UV Measurement: Prescription for a Better Cure

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Similarities between Medicine & UV Curing

Medicine: Emphasis is on Preventative Medicine

"An ounce of prevention is worth a pound of cure"

UV Curing: Emphasis is on Preventative Maintenance

"An ounce of preventative maintenance is worth a pound of uncured ink"

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Comparing Medical and UV Worlds

Medical

- Medical History
- Visual Examination
- Diagnosis
- Natural Causes
- Sudden
- Abuse
- Malpractice

UV

- Job History or Job Log
- Visual Examination
- Diagnosis
- Natural Causes
  - Lamp output decays over time
  - Materials have a shelf life
- Sudden
  - Something breaks
  - Changes to settings
- Operator Error/Malpractice
  - Lack of maintenance
  - Changed/Wrong Settings
  - Tinkering with formulas

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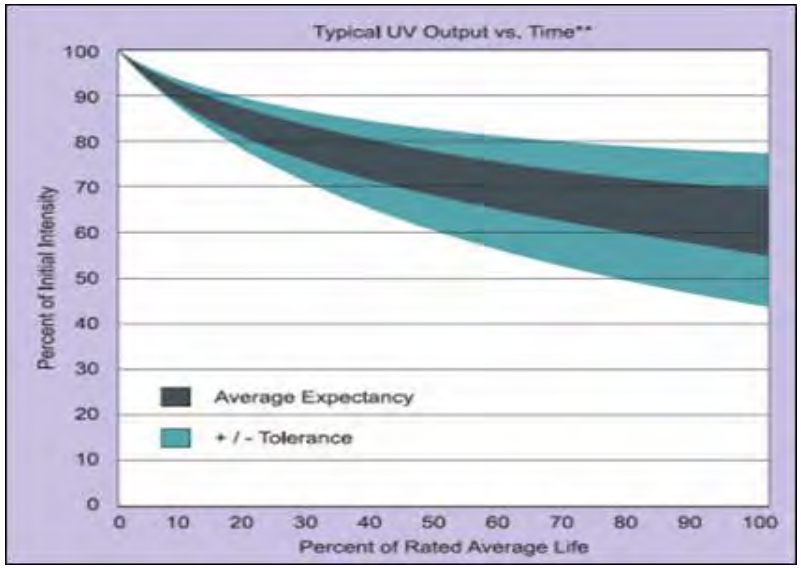
Natural aging



UV lamps age…

and so does (opened) ink.

Natural arc lamp aging

55” (140 cm) bulb

Irradiance mW/cm²			Data collected 3/24/16	
Band	Left	Center	Right	Highest Delta
UVA	797	983	635	35.4%
UVB	713	888	573	35.5%
UVC	200	257	167	35.0%
UVV	612	757	492	35.0%
Energy Density mJ/cm²				
UVA	243	282	234	17.0%
UVB	206	239	195	18.4%
UVC	58	68	55	19.1%
UVV	231	264	222	15.9%

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Un-Natural Aging

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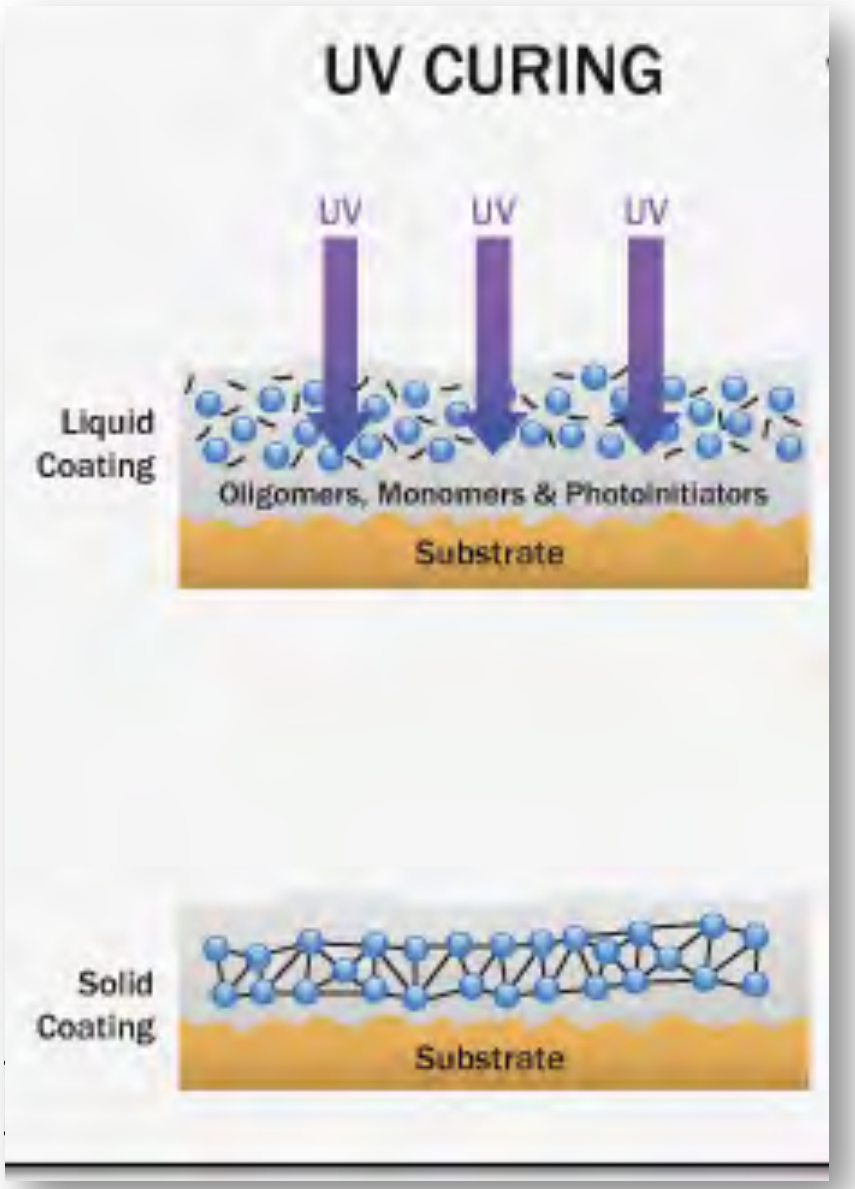
The UV Process



- **Irradiance (Intensity)**
- **Line Speed or Exposure Time (Energy Density/ Dose)**
- **UV Source Output**

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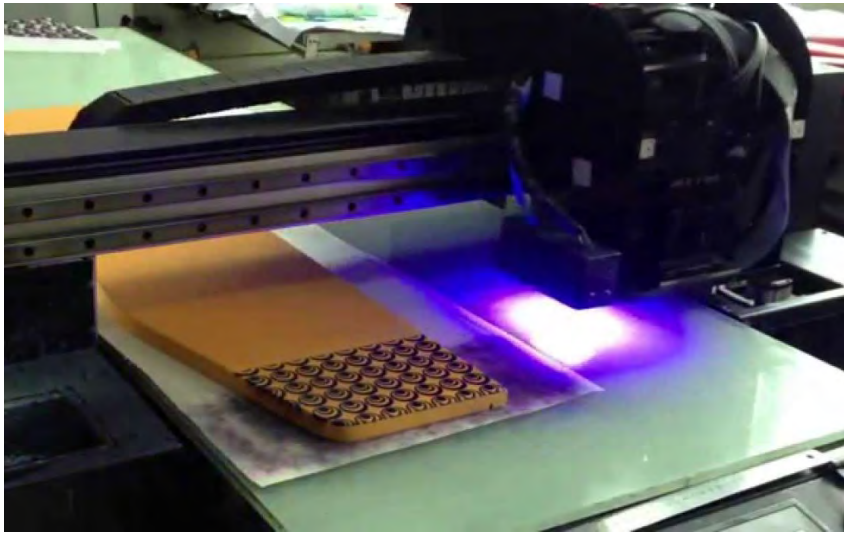
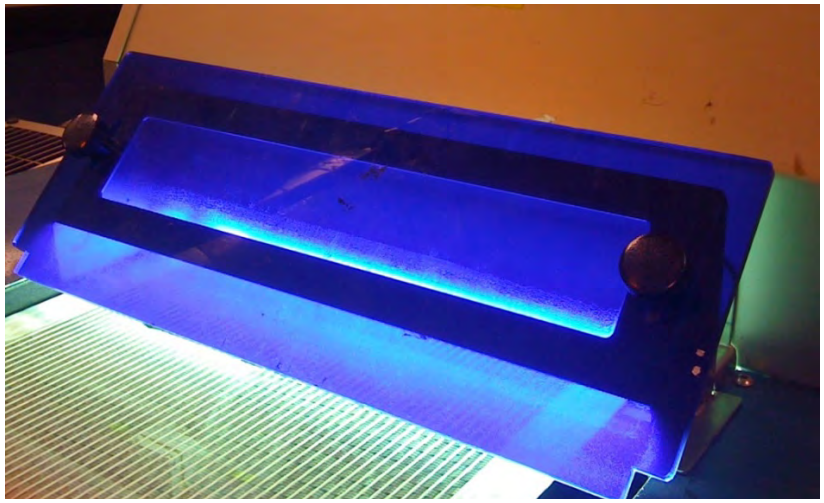
UV Source Meets UV Ink





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Variable: Ink Thickness & Color

Different pigments absorb UV light differently depending on thickness. The proper wavelength, irradiance and energy density of UV exposure may vary somewhat across the color spectrum.

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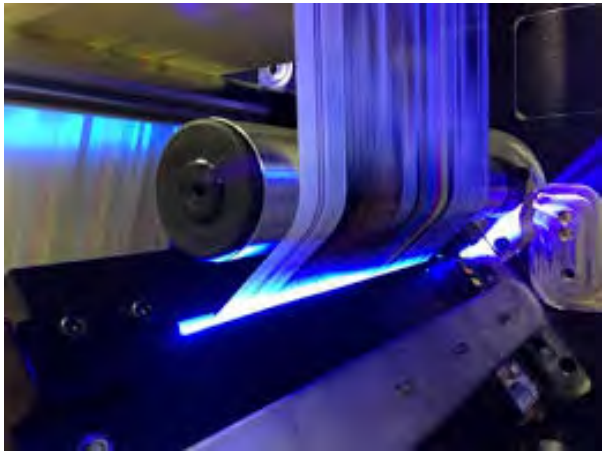
Variable: Substrate Color

1. Substrate color affects cure speed of a UV ink.

2. Substrates reflect UV, increasing speed.



3. Lighter colored substrates can increase cure speed as much as 20%

4. Transparent substrates with reflective support may also cure faster.

5. Advantageous in the printing of halftones and discontinuous solid patterns.

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Looking for Clues… or Clueless?

"What do you call the person that graduates last in his medical school class?"

Doctor

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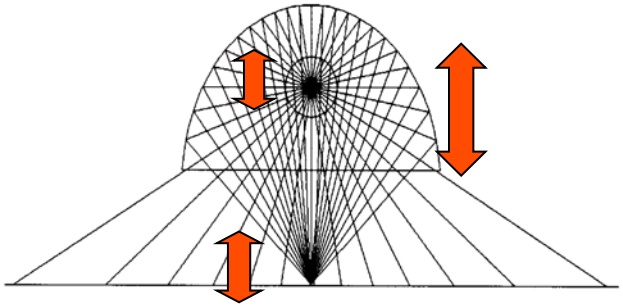
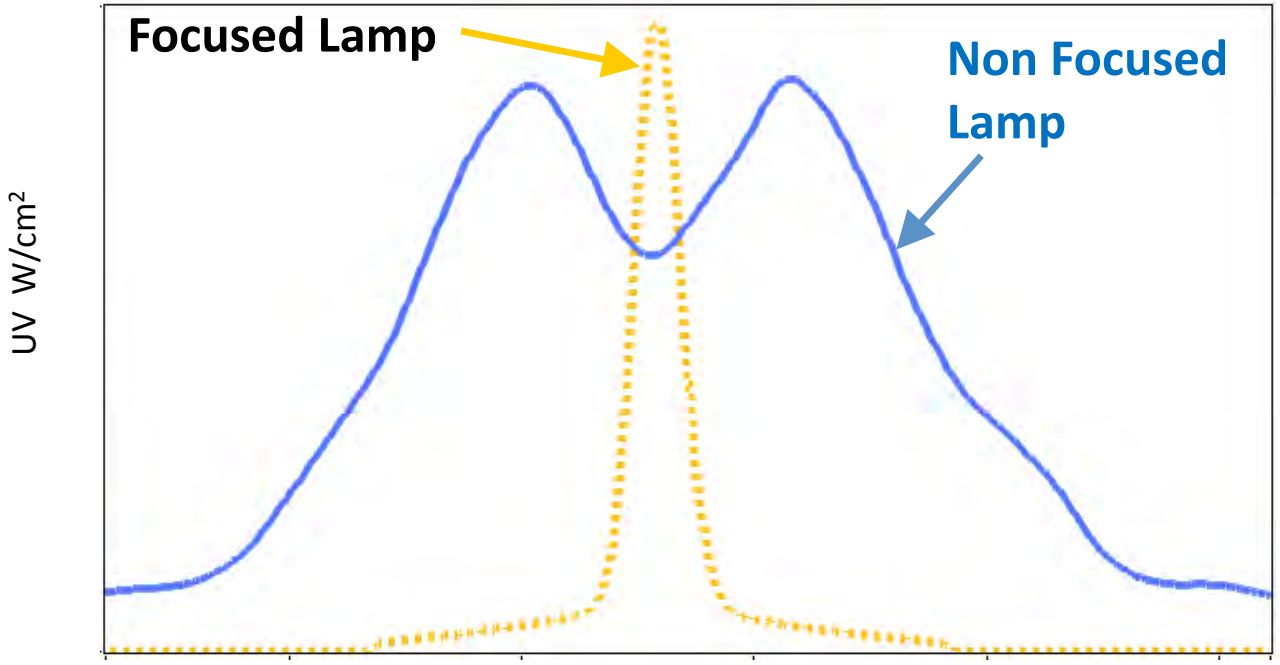
Distance Changes



- System Housing Moves
- Position/diameter of bulb
- Substrate Height Differences



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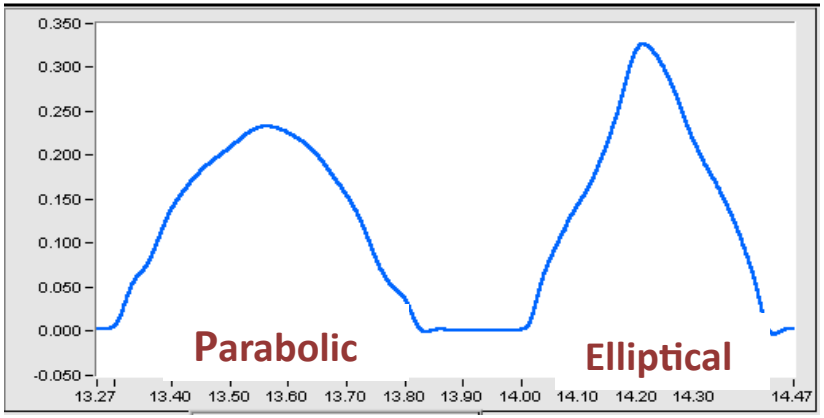
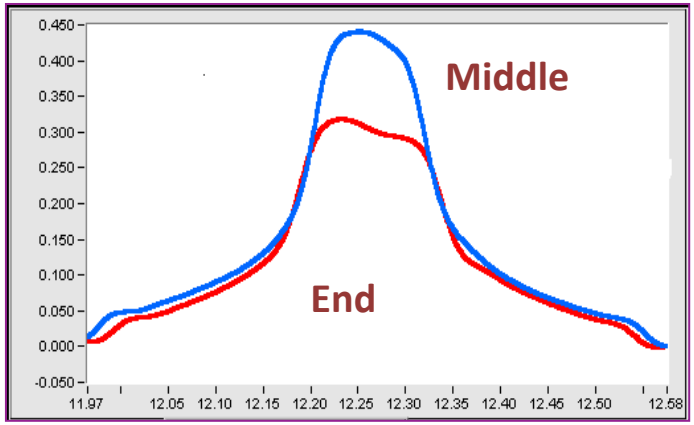
Interpreting Symptoms & Results

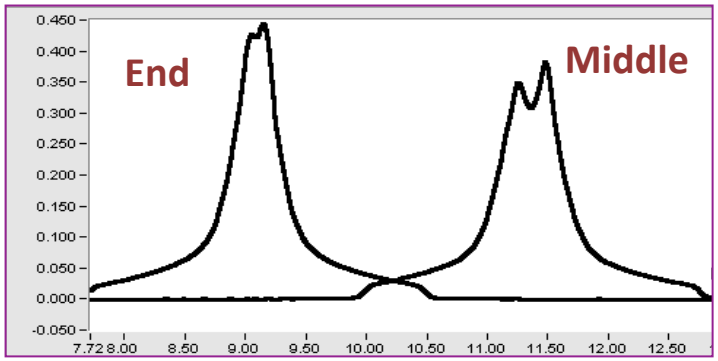


Reflectors



Aged Bulbs (Above)

Cooling Issues (Below)



Inspect Bulbs

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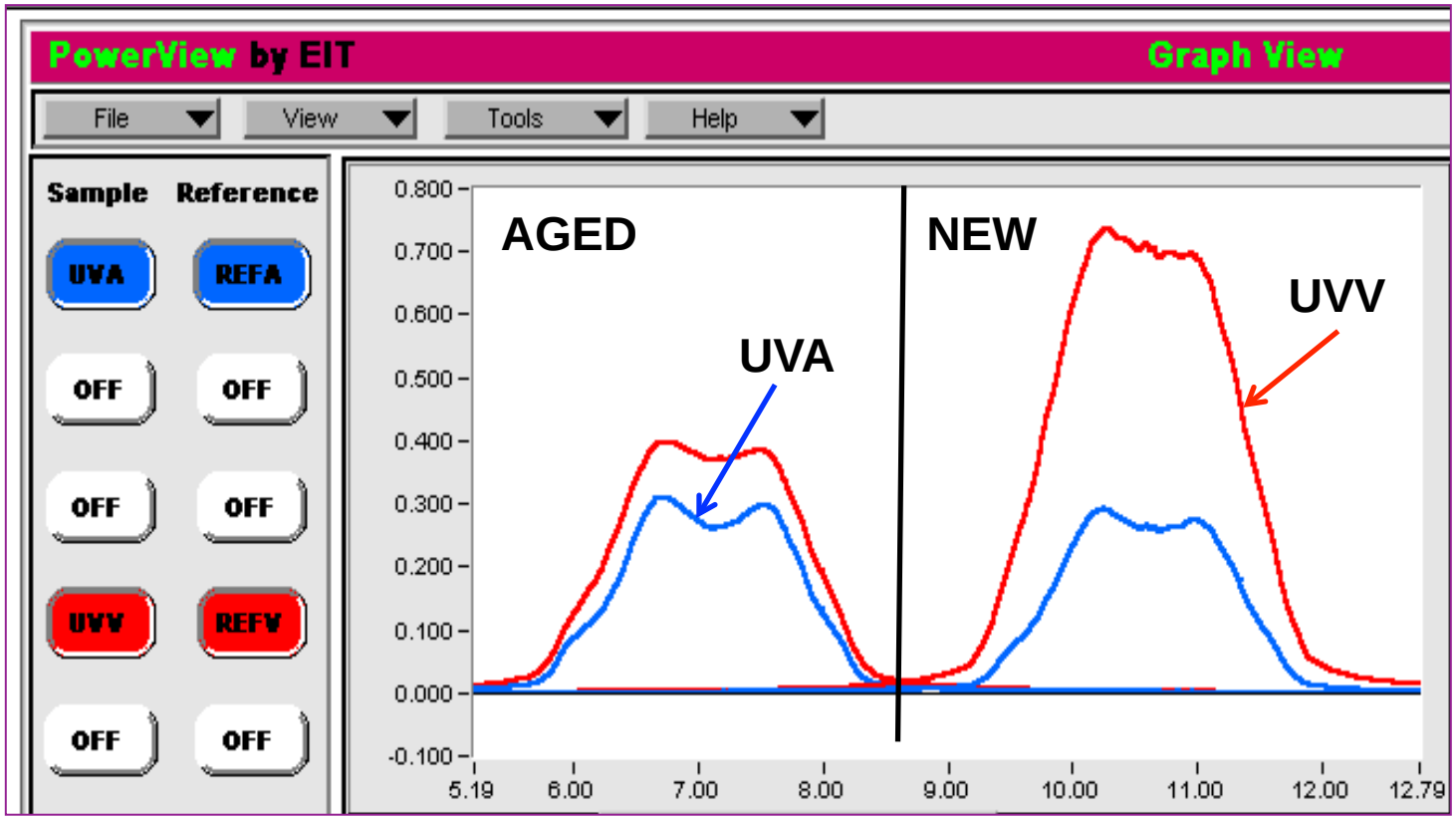
Lamp/Bulb Type or Aging



UVA Irradiance: 309 to 290 mW/cm²

UVV Irradiance: 397 to 734 mW/cm²

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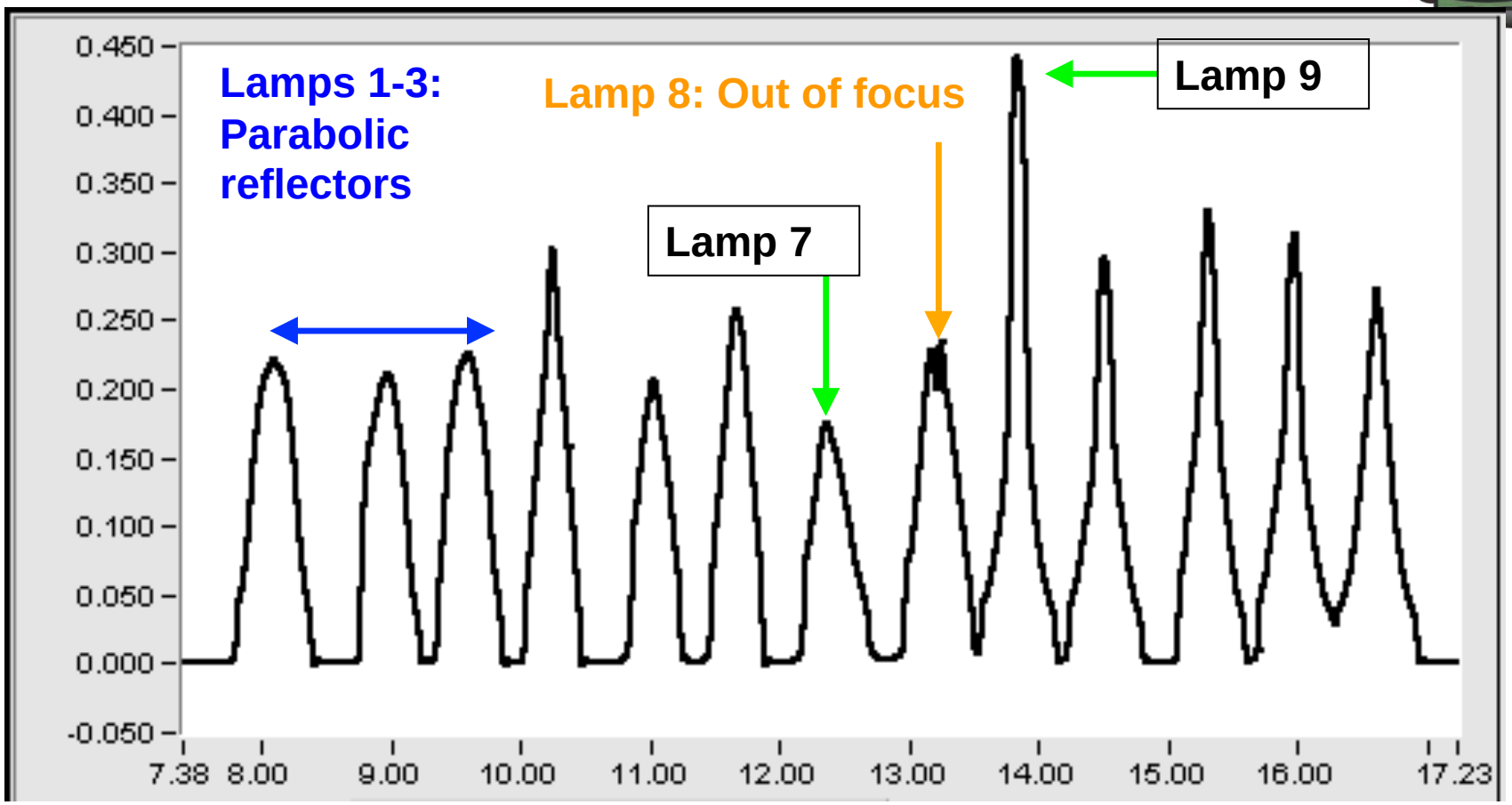
Multiple Systems or Multiple Passes



Lamp 7 to Lamp 9: 173 vs. 440 mW/cm^2 , 58 vs. 93 mJ/cm^2

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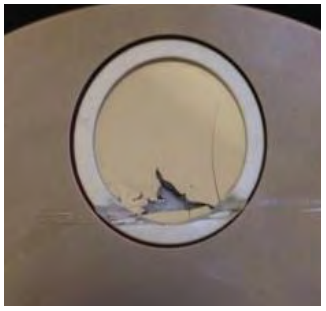
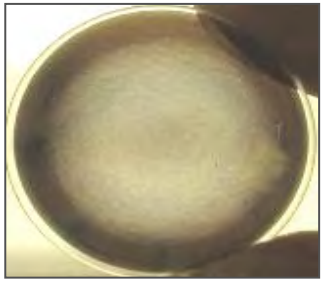
The Blame Game





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Instrument Cleanliness

Irradiance mW/cm²			
Band	Before	After	Difference
UVA	1223	983	-19.6%
UVB	1066	888	-16.7%
UVC	277	257	-7.2%
UVV	889	757	-14.9%

Energy Density mJ/cm²			
Band	Before	After	Difference
UVA	349	282	-19.2%
UVB	284	239	-15.9%
UVC	75	68	-9.33%
UVV	309	264	-14.6%

Data collected 3/24/16

Before: Data collected with contaminated optics

After: Data collected after cleaning

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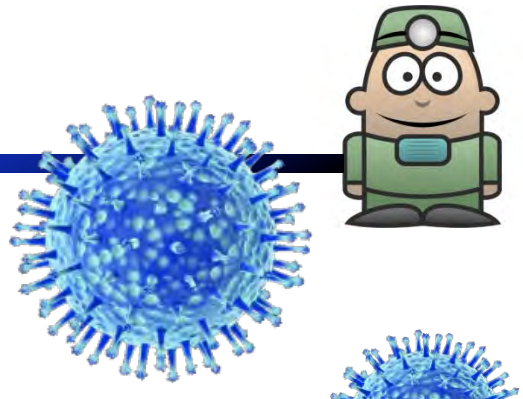
Problem: The Print Flu



Symptom(s)

- Losing Adhesion
- Smells Funny
- Loss of Gloss
- Wrinkly Ink
- Soft Surface
- Blocking / Offsetting
- Rewetting

Diagnosis

- Under-cure

Test(s)

- Check wavelength / output
- Add clear
- Increase cure output
  - Intensity
  - Dose
- Lower ink deposit
  - Higher mesh
  - Harder / Sharper Squeegee
  - Adjust flood

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Problem: Print Osteoarthritis

Symptom(s)

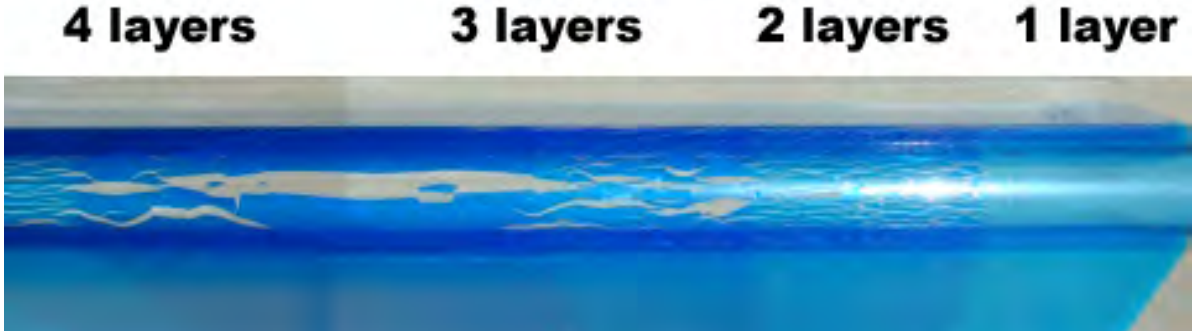
- Ink chipping when flexed
- Cracking Substrate

Diagnosis

- Over-cure
- Too much heat

Test(s)

- Reduce UV output
- Check temperature at press and in the stack
- Reduce ink deposit



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Problem: Rashes and Spots

Symptom(s)

- Spotty Adhesion
- Spotty Gloss
- Offsetting in certain places

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Diagnosis

- Uneven cure
- Uneven press set up
- Unmixed ink
- Inconsistent Substrate

Test(s)

- Same tests for under-cure
- Print an even % halftone for entire image area
- Mix ink and try again
- Dyne Test

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Problem: Uneven Coloring

Symptom(s)

- Uneven color
- Surface bubbles & pitts

Diagnosis

- Settling of the Ink

Test(s)

- Remove ink – mix - print

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Not Curing?

- Maintain System
- Establish Baseline (Targets) when curing
- Track & Record Key Process Parameters
- Physical Exam
- Radiometer Exam (Watts & Joules)
- Irradiance Profile (Watts as a function of time)
    - Analyze system over time
    - Compare multi-lamp systems
    - Trouble shoot
    - Lamp focus
    - Determine lamp type
    - Power supply analysis

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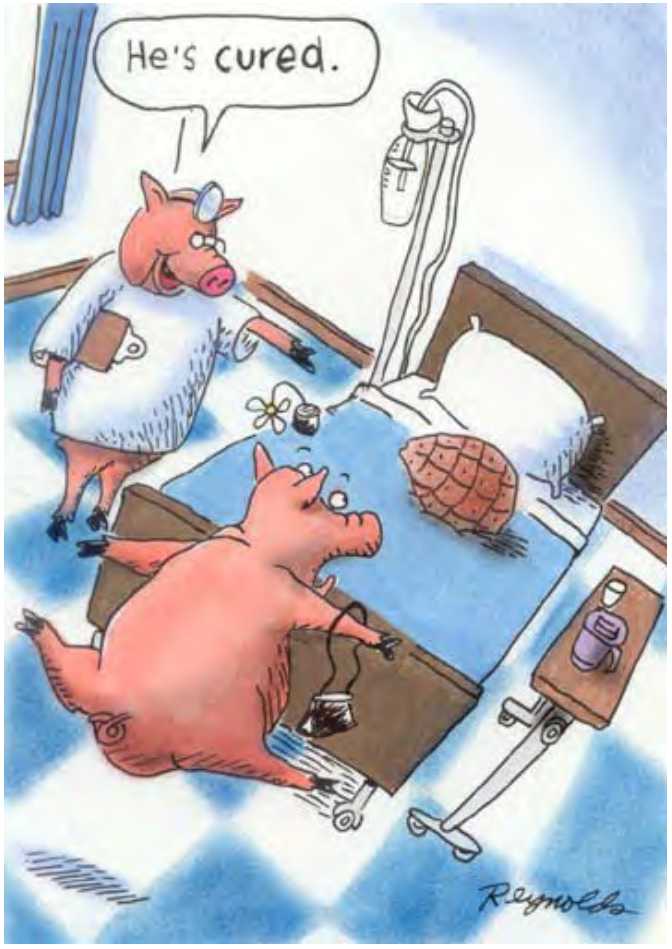
Prescription for Profit

- ✓ Establish a baseline.
- ✓ Establish a process window.
- ✓ Make measurements routinely.
- ✓ Measure consistently. Same location, speed, device
- ✓ Document test procedures
- ✓ Label & mark equipment
- ✓ Calibrate all of your tools
- ✓ Communicate



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