



Building Leadership Excellence



Continuous **Color**ation of Coatings for Coated Paper and Board

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RETHINK PAPER:
Lean and Green

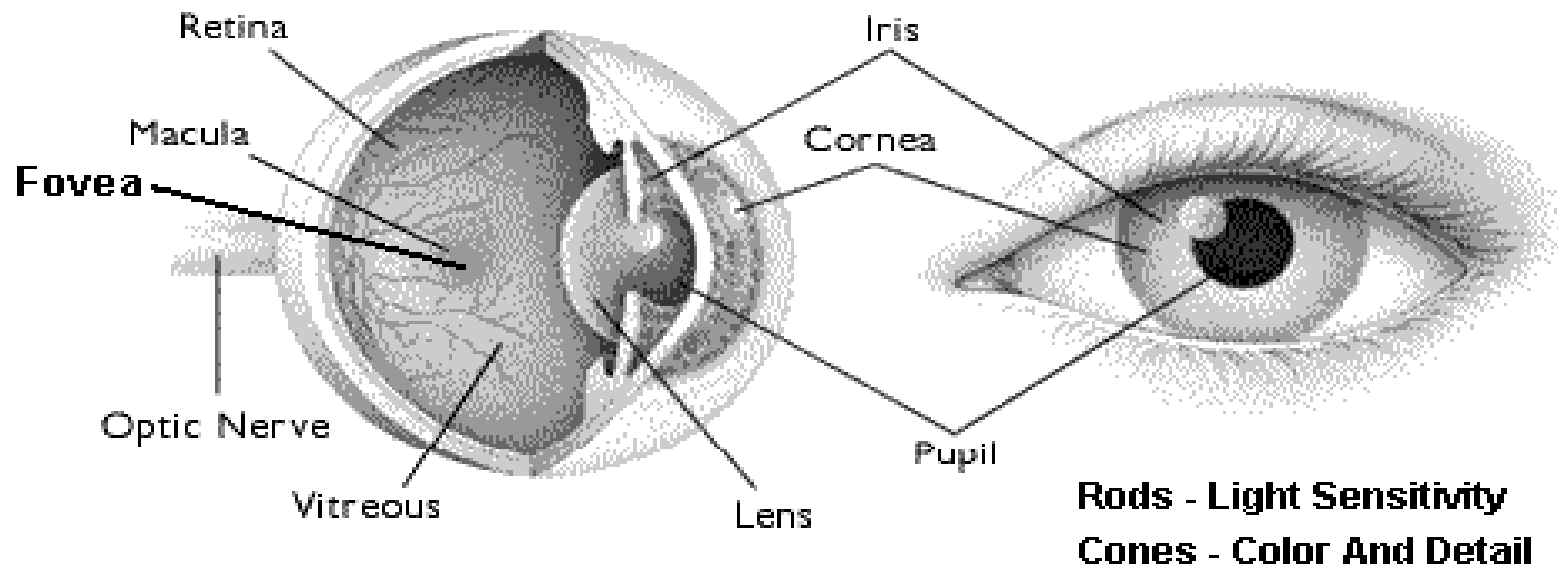
Why Even Worry About Color (or Shade)?

- ***“Marketing psychologists state that a lasting impression is made within ninety seconds and that **color** accounts for 60% of the acceptance or rejection of an object, person, place, or circumstance. Because color impressions are both quick and long lasting, decisions about color are critical factors in the success of any visual experience.” - About Color***
- **The fields of shade (or color) and appearance are critical to the acceptance of paper and board products, yet these product attributes are often overlooked. Or, systems to support them are often an afterthought in the design and operation of a paper machine or coater.**



What is Color?

Anatomy of the Eye



Color processing is done in the brain and is therefore subject to the interpretation of the viewer.

What Makes Color?



Light
Source



Object

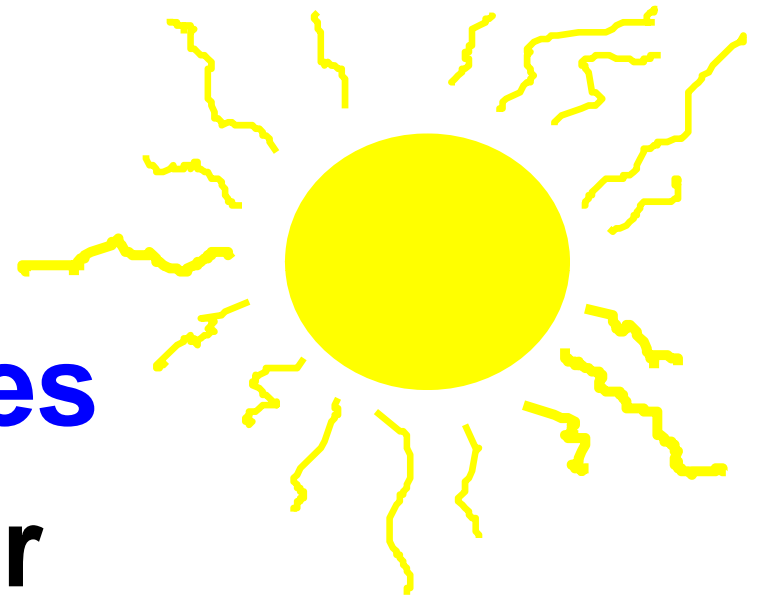


Observer
(Eye - Brain)

Color=(**Light Source**) x (Object) x (Observer)



**Common
Light
Sources
for
Color
Viewing**



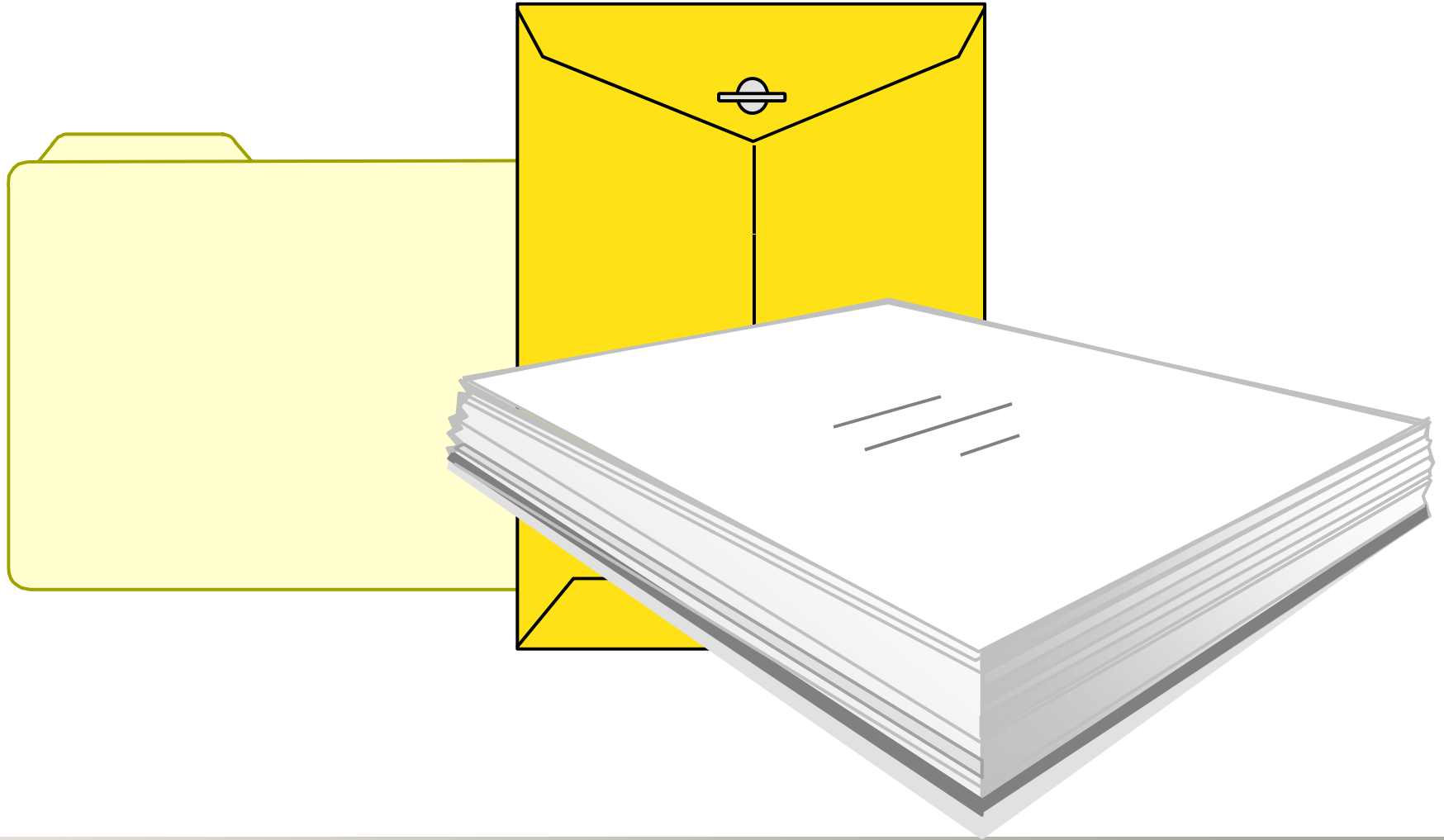
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COMMON COLOR LIGHT SOURCES

- **Incandescent (most home lighting)**
- **Cool White Fluorescent (most office lighting)**
- **Daylight (outside lighting)**



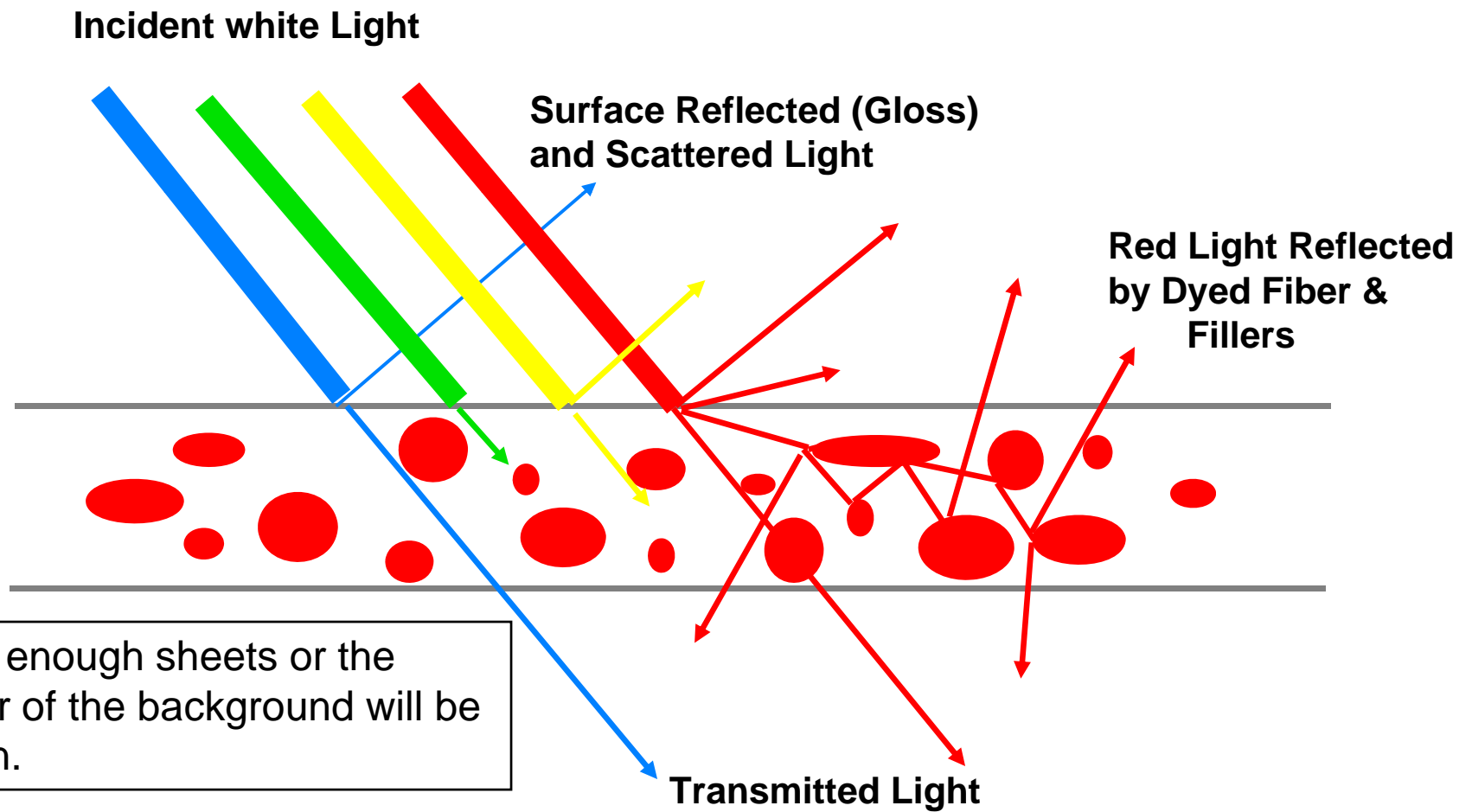
Color=(Light Source) x (**Object**) x (Observer)



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The Interaction of Light with Paper



$$\text{Color} = (\text{Light Source}) \times (\text{Object}) \times (\text{Observer})$$

- Different people see color differently due to:

- Age

- Macular Pigment

- Number and ratio of *rods* and *cones*

- **Some average or "standard" observer of color must therefore be established for consistent color measurements to be determined for any object.**

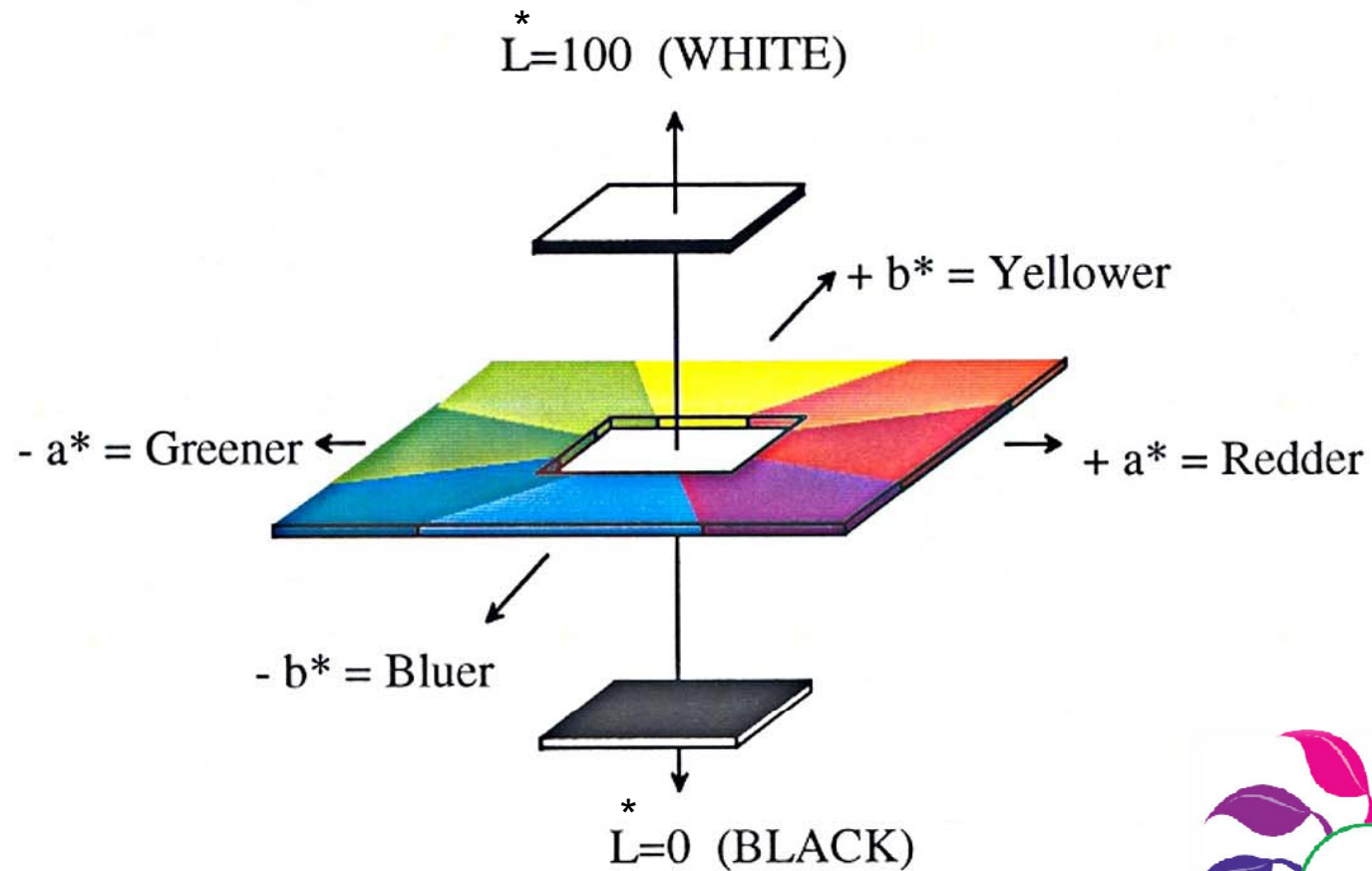
***For more information on color, see Principles of Color Technology by Billmeyer & Saltzman.**



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CIELAB Color Space



What If We Changed the Way We “Colored” On A Coater?

- And, we treated the coater on a paper machine or off-machine coater (OMC) like size presses on some paper machines . . .
- Adding dyes and optical brightening agents (OBAs) there continuously?
- Finally! We'd have the ability to adjust shade throughout a reel right at the coater.
- Shade adjustment would no longer have to be done batch-wise.



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So What? What Are The Advantages?

- Shade control could be done continuously, fine-tuning the appearance of the finished product.
- When an Off-Machine Coater is used, there would be the possibility to correct shade versus downgrading or broking the product.
- The “heels” of coating batches would not need to be dumped when it was time for a shade change (if only color needs to be altered).



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Are There Any Other Advantages?

- Shade development could be done much more quickly for new grades.
- It is possible that 2-sidedness in shade and fluorescence could be minimized or eliminated – without altering the amount of coating applied to one side of the sheet versus the other.
- There would not be “ruined” batches of coating due to the addition of too much dye or OBA.
- No need to “doctor” batches of coating.



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Are There Precedents for Doing This?

- **Yes. Originally dyes [often powders] were added to uncoated paper machines in batch quantities (e.g. in a hydropulper*).**
- **Later, liquid dyes were introduced to paper machines, and they were added continuously with adjustment to achieve and maintain shade.**
- **Dyes were added at the wet end of the machine first, and later papermakers began adding them to size presses (and even calender boxes) near the reel.**

***Note: This is still done, and color “trimmed” with liquid dyes for deep shades in some mills.**



Why Bother? What Are the Losses Now?

- There is currently no way to adjust shade “on the fly.”
- This means that paper is either broked or downgraded and sold for a lesser price than its full value when the color is off.
- Broking or downgrading paper means that there is a loss which drops directly to a paper company’s bottom line.
- From a sustainability point of view, there is additional energy, raw material, water, labor, etc. necessary to fill a customer’s order.
- Sewer losses are reduced, energy is saved, more money is made when we produce the right shade of paper the first time.
- And, run-to-run shade match can be greatly improved!



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So How Much Money Are We Talking?

- That's a very good question. And paper companies do not really talk about the potential.
- **Why? Because to our knowledge, no one has “run the numbers” on this opportunity.**
- Or . . . if they have, they certainly are not making this information public.
- **No one likes to talk about the losses or inefficiencies in their process.**
- But, we can say that some large paper companies have shown interest in this project.
- **We have personally seen significant amounts of paper downgraded due to coating shade.**



What Would Be Required On A Coater?

- Dye and OBA would need to be added to the coating delivery line, close to the coating head.
- Adequate mixing would be required to distribute the dyestuffs homogeneously throughout the coating.
- It will be necessary to have good color, fluorescence, and brightness measurement of the coated paper.
- Closed-loop color control is highly recommended as there will be a ramp-up of dyestuffs in the coating with recirculation of coating.
- A team should be assembled to pull it off.



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Let's Get Specific – Dye Where?

- Dye and OBA should be added as close as possible to the coating head while still achieving good mixing.
- Two process elements which provide good mixing are the Moyno coating delivery pump and the coating screens.
- If additional mixing is necessary (not likely) OR if it is desired to have dye and OBA introduced even closer to the coating head, then an in-line mixer (e.g. Kenics) can be used.
- See the photo on the following page from pilot work on the CIC coater at Trois Rivières, Quebec.



What Would Be Required To Do It?



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Will This Give Adequate Mixing?

- Simulation work by Chang Park, a former IP employee with strong skills in fluid dynamics, predicted excellent mixing results.
- The work mentioned above showed dramatically that with minimal mixing in the coating line (passing through the coating filters only), complete mixing was achieved.
- What did the pilot machine work show?



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How Did the Dye Mix In the Trial?



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How Did It Work On the Machine?

- Two separate trials were executed to evaluate the mixing/coverage of the colorants when added to the coating directly in front of the coating delivery pump (suction side).
- The 1st trial used a combination of a light, aqua-colored tinting dye and an OBA.
- When evaluated at the reel, it was obvious under “black light” that the coverage was good and continuous.



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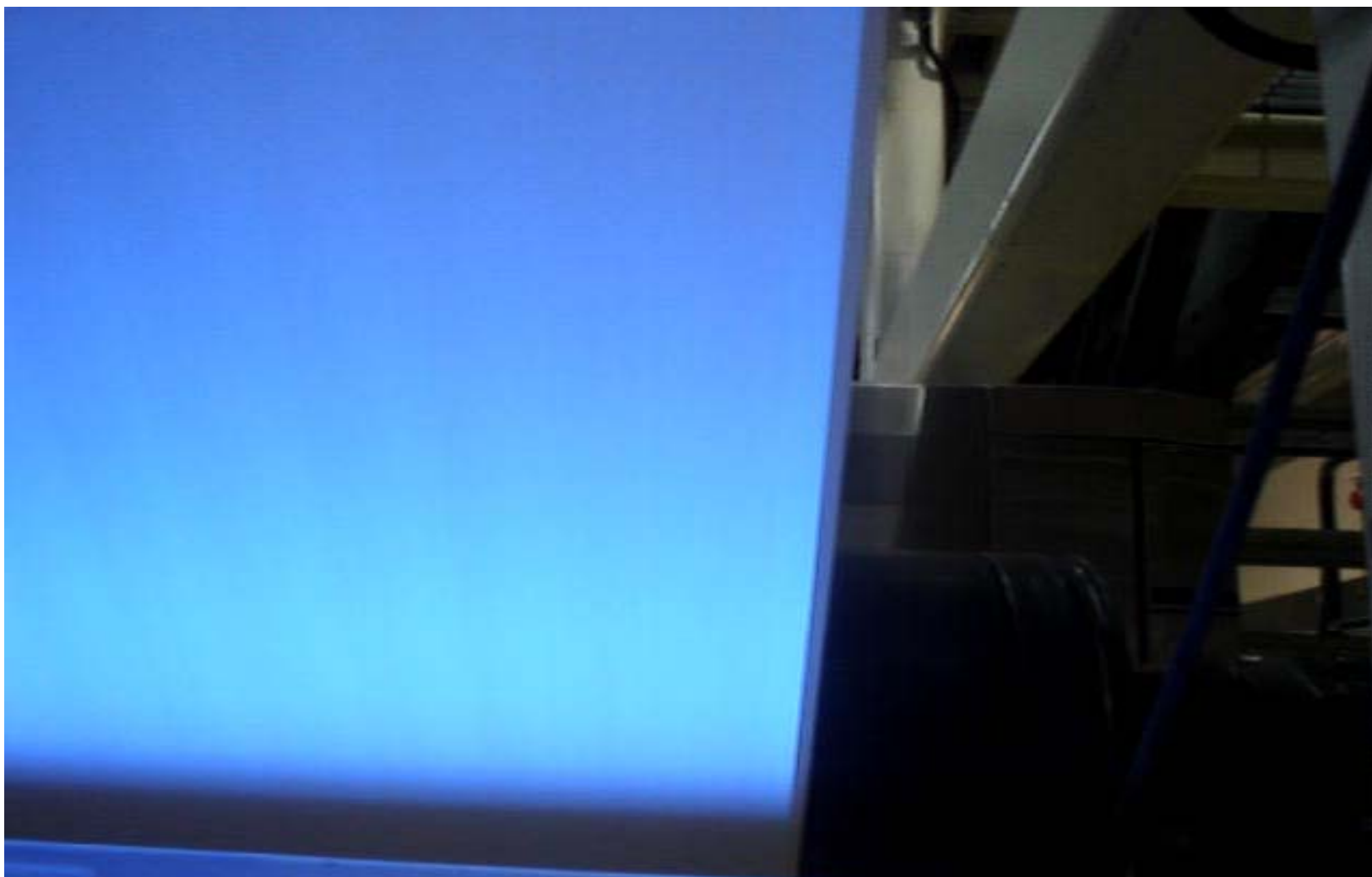
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Here's Some of The Machine Run



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Steady State Run



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What About Trial 2?

- In Trial 2, a violet-shaded pigment was applied much more “deeply” than would be seen in white papers. It also demonstrated thorough coverage on the sheet.
- NOTE: No dyestuffs were used in the basesheet (pre-made).
- On the next 3 pages, please see the layout of the equipment (wet end) and the resulting paper from Trial 1 (aqua dye with OBA) and Trial 2 (violet dyestuff).

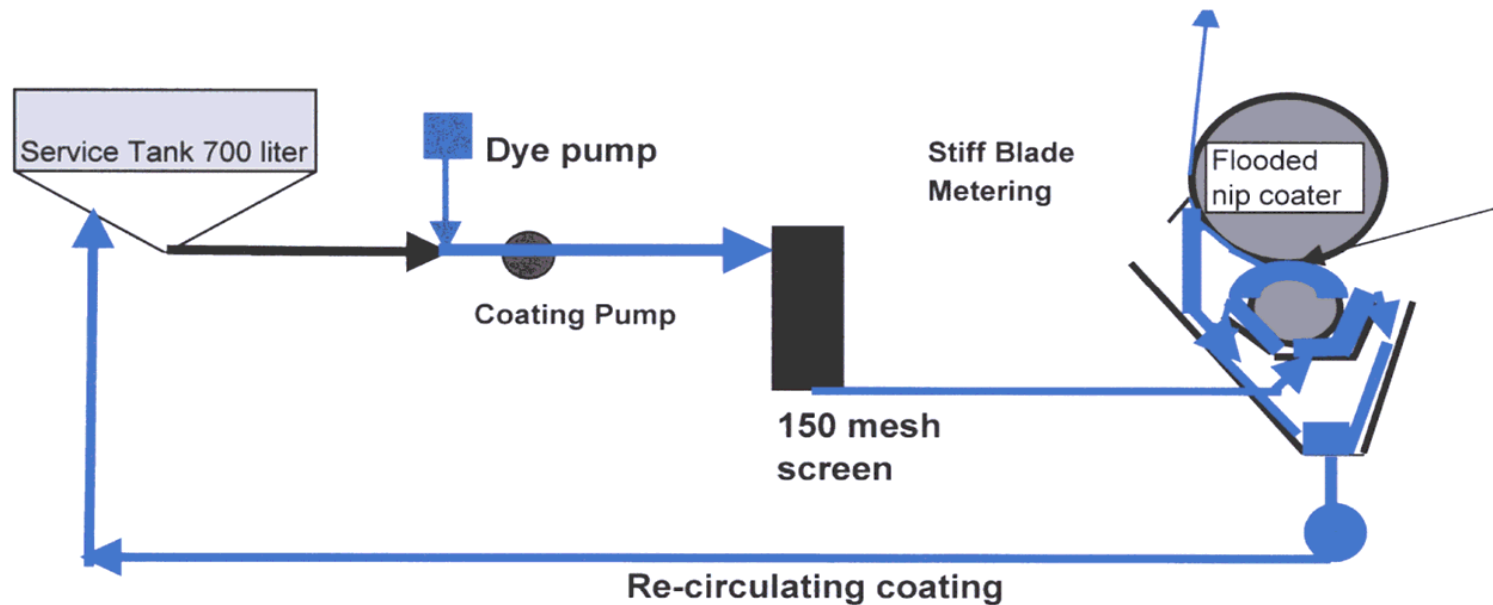


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How Was the Equipment Setup?

SOLAR T BLUE TRIAL CIC TRIAL 2005-98 COATING SYSTEM & DYE ADDITION POINT



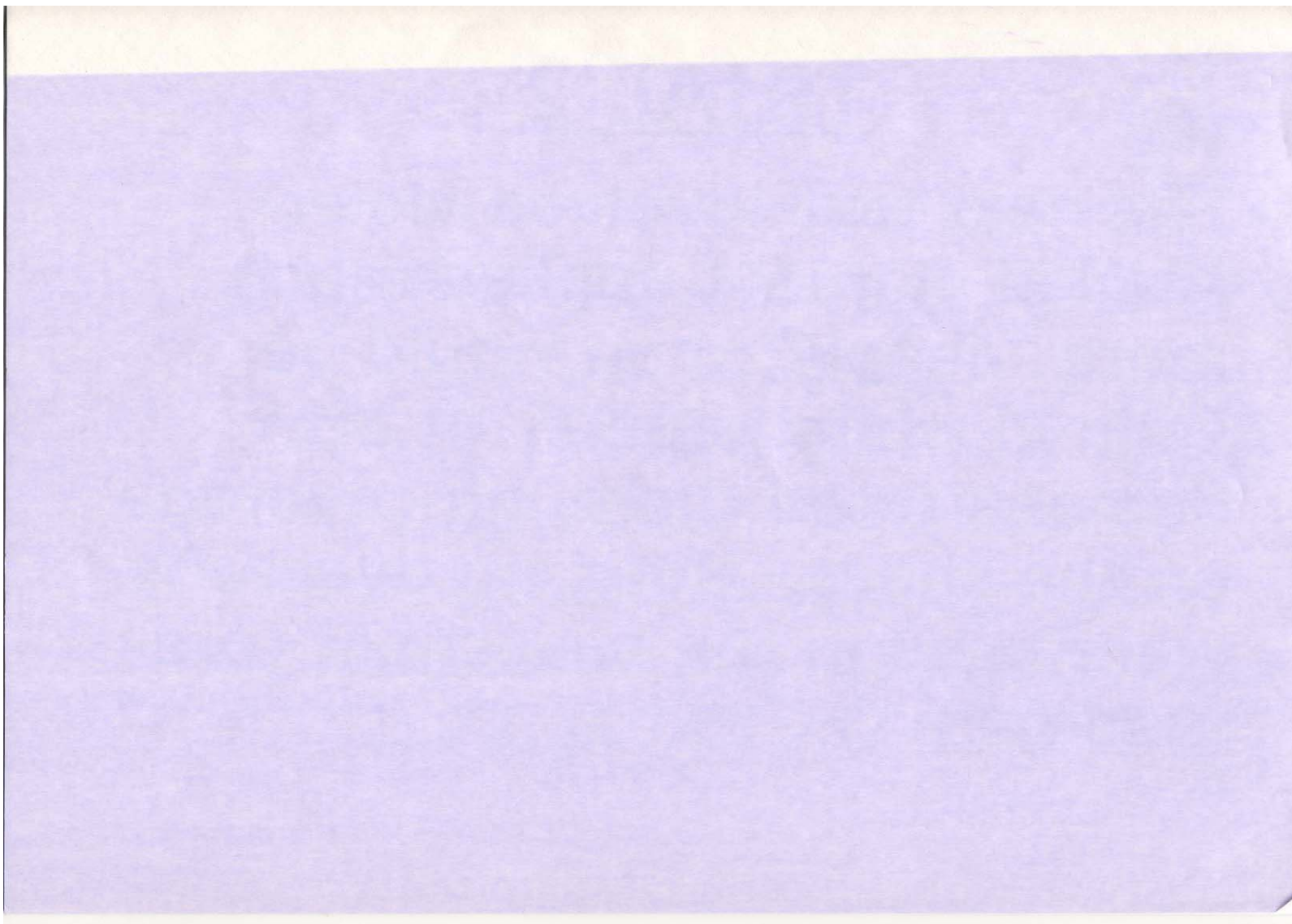
Aqua Sheet With OBA – Trial 1



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Violet Sheet – Trial 2



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Summary

- Traditionally, coated paper and paper-board mills have tinted the coating of white papers in the coating batch-wise.
- This has several disadvantages:
 - There is a long lag time between coating makedown and use at the coating heads. During this time, shade can not be adjusted in the coating either for grade change or tinting adjustment to stay on shade.
 - Coating which remains at the end of a grade run must be dumped if it is of a different shade than that of the new grade.



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Summary

- With continuous adjustment of the tinting dyestuffs going into the coating:
 - Shade 2-sidedness can be eliminated.
 - No more doctoring of coating batches.
 - Full coating batches would not be ruined by the accidental overdosing of dyes and OBAs.
 - Rapid prototyping of new products for coating shade can be achieved since the dyes can be adjusted continuously until the desired shade is achieved.
 - The finished product shade can be optimized, not compromised.



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