

Innovative Combinations of Print & Digital – attitudes towards change in the European printing industry

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Short Abstract

The present study reports a European industry survey of the state and future of innovative printing. Main emphasis addresses how paper and board and graphics industry could benefit the most from the possibilities provided by combining print with digital and by printed functionality. Experiences and inputs from representatives of the industry were collected to provide viewpoints on how print media and packaging could be developed and used in the future and how the industry can utilize available knowledge in science for the benefit of their customers and the consumers.

First innovation adaption process and methodologies are reviewed and then the available empirical results are described and analyzed. It can be suggested that (1) European graphical companies see their future in innovative printing, (2) beside costs, lack of market demand is the most important factor in preventing companies to move to innovative printing, and (3) approach and vision of the industry is in general similar across Europe although Western European printing houses seem to be more active in the field of innovative printing, while innovations utilized today by printers in Eastern Europe mainly comprise effect and personalized printing, indicating a delay in implementation of available technologies.

Keywords: Innovation, Printing, Europe, Prospective study

1. Introduction and background

Innovation has long been recognized as a key element of economic development. Today there is a great need for understanding the state of the printing industry and providing further direction on this topic that entails both technological and strategic dimensions. To achieve this, various aspects of diffusion of innovation need to be considered and put into relation with current situation of innovative printing in Europe.

Academic literature about innovation is plentiful; many research contributions exist that characterize different aspects and originate from different disciplines, as summarized by Connolly, Gauzente and Dumoulin (2012). They state that in economic literature the focus has been ‘technology push’ (attempts to commercialize and increase diffusion of the innovation) versus ‘demand pull’ (user need for the technological innovation). Looking at different aspects of innovation, they discuss that uncertainty and perceived risk play an important role from the perspective of potential adopters. The benefit might not always be obvious, thus one cannot be sure that the innovation is preferable to the existing product. Nor is the consequence, increasing the perception of risk and uncertainty. In addition, resistance to change is a powerful factor that hinders the adoption of innovations. As far back as 1964,

Bright observed that “Anyone introducing a technological innovation is implicitly or explicitly predicting acceptance and a rate of adoption. Yet a fact of technological history is that many innovations are subject to frustrating delays and deliberate resistances to adoption” (1964: 171).

2. Printing industry in Europe

Nowadays, the European printing industry has around 120,000 (mainly small sized) companies, employing around 750,000 people for a turnover of about €85 billion (Eurostat, 2015). On the other hand, according to Confederation of European Paper Industries (CEPI, 2015), its members produced 91 Mt paper and board in 2014. There are around 630 companies active in pulp, paper and board industry in Europe (excluding paper and board mills), generating a turnover of approximately €75 billion and more than 180,000 workplaces (CEPI, 2014).

While the paper and board industry is struggling with stagnation or very slow growth in some countries, many printers are currently facing overcapacity problems, price competition and replacement of print by digital (Intergraf, 2011) which they try to overcome by cutting costs, investment in new technologies and equipment. All Intergraf’s respondents agreed that the main investment needs to be put in new knowledge. These new opportunities came from maturing of several important innovations which emerged along time, like digital printing, printing on demand, 3D printing, augmented reality, and printed electronics. Numerous aspects of the last one, important for developments in paper and board as well as printing industry, are discussed in literature (e.g. Bollström et al., 2014; Pettersson et al., 2014; Määttänen et al., 2010). Innovative technologies enable increased productivity, new markets, products and services and open up opportunities to integrate services along the value chain, and eventually even reduce costs (PMG, 2012).

According to Vehmas et al. (2011), printing houses still are not willing to move to completely new business areas due to the huge investments and R&D needed for old printing machines to produce totally new products and the risk is seen to be too high in new customer markets. Drivers for enormous change are missing and new business cannot therefore evolve, but even if giant leaps are not taken, many actors in the European printing industry had recognized the need to transfer within the current business area. Three approaches to survive were identified:

- Efficient web printing production via flexible production and effective materials usage
- Added value for the printed product
- Printed non-media products.

In all cases customer service, co-operation in print production chain and open communication are needed to succeed.

A report by Aistrup (2009) states that collaboration is important as companies cannot handle the cascade of complex knowledge and they should cooperate in complementary innovation networks to expand value rather than simply improving their existing value share. Currently many segments of the printed electronics are not profitable with mostly more than 10 years of development: as the profitable ones are identified electroluminescent displays, sensors and conductive inks (IDTechEX, 2015).

In this study, the goal was to promote discussion between industry and academia on the benefits that may arise from combining print and digital. Several examples exist where successful combinations have been applied e.g. through the use of image recognition, augmented reality or printed electronics to bring interactivity into fiber based products. Experiences and inputs are collected to provide viewpoints on how print media could be developed and used in the future, how industry can utilize the information for the benefit of their customers, and to find out the awareness of the possibilities for combining print with digital as well as the attitude of the industry towards these technologies.

3. Materials and Methods

To initiate this discussion, a questionnaire was set up to assess industry's opinion on innovative printing, referring to printed electronics, printed intelligence, printed functionalities, combining print with digital, etc. In each country (Czech Republic, Hungary, Netherlands, Portugal, Serbia, Slovenia, Slovakia, and United Kingdom), the composed questionnaire was distributed among the targeted companies in their local language in order to overcome any language barriers and to maximize understanding. Further, the English version reached respondents in several other Western European countries (Belgium, Germany, Italy, Norway, and Sweden); the origin of these responses is jointly designated as "Other" in following text as the number of responses per country was too low to analyze them separately.

3.1 Survey instrument – questionnaire

The questionnaire consisted of six questions, both open and closed. First question was meant to characterize the companies based on e.g. company size and printing technology. The second question inventoried the use of innovative printing techniques, after which questions three and four tried to identify the most important limitations to develop such printing solutions and the presence of competitive and financial advantage. Question five gave the opportunity for the industry to express their interest and opinion on cooperation with academia. Finally, the last question requested the outlook and opinion of the industry into the fastest growing markets in the area of innovative printing.

Intentionally, the questionnaire remained brief in order to increase responses and willingness of companies to participate.

Table 1: Survey Instrument

Country	Online questionnaire	E-mail questionnaire	Phone conversation	Personal conversation
Czech Republic (CZ)	✓ (B, C)		✓	
Hungary (HU)	✓ (A, C)			
Netherlands (NL)	✓			✓
Portugal (PT)	✓ (D)	✓ (D)		
Serbia (RS)	✓		✓	
Slovenia (SI)		✓		
Slovakia (SK)	✓			
United Kingdom (UK) and Others	✓	✓		

A – Posted on a web portal, B – Link distributed by e-mail to general contact addresses,

C – Link distributed by e-mail addressed to company representatives,

D – With a previous phone contact with the company representative

Various ways were employed for gathering results (as summarized in Table 1) to optimize the effectiveness of the study and to receive the maximum amount of responses, especially in countries where the target group was relatively small. More detailed answers were possible in personal or phone conversation, in some occasions only used as a follow up. In all cases however, the questions remained the same.

3.2 Sample size and characteristics

The study aimed at a well spread sample size across the European countries. To date, over 190 companies participated; both Western and Eastern European countries (Figure 1a), and bigger as well as small enterprises (Figure 1b). Predominantly, the sample was random, although in some cases it was known beforehand that the printers are working on innovative printing.

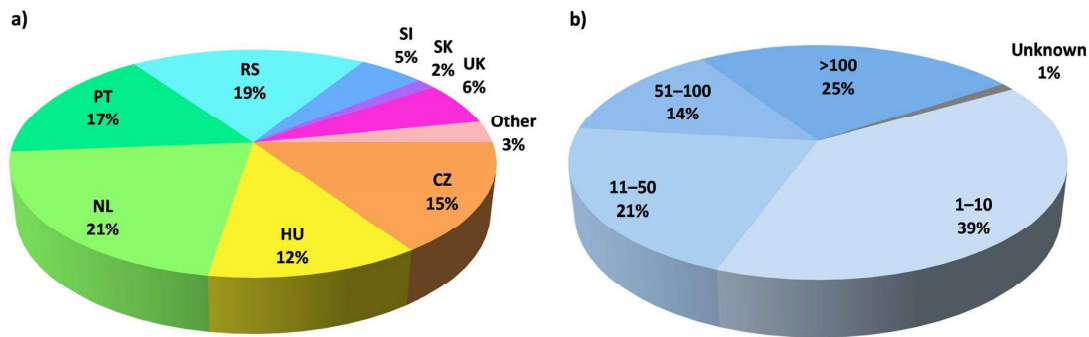


Figure 1. Respondents' country of origin (a) and number of employees amongst the respondents (b)

In terms of the distribution of the respondents throughout the different countries, the current results show that the majority of the respondents come from the Netherlands, Serbia, Portugal, the Czech Republic and Hungary. The cleavage between the countries representation seems to be, at first instance, result of different schedules and instruments for administering the surveys. In addition, since the graphical industry is not the same in each country, it is rather impossible to target the same amount of responses in each country. Finally, some interviewees just seemed more active and willing to answer. For all these reasons, the aim was to have as many responses as possible per country. To date, the total amount of responses considered as sufficient for quantitative analysis was not reached and is in fact expected to be impossible to be reached per individual country, because the authors contacted actual industry. Nevertheless, monitoring the survey progress suggests that it would give very similar results, as the patterns in current results for almost 200 respondents are very close to those obtained with half of this number. It must be concluded that the survey results are a fair representation of the printing industry throughout Europe. However, the data collection that started in 2014 is still ongoing and will be extended beyond what is presented in this paper.

With regards to the size of the companies, so far in this research, the respondents come mainly from small companies with 1–10 employees (39%). Nonetheless the other categories of companies' sizes are also sufficiently represented. The respondents also provided a diverse representation of industry types, ranging from general printing over packaging and security printing to digital media or paper production and converting.

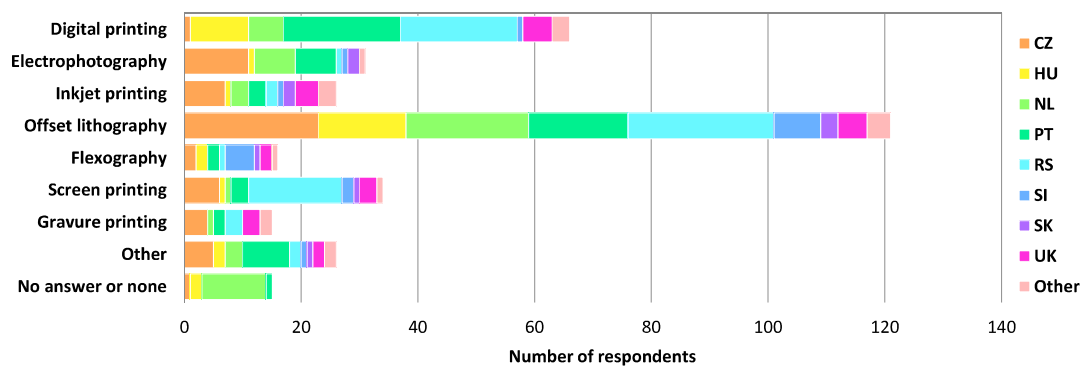


Figure 2. Printing technologies employed by the respondents

Figure 2 shows the variety of printing technologies that the participants employ. This clearly identifies offset lithography as the most popular printing technique along with the digital printing in general and electrophotography or inkjet printing in particular (in total listed by 123 respondents). From the main printing technologies, flexography and gravure printing are shown as the techniques that the participants use the least.

4. Results and Discussion

The results indicate that all respondents (no matter the extent to which they are aware of new technologies) would welcome more info on this subject. Obviously, printers are open towards cooperation with academia (see Figure 3), for example by local meetings to moderately discuss relevant topics. The majority of the respondents are interested in training and short courses, would like to participate in research partnerships and believe that the academia plays a valuable part in terms of specific measurements.

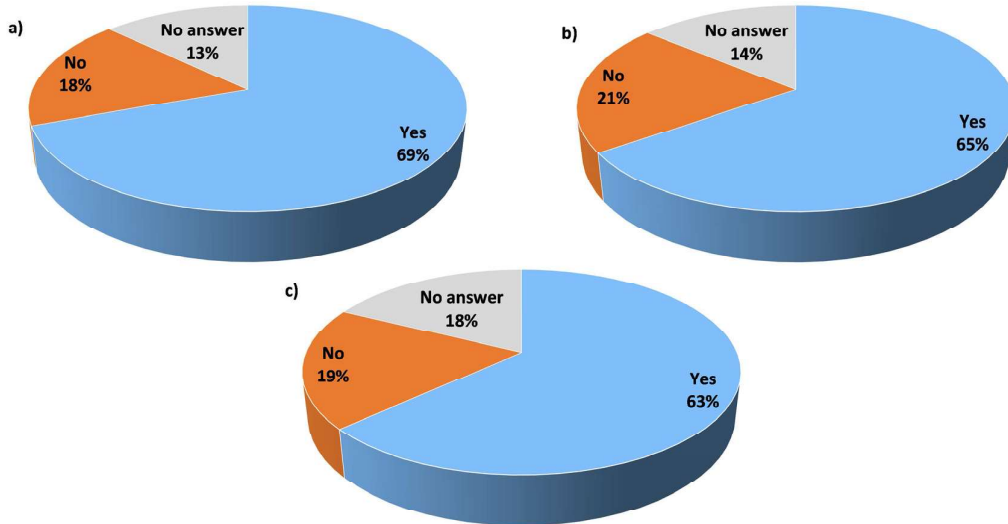


Figure 3. Respondents' attitude towards cooperation with academia – interested in training seminars and short courses (a), in research partnership (b), and in measurements (c)

During the past years printing industry has crossed structural changes, e.g. consolidation and closing overcapacity. Still, printing houses have a strong faith on prevalence of printed media products, but they also understood that some changes need to be done to survive (Vehmas et al., 2011). Consequently, based on available results (Figure 4), 40 % of the respondents offer innovative printing (as defined in 3. Materials and Methods), while the half did not yet do so. According to this study, printing houses in Western Europe seem to be more active in this field, while innovations utilized today by printers in Eastern Europe mainly comprise effect and personalized printing. This indicates a delay in implementing technologies related to printed functionalities and combining print with digital. However, the limitations of these innovations perceived in surveyed countries do not copy this scheme and their distribution is more similar in all countries.

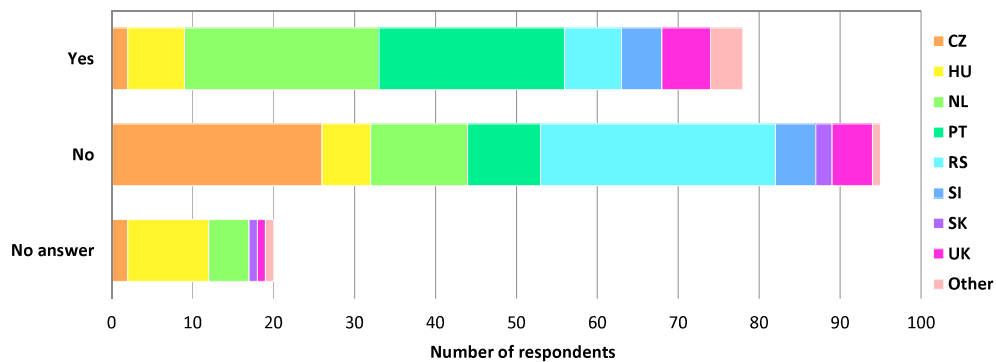


Figure 4. Responses to the question 'Are you involved in innovative printing?'

Most mentioned limitations (Figure 5) are the lack of market demand and costs related to new equipment, new skill sets or training of employees etc. The lack of market demand was stressed by many respondents as the key factor. In this context, the costs on customer side were mentioned as well as previously mentioned by Vehmas et al. (2011). The responses of the participants showed that in the great majority of the cases, their customers are exerting little or no pressure for innovative printing. About one third of the respondents did answer that the specialties are beneficial to the company's turnover (Figure 6).

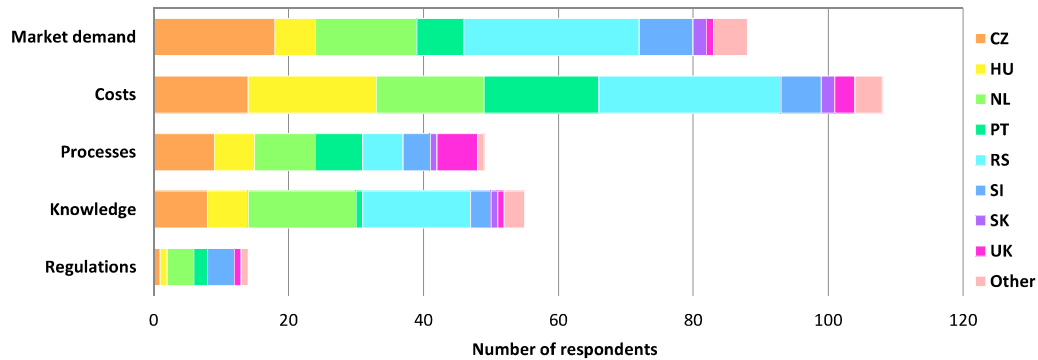


Figure 5. Limitations to use innovative printing as perceived by the respondents

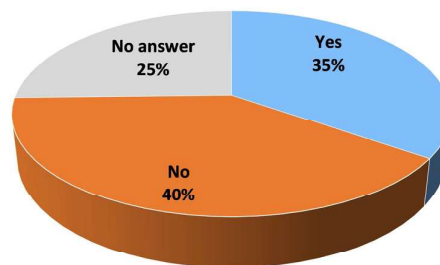


Figure 6. Distribution of the answers to the question if the companies gained competitive advantage and increased margins due to innovative technologies

As for the manner of receiving responses, a combination of different methods works best. Even though personal conversation is subjective, it gives a bit more detail to the answers than an online questionnaire.

5. Conclusions

This study does in a sense show the 'old truths', discussed in the introduction, as still valid in today's printing. The combination of lack of market demand with the perception that innovative printing is expensive and complex may be at the origin of the shy investment of certain industries in this area. On the other hand, nearly 200 industrial respondents took the time to reply to the questionnaires, which shows their commitment to the subject and innovation in general. In contrast to often presented opinion that the markets in question are open mostly for specialized and agile companies outside printing sector or only to the strongest but at the same time flexible printers, it was shown that innovations more or less related to printed electronics and combining print with digital are considered also by some traditional printers belonging to SMEs. Despite all the limitations associated with innovative printing, one of the main conclusions is the fact that companies are manifesting their interest in education in this area, as well as their willingness to take part in research partnerships. This predisposition towards innovative printing, might, in the long term, work in favor of this area.

Furthermore, even though all countries differ in the progress they made in innovation or technology, the approach and vision of the industry in general is similar across Europe. New technology is not the bottleneck. The challenge is to fit new technology to future requirements and business concepts. R&D and cooperation between different partners is needed to reach future goals. Since most of the respondents use paper and board as a substrate, this willingness to innovate also creates new opportunities for the European paper and board industry and help sustain the future of the graphical industry overall.

This activity driven by participants of COST Action FP1104 will continue to strengthen the cooperation between printing industry and academia and to gather in depth feedback on the survey results. Within COST Action FP1405, focusing towards active and intelligent packaging, industry will be continuously motivated to invest and develop. This will also enable the researchers to revisit the current studies, get more in-depth feedback on drivers for change, and focus on patterns, relations or discrepancies among the results.

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References

- Aistrup Consulting, (2009). *Linking into the Value Chain for the Printed Electronics Industry*. [online]. http://www.aistrupconsulting.com/resources/linkingintothevaluechain_printedelectronics.pdf
- Bollström, R., Pettersson, F., Dolietis, P., Preston, J., Österbacka, R. and Toivakka M., 2014. Impact of humidity on functionality of on-paper printed electronics. *Nanotechnology*, 25(9), 094003
- Bright, J.R., 1964. *Research, development and technological innovation*, Illinois: Richard Irwin Inc.
- CEPI, 2014. *Key Statistics 2013 European Pulp and Paper Industry*. [online] <http://www.cepi.org/system/files/public/documents/publications/statistics/2014/Final%20Key%20statistics%202013.pdf>
- CEPI, 2015. *Preliminary Statistics 2014*. [online] <http://www.cepi.org/system/files/public/documents/publications/statistics/2015/Preliminary%20Final%202014.pdf>
- Connolly, R., Gauzente, C. and Dumoulin, R., 2012. Adopting IT in public healthcare sector : an institutional research agenda. In: Nunes, M. B., Isaias, P. and Powell, P., eds. *Proceedings of the IADIS International Conference Information Systems*. <http://www.iadisportal.org/information-systems-2012-proceedings>
- IDTechEX, 2015. *Printed, Organic & Flexible Electronics: Forecasts, Players & Opportunities 2015-2025*
- Eurostat, 2015. *Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E), Most recent data: 2013* [online] http://ec.europa.eu/eurostat/web/products-datasets/-/sbs_na_ind_r2 [Accessed 24 April 2015]
- Intergraf, 2011. *The Future of the European printing industry-In our own hands, What the industry says*. [online] http://www.intergraf.eu/images/SociallyResponsible_Study_ENG.pdf [Accessed 13 February 2015]
- Määttänen, A., Ihalainen, P., Bollström, R., Toivakka, M. and Peltonen, J., 2010. Wetting and print quality study of an inkjet-printed poly(3-hexylthiophene) on pigment coated papers. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 367(1–3), pp. 76–84

Pettersson, F., Österbacka, R., Koskela, J., Kilpelä, A., Remonen, T., Zhang, Y., Inkinen, S., Wilén, C.-E., Bollström, R., Toivakka, M., Määttä, A., Ihalainen, P. and Peltonen, J., 2014. Ion-modulated transistors on paper using phase-separated semiconductor/insulator blends. *MRS Communications*, 4(2), pp. 51–55

PMG, 2012. *Print Media in Times of Change, A Key Contributor to EU 2020*. [online]
http://www.intergraf.eu/images/PMG_WEB.pdf

Vehmas, K., Kariniemi, M., Linna, H., Jokiaho, K. and Torniainen, E., 2011. *Future of European Printing Industry*. Espoo: VTT publication. 9 p.