Polarization in Art Reproduction
Cross-Polarization

Or...

Observations, Intuition and Curiosities REGARDING Cross-Polarizing
Cross-Polarization

An expert is someone who has made every possible mistake in a narrow field.

—Neils Bohr
Cross-Polarization

A Quest for Information...

- We all have questions, concerns and objections to the results with polarization.
- There is almost no information available on cross-polarization related to art copy work.

...so inquiring minds want to know!
Cross-Polarization

A WORK IN PROGRESS
Why Polarizing is Needed
Why Polarizing is Needed
Cross-Polarization
Cross-Polarization
Why Polarizing is Needed

**SPECULAR REFLECTIONS**
The best controlled by polarizers and the type we most often have to suppress

**DIFFUSE REFLECTIONS**
Light scatters and changes polarity which passes the camera polarizer aiding in the exposure of the image.
Why Polarizing is Needed

SPECULAR HIGHLIGHT ON ONE GLOSSY BUMP (canvas or paint)
Aligning the Polarizing Filters

Filters Parallel  Partially Crossed  Filters Crossed

Polarizing filters on each of two copy lights and glass Polarizing filter on lens
Aligning the Polarizing Filters

- Filters Parallel
- Partially Crossed
- Filters Crossed
Why Polarizing is Needed
Aligning the Polarizing Filters

Robin Myers Imaging
Polarizer Alignment Card™

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www.rmimaging.com

2 Cards $14.95
www.RMimaging.com
Cross-Polarization

Change the angle of the lighting to avoid influence of stray light

Move the camera back so the angle of view with a longer lens can avoid the stray light
The Physics of Lighting

ANGLE A = ANGLE B

Sam Clemens calculates the angle of reflectance
Lights at 45° is the Best Compromise

Copy lights are setup at 45° to compromise between the intensity of incident light to the lens and elimination of reflections.

Intensity of Reflections:

- 90° = 100%
- 60° = 75%
- 40° = 44%
- 20° = 13%
**Lighting**

**INVERSE SQUARE LAW**

**DOUBLE THE DISTANCE = OPEN 2 F-STOPs**

Therefore: **HALF THE DISTANCE = CLOSE 2 F-STOPs**

And: **ONE QUARTER THE DISTANCE = CLOSE 1 F-STOP**
The 2X Factor

Light-to-Subject Distance vs. F-stop Gain / Loss

Light-to-Subject Distance in Feet

f-stop gain

f-stop loss

1/2 Stops

1.2 1.7 2.4 3.4 4.8 6.7 9.5 13.5 19 27 38 54

Full Stops

1 1.4 2 2.8 4 5.6 8 11 16 22 32 45 64

1/3 Stops

1.3 1.8 2.2 2.5 3.2 3.6 4.5 6.3 9 12.7 18 25.4 35.9 50.8

Archetype
Digital Imaging Alliance
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Put Lines on floor at 90° and 45° to have reference angle for light and camera positions and marks at 1 f-stop increments.
Lighting Options - 16” Parabolic
Lighting Options - 2’x3’ Fluorescent
Lighting Options - Diffusion Panel
Problems with Veiling Glare

Single 900w NorthLight at Varied Distances

36”  48”  72”  96”  144”  192”
Problems with Veiling Glare

TO VARNISH…
OR NOT TO VARNISH!

Contrary to what you might expect the varnished side has fewer glare problems than the side that is not varnished.

The varnish is filling the gaps in the canvas texture making a smoother surface.
Problems with Veiling Glare

- Original Canvas 8 ft. x 50+ ft.
- 13 Segments @ 450 MB 8-bit files
- 2 - NorthLight 900 watt Copy Lights
- No EquaLight or Photoshop Corrections
Problems with Veiling Glare
Problems with Veiling Glare
The Physics of Lighting

Short focal length lens has camera too close to subject and in path of stray reflected light. Moving back and using lens with narrow angle of view can avoid issues of veiling glare.
Problems with Veiling Glare

Focal Length Variations and Glare Reduction

135mm 51”
150mm 56”
180mm 66”
210mm 75”
210mm 108”
300mm 108”
Alternatives to Polarizing
Alternatives to Polarizing
Alternatives to Polarizing
Alternatives to Polarizing
If It Can Go Wrong... It Will Go Wrong!
If It Can Go Wrong... It Will Go Wrong!
Two Wrongs Can Make a Right!
If It Can Go Wrong... It Will Go Wrong!
If It Can Go Wrong... It Will Go Wrong!
If It Can Go Wrong... It Will Go Wrong!
Two Wrongs Can Make a Right!
Elements of Quality in SCAN

Exposure is critical to maintain maximum detail.

Representation of Linear RAW file with 6 f-stops of tonal range and 4,096 bits from black (1) to white (4,096).

The first stop of highlight values contains 2,048 tones - half of the data!

The last stop has only 64 bits of data, so the shadows will compress tones and have far more noise than usable data.
## Profiling Polarized Images

### Untagged Image Files

#### NO Polarization

- Target - RPRPO 2.2

<table>
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<th>243</th>
<th>201</th>
<th>161</th>
<th>122</th>
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<td>198</td>
<td>156</td>
<td>118</td>
<td>86</td>
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#### Filters - NOT Crossed

| 243 | 200 | 161 | 127 | 97 | 65 |

#### Cross-Polarized

| 243 | 195 | 149 | 107 | 66 | 36 |
Profiling Polarized Images

Profiles Applied to Charts

NO Polarization

<table>
<thead>
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<th>Target - REF: iso 2.1</th>
<th>243</th>
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<td>52</td>
</tr>
</tbody>
</table>

Filters - NOT Crossed

|                      | 243 | 199 | 160 | 118 | 84 | 51 |

Cross-Polarized

|                      | 243 | 200 | 161 | 118 | 84 | 51 |
Matte vs. Gloss Surfaces
Matte vs. Gloss Surfaces - No Polarizing
Matte vs. Gloss Surfaces - Polarized
Matte and Gloss Materials

Not Polarized
Very matte look with matte inks on watercolor paper.
Veiling glare washing out blacks and loosing color saturation.
No profile
Repro 2.2 tone curve

Cross Polarized
Polarization removed veiling glare and increased saturation and contrast.
Closer to visual perception of original.
No profile
Repro 2.2 tone curve
Profiling Polarized Images

Not Polarized
Both profiles match quite closely with exception of background detail which seems a bit hazy.
No Polarizing Profile #101
Repro 2.2 tone curve

Cross Polarized
Polarized image seems to retain some additional subtle detail in background brush strokes.
Polarization Profile #107
Repro 2.2 tone curve
Profiling Polarized Images

Matte Subject Matter - Cross Polarized

Classic 24 Patch Chart

Color Checker SG Chart

Cross-Polarized

Untagged

Profile Applied

243 200 161 118 84 51
Profiling Polarized Images
Why Polarizing is Needed
Why Polarizing is Needed

Section of painting: UNPOLARIZED

Using same unpolarized profile increases contrast and saturation which a good profile can correct.

Polarization “eliminates” highlights and shadows of texture by blocking specular highlights and compression of dark tones.

Section of painting: CROSS-POLARIZED

Profile (on both images): “color checker SG 9-06”
Why Polarizing is Needed

Section of painting:

VARIATIONS OF POLARIZATION

UNPOLARIZED

PARTIAL POLARIZED

CROSS-POLARIZED
Why Polarizing is Needed

Section of painting: Cross-Polarized

Top image had embedded profile of “color checker SG 9-06”, and was OPENED and CONVERTED to Adobe RGB 1998 on opening.

Then, the correct profile was APPLIED and then CONVERTED once again to Adobe RGB.

Bottom image was opened with the “color checker SG 9-06”.

A cross-polarized profile was APPLIED and then CONVERTED to Adobe RGB 1998.

There is a noticeable color shift in grass, roof and trees resulting in some loss of detail in shadows and slight posterizing on the red roof.

Conclusion...only CONVERT once for best results!
Metallics with Polarization

NO Polarization

Cross-Polarized
Metallics with Polarizations

NO Polarization

Cross-Polarized
Metallics with Polarizations

NO Polarization

Cross-Polarized
Conclusions & Assumptions

Use it when you need it...avoid it when you can!

- Cross-polarization will reduce light by about 3 f-stops (75%)
- Exposure conditions greatly increase chance of noise
- Less tone values are in darkest shades contributing to loss of dynamic range
- Contrast and color saturation will be increased
- Visual perception without polarization effects will differ from image capture
- Matte tones (especially dark) will record darker than equal glossy tone
- Cross-polarization can cut through glare of heavily matted surfaces
- Good ICC Profiles can match non-polarized and polarized results
- Lighting and exposure remain very critical for successful imaging
- Lighting can be “cheated” to boost amount of lumens on subject
- Partial polarization is sometimes needed to maintain texture and detail
- Cross-polarization will kill metallic gold in art and frames
- Using longer lenses and large diffuse light sources can avoid polarizing
- There will be a strong desire to find ways around polarizing
Cross-Polarization

I’LL BE BACK!