A Memory Effect in sheet fed offset printing

42nd International IARIGAI Conference, Helsinki, Finland
W. Fuchs, M. Dauer, U. Hirn, W. Bauer
Institute of Paper, Pulp and Fibre Technology, TU Graz

07.09.2015
Print Mottle in Offset Printing

“Non uniformity of perceived print density”

uniformly printed image
non uniformly printed image

3 common types\(^1\):
- Backtrap Mottle
- Water Interference Mottle
- Ink-trap Mottle


Fuchs et al., Institute of Paper, Pulp and Fibre Technology, TU Graz
07.09.2015
Print Mottle in Offset Printing

Our initial aim:

- correlation between local paper properties and print mottle
- study local back trap mottle

but

- instead of back trap mottle we found the Memory Effect
Memory Effect

sheet nr.: 4  
sheet nr.: 2587
Memory Effect

The *exact same position* of colour fields on two different printed sheets.
Memory Effect

Hypothesis: Local patterns are transferred from rubber blanket to the printed sheets.

“Similarity of print mottle patterns over thousands of printed sheets.”

print mottle patterns are stable in time and location
Print Trial

Printing Machine:
Heidelberg SM XL 8
6 colours (sequence: K C M Y P B)
8000 sheets/hour

Paper Samples:
Wood Free Coated (WFC) 115 g/m², cw: 24 g/m² per side
two samples:
• WFC A
• WFC B
Print Trial

for evaluation: 80 printed sheets

- 350 sheets WFC B
  - 10 last printed sheets
  - 10 first printed sheets

- 350 sheets WFC A
  - 10 last printed sheets
  - 10 first printed sheets

- 350 sheets WFC A
  - 10 last printed sheets
  - 10 first printed sheets

- 350 sheets WFC B
  - 10 last printed sheets
  - 10 first printed sheets

2000 sheets other WFC papers

First printed

Last printed
Investigated color fields

- 40% C
- 100% C
- 100% C 60% M
- 80% K
- 80% B
Registration (Alignment) of Colour Fields

sheet nr.: 4

sheet nr.: 2587
Registration (Alignment) of Colour Fields

Registration was performed with corner of color field as marks\(^1\).

Result →
stack of 80 aligned images for each examined colour field

Size of colour field: 100x70mm
Scanned at 1200 dpi = 21.17 µm/pix

---

Registration and Filtering of Colour Fields

pass band filtering (FFT) in 1-16 mm wavelength band
→ relevant region for print mottle

First printed (Nr. 1)
Similarity of Print Mottle Patterns $\rightarrow R^2$

image of 1\textsuperscript{st} printed sheet

pass band filtered (FFT) images (1-16 mm wavelength band)

image of 2\textsuperscript{nd} printed image

Sample size: 50x50 mm

Fuchs et al., Institute of Paper, Pulp and Fibre Technology, TU Graz
07.09.2015
Similarity Matrix

Each image was point wise correlated to all others
Example: first printed black (80%K)

R² between 1st printed and 1st printed

R² between 1st and 20th

R²: 20th and 1st

R²: 20th and 20th

Scale of R² [-]

Fuchs et al., Institute of Paper, Pulp and Fibre Technology, TU Graz
07.09.2015
80% K, pass band 1-16 mm

Similarity Matrix

Fuchs et al., Institute of Paper, Pulp and Fibre Technology, TU Graz
07.09.2015
80% K, pass band 1-16 mm

calculation of variance of each image
80% K, pass band 1-16 mm

- high similarity between images close to each other in the stack ($R^2 = 0.40-0.50$)
- print defect rises variance ($R^2 > 0.50$)
- structure seems to reoccur after print defect
- reasonable similarity between images over more than 3000 sheets ($R^2 = 0.20-0.30$)
100% C & 60 % M, pass band 1-16 mm

- high similarity between images close to each other in the stack
- Memory Effect appears over different paper grades

→ pattern could be transferred by rubber blanket
Full Tone Colour Fields (1-16 mm)

100% K

100% C
Conclusion

- We have developed a method to detect similarity of print mottle patterns

Memory Effect patterns:
- are systematically transferred
- appear on the *exact same* location in one colour field
- reoccur or stabilise after print defects
- are traceable over more than 3000 sheets
- only observed for screen printing

Memory Effect seems to be generated by printing machine
Shape Preserving Coordinate Transform

\[
\begin{pmatrix}
    x' \\
    y'
\end{pmatrix} = \mathbf{t} + s \cdot \begin{pmatrix} x \\ y \end{pmatrix} \cdot \mathbf{r}
\]

\[
= \begin{pmatrix} t_x \\ t_y \end{pmatrix} + s \cdot \begin{pmatrix} x \\ y \end{pmatrix} \begin{pmatrix} \cos \varphi & \sin \varphi \\ -\sin \varphi & \cos \varphi \end{pmatrix}
\]

- \(x, y\): target image coordinates
- \(x', y'\): source image coordinates
- \(t\): translation vector
- \(r\): rotation matrix
- \(\varphi\): rotation angle
- \(s\): scale parameter