CIE TC8-05 met April 22 and 23 in Montreal, Quebec at the IS&T PICS conference. In attendance were Po-Chieh Hung (Konica), Naoya Katoh (Sony), Kevin Spaulding (Eastman Kodak) and Rob Buckley (Xerox).

April 22

Sunday's meeting began with Kevin Spaulding reporting on the work he's done for Criteria IA (gamut volume) and IB (gamut coverage). He noted that IA is an intermediate result on the way to IB, which is the more useful of the two criteria, since people want to know if a color encoding covers "target" colors that are useful to them. The calculation in IA should be limited to "legal" colors. Several definitions of "legal" colors were discussed (inside spectrum locus, non-negative XYZ values, MacAdam's optimal colors, within ICC PCS), but no consensus was reached. In the end, let the IA evaluator make the choice; the rest of the committee can comment on it when they review the results.

Kevin reviewed the IA procedure and template, noting that the gamut volume was computed in CIELAB PCS. This means that a Chromatic Adaptation Transform (CAT) is needed when the PCS and encoding white point are different. The procedure documents the CAT, recognizing that it may change. Kevin showed results of Criterion IA applied to several color spaces, all output-referred. Scene referred color spaces were mentioned, but there was no discussion on extending IA to include them at this time. Proposed was revising the IA template to check the gamut volume against the number of bits, e.g. how finely is the gamut sampled.

The group began a discussion of Criterion IB, which continued on the next day. We also reviewed the current list of criteria (ver. 7, attached). For example, what's the reference for chroma uniformity? Naoya Katoh thinks it's an important but difficult criterion. Also, what does chroma uniformity mean for an RGB space, which doesn't have an obvious correlate to it.

April 23

On Monday we resumed the discussion on Criterion IB (gamut coverage). Kevin described the procedure, which involves determining the volume of (A) the color encoding gamut, (B) the target color gamut, (C) the intersection of A and B and the ratios C/A and C/B. Three "metrics" can be derived:

1) % target colors covered by color encoding, ratio C/B
2) % color encoding gamut volume used by target color gamut, ratio C/A
3) % color encoding code values used by target color gamut

Kevin preferred the 3rd to the 2nd, which are the same if the encoding values are uniformly distributed in comparison space. Determining the 3rd means using the lattice of color encoding values (rather than the volume). Computing the color encoding gamut (A) can be ambiguous, and also misleading, for color encodings such as e-sRGB that have color values with negative tristimulus values. As a result the volume can be deceptively large even though a relatively small number of code values are used to produce the unrealistically large gamut. This makes the C/A ratio for this space look unnecessarily bad. The more relevant question is really how many of the possible code value combinations are used for the target colors. This would seem to be a better measure of the encoding efficiency of the color encoding, which was the goal of the C/A criterion.

Kevin reported on tests against a set of "real world surface colors." He will document this set, although it contains some commercial colors, i.e. Pantone. He plans to publish the convex hull of the set he used. He showed results of the metrics for e-sRGB, where it is hard to determine the gamut A because of negative XYZ values. For e-sRGB, he concluded that the 3rd was more meaningful (and larger) than the 2nd. For ROMM RGB, the 3rd is smaller than the 2nd. For PCS LAB, 2nd and 3rd are different, although they were expected to be the same, the PCS LAB values are uniformly distributed in the comparison space, which is PCS LAB.

Kevin's updated draft procedure/template for Criterion I (Gamut Metrics) are attached.

The group also discussed target color sets, whose selection in the end is application dependent. Possible target color sets are:

- Real world surface
  - Set Kevin used
    - exclude fluorescence
  - SOCS CD-ROM
    - Only available in Japan (with Japanese documentation)
    - All spectral data; includes some self-luminous, e.g. sky
    - Has most reasonable data, incl. ink jet
      - can select from subsets
      - how representative of current technology?
        - be careful in selecting subsets
        - explain what we are doing and possible limitations
    - Have to go through JIS to get: Naoya Katoh will supply contact (see below)

      JIS-TR X 0012:1998, "Standard Object Colour Spectral Database for Colour Reproduction Evaluation (SOCS)"
      Ms. Sakaguchi, Tomoko of JSA (Japanese Standards Association)
      E-mail : sakaguch@tokyo.jsa.or.jp
      Homepage : http://www.jsa.or.jp/
      Price: ¥ 10,000

- Optimal colors (from MacAdam)
  - Procedure for generating; see if someone already has

- Legal colors, i.e. inside spectrum locus
  - Incl. Self luminous
  - Everything within spectrum locus with Y between 0 and 100
    - With non-negative X and Z
  - Kevin Spaulding has this under control

- Photographic colors
  - Base on existing material (rather than going to companies for their internal data)
    - Get from IT8 targets—Rob to ask Dave McDowell
    - Low priority, difficult to get this data from manufacturer
      - may be able to get convex hull data released
    - Ohta-san as a source? Naoya Katoh will ask
    - Po-Chieh Hung will ask at Konica
    - Kevin's preference is to use published and standardized data
  - Reflectance vs. slide (e.g. Kodachrome)?

- CRT colors (CCIR 709, update reference ITU-R BT 709)
  - Was sRGB, but that's an encoding

- Printed colors
  - SWOP (ask Dave McDowell)
  - Japan Color (has published data)
  - Eurocolor (ask Mike Wilshire)

It was observed that it is likely beyond the ability of this committee to do this for every possible printer, e.g. some ink jets. We will at least publish procedure so that others can use it for target color sets they supply.

Naoya Katoh recommended adding sYCC and e-sYCC as color encodings in the study. We also discussed the compressibility criterion, and restricting it to JPEG and JPEG 2000. This criterion is sensitive to compression parameters and images. It may be sufficient for us to provide a commentary on all these issues, i.e. how you would go about it, but there are too many variables, many of which will depend on image set/genre, and an application's ability to set controls or specify parameters. Naoya Katoh recommended Po-Chieh Hung examine hue linearity. We also discussed the Completeness criterion, which implies a reference, e.g. a link to appearance models and their parameters.

Closing Remarks and Next steps

We have a long list of criteria, not all of which are equally well understood or described with the same amount of detail. Rather than to continue to process the list, recruit members to develop procedure and templates for the criteria they are interested in and think are important, and are in a position to evaluate. Also, for each criterion so selected (self-selected), have two groups involved—a tester and a verifier. Presumably the tester would have primary responsibility for developing the criterion, but the details and agreements can be left to the tester and verifier to work out as they see fit. The current list of testers/verifiers (or Tester 1/Tester 2) is included in this package with the minutes.

The next committee meeting will be held around the time of the Color Imaging Conference, Nov. 5-9 in Scottsdale, Arizona. Rob will send out a note to see if enough people are attending the AIC Colour Congress, June 24-29 in Rochester that an interim meeting can be held then.