Brand Color Reproduction Using Expanded Gamut Technology With Offset Printing

Reem El Asaleh, Martin Habekost, Emilija Biga
Ryerson University
Overview

- Brief History
- Recent developments
- Why did we do this project
- Equipment used
- Test charts
- Ink dry back
- DE comparisons
- Ink composition comparisons
- Color gamut
- Conclusion
Brief History

- Expanded gamut started to be used in 1960 by Hallmark
- Most known systems from the past are Opaltone and Pantone Hexachrome
- Currently under expanded gamut printing the standard ink set of CMYK is expanded through the colors Orange (O), Green (G) and Violet (V).
Recent developments

- O’Hara et al. presented at the 2019 conference their research into expanded gamut printing by reducing the chroma of Orange, Green and Violet (OGV) from 100% to 80% in 10% increments. The main points from the study were:

  - The greatest chroma of the OGV inks does not mean the largest gamut volume
  - The greatest chroma does not mean the most Pantone colors. Low chroma inks can often make more Pantone colors
  - The greatest gamut volume doesn’t mean the most Pantone colors and
  - The ink film thickness appears to influence the gamut size beyond its influence on the chroma of solids
Recent developments

- Hoffstadt talked at the 2019 conference about the ideal number of test patches for EG printing
- The ideal number of test patches should be between 1,000 and 5,000
- Idealliance ECG project → test chart for everyone
  - Small chart with 420 patches
  - Large chart with 4340 patches (4 x 1085 patches)
- Goal: Get a better understanding of the EG printing
Recent developments

- EG printing study conduct by A. Sharma
  - Used a proofer and an HP Indigo 7900
  - Will be expanded into flexographic printing
- FOGRA studies
Benefits of EG printing

- Ink inventories can be standardized
- Fewer wash-ups of ink trains
- No blanket changes
- Simple plate changes
- Gang run efficiencies
Why did we do this project?

- We wanted to see how selected corporate colors can be reproduced using expanded gamut printing
- Does expanded gamut printing fulfil the promises that it makes?
Equipment used in this study

- **Equipment:**
  - Heidelberg PM74-4P
  - X-Rite Intellitrac
  - X-Rite iSis XL (M1)
  - X-Rite eXact (M1)
  - GMG OpenColor V2.2
  - GMG ProfileEditor (V 5.10.1.121)
  - Epson SureColor P9000
  - Kodak Prinergy & Preps
  - Pantone Color Manager
  - Esko Equinox Profile Creator V14
  - Esko ColorPilot v14
  - Esko PackEdge v14
  - ColorThink

- **Materials:**
  - Offset inks from Hubergroup Canada
    - Black: 49 RL 2501
    - Cyan: 43 F 10 PX
    - Magenta: 42 F 10 PX
    - Yellow: 41 F 11 PX
    - Orange 2 ONX 51500
    - Green 4 ONX 51502
    - Violet 3 ONX 51501

- **Substrate:** Caroline 8pt C1S
## Selected Brand Colors

<table>
<thead>
<tr>
<th>Brand</th>
<th>Color 1</th>
<th>Color 2</th>
<th>Pantone#1</th>
<th>Pantone#2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telus</td>
<td>Green</td>
<td>Purple</td>
<td>376</td>
<td>2745</td>
</tr>
<tr>
<td>CIBC</td>
<td>Red</td>
<td>Yellow</td>
<td>201</td>
<td>137</td>
</tr>
<tr>
<td>RBC</td>
<td>Blue</td>
<td>Yellow</td>
<td>286</td>
<td>116</td>
</tr>
<tr>
<td>BMO</td>
<td>Blue</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Bell</td>
<td>Blue</td>
<td></td>
<td>7692</td>
<td></td>
</tr>
<tr>
<td>Canadian Tire</td>
<td>Red</td>
<td>Green</td>
<td>485</td>
<td>355</td>
</tr>
<tr>
<td>Cadbury</td>
<td>Purple</td>
<td></td>
<td>2685</td>
<td></td>
</tr>
<tr>
<td>UPS</td>
<td>Brown</td>
<td></td>
<td>476</td>
<td></td>
</tr>
<tr>
<td>Yahoo</td>
<td>Purple</td>
<td></td>
<td>527</td>
<td></td>
</tr>
<tr>
<td>John Deere</td>
<td>Green</td>
<td>Yellow</td>
<td>364</td>
<td>109</td>
</tr>
</tbody>
</table>
Test charts used (GMG)
Test charts used (Esko)
Processing of the files

- Test charts were processed using Kodak Prinergy workflow
- Screen angles:
  - 0 degrees for yellow and violet,
  - 105 degrees for Magenta and Green,
  - 165 for Orange and Cyan and
  - 45 for Black
## Screening angles

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated workflow started: rule set 'Pre-render Surfaces', rule 'Render Surfaces', event 'FinalOutputOk'. (2)</td>
</tr>
<tr>
<td>Outputting 1 surfaces (7 separation(s)) using the template CTP: Magnus_150lpi_Sonora at priority Normal. (16)</td>
</tr>
<tr>
<td>CIP3Processing: processing has completed.</td>
</tr>
</tbody>
</table>

- Output has finished. It was queued for 0.0 seconds and active for 49.6 seconds. 
- PrintLink files were output to the location `\\Prepress\PPJobs\PPFin\PM74`. 
- Screening Information: Separation: Yellow, Screen System: Maxtone, Dot Shape: Light Elliptical, Angle/PATTERN: 0, Ruling/Feature Size: 150, Calibration: 100LB_Coated CMYK. 
- Screening Information: Separation: Violet, Screen System: Maxtone, Dot Shape: Light Elliptical, Angle/PATTERN: 0, Ruling/Feature Size: 150, Calibration: 100LB_Coated CMYK. 
- Screening Information: Separation: Green, Screen System: Maxtone, Dot Shape: Light Elliptical, Angle/PATTERN: 105, Ruling/Feature Size: 150, Calibration: 100LB_Coated CMYK. 
- Tonal Control Information: Curve Source: Harmony.
Chart with test colors

Seven color side

Four color side
Dryback Results Old Formulation vs New Formulation

CMY Dryback results

KOGV Dryback results
DE00 Comparisons EG build vs. CMYK build

OpenColor and Esko vs CMYK

- OpenColor EG ALT
- OpenColor EG
- Esko EG
- CMYK set 1
- CMYK set 2

P109, P116, P137, P201, P286, P2745, P2685, P300, P355, P364, P376, P476, P485, P527, P7692
DE00 Comparison Esko EG build vs. CMYK build

Esko EG vs CMYK

- Orange: Esko EG
- Light Blue: CMYK set 1
- Dark Blue: CMYK set 2

DE00 Comparison GMG vs CMYK

Open Colour EG vs CMYK

- **OpenColor EG ALT**
- **OpenColor EG**
- **CMYK set 1**
- **CMYK set 2**

![Bar Chart](chart.png)
Pantone 109 - Similar DE00 - Slightly Different Composition

Pantone 109 EG OpenColor
DE2000: 3.93

Pantone 109 EG Esko
DE 2000: 3.91
Pantone 201 - similar composition yet different DE00

Pantone 201 EG OpenColor
DE 2000: 2.02
- Orange: 27.9%
- Black: 20.3%
- Magenta: 51.8%

Pantone 201 EG Esko
DE2000: 0.64
- Orange: 25.9%
- Black: 14.5%
- Magenta: 59.6%
Pantone 355 – Esko 4-color composition and successful alternative composition

Pantone 355 EG OpenColor
DE2000: 11.9

Pantone 355 ALT EG OpenColor
DE2000: 5.56

Pantone 355 EG Esko
DE2000: 3.55
Pantone 364 - Slightly Different Compositions

Pantone 364 EG OpenColor
DE2000: 5.4
- 45.1%
- 30.8%
- 24.1%

Pantone 364 EG Esko
DE2000: 3.61
- 53.5%
- 25.3%
- 21.2%
Colors with a lower DE00 than the 4c composition

- P201
- P286
- P2745
- P2685
- P364
Colors with a lower DE00 in their 4color composition

- P116
- P300
- P485
- P527
- P7692
Color gamut of the test patch charts
Color gamut with the test colors

GMG

Esko
Color gamut with the test colors (video)
Color gamut with the test colors (video)
DE00 color differences between the Pantone data and the measured colors

Average DE00: 7.07
DE00 color differences between the Pantone data and the measured colors

Average DE00: 4.30
Possible reasons for the observed color differences

- Solid ink density differences between the press run of the calibration patches and the press run of the test form
- Color differences in the process colors between the two press runs
- Tone value increase differences between the same press run
Possible reasons for the observed color differences

<table>
<thead>
<tr>
<th>Color</th>
<th>Ink density difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>-0.06</td>
</tr>
<tr>
<td>Cyan</td>
<td>0.08</td>
</tr>
<tr>
<td>Magenta</td>
<td>0.03</td>
</tr>
<tr>
<td>Yellow</td>
<td>0.05</td>
</tr>
<tr>
<td>Violet</td>
<td>0.07</td>
</tr>
<tr>
<td>Green</td>
<td>0.00</td>
</tr>
<tr>
<td>Orange</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Significant density differences in black, cyan and violet
Pantone color formulations

<table>
<thead>
<tr>
<th>Ink</th>
<th>Black</th>
<th>Cyan</th>
<th>Magenta</th>
<th>Violet</th>
<th>Green</th>
<th>Orange</th>
<th>Yellow</th>
<th>DE 00 measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 109</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11.09</td>
<td>94.71</td>
<td>3.93</td>
<td></td>
</tr>
<tr>
<td>P 116</td>
<td>0</td>
<td>0</td>
<td>20.88</td>
<td>0</td>
<td>0</td>
<td>85.29</td>
<td>7.97</td>
<td></td>
</tr>
<tr>
<td>P 137</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>55.94</td>
<td>53.67</td>
<td>7.82</td>
<td></td>
</tr>
<tr>
<td>P 201</td>
<td>100</td>
<td>0</td>
<td>90.3</td>
<td>0</td>
<td>0</td>
<td>48.59</td>
<td>0</td>
<td>2.02</td>
</tr>
<tr>
<td>P 286</td>
<td>28.05</td>
<td>30</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5.78</td>
</tr>
<tr>
<td>P 2745</td>
<td>28.29</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9.22</td>
</tr>
<tr>
<td>P 300</td>
<td>14.21</td>
<td>98.81</td>
<td>0</td>
<td>30.93</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.43</td>
</tr>
<tr>
<td>P 355</td>
<td>21.97</td>
<td>71.89</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>81.8</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td>P 355 alternate</td>
<td>20.85</td>
<td>-</td>
<td>0</td>
<td>88.14</td>
<td>0</td>
<td>50.04</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>P 364</td>
<td>49.37</td>
<td>38.74</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>72.38</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>P 376</td>
<td>13.12</td>
<td>35.77</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>92.88</td>
<td>10.07</td>
<td></td>
</tr>
<tr>
<td>P 476</td>
<td>75.02</td>
<td>0</td>
<td>18.12</td>
<td>0</td>
<td>0</td>
<td>39.18</td>
<td>0</td>
<td>7.54</td>
</tr>
<tr>
<td>P 485</td>
<td>7.89</td>
<td>0</td>
<td>84.42</td>
<td>0</td>
<td>0</td>
<td>77.24</td>
<td>0</td>
<td>6.51</td>
</tr>
<tr>
<td>P 485 alternate</td>
<td>7.89</td>
<td>0</td>
<td>97.11</td>
<td>0</td>
<td>75.28</td>
<td>8.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 527</td>
<td>12.9</td>
<td>59.63</td>
<td>83.93</td>
<td>0</td>
<td>0</td>
<td>10.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 527 alternate</td>
<td>11.16</td>
<td>-</td>
<td>57.21</td>
<td>65.31</td>
<td>0</td>
<td>9.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 7692</td>
<td>39.91</td>
<td>79.79</td>
<td>33.79</td>
<td>0</td>
<td>0</td>
<td>9.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 7692 alternate</td>
<td>39.71</td>
<td>63.41</td>
<td>39.19</td>
<td>0</td>
<td>0</td>
<td>7.61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Color differences in DE00 between test run and Pantone color press run

Color difference between test chart run and Pantone test color run (GMG)
TVI comparison

TVI comparison test chart run - Pantone test patch run

<table>
<thead>
<tr>
<th></th>
<th>K</th>
<th>C</th>
<th>M</th>
<th>Y</th>
<th>V</th>
<th>G</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>30%</td>
<td>25%</td>
<td>20%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>Pantone run</td>
<td>test chart run</td>
<td>Pantone run</td>
<td>test chart run</td>
<td>Pantone run</td>
<td>test chart run</td>
<td>Pantone run</td>
<td>test chart run</td>
</tr>
</tbody>
</table>
Conclusion

- Printing a seven-color job on a four-color press is not without its challenges
- Tight control of the ink densities is very important to minimize printed color differences
- Unknowingly we chose colors that were at the edge of the color gamut of the inks used in this project
- We learned a lot about screen angles, test charts, expanded gamut printing
Acknowledgements

- We are grateful to GMG North America for donating their OpenColor software and Esko for the donation of the required software applications.
- Our thanks go also out to Birgit Plautz and her team from GMG and Julian Fernandez from Esko for their support during this project.
- We like to thank print technician Peter Roehrig for his help during all the press runs.
- We would like to thank instructor Scott Millward for his help with the prepress work on Kodak Prinergy.
- We would also like to thank research assistant Victoria Porteus for all her work on this project.
- We would like to thank Hubergroup Canada for the donation of the inks for this project.
- We would like to thank the Faculty of Communication and Design (FCAD) for its support of the project through the FCAD travel grant that made the attendance of this conference possible.
- This project was funded by Ryerson’s Fall/Winter Work Study Program.
Thank you for your attention!

Contact information:

Martin Habekost, Dr. rer. nat.
Associate Professor
School of Graphic Communications Management
Ryerson University
mhabekos@ryerson.ca

Reem El Asaleh, Ph.D.
Associate Professor
School of Graphic Communications Management
Ryerson University
reem.elasaleh@ryerson.ca

Emilija Biga
Research Assistant
School of Graphic Communications Management
Ryerson University
ebiga@ryerson.ca