Streaks and Banding
Measuring Macro Uniformity in the Context of Optimization Processes for Inkjet Printing

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Streaks and Banding

Directional Printing Artefacts
What are they and why are they a problem? (3 slides)

Directional Streaking: High Spatial Frequency
Typically due to pixel or drop-level effects
for example:
- Missing nozzles
- Down-web streaks
- Nozzle timing jitter
- Across-web streaks
- Intra-screen defects
- Can cause 2-D orthogonal (X and Y) streaks

Directional Banding: Low Spatial Frequency
Usually due to system-level effects
for example:
- Printhead density variations
- Down-web bands
- Transport encoder problems
  - Across-web ‘wow and flutter’ bands
- Inter-screen moiré effects
- Can cause 2-D orthogonal banding

Why are Streaks and Banding Such a Problem?
- Restricts the jobs that can be printed on a digital press.
  - In some industrial applications only 30% of jobs can be printed digitally due to directional issues: no printing blue sky
- Reduces the value of the output
  - Bad output sometimes sold at a discount
- Time and cost required for remediation
  - Frequent printhead purging, voltage trimming, etc.
- Breaks the color calibration process
  - Patch color can vary by print location

What are they and why are they a problem? (3 slides)
What causes them? (4 slides)
How can we measure them? (5 slides)
How can we fix them? (5 slides)
Directional Printing Artefacts
What causes them?
(4 slides)

Down-web Streaking: Nozzles
- Missing Nozzles!
  - Often caused by gas bubbles or other temporary obstructions
  - Sometimes actuators break and a nozzle will become irrecoverable
- Deflected Nozzles
  - Dirt or other contamination can cause drop trajectories to become deflected
  - Produces a light streak and a dark streak where the drops are deflected
- Nozzle variability
  - Manufacturing tolerances lead to variations in apertures and driver actuators

Down-web Banding: Printhead Variation
- Manufacturing variability
  - Some printheads are just darker than others
  - Wide solid bands
- Across-printhead variations
  - The classic printhead ‘smile’
  - Often ink pressure differences across the printhead
- Printhead stitch variations
  - Stripes between printheads

Across-web Streaking
- Timing jitter
  - Usually an electronic source
  - Either in the printhead driver or transport encoder electronics
  - Normally fixed at the press manufacturing stage
  - Changes in environment can uncover latent problems
- Mechanical vibrations
  - For example lorries passing by!

Across-web Banding: Encoder Issues
- Substrate transport systems are mechanically complex
  - The substrate can speed up or slow down
    - Leading to across-web density variations
  - Encoders can fix the problem
    - But may introduce others, e.g. timing jitter

Directional Printing Artefacts
How can we measure them?
(5 slides)
The Traditional ‘Porthole’ Test
Used with décor printing long before digital

If you can tell the direction of printing then it’s a fail

What are we measuring? The Press or the Print?
For production the print is key:

But we also need an objective measure for the press:
*How directionally biased is this press?*

Emerging ISO technical specification
*Graphic Technology: Image quality evaluation methods for printed matter*

- Part 21:
  *Measurement of 1D distortions of macroscopic uniformity utilizing scanning spectrophotometer*
  *ISO/NP TS 18621-21*

Challenges for standards to address
- Frequency response?
- Spectrophotometers typically have limited spatial resolution
- Emphasise banding over fine-scale streaking
- Noise sources are coupled to specific frequency bands
- Visual response dependant on viewing distance
- Inter-press color targets?
- Different presses have different color gamuts
- Saturated colors have more density to vary

Possible recommendations
1. Extend measurement to use high resolution scans
   - *E.g. like ISO/DTS 18621-31.3*
   - Evaluation of the perceived resolution of printing systems with the contrast - resolution chart
2. Target mid-point color density for each channel
   - *Easy to measure*
   - Objective within-gamut target

Directional Printing Artefacts
How can we fix them?
(5 slides)
Mechanical fixes

- Press design
  - For example: printbar arrangements that require sub-pixel registration can create sensitivities to vibration.

- Environmental control
  - Where possible, controlling dust, temperature and humidity is a good idea
    - Physically small drops have very low inertia

Electronic fixes

- Voltage trimming
  - Press adjustment is possible, but limited to voltage-bank resolution
  - Best to tune voltages for stability and lifetime rather than density

- Waveforms
  - Tuning actuator waveforms for the ink, speed and throw distance of the press can increase stability

- Thermal modulation
  - Can be used as an adjunct to voltage trimming.

Software fixes

- Press density compensation
  - PrintFlat™
    - Increase quality
    - Save time
    - Improve color calibration

- Nozzle-out compensation
  - Need to identify which nozzles to switch off
    - Can be done effectively at different stages

- Screening
  - For example, reduced sensitivity to ink-drop neighbor effects

Global Graphics Software – PrintFlat™

- High quality press compensation
  - The sky looks smooth
  - Color patches are consistent
  - Flat tints are flat

Global Graphics Software – AIS™

- Advanced Inkjet Screens
  - Specialized screening patterns to improve inkjet performance
    - Allow careful tuning of drop-size mixing

- AIS-Pearl™
  - Pattern optimised for most inks / substrates

- AIS-Mirror™
  - Pattern optimised for difficult and poorly wetting substrates
Thank You PIA for the InterTech Award!

Any Questions?
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