Color Gamut Extension on a 4-color Sheet-fed Offset Press Using Ink Fountain Divider Method

Dr. Ruoxi Rachel Ma, Prof. Brian Lawler

Graphic Communication
California Polytechnic State University
San Luis Obispo, CA
Overview

- Background
- Problem Statement
- Innovation and Significance
- Materials and Methodology
- Experimental Procedures
- Conclusion and Future Work
Background

- Color Gamut
- Process color
- 4-color sheet-fed offset press
- 7-color sheet-fed offset press

Figure 1 CIE color gamut
Problem Statement

- The capacity of a four-unit offset press is limited for reproducing photo-heavy print jobs with vibrant color presentation.
- Dry trap 7 or 8 colors on a 4-color press is not cost-effective due to slow turnaround and labor cost.
Innovation and Significance

- This research is aimed to offer a more cost-effective way to enable 4-color offset press to deliver 7-color jobs with wet trap and significantly extended color gamut with premium quality.

Heidelberg SM CD 74
Materials and Devices

- Printing Machine: Heidelberg Speedmaster CD74
- Screen method: Staccato
- Screen Resolution: 10 μm
- Screen Angle: Cycle through screen angles
- Plate: Kodak Sonora Processless plate
- Paper: Spicers 135gsm Dull Coated
- Ink: Heidelberg Saphira process: Cyan, Magenta, Yellow, Black; Heidelberg Saphira Spot: Orange, Green, Violet.
- Density Measurements: X-Rite Spectrophotometer, i1 Profiler
Procedures Overview

- Create a test chart with 7 color channels
- Print the test chart with wet trap on the 4-color press
- Read the test chart with i1 Profiler and calculate the color gamut, generate and load the color profile.
- Create a test photo, print with 4-color and 7-color respectively.
- Color Gamut Calculation and Comparison
Procedures Overview

- Create a test chart with 7 color channels
- Print the test chart with wet trap on the 4-color press
- Read the test chart with i1iO and calculate the color gamut, generate and load the color profile.
- Create a orange-heavy photo, print with 4-color and 7-color respectively.
- Color Gamut Calculation and Comparison
Test Chart Creation

- Using the advanced version of i1 Profiler, a 7-color patch set was created. The size was limited to 9.5 x 19 inches.
- i1 Profiler needs to know the +colors: orange, violet, green
- i1 Profiler generates an .eps file (actually a .dcs file) with 7 colors
- The file can only be opened in Adobe Photoshop as a .dcs file
- In Photoshop, the individual channels can be manipulated
Procedures Overview

- Create a test chart with 7 color channels
- Print the test chart with wet trap on the 4-color press
- Read the test chart with i1iO and calculate the color gamut, generate and load the color profile.
- Create a orange-heavy photo, print with 4-color and 7-color respectively.
- Color Gamut Calculation and Comparison
Test Chart Reproduction

- Print Specs: 2400 Spot per Inch @ 3400 sheets/min
- Density Target: GRACol 2006 Coated 1; VGO – L* values

<table>
<thead>
<tr>
<th>Density</th>
<th>L*</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>1.70</td>
</tr>
<tr>
<td>C</td>
<td>1.40</td>
</tr>
<tr>
<td>M</td>
<td>1.50</td>
</tr>
<tr>
<td>Y</td>
<td>1.05</td>
</tr>
<tr>
<td>O</td>
<td>61</td>
</tr>
<tr>
<td>G</td>
<td>58</td>
</tr>
<tr>
<td>V</td>
<td>19</td>
</tr>
</tbody>
</table>

Density Standard: GRACoL 2006 Coated 1
Ink Fountain Settings

- Two ink dividers are set in the center of each ink fountain tray, except for the unit 3.

Ink fountain tray split by the ink divider: Unit 4 - C+Y
**Ink Fountain Settings**

- The color sequence are set as following based on lightness value of each color.
- The print sequence will be from dark to light

<table>
<thead>
<tr>
<th>Unit</th>
<th>O.S.</th>
<th>L* values</th>
<th>D.S.</th>
<th>L* values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>K</td>
<td>10</td>
<td>G</td>
<td>58</td>
</tr>
<tr>
<td>Unit 2</td>
<td>V</td>
<td>19</td>
<td>O</td>
<td>61</td>
</tr>
<tr>
<td>Unit 3</td>
<td>M</td>
<td>50</td>
<td>M</td>
<td>50</td>
</tr>
<tr>
<td>Unit 4</td>
<td>C</td>
<td>57</td>
<td>Y</td>
<td>94</td>
</tr>
</tbody>
</table>

O.S: Operator Side; D.S.: Driver Side
Test Chart Reproduction

- Wet trap: IR drier off, drying powder off
- Switch gripper side and Side guide - run 2nd pass
- Operator side guide– driver side guide
- Density Check
- Once reached- run 100 good sheets
Procedures Overview

- Create a test chart with 7 color channels
- Print the test chart with wet trap on the 4-color press
- Read the test chart with i1 profiler and calculate the color gamut, generate and load the color profile.
- Create a orange-heavy photo, print with 4-color and 7-color respectively.
- Color Gamut Calculation and Comparison
Read Test Chart

- I1 Profiler can’t recognize the same color with too much variance.
- This is due to the gradually mixing of the two colors in one ink tray.
- This is done by the oscillators in each unit.
Ink Contaminations

- The ink dividers are not sufficient to keep two colors separated
- Two color gradually blended in and cause various levels of color variations on each unit.

Unit 4- Cyan bleeds into yellow results in greenish color
Trouble shooting: Oscillator Rollers

- Move laterally to spread ink evenly across the inking train.
- Main challenge for divided inking train with dual colors – gradually get mixed.
Oscillator Rollers

- Disengage oscillator rollers
  - Mechanically
  - Digital control
- After consulting the Heidelberg technicians, we managed to disengage all the oscillators in each unit.
The ink dividing is significantly improved after oscillator disengagement.

However, ink weren’t being fed across inking train uniformly.

As a result, there are obvious ink stripes on the prints.
Procedures Overview

- Create a test chart with 7 color channels
- Print the test chart with wet trap on the 4-color press
- Read the test chart with i1 profiler and calculate the color gamut, generate and load the color profile.
- Create a photo, print with 4-color and 7-color respectively.
- Color Gamut Calculation and Comparison
Test Photo Reproduction

- Create a photo file (image), run with 4 color and 7 color respectively
- I1 profiler read the color gamut
- Compare the color gamut of the 2 prints
Results and Discussion

- Unfortunately, on this press the oscillators cannot be partially defeated; other Heidelberg presses have variable oscillation options.
- As a result of the oscillator problem, we were unable to make a Color Gamut Comparison
- We were forced to stop and reconsider our options
Conclusion and Future Work

- We might try a dry-trap version of the same job, running colors in the darkest-to-lightest order as either 4-then-3, or vice versa
- Run the same photos on a 4-color process run
- Compare the differences
- “Learn by doing!”
Thank you!

Questions?

Dr. Rachel Ma: rma07@calpoly.edu
Prof. Brian Lawler: blawler@calpoly.edu