latest edition to incorporate the production of narrow-to-mid-web package printing, the fast-changing world of digital imaging, printing and finishing, digital direct-to-shape and the new technologies of digital watermarking, mobile interactive labels and packaging, as well as the latest converting and tooling solutions and an understanding of printed sachets, pouches, flexible packaging and cartons. More information has been included on the environment and sustainability and mention made of all the leading industry associations and relevant bodies.

More informative, more relevant and more comprehensive, this new edition of the Encyclopedia should be a basic reference source for every label printer/converter and industry supplier - as well as for the designer, pack producer and brand owner looking to better understand label and related technology, markets and applications.

Encyclopedia of Label Technology
Author: Michael Fairley
Publisher: Tarsus, UK
2nd edition August 2014
ISBN-10: 1910507008
ISBN-13: 978-1910507001
Paperback, 260 pages

The Printing Ink Manual

The first edition of the Printing Ink Manual was published by the Society of British Printing Ink Manufacturers back in 1961 to fill the need for an competent textbook on printing technology, which would serve both as a training manual and a reliable reference book for everyday use. The book soon became established as a standard source of information on printing inks and reached its fourth edition by 1988. This, the fifth edition, is being published only five years later and reprinted in 2014, so rapid has been the development in technology. The objective of the Manual remains unchanged. It is a practical handbook designed for use by everyone engaged in the printing ink industry and the associated industries. It provides all the information required by the ink technical for the day-to-day formulation of printing inks. It supplies the production manager with details of the latest equipment and manufacturing methods, including large-scale production, and gives guidance on achieving quality assessment and total quality management specifications. Care has been taken to maintain the value of the Manual for training both technical personnel and others who require some knowledge of inks. Readers with little scientific knowledge will not find difficulty in using the Manual, but sufficient chemistry and physics have been included to provide an explanation of the underlying principles and theories governing the behavior of inks for use by the advanced technologist. Suppliers of raw materials, substrate manufacturers, printers and print users will find the book a valuable source of information.

The Printing Ink Manual
Editors: Robert Leach and Ray Pierce
Publisher: Springer Verlag
5th edition reprinted September 2014
Language: English
ISBN-10: 940175148X
ISBN-13: 978-9401751483
Paperback: 1008 pages

Mastering 3D Printing

Author: Joan Horvath

Publisher: Apress Media, USA
1st edition August 2014
ISBN-10: 1484200268
ISBN-13: 978-1484200261
Paperback, 224 pages

Mastering 3D Printing shows how to get the most out of the printer, including how to design models, choose materials, work with different printers, and integrate 3D printing with traditional prototyping to make techniques like sand casting more efficient.

This book is intended for new 3D printer owners, makers of all kinds, entrepreneurs, technology educators, and anyone curious about what can be done with a 3D printer and ready for innovations to start a business, educate or inspire the others.

Digital Label and Package Printing:

Terminology, technology, materials, management and performance

Editor: Michael Fairley

Publisher: Tarsus, UK
3rd edition, May 2014
ISBN-10: 095475185X
ISBN-13: 978-0954751852
Paperback, 132 pages

Digital Label and Package Printing incorporates much of the combined knowledge of many of the world's leading experts to provide a comprehensive guide to understanding how these technologies work - whether electrophotographic liquid and dry toner or inkjet.

It also explains the enhanced requirements that digital printing brings to color management, origination and prepress, workflow, demands on substrates, digital analog and laser finishing, and how converters should look to manage and market the digital printing operation.

Bookshelf

Academic dissertations

Doctoral thesis - Summary

Author:
Zied Marrakchi

Speciality field:
Materials

Supervisors:
Evelyne Mauret
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Valorization of Alfa fibers

This thesis aims at valorizing herbaceous plant called Alfa (Stipa tenacissima) in added value application. The main idea of this work is to use Alfa fibers as reinforcing elements in bio-composites. The literature review revealed that this plant has not been extensively studied, which motivated undertaking a comprehensive study of these fibers. A systematic and deep study of the chemical composition, the morphological properties, the electrical charges, the refining kinetics of pulp as well as the physical properties of the paper produced from these fibers was performed and gave several rational insights on Alfa fibers in the context of papermaking. The second part of this work was devoted to the use of Alfa fibers, as reinforcing fiber mat in composite materials based on biodegradable polymer matrices. In this context, an impregnation technique of the paper films in solutions of two biodegradable polymers - polycaprolactone (PCL) and poly-L-lactide (PLLA) - was chosen. The structural, morphological, thermal and mechanical properties of these new composites were analyzed and discussed. In addition, an original microwave-assisted grafting of surface chemical modification of Alfa fibers was proposed. In this context, stearic acid was used as a coupling agent. Finally, the effect of the surface modification of the reinforcement on composites properties was assessed and analyzed.

Doctoral thesis - Summary

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Speciality field:
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Properties and print quality of recycled papers

The aim of the thesis was to investigate printing papers made of recycled and virgin fibres, their print quality and durability. In the research study two 100 % recycled papers and two wood-free papers made of virgin fibres were included. Basic, mechanical, surface and optical properties of papers, their fibre components and surface structure were determined. Papers were examined with UV/VIS and FT-IR spectroscopy. To determine print quality, papers were printed with electrophotographic printing technology using dry toners. Print quality was evaluated with image analysis, spectrophotometric and densitometric measurements. Treatment with increased temperature and humidity and treatment with irradiation of xenon arc lamp were applied. Some properties, their surface structure and UV/VIS and FT-IR spectroscopy were determined again. Durability of offset and electrophotographic prints was evaluated with spectrophotometric measurements and new chrominance histogram method. Results showed that some mechanical properties ensure better resistance of recycled papers due to their larger fibre fibrillation and more filled structure between fibres. Due to small ink particles left in the pulp and to smaller content of optical brighteners, recycled papers have smaller brightness. Print on recycled papers established a bit smaller colour gamut. Otherwise the results showed that recycled papers are suitable for every day office use. During accelerated ageing the tensile strength of investigated papers was reduced. Results proved a slightly better light fastness of optical properties and degree of polymerization for recycled papers. Results showed hydrolytic and oxidetive degradation of cellulose which were the most noticeable for uncoated recycled paper. Results revealed different colour stability of prints. The effect was depended on pigment type in ink and paper coating. Meanwhile, type of fibres did not have influence on prints durability. New method of assessing the light fastness of prints by image chrominance histogram quantification showed very valuable results.

Events

World Publishing Expo - back to Amsterdam

IFRA Expo & Conference

Amsterdam, The Netherlands
13 to 15 October 2014

This year the traditional Expo and related events - the World Printers Forum, the 7th Tablet & App Summit, and the 13th International Newsroom Summit - are expected to draw 300 exhibitors and more than 8000 visitors to Amsterdam.

The World Printers Forum will come together with an inaugural conference within the World Publishing Expo 2014, the largest global exhibition for the news publishing and media industry.

The World Printers Forum (WPF) will guide WAN-IFRA's activities in all areas of newspaper production, materials and sustainability. This will include promoting the unique value of print, encouraging the creation of innovative products, as well as developing new business models for print and operating printing plants as an independent profit center.

The inaugural two-day WPF conference (15 - 16 October) will feature:

- ✧ innovations in print from around the world
- ✧ how to make the printing plant into an independent profit center
- ✧ savings from "going green"
- ✧ latest developments in digital printing
- ✧ cost calculation models for digital printing and more.

Paper Recycling Conference Europe

Milan, Italy
29 to 30 October 2014

Taking place in this region of opportunity, the Paper Recycling Conference Europe 2014 will address numerous trends, opportunities and challenges for the paper and plastic recycling industry, including changing quality and mill capacities, investment and export dynamics and developments in recycling efficiency optimization. Shaped by an expert industry advisory board the conference will provide delegates with the perfect opportunity to learn and discuss all these issues in the European market and beyond, and the expected impacts on your business.

Paper Recycling Conference Europe will provide unparalleled networking opportunities, a diverse program and a number of high-profile speakers who will address many of the top issues confronting the paper and plastics recycling industry.

Frankfurt Book Fair

Frankfurt, Germany
8 to 12 October 2014

The Frankfurt Book Fair is considered to be the most important event of its kind in the world. It is not only an exhibition of books from around the world, but a key marketing opportunity for the promoting and launching of books, and also a venue to facilitate the negotiation of the international sale of rights and licenses. Visitors take the opportunity to obtain information about the publishing market, to network, and to do business.

FRANKFURTER BUCHMESSE

Key players from around the world present their printed publications next to tomorrow's trendsetters. Individual exhibitors, national stands, as well as licensing and cultural contacts from approximately 90 countries are gathered at this fair. Exciting publishing content - also for films, apps and games - can be found here. The guest of honor this year is Finland.

Traditionally, the Fair is open the first three day to the publishers, authors and to the press, while the remaining two days it is open for the general public.

From October 2015 the Book Fair will experience a new development, with an improved hall layout to be launched. It will take into account the increasing transformation of the international book markets. The new layout will considerably reduce travel times between meetings on the exhibition grounds to just a five-minute walk. Using the methods of modern urban development, an original infrastructure program is applied that allows exhibitors and visitors more attractive facilities, optimized traffic flow, and new opportunities to interact with fellow fairgoers.

Graph Expo 14

Chicago, Illinois, USA
28 September to 1 October 2014

Recognized as the most innovative and comprehensive exhibition in the Americas of digital, offset, inkjet, flexo, gravure and hybrid technologies, products, and services for the commercial, transactional, converting and package printing, publishing, mailing, in-plant, photo imaging, marketing and industrial printing industries, this year's 'Integrate' themed event offers an exciting showgoing experience. The tradeshow presents the latest graphic communications technologies in live equipment demonstrations across the show floor, plus education on the most in-demand products and newest profit-making opportunities. Graph Expo 14 offers more than 70 interactive learning sessions and 60+ co-located events for attendees across 12 key market segments.

This year the world's graphic communications industry will convene in the largest print market in the world to rejuvenate, energize and find the trending business solutions and exciting new profit opportunities.

International Forum on Print Efficiency and Quality

Zagreb, Croatia
23 and 24 October 2014

Ninth meeting of the InPEQ Forum will take place in Zagreb, Croatia and will be hosted by the University of Zagreb, Faculty of Graphic Arts and manroland Adriatic.

The forum is intended for managers, experts and members of the National Printers Federations of the Balkan Print Forum and will present interesting and innovative information under the motto: "East meets West - printers for efficiency and success". Experts and specialists will inform about trends and perspectives in the printing and media industry and will discuss future challenges of the European printing industry. This is another good possibility for the participants to get acquainted with technological novelties and innovative solutions.

Labelexpo India 2014

29 October to 1 November 2014
New Delhi, India

29 Oct - 1 Nov • New Delhi
LABELEXPO INDIA 2014
www.labelexpo-india.com

Labelexpo India 2014 is the largest event for the label and package printing industry in South Asia - with more products, more launches and more live demonstrations.

The show will demonstrate technology in action:

- ✧ Pressure sensitive developments;
- ✧ New materials - focus on film: shrink it, stretch it, cut it, stack it, wrap it around;
- ✧ Cutting edge printing processes: UV flexo and digital dominate
- ✧ High added value solutions, from extended text solutions to foiling, new coatings and varnishes;
- ✧ Innovation product decoration ideas, including sachet solutions and pouch possibilities;
- ✧ Maximizing service levels: supply chain management, flexible production and MIS.

Visitors will have an opportunity to see working machinery, cutting edge technology, multi-substrate presses, digital presses, laser die cutting, RFID, pre-press and plate making, in-line decoration systems, multi-process ink systems, VIP substrates, high technology label materials, films, sleeves and wraps etc.

Digital Media Asia

18 to 21 November 2014
Singapore

Another in a series of WAN-IFRA regional events, Digital Media Asia (DMA) has since its launch in 2009, grown to become the largest new media conference dedicated to the news publishing industry in Asia. The event offers four focused days of conference and masterclasses and a foyer expo. The 5th Asian Digital Media Awards will be presented during the conference.

Digital Media Asia 2014 will showcase some of the hottest international trends in digital media. Media executives around the globe with share their best practices and insights on online content monetization, digital advertising, social media, tablet publishing, big data, and other recent digital innovations.

WCPC Annual Technical Conference

24 and 25 November 2014

The conference is an opportunity to view the latest WCPC research in printing technology, to discuss the findings with researchers and to network with like-minded industrial delegates. Each presentation will be a technical paper based on latest results and analysis derived from controlled experiments and numerical models. All attendees will receive printed copies of the abstracts for each of the papers presented. Delegates will also have the opportunity to network at the conference dinner and should you wish the chance to arrange future visits to the WCPC laboratories.

WCPC is a world renowned research centre dedicated to advancing the understanding and productivity of all aspects of printing and coating. WCPC enhances the understanding of the printing and coating processes, exploits novel manufacturing using printing and applies its scientific findings to the benefit of its global industrial partners. With extensive experience in packaging and graphics printing the WCPC has built on this knowledge and become a centre for functional materials, plastic electronics and bio printing.

Digital Print For Packaging Europe

10 and 11 December 2014
London, United Kingdom

Digital Print for Packaging will bring together the key players from across the supply chain in one place at one time. This year's conference will facilitate business connections with decision makers you would not have had the chance to meet before. The adoption of digital print is happening now, find out how your business can take hold of this exciting opportunity from the global experts in this field. Digital Print for Packaging Europe is arranged by Simthers-Pira.

Digital Print for Packaging 2014 provides the opportunity for you to draw on the expertise of an international group of brands, designers, technology providers, and packaging manufacturers, creating a unique forum for the entire packaging supply chain to work together and realize the opportunities in digital print for packaging.

Having attained the benefits of digital print for packaging this year's conference provides expert guidance on the next steps to implementation, through:

- ✧ Case studies from those who have implemented successfully;
- ✧ Key solutions for brand and retailer "pain-points";
- ✧ Linking digital print for packaging with the marketing communications strategy;
- ✧ The future of digital print: gearing up for the future.

Helsinki Book Fair

Helsinki, Finland
23 to 26 October 2014

Helsinki Book Fair is a highly popular trade show event, dedicated to the books and paper industry. The fair serves as the ideal meeting place for a large number of book-readers, and a host of publishers, booksellers, and magazine publishing houses. The comics and cartoon industry also has representatives to this book fair. Literary experiences are seamlessly shared among those attending the show, and visitors get the chance to grow familiar with new reading material as well. The event, organized by Suomen Messut, has a wide array of different items on exhibit, ranging from books for children, science texts and travel books, right to digital audiobooks, disks, magazines and religious books, like the Holy Koran. Calendars and stylish greeting cards are also displayed at the fair.

GRID 14 Symposium

Novi Sad, Serbia
13 and 14 November 2014

GRID14, the 7th professional and scientific symposium aims to continue the exchange of expertise among scientific researchers, experts and professionals who work in the graphic industry in Serbia and abroad.

GRID14 international symposium will take place in November 13 and 14, 2014 in Novi Sad, Serbia. Symposium will be hosted and organized by the Department of Graphic Engineering and Design - University of Novi Sad, Faculty of Technical Sciences. It is organized every two years as an international event, with the objective of connecting researchers from industry and institutions related to the field of graphic engineering and design through presentation of research results to scientific and professional community.

Program and peer review committee of the symposium consists of eminent scientists from Serbia and abroad. A wide range of topic swill be presented at the symposium by prominent authors from several countries.

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.

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

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

- Printing technology and related processes

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

- Premedia technology and processes

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

- Emerging media and future trends

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

- Social impacts

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

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

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

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

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

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

Submissions and queries should be directed to:

journal@iarigai.org or office@iarigai.org

Guidelines for authors

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

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

A - General

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

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

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

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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).

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

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

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

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

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

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

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

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

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

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

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

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

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3-2014

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

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