W1.1 Image Quality of Printers NCITS W1.1 2002 – 029
Gloss and Gloss Uniformity
Yee S. Ng, June 13, 2002

Gloss/gloss uniformity ad hoc Teleconference Meeting Notes
(6/11/2002 teleconference)

Present: Chung H. Kuo (NexPress), Dale Mashtare (Xerox), Jeff Wang (NexPress), John Kessler (Paxar).
Absent members:
Norm Burningham (HP), Ted Bouk (Kodak), Eric Schneider (HP), Yee Ng (NexPress), Eric Zeise (NexPress)

Next Teleconference: Tuesday June 25, 2002 @ 1:30 PM EST

Agenda

1. Review/modify agenda
2. Discuss measurement method and result.
3. Schedule next teleconference

The Gloss/gloss uniformity ad hoc met on 6/11/2002. The ad hoc team discusses the preliminary result summary (by YN) and the differential gloss experimental report (by CK) distributed before the meeting (by YN). Both the preliminary result summary and the report are included with this Meeting Minute.

Preliminary Results:

Basically the observations was

(1) With the differential gloss test chart (remember this is really an objective measurement test chart, not a subjective test chart - we use it anyway for now), if the dark patches are glossier than the light patches, then the print samples (5 additional ones) fall in line with the 5 anchor prints on the subjective versus objective measurement scale.

(2) If the samples are too glossy (in this case for 60 degree measurements) and saturation occurs (judged from the fact that many patches get to very high number and even the lowest gloss value patches have high gloss values), then the subjective versus objective measurement does not follow the 5 anchor point chart. Of course in cases like this, it is anticipated that a different angular gloss measurements should be used and we need to work on the threshold for this to happen. We are currently working on a gloss discrimination study to get a better understanding of this area.

(3) Some samples that exhibit an objective gloss reversal between 60 and 85 degree gloss measurement - those samples also failed the subjective versus objective chart. One countermeasure that we have discussed is to restrict the subjective test viewing angle at a set-point with freedom of limited rotation, so if we are interested in the 60 degree gloss scale, at least we know the human subject in fact is looking at the samples at that angle but with some sample rotation capability to distinguish differential gloss. This refinement is being tested now.

(4) The remaining non-conforming samples (some have the gloss angle reversal issue as well) fall into the category that the dark patches are less glossy than the light patches. It appears they fall on a different slope of the subjective versus objective scale than the dark (glossy) versus light (less glossy) samples. CK is now studying this effect and may need more samples to produce a better test chart for subjective measurement.

The Differential Gloss Experiment Report below:

Differential Gloss Pilot Experiment Report

Chunghui Kuo

Objective:

This is a pilot visual experiment to identify the relationship between the measured differential gloss and human visual response.

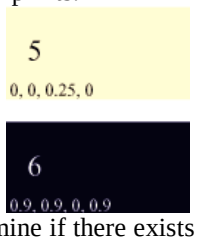
Experiment Method:

The "*NCITS W1.1 Differential Test Target*" is adopted for observers to judge the amount of differential gloss among patches. This test target is printed via various printers and paper types, including *Xerox*, *HP*, *Lexmark* and *NexPress*. 60-degree and 85-degree gloss readings were recorded.

The experiment was conducted in an illumination-controlled environment, and it can be separated into three parts:

1. Five anchor prints are identified which contain various amount of differential gloss among patches. A magnitude estimation experiment was conducted where observers were instructed to rate the visual gloss difference according to their own scale. A ratio scale was obtained after some mathematical analysis.

2. Twelve remaining prints are then became subjects to be judged upon. The previous five prints with calculated scales were used as anchor prints. Observers were instructed to place each test page among anchor prints and assign a corresponding number regarding the perceived differential gloss relative to the scales of anchor prints.



3. Patch 5 and 6 were selected to examine if there exists other factors except the algebraic difference between measured gloss affecting visual gloss difference. Another magnitude estimation experiment was adopted, and observers were asked to assign a number which is most appropriate for the perceived differential gloss.

Experiment Results:

Anchor Print Experiment:

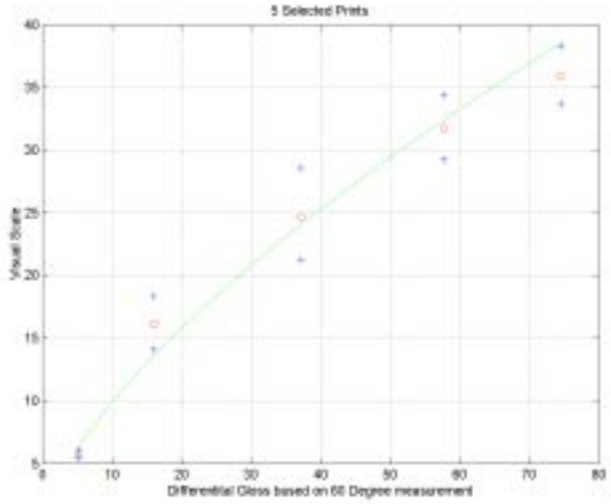


Figure 1: Ratio Scale for Five Anchor Prints

Figure1 shows the relationship between the algebraic Max-Min gloss difference among patches and the visual score. It shows a satisfactory fit to a power function with exponent approximating to 2/3.

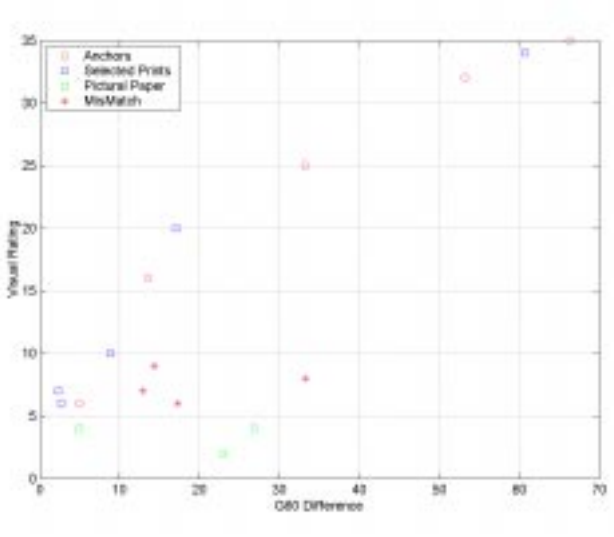


Figure 2: Test Prints compared with anchor prints

Anchor Comparison Experiment:

Figure2 illustrates the visual rating on twelve test prints based on the identified five anchor prints. Although the differential gloss visual ratings of some prints are close to the fitted function derived from the previous experiment, this experiment clearly shows that the algebraic gloss measurement difference is insufficient to completely explain differential gloss perceived by human beings. Among the discrepancies, we can further separate them into two scenarios: One case is when the whole print is very glossy, and the other case appears to have light patches being glossier than the dark patches according to the 60-degree gloss reading. For the first scenario, we believe that the overall high glossiness decreases the sensitivity of observers such that a lower rating was given compared with other less glossy prints. This is also implied by the previous experiment where a power function with exponent being less than one. However, it is less obvious for the other scenario. Furthermore, the viewing angle was not fixed during this experiment; hence, observers are free to tilt the print to any angle. As a result, it is not clear that if we should use 60-degree gloss measurement. The following figures demonstrate the relationship between the measured 60 and 85-degree gloss where the x-axis represents the 60-degree reading, y-axis is the 85-degree gloss reading and the blue square indicates the paper gloss reading. They show obviously that it is possible for one to have lower 60-degree gloss reading and higher 85-degree gloss while comparing two patches and this happens for matte, medium gloss and high gloss paper. Among the four mismatch prints, we also found that, although all light patches are measured to have higher 60-degree gloss reading than dark patches, observers often times rated dark patches being glossier than light patches. Hence, we design the next experiment to look at this aspect.

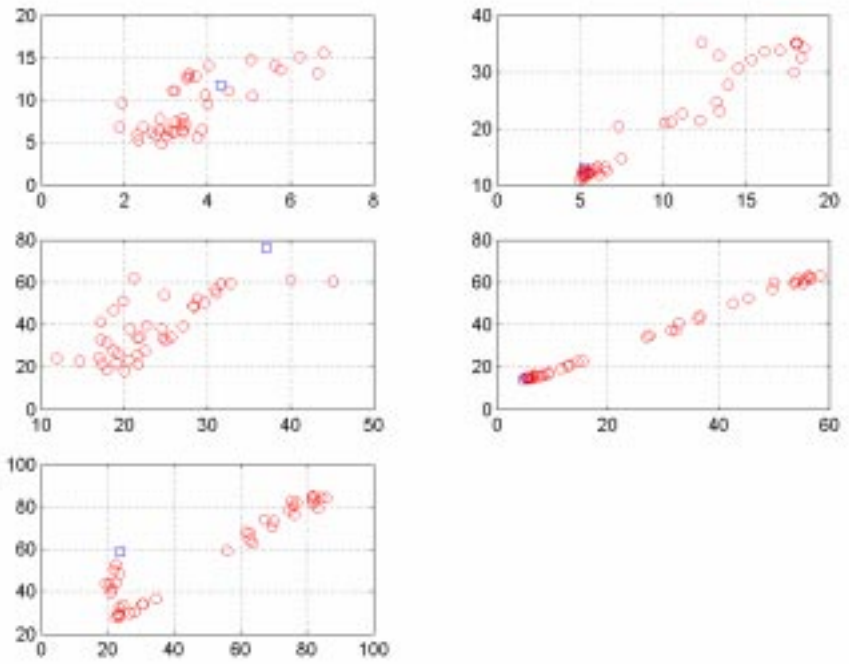


Figure 3: 60 and 85 Gloss for Anchor Prints

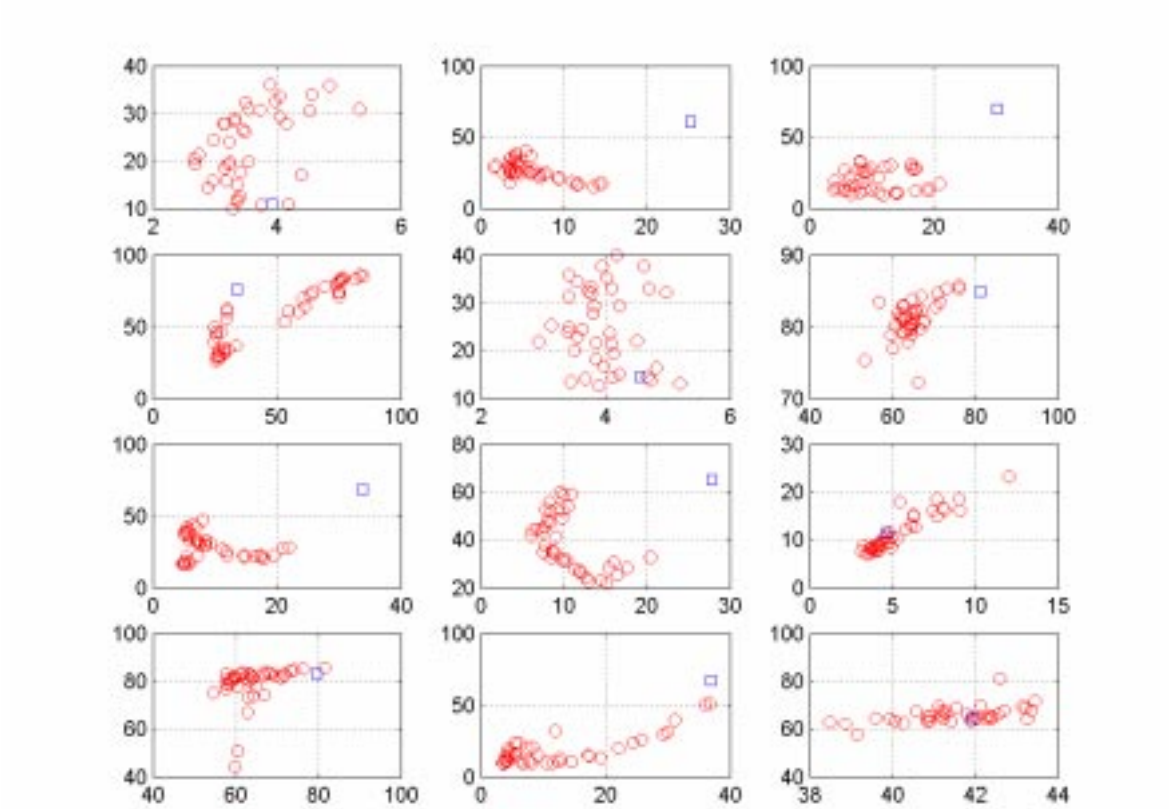


Figure 4: 60 and 85 Gloss for Test Prints

Luminance-Dependent Experiment:

The sense of gloss occurs when viewing an object at certain angles; hence, it is entirely possible that this visual sensation as well as the objective gloss measurement is affected by the brightness of the object. For example, gloss is rarely observed on a light-emitting object. For reflective prints, reflected light perceived by observers comes from two origins: directional light and diffused light. The directional light can only be seen at a specific angle (we will denote this angle as specular angle), and it is the major contributor to the sensation of gloss. This light is reflected from the topmost surface of the reflective print, and usually contains the same color as the light source. The diffuse light, on the other hand, is reflected by the colorant on the surface, and can be seen from almost all angles. For objective gloss measurement, the gloss meter projects light at a specified angle and collects the reflected light at the corresponding specular angle. The assumption is that the major contributor of the reflected light at the specular angle is the directional light. While this is true for object with low luminance, it might be necessary to verify this assumption for surface with high luminance. Subjectly, two scenarios will occur: First, when observers tilt the object while casting their judgment on the glossiness of the surface, the difference of the amount of reflected light across the specular angle is less pronounced for the high-luminance object than the low-luminance object assuming they both have the same gloss reading. Secondly, the larger amount of the diffused light will likely trigger the visual adaptation mechanism and reduce the light sensitivity. As a result, high-luminance object will also be perceived with lower gloss than the low-luminance object with the same gloss reading.

Patch 5 and 6 are selected to investigate this hypothesis. Although it might be better to choose two patches differing only in terms of luminance, we could not find neighboring patches with this characteristic within our test target. Observers were instructed to assign a number to best describe the significance of the gloss difference across these two patches. Ten prints were selected: all five anchor prints and five test prints. Four out of five anchor prints have higher 60-degree and 85-degree gloss reading on the dark patch than on the light patch. While three remaining prints all have higher 60-degree and 85-degree gloss reading on the light patch than on the dark patch, the other three prints have mixed gloss reading: one patch have a higher

60-degree reading and lower 85-degree reading. The experiment shows that all observers successfully identified the dark patch being the glossier one. While some observers correctly pinpointed the light patch being glossier, there exists significant confusion among observers for five out of six prints with this characteristic. Two prints are selected to demonstrate the dependence between the luminance and gloss. The first print is the *Mohawk Navajo Regular Gloss* with (5.75, 16.11) and (12.6, 33.6) in 60-degree and 85-degree gloss reading. The other print is the *Xerographic Color Printer NC60 LustroLaser Coated* with (36.7, 5.5) and (50.9, 15) in 60-degree and 85-degree gloss reading. All observers successfully identified the glossier patch and rated them as being similar in terms of the amount of differential gloss. However, the algebraic difference is –10.4 and –21 in 60-degree and 85-degree gloss measurement and 31.2 and 35.9 respectively. As a result, this experiment demonstrates the dependence between the luminance and gloss in human visual system and simple algebraic gloss difference might be insufficient to fully describe the perceived differential gloss.

End of the Report

JW and CK explains the experimental result in the report to the rest of the ad hoc team. DM indicated that he's working on a visual differential gloss target of color patches with different color and location with help from Eddy D. He's going to bring the target to the meeting next time. CK also talked about selecting an image of both high and low-key components for the study of low density with high gloss versus high density with low gloss. DM also mentioned that the Line & Text Quality Group would like to ask us to keep Text Gloss on our book as one of the items to study. Our general reaction was yes, it probably belongs to this group but with a lower priority and we will include that as part of our discussions in a later date. There are some action items that the ad hoc has agreed on and they are:

1) JW will check with Eric Zeise regarding his finding of other Standard activities that related to gloss.
2) YN could find out what happened with Eric Snyder, he has not participated in the meeting for 4 weeks now.
3) CK and JW will continue the gloss detectability study
4) CK will share the results of picture selection
5) DM will share the results of patch selection and position

Next call-in teleconference: Tuesday, June 25, 2002 @1:30 AM EST

Proposed agenda for June 25, 2002

1. Review/modify agenda
2. Discuss gloss subjective scaling results and path forward.
3. Schedule next teleconference

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