

Standards Update

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This issue of Standards Update focuses on some new work being undertaken by ISO/IEC JTC1 SC28 and INCITS W1.1 with the goal of standardizing perceptually based image quality for printing systems.

Because the charter of both SC28 and INCITS W1 is office equipment, this work is principally focused in that area. However, it is hoped that many of the references developed will find broader applicability.

I am grateful to a number of members of INCITS W1 and JTC1/SC28 for assistance in gathering the information of this report, in particular Robert Cookingham of Eastman Kodak Company and Eric Zeise of Nexpress LLC.

Organizational Relationships

ISO/IEC JTC1/SC28, is the international standardization committee for office equipment. In the United States, Technical Committee W1 of INCITS (InterNational Committee for Information Technology Standards, formerly NCITS, National Committee for Information Technology Standards) is the ANSI committee that both develops US standards in this area and is the USTAG to ISO/IEC JTC1/SC28.

Within W1 (Office equipment) a special subgroup, W1.1, has been established to focus on Image Quality for Printer Systems.

Background

Currently ISO/IEC 13660:2001, *Information technology — Office equipment — Measurement of image quality attributes for hardcopy output — Binary monochrome text and graphic images*, is the only international standard describing a broad set of image quality measures for printing systems. ISO 13660 provides simple guidelines for the quantitative measurement of many aspects of image quality for binary, monochrome, printing systems, and has had a significant impact in the printing industry.

However, as in most measures of imaging system performance, the visual significance of a measurement difference is not addressed in ISO 13660. This weakness prevents meaningful comparisons of printing system specifications. To address this

weakness, and to provide evaluation methods applicable to more capable systems incorporating gray-level and full-color imaging technologies, JTC1/SC28 has approved a work item to develop a new standard which will be known as ISO 19751, *Information technology — Office equipment — Image quality standards for printer systems*.

INCITS W1.1 is working on behalf of SC28 to develop the preliminary draft of ISO 19751. It is currently envisioned as a multi-part standard in which each of the key image attributes will be addressed in a separate part. Part 1 will provide the introduction, glossary, overall testing procedures and measurement practices common to all the parts. The additional parts will provide attribute specific test targets, test procedures, measurement/evaluation procedures, data analysis tools, and reporting formats.

What ISO 13660 Provides

The proposed standard is seen as a compliment to and extension of ISO 13660. That standard provides definitions and measurement procedures for fourteen image attributes relating to text printed using black colourant on a white substrate;. These fall into two classes: large area density attributes and character and line attributes.

A key aspect of this standard is that the evaluation of these attributes relies upon the intrinsic properties of the images printed and not on any test object or reference image. Measurement procedures are well defined. However, an important ingredient of this standard is the concept that each user must establish their own quality standards and sampling requirements. Therefore, comparison between different systems becomes difficult. Because there is no data to provide correlation with visual effects, any ranking of the importance of the individual attributes to be measured is uncertain.

What ISO 19751 Will Add

ISO 19751 will be more extensive than ISO 13660, utilizing metrics related to human perception that are applicable to the evaluation of monochrome and color, binary and gray-level printing systems. The image quality measurement tools of this standard will provide a fair, reliable, and perceptually meaningful basis

for comparison of printing system characteristics that users, reviewers and manufacturers can use to compare, evaluate and describe competitive products.

The perceived quality of a printed image is governed by the visual characteristics of the image, not by material or engineering specifications. Examples of these visual characteristics are sharpness, color rendition and graininess. These visual characteristics are related to objective metrics by vision models and through psychometric scaling. These connecting relationships give information on how changes in the magnitude of the objective metric affect the visual characteristic. Various visual characteristics of an image can be combined into broad-based attributes that characterize perceived image quality. This standard will address three vital elements in quantifying perceived image quality:

- 1 Precisely defined measurement procedure(s) for objective image quality metrics. The metrics will be appearance- based rather than technology-based. They will quantify how the image appears on the printed page.
- 2 Test images from which the defined measurements can be obtained.
- 3 Determination of the correlation of the clearly defined and measured attributes with visual assessment. This part of the work provides technical validation for elements (1) and (2).

The Development Process

When INCITS Technical Committee W1 took on the task of developing the draft of ISO 19751 on behalf of JTC1/SC28, it formed Working Group W1.1 with specific responsibility for this work. The W1.1 Chairman is Eric Zeise, NexPress Solutions LLC (eric_zeise@nexpress.com) and the Vice-Chairman and Webmaster is Bob Cookingham, Eastman Kodak Company (robert.cookingham@kodak.com).

Within W1.1 the work has been further divided among several task teams, each of which will focus on one or two major attributes. This work is being conducted in a manner that ensures that the developed standards are comprehensive and suitable for comparisons of print quality independent of printing tech-

nology, engineering parameters, or material characteristics.

The overall process to be applied for each major attribute is as follows:

- a. Define the attribute and sub-attributes being studied, clearly and unambiguously.
- b. Design platform-independent digital test targets suitable for characterizing all aspects of the attribute.
- c. Produce hardcopy samples of the test targets that encompass the relevant printing technologies and the relevant levels and types of defects related to the attribute.
- d. Measure each hardcopy sample (and/or digitize into other suitable representation for analysis, such as a digitized raster image).
- e. Develop computational analysis procedures for objective evaluation of measurements, or other representations, created from the hardcopy samples.
- f. Apply the objective measures on the digitized images, or other representations, created from the hardcopy samples.
- g. Establish quantitative, subjective quality scales of the attribute for each hardcopy sample through psychometric scaling experiments.
- h. Correlate the outputs of the subjective quality scales (Step G) and the objective measures (Step F). If they do not correlate well, repeat steps E, F and G.
- i. Independently confirm the validity of the procedures for objective metrics by repeating steps C, D, F and G, using an additional, independent set of hardcopy print samples.

The goal of this process is the creation of an appearance-based metric that quantifies the visual significance of an attribute through correlation of an objective measure of that attribute with a psychometrically derived quality scale for that same attribute.

Currently Defined Tasks

Although the list of attributes is not closed, task teams have been established and have started work on the attributes identified to date. These groups, the attributes that they are investigating, and the key contact within each group are:

Text and Line Quality (Edul Dalal, Xerox Corporation, edalal@crt.xerox.com)

- Text character purity: (sharp and smooth edges, freedom from visible voids and breaks)
- Text character fidelity: (visible faithfulness of the characters to the intended shape)
- Text uniformity: (perceived uniformity of the text weight)
- Text color: (proper color, density or contrast to background contrast between styles)
- Line purity: (sharp, smooth and parallel edges, freedom from visible voids and breaks)
- Line fidelity; (visible faithfulness of the line to the intended type and shape)
- Line color: (proper color, density or contrast to background)
- Line weight progression: (visually smooth progression of line weights)

Macro-Uniformity (Rene Rasmussen, Xerox Corporation, rasmussen@crt.xerox.com)

- Color uniformity (variations in hue, saturation, lightness, separately or in combination). Contributors such as: streaks, bands, mottle, gradients, moire, etc.
- A single overall measure will need to be developed as well as measures for individual contributors to nonuniformity.

Micro-Uniformity (Robert Zeman, Eastman Kodak Company, robert.zeman@kodak.com)

- Color uniformity (variations in hue, saturation, lightness, separately or in combination). Contributors such as: streaks, bands, voids, mottle, granularity, textures, noise, etc.
- Field of view is restricted to 25 mm. square (>0.04 cy/mm) to complement macro-uniformity measures.

Gloss and Gloss Uniformity (Yee Ng, Nexpress LLC, yee_ng@nexpress.com)

- Gloss value
- Within page (flat-field) gloss uniformity
- Page to Page (flat-field) gloss uniformity
- Differential Gloss
- Gloss Artifacts

Color Rendition (Robert Cookingham, Eastman Kodak Company, robert.cookingham@kodak.com)

- Color Fidelity: Colors look correct (does not necessarily imply color matching)
- Color Scale: Colors that should be perceived as separate are distinguishable.
- Color Continuity: Colors that should be perceived as smoothly varying are free of contouring.

Effective Resolution (Norman Burningham, Hewlett Packard Company, nwb@boi.hp.com)

This task group was recently formed and has not yet identified the attributes to be investigated.

Next Steps

Once the preliminary drafts of the individual parts are completed they will be circulated by JTC1/SC28 in the traditional international balloting process. We will try to revisit the work of this task group on a regular basis to keep you informed.

As with all standards committees, Technical Committee INCITS W1, and in particular W1.1, would welcome additional participation. If you feel you have something to contribute to these tasks do not hesitate to contact the people identified above.

One benefit of participating in a standards committee, particularly one that is breaking new ground, is the learning experience that can benefit both you and your company. If your company and its products will be affected by this new standard now is the time to begin to understand the details of what is involved. Outside of this type of standards environment, you will probably never have access to such a competent group of industry experts in this particular area.

For information or questions about the U.S. office equipment standards committee W1, please contact chairman Paul Spencer (paul-spencer@pullman.com).

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STANDARDS COLUMN

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Other Standards Notes

The following imaging related standards are in ballot. If you are interested in commenting contact the USTAG secretariat:

TC130 Documents. All in DIS ballot. (mabbott@npes.org)

- ISO 12639, *Graphic technology — Prepress digital data exchange — Tag image file format for image technology (TIFF/IT)*
- ISO 12640-2, *Graphic technology — Prepress digital data exchange — Part 2: XYZ/sRGB encoded standard colour image data (XYZ/SCID)*

ISO 15930, *Graphic technology — Prepress digital data exchange —*

Use of PDF

- *Part 1: Complete exchange using CMYK and spot colour data (PDF/X-1a)-1*
- *Part 2: Partial exchange of printing data (PDF/X-2)*

- *Part 3: Complete exchange suitable for colour-managed workflows (PDF/X-3)*

Note: Parts 1 and 3 are revisions to reflect PDF 1.4 compatibility. Part 2 is a new standard.

TC42 Documents All in CD ballot. (jamesp@i3a.org)

ISO 20462 *Photography - Psychophysical experimental method to estimate image quality -*

- *Part 1: Overview of psychophysical elements*
- *Part 2: Triplet comparison method*
- *Part 3: Quality ruler method*

Note: These are three separate documents.

For suggestions for future updates, or standards questions in general, please contact the author at mcdowell@npes.org or mcdowell@kodak.com