The Synergistic Relationship between Standards for Data Exchange, Metrology, Process Control, and Color Management.

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Abstract

Traditionally standards for data exchange, metrology, process control and color management have been pursued somewhat independently by different groups within the standards community. However, as printing becomes more global, and is almost totally dependent on digital data preparation/prepress, these standards areas have become heavily dependant on each other and intertwined in surprising ways.

This paper will review the current graphic arts and photographic standards landscape and will describe the interdependence among the various key areas. It will discuss some of the new approaches being taken in the area of process control as well as some of the steps being taken to revised standards to bring them into closer alignment with industry practice. It will also provide an update on the latest standards activities in ANSI/CGATS and ISO/TC130 committees.

Introduction

Before I get too far let me describe my definition of standards. The dictionary definition is "something established by authority, custom, or general consent - as a model or example" a second dictionary definition is "something, such as a practice or a product, that is widely recognized or employed, especially because of its excellence". I agree with both of those definitions. I am sure that most of the standards community does also.

However, one of the big differences and sources of confusion is the way in which that general consent, or agreement, is achieved. At one end of the spectrum we have de facto specifications established by a single company,

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which (because of their dominant role) are accepted by everyone. Adobe Postscript is an example of a de facto specification.

In the middle we have specifications established by trade associations and industry groups, broader involvement but often closed unless you fit a specific requirement or pay a fee. SWOP is an excellent example of such a trade specification.

At the other extreme are the standards developed under the auspices of international groups like ISO, IEC and CIE or National bodies like ANSI. We often call these accredited standards.

All three categories (and everything in between) are critical to the ongoing work of our printing and publishing industry. However, they all vary in their openness and the ability of individuals or companies to impact them and influence the results.

On a historical note, prior to the early 1980's there were no active accredited standards activities in our industry either in the US or in ISO. We did borrow standards from others – densitometry from the photographic community, paper measurements from TAPPI, and ink measurements from NAPIM. SWOP was one of the few active industry groups in the US developing specifications for printing and publishing.

The first consensus standards activity in the printing and publishing industry in the United States was the development of file formats for digital exchange of content data. This work began in the early 1980's with an industry activity that was called Digital Data Exchange Standards (DDES), which quickly became the ANSI IT8 committee. These committees first developed a magnetic tape standard which was followed by the TIFF/IT standards. File formats for digital exchange of content data were also the basis for the reactivation of ISO TC130 in 1989 and have been central to the ongoing standards efforts. IT8 has been absorbed into CGATS and today much of the work is being done in TC130.

Currently, content data digital exchange standards are focused on PDF/X, a standardized subset of the PDF file format specification. This family of standards includes provisions for "blind" exchange as well as exchanges requiring interaction between sender and receiver.

The Larger Picture

From the beginning, the graphic arts standards community realized that simply enabling the exchange of data was not enough. The meaning of the data being exchanged had to be defined. Accomplishing that data definition became an even larger task than creating the content exchange formats themselves. The task

of defining the meaning of the content data has paralleled and built on (or led) the industry decentralization and decoupling of the strong relationships between design, prepress, publisher, and printer that used to be necessary to convey the meaning of the data being exchanged as physical film separations.

In the beginning days of DDES our focus was on the encoding of the CMYK data. What code values represented 0% dot and 100% dot values. What was the orientation of the data and how different files related to each other. We hoped that if the file got moved from the database of one system to that of another someone would provide the data that said how it should be printed. Today, the concept of "open" or "blind" exchange of digital data is the norm. This means that the file must contain all of the data (metadata) that is necessary to allow the recipient to print the content information so that its appearance matches the proof the customer approved before the data was transmitted.

To look at where we are today, let's focus on data exchange based on the PDF/X file format (any of the the various parts of ISO 15930, *Graphic technology — Prepress digital data exchange using PDF*). Currently, the primary mechanism used to define the meaning of the data in a PDF/X file is a pointer to color characterization data — data that relates the tone values of CMYK data used to prepare a printing master and the color reproduced on a printed page under specific printing conditions. Such color characterization data may be provided by individual printers or printing organizations, but most commonly is prepared by standards groups or industry associations.

Currently, the format for this characterization data is an ASCII key-word/value pair file format defined in ISO 12642-1. The recently approved ANSI CGATS.17 provides an XML format to supplement the key-word/value pair format. It is also currently in ballot as a new work item in TC130. TC130 has also identified a longer term work item to develop a more complete XML exchange format that will satisfy the printing industry needs for exchange of non-content data for and about printing.

In a PDF/X file, the International Color Consortium (ICC) printing condition registry (www.color.org) is identified as the preferred location for reference characterization data. Where color managed data is exchanged, in a PDF/X-1a or PDF/X-4 file, an ICC profile must also be incorporated in the file. Either ICC.1 from the ICC or ISO 15076, *Image technology colour management — Architecture, profile format and data structure — Part 1: Based on ICC.1:2004-10,* from TC130 is required to define the data and format of the profile.

To move data, looking at only the topmost level, we need content data file formats from TC130, profile formats and a registry from the ICC and characterization data in standard formats from industry groups. But let's look further, because this is simply the tip of the iceberg.

Some Slightly More Detailed Looks

Characterization data, and its preparation and definition, is made up of several pieces. The simplest definition of characterization data is that it is the agreed upon measurement of a representative sample of printing done in a defined way.

Looking at the measurement side first we realize that recommendations and standards from the Commission International d'Leclarage (CIE) are the basis for all color definition. However, they leave many options to the individual application area or user – things like measurement geometry, sample backing, observer, and illuminant. ISO 13655 (*Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*) has been created by TC130, with assistance from TC42 to provide this additional guidance for both the photographic and the printing industry. However, today most measurements are made with spectrophotometers and users want to derive density data as well as color data from the same set of measurements. Also, it only makes sense that the measured color should correlate with the color viewed under standard viewing conditions. Therefore ISO 13655 must be compatible with the densitometry standards defined in ISO 5 (*Densitometry*) and the viewing standards defined in ISO 3664 (*Viewing conditions -- Graphic technology and photography*) – both of which are the responsibility of TC42. In addition the specifications for color management profiles defined by the ICC must also be in agreement with the viewing and color measurement standards. Sample backing, spectral power distribution of the illuminant, measurement geometry, etc. must all be compatible between these standards.

To facilitate the necessary coordination, the latest revisions of ISO 5, ISO 3664, and ISO 13655 are being accomplish in joint working groups composed of representatives of both TC42 and TC130 with strong input from the ICC.

But measurement is only one part of the task. The sample being measured must be representative of a defined printing condition which is reasonably repeatable. This involves specification of the materials to be used (paper and ink) and the process aims (solid ink density, solid ink colors, tone value characteristics) for those materials in a variety of printing and proofing technologies. TC130 has a family of ink standards (ISO 2846, *Graphic technology — Colour and transparency of ink sets for four-colour-printing*, and ISO 2834, *Graphic technology — Test print preparation for offset and letterpress inks*) that help define the ink used. Ongoing discussions between the ICC, TC130, and TC6 (Paper) are aimed at defining paper characteristics that relate to the printing characteristics of paper. The ISO 12647 (*Graphic technology — Process control for the production of half-tone colour separations, proof and production prints*) family of standards provide the process control aims for various classes of proofing and printing.

These process control aims also use the same color measurement and density standards to define and maintain the consistency of the selected printing conditions. Because the printing industry uses a series of parameters derived from density and color (tone value, trap, etc.) ISO 13656 (*Graphic technology — Application of reflection densitometry and colorimetry to process control or evaluation of prints and proofs*) was prepared to define these computations.

However, characterization data depends on industry groups creating specific grouping or subsets of these parameters that can be used as aims for individual industry segments and then printing samples to these aims. Examples of these activities are: SWOP, GRACoL, and SNAP in the US; IFRA and ECI in Europe; and Japan Color in Japan. The first characterization data set was CGATS TR 001 (SWOP printing) which was published in 1995. The ICC registry (www.color.org) currently lists 39 registered characterization data sets.

For such printing to be easily compared, consistent test targets and sample images become important. ISO 12642 (*Graphic technology — Input data for characterization of 4-colour process printing*), Parts 1 and 2 provide CMYK data sets of 928 and 1617 elements that can be printed to provide a reasonable sampling of the printed color space. The three parts of ISO 12640 provide CMYK test images, sRGB test images, and a large gamut CIELAB image set that are useful in comparing various reproduction and proofing systems. In addition, ISO 12642-3 includes the definition of the boundary of a large gamut color space used as the limiting gamut for the CIELAB images. This same gamut boundary has been adopted by the ICC as the reference gamut for perceptual rendering.

One very recent new development is the work being done by the GRACoL committee to develop a digital press calibration technique. The technique being proposed, which is based on the use of three-color grey balance as a tool to both set and monitor TVI, is expected to significantly improve the consistency of printing between and among presses for both characterization data set development and more importantly production printing. This is being documented in an ISO Technical Report which will be introduced at the TC130 meeting later this spring.

Summary

To an outsider it probably appears to be a tangled web of inter-dependent definitions, requirements, and specifications that must all work together to enable meaningful open exchange of printed material within the printing and publishing industry. Further these definitions, requirements, and specifications are not all under the responsibility of a single group.

But it is working!

Part of the reason is that may of the players are involved in multiple committees. More importantly, today the industry is committed to standards. When I gave my first standards talk (TAGA 1982) the prevailing attitude was that standards were the lowest common denominator – and no one printed that way. Today, standards are either 1 or 2 in the priority of almost all associations and groups in the printing and publishing industry. Standards have shown that they enable more cost effective and efficient workflow within the industry.

While we are still struggling to define many of the elements involved, there are discussions of new initiatives such as printing across borders, single worldwide aims for individual classes of printing, unified characterization data, etc. Standards have become an integral part of the printing and publishing industry.

We have, and are continuing to, learn to work with those who have more expertise in some areas than we do and through joint activities make sure that their standards can be used to advance our needs.

The general consistency between jobs (or more importantly advertisements) printed in multiple sites is excellent. The ability for a client to see a reasonable prediction of the final printed sheet in either a soft or hard-copy proof is the accepted norm. Digital files have almost completely replaced halftone film as the medium used to exchange content data. Through the use of color management tools and other standards, these digital files are also completely self defining in terms of required printing conditions and the expected color appearance of the final printed sheet.

Not bad for an industry that only embraced standards a little over 20 years ago.

Literature Cited

McDowell, D. Q.; "Data Storage in Graphic Arts Offset Printing", TAGA Proceedings, 1982, pp.121-128.