Eliminating Banding in Inkjet Output

Dr Danny Hall
Chief Screening Scientist
Global Graphics

Presentation structure
- Why am I here?
- Update on ScreenPro™
- PrintFlat™ progress
  - Research
    - Optimizing Stability and Software Density Compensation
  - Future Directions

Recipient of a 2018 and 2019 InterTech Award

Update on Advanced Inkjet Screens (AIS) and ScreenPro™
- 2018 PIA Intertech Award winner

Why is screening so important?
QUALITY
- Screening controls output image quality in binary and multi-level printing
- Poor screening can accentuate print defects highlighting moiré, chaining and streaking
- Poor screening can introduce artifacts inherent to std generic algorithms
- Advanced Injet Screens (AIS) instead provide high quality optimized output

AIS screens
**Why is ScreenPro significant?**

- High-quality at ultra high-speed
  - Works on any inkjet press
  - With any workflow
  - With any ink or substrate
  - With any combination of printheads and electronics
- The only solution to improve inkjet output quality that is generally available to any inkjet press manufacturer
- In use by multiple inkjet press vendors in industrial inkjet markets

**Why is speed so important?**

**SPEED**
- Screening can be a bottleneck in high speed and real-time printing
- Screening can be processor intensive hogging system resources
- Screening can be inefficient, using old algorithms not optimized for modern processors
- ScreenPro screening can provide guaranteed throughput

---

**Update on PrintFlat™**

- 2019 PIA Intertech Award winner

---

**PrintFlat explainer**

---

**Before... and after**

---

**Corrections in software vs hardware**

- Many vendors try to solve banding by adjusting the voltage to the printhead:
  - Limited resolution
  - Fewer voltage adjustment points than needed
  - Time consuming, expert, expensive job
- Steep press requirement:
  - Complicated and time in-field maintenance and head replacement
  - Not affordable in correction as is for environment changes
- Correcting is software:
  - Can match nozzle resolution
  - Can be very fast to adjust and/or run
  - Adjustment can be automated
  - Cheaper, faster, better

**Actual print bar response (density across print)**

**Compensation curve in software**

**Typical head adjustment: compensation, adjusting voltage**
Global Graphics Software – PrintFlat®

- Automatically correct for banding based on measurement of uncorrected prints
- Adjusts every nozzle separately without time-consuming voltage adjustments
- PrintFlat is an option in Global Graphics ScreenPro

PrintFlat adopted in a wide range of applications

<table>
<thead>
<tr>
<th>Partner</th>
<th>Markets</th>
<th>Format Scale</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM1</td>
<td>Posters, Industrial</td>
<td>Very Large**</td>
<td>Low</td>
</tr>
<tr>
<td>OEM2</td>
<td>Wall Coverings</td>
<td>Large</td>
<td>High</td>
</tr>
<tr>
<td>OEM3</td>
<td>Labels</td>
<td>Medium</td>
<td>Very High***</td>
</tr>
<tr>
<td>OEM4</td>
<td>Packaging, Flooring</td>
<td>Large</td>
<td>High</td>
</tr>
<tr>
<td>OEM5</td>
<td>Textiles</td>
<td>Very Large**</td>
<td>Very High***</td>
</tr>
<tr>
<td>OEM6</td>
<td>Ceramics</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>OEM7</td>
<td>Packaging, Flooring</td>
<td>Large</td>
<td>High</td>
</tr>
</tbody>
</table>

* Some of our OEM partners are using PrintFlat on a commercial level
** Very Large: Very large print width
*** Very High Speed: Very fast

Optimizing Stability and Density Compensation

- Software density compensation free-up voltage compensation for optimizing press stability.
- Voltages can be adjusted to minimize, e.g.
  - intra-printhead density variance
  - or nozzle jetting variance

Technical approach

- Image analysis techniques originally developed for density compensation.
- Determine optimal printhead driver voltages for reduced intra-head variation and jetting stability. Process:
  1. Print Stability Calibration Image at different voltages
  2. Automate determine most stable voltages
  3. Set optimal voltages on press
  4. Use PrintFlat™ to compensate remaining density variation.

Research results: test image

Results at different drive voltages
Analysis: voltage vs variance

- The default voltage of 22.0 V is sub-optimal for both printheads.
- Setting the new printhead (PH4) to match the density of the old printhead (PH1) would set PH4 at 22.0 V and PH1 at 23.0 V.
- This is highly sub-optimal for PH1 variance and leads to long-run instability.
- Variance minimization (20.0 V, 17.0 V) would set very different densities for the two printheads.
- Variance is in conjunction with software density compensation.
- Significance of results needs to be replicated and the wider scope determined.
- Automation: One could envisage a system that automatically determines optimal process parameters (e.g., printhead trim, voltages) for enhanced press stability.

Conclusions

- The results are tantalizing!
- Clearly the opportunity exists to improve printing stability.
- It was a surprise that the scope for stability improvements seems quite significant.
- We believe that lower intra-head variance will be correlated with printhead stability over time. And it is known that there is often a correspondence between driver voltage and nozzle instabilities.
- May usefully address one of the most challenging issues in digital printing: press stability.
- We would welcome collaborations to help explore these issues in detail.
- Paradoxically by loosening control of printhead average density we may achieve greater printer stability.

Future directions for screening, density compensation and press stability

- Techniques work beneficially together.
- Good screening reduces streaking and other artefacts.
- Density compensation reduces streaking and banding.
- Automatic press adjustment for stability can enhance screening, compensation and overall productivity.

Thank you

- Global Graphics Group contacts here at TAGA:
  - Danny Hall, Global Graphics Software
  - Paul Hagen, Global Graphics Software
- New Educational Resource
  - “Full Speed Ahead”, Guide available in May 2020
  - Hints and Tips for Variable Data PDF design
  - Free copies for educators and students