Graphic Arts Standards—A Current Status Report

25th IARIGAI Research Conference

David McDowell
Senior Technical Associate
Eastman Kodak Company/Kodak Polychrome Graphics

Abstract

Within the graphic arts industry, the exchange of digital data has been a major concern ever since the introduction of the computer as a tool in the preparatory process. Although the exchange of data in the various proprietary formats associated with application programs has been common, the ability to use standard formats to exchange data is the goal of the industry. Accomplishing this goal has been the focus of a number of standards activities. Most recently, the focus has been on the exchange of print-ready material, in both raster based and object based file formats, primarily as it applies to advertising for the publication marketplace.

As the standards for data exchange have evolved, it has become obvious that the meaning of the data being exchanged is equally critical to the successful use of that data. This has led to development of standards to define and characterize those factors that affect the color of the printed result.

This paper provides an update on the progress that has been made in these areas. It also proposes some future directions, in both standards development and workflow, that may have significant impact on the printing and publishing industry.

Introduction

As we look at the world of digital data and graphic arts, three issues are intertwined and impact upon each other. These are data exchange, printing process characterization, and color management. This presentation will provide an overview of these issues and suggest some directions that our industry needs to follow as we move toward the future.

Data Exchange

It was only in the early 1980's that computers became powerful enough, and computer data storage and memory became large enough, for the graphic arts to be able to store and operate on the image of a complete page. Between 1980 and 1984 several companies introduced systems that became referred to as CEPS, or color electronic prepress systems. These were specialized computer systems that were optimized to handle and manipulate image data. Because virtually all material was scanned, to convert it from hard copy to electronic data (including text and line art), image manipulation software and file formats were all raster based. Magnetic tape was the only economical form of electronic data storage available that could be used to store and transport data.

Almost immediately, people wanted to share and/or exchange data. In part because systems developed by different vendors evolved separately, each vendor had a different set of data storage formats – usually incompatible with anyone else. This led to the first standards work in graphic arts digital data exchange and a family of standards known as the IT8 standards. (An ANSI standards committee was created under the auspices of the Image Technology Standards Board to work in the area of digital data exchange and was given the designation of IT8. Somewhat later, a graphic arts umbrella standards committee called Committee for Graphic Arts Technologies Standards, CGATS, was also created. In 1996 the work of IT8 was merged with CGATS.) These initial standards were based on the use of 9-track magnetic tape to exchange raster data files. As 9-track magnetic tape was quickly replaced by more efficient media, the file formats were migrated to media independent file structures based on TIFF. The current raster standard is ISO 12639, *Graphic technology — Prepress digital data exchange — Tag image file format for image technology (TIFF/IT).* TIFF/IT-P1 (Profile 1), optimized for compatibility with DTP systems, is the most widely implemented version of TIFF/IT.

By the late 1980s computer capabilities had increased and computer costs had decreased so significantly that a whole new class of publishing tools became available – the so-called desktop or DTP systems. These were based around an object-oriented data structure which uses contone raster data for pictures, vector lines and fills for line art, and ASCII character strings and font data for text. Key to implementation of the DTP systems was the introduction, at this same time, of Adobe PostScript as a programming language and printer driver. Initially these DTP systems were limited to initial file creation and/or primarily black and white work. However, as computer capabilities continued to increase, and the capability of PostScript increased, the DTP systems took on a more significant role in graphic arts prepress.

Because each DTP program initially had its own proprietary file format, work on standard file formats for object-based data followed much more slowly than the raster format work. Early work, by the IT8 and CGATS standards committees, led to the conclusion that development of an object-oriented file format by the standards community itself was impractical. However, when Adobe developed the PDF file format and made it publically available, it opened new opportunities for the standards community. CGATS was able to work with Adobe to extend the PDF format to meet the needs of the graphic arts industry and to develop a standard that defined appropriate usage of the format in graphic arts applications. This led to the development of CGATS.12, *Graphic technology — Prepress data exchange — Use of PDF for composite data.*

This development work has been done within Subcommittee 6 (SC6) of CGATS, which is charged with the responsibility of developing standards to support the exchange of digital data of advertizing for publications. Early in their work SC6 determined two separate specifications needed to be written. One, for the complete exchange of all of the material necessary for the printing of an advertisement in such a way that no negotiation was needed between sender and receiver – what is sometimes called a blind exchange (what we do with film today). The other standard, is needed to cover what has been called partial exchange – a more lenient exchange standard where fonts, some images, or other elements can be assumed to be available at the recipient's site. This requires much greater communication between the parties in the exchange for successful rendering of the data. The first standard is "*CGATS.12/1, Graphic technology — Prepress digital data exchange — Use of PDF for composite data — Part 1: Complete exchange (PDF/X-1).*" As its title suggests it covers complete exchanges. Part 2, which will follow shortly, will cover the exchange of partial data.

The term "composite" may be confusing. Unfortunately, the graphic arts has no consistent way to refer the various part of the job during the typical workflow. Therefore, CGATS/SC6 had to create definitions to allow them to communicate — particularly with the computer community. One of these is composite entity, which is defined as

> "A unit of work with all text, graphics and image elements prepared for final print reproduction. A composite entity can represent a single page for printing, a portion of a page or a combination of pages."

TIFF/IT (ISO 12639) is widely implemented today and although CGATS.12/1 is just being completed, it is expected that application program vendors will quickly respond with compliant software. Together, these two standards provide the capability for open data exchange of print ready files within the graphic arts industry. Although both standards have been optimized for the exchange of 4-color CMYK process color data, typically publication advertizing, they are applicable to the full spectrum of graphic arts work.

However, the industry and the standards community has quickly realized that being able to exchange data does not do much good unless there is also a way to describe the meaning of the data being exchanged.

Printing Definition and Characterization

The only logical meaning that can be given to a set of CMYK data is the color of the image that data will produce on a printed sheet. Within the standards and color management communities, the term "characterization" is often used to describe the relationship between CMYK input data and printed color for a particular printing condition.

Unfortunately, the color that is produced by the printing process is dependent on many variables. This has led to a three tiered approach in standards development. First, the color of the "ink-in-the-can" is defined, based on the use of reference substrates and laboratory procedures. Then, specific printing process control procedures are defined. These include paper, solid ink densities, tone value (dot value) curves, overprint colors, etc. With these variables defined, a standard test pattern can be printed and measured to provide the characterization data.

This characterization data can then be used as the reference for prepress color separation aims, as the aim and control for both analogue and digital proofing systems, and as the reference for printing process control. While this may sound strange and futuristic, it is exactly what the United States gravure publication industry has been doing in a very practical way for some time using SWOP as the reference.

SWOP, Specifications for Web Offset Publications, initially developed proofing aims for advertizing intended for reproduction in offset publications. By insuring that all inputs (halftone film separations) were press proofed under consistent conditions, the publisher and printer could be assured that they would print together on the production press. Under the SWOP guidelines, the printer was responsible for making the printed sheet match the appearance of the proof. With the advent of halftone gravure in 1986, the gravure publication printers accepted as input both the halftone films and the accompanying offset proofs, and using appropriate cylinder engraving tools produced printed results that provided a "visual color match" to the provided proofs.

At about the same time SWOP was moving to accept off-press proofs, and the industry was beginning to use and exchange digital data, The off-press proofs that printers were asked to match visually were supposedly made to match SWOP printing conditions but they varied considerably from vendor to vendor because each vendor had their own interpretation of SWOP.

While SWOP provide hi-low color references for the solid tone value aims and stated midtone dot gain aims, no physical color references existed for the entire SWOP printing range. It therefore became important to provide more specific and technical definitions of SWOP proofing conditions as well as printed references.

In response to this need SWOP, with the collaboration of CGATS and the GAA (Gravure Association of America) Color Correlation Task Force, developed a press test form which was used create a SWOP Calibration Kit Out of this work several standards also emerged. These include CGATS.6 (Graphic technology — Specifications for graphic arts printing — Type 1) and CGATS/TR001 which documents reference characterization data for SWOP proofing based on practical printing tests using this test form.

At the same time, ink testing standards were developed in ISO/TC130, the international graphic arts standards committee. These were used to document the ink color characteristics in the CGATS standards. Incidently, when TC130 was working to develop the offset ink standards, it was determined that offset publication inks used in Europe, Japan, and the United States all meet the same "ink-in-the-can" colorimetric specifications.

But What About Other Printing Conditions

Publication printing is not the whole world of either gravure or offset printing. The SWOP approach, however, provides a model for us to follow in other application areas. Conceptually, printing characterization data could be established for every press, or group of presses for each application. However, for that to work data would have to be made available to every prepress organization sending printing to that press. In addition, each proofing vendor would need to have a separate calibration setup for each of those printing conditions. Probably an impractical solution, even in the emerging world of color management and electronic data exchange.

We cannot talk about printing characterization without talking about color management – from both the perspective of what can be done and what is practical to do in a production environment. Lets look at color management and then come back to discuss the broader issue of printing conditions.

A Look at Color Management

The basic concepts of color management have been around since the beginning of color photography and since the graphic arts first printed colored images. It is nothing more than the management of color data to achieve pleasing reproductions of original scenes or images. Every company developing color film or color separation tools has had its own, often proprietary, techniques.

In 1993, the International Color Consortium (ICC) was formed to further the concept of the open exchange of color information and today the term "Color Management" generally is accepted to reflect the work of that group. It can be thought of as incorporating into software (from individual vendors) the expertise necessary for good color reproduction, and providing a common architecture and data format to allow individual applications to communicate with each other.

The current ICC color management architecture conceptually is very straightforward. It basically consists of three parts. A color space definition which can be used as the reference for color transformations – this is called the profile connection space (PCS). A format by which the relationship between the color of an input, output or display device can be related to the PCS – this is the Profile Format. And agreements about how the computations to relate input to output are to be accomplished based on the color information contained in the profiles – this is called the Color Management Module (CMM).

The ICC defines the profile connection space as the "CIE colorimetry which will produce the desired color appearance if rendered on a reference imaging media and viewed in a reference viewing environment. This reference corresponds to an ideal reflection print viewed in an ANSI standard viewing booth."

Again based on the ICC definitions, profiles are made up of "tags which provide the complete set of information necessary for the default CMM to translate color information between the profile connection space and the native device space. Each profile class determines which combination of tags is required." The ICC currently has identified several profile classes which include input, display and output.

Scanner input profiles, for example, contain the transforms necessary to convert the code values produced by a specific scanner, looking at a specific type of chrome or print, into the values needed to describe the appearance of that original image in the color space of the PCS. Other input profiles provide the same type of relationships for electronic cameras, monitors, PhotoCD, TV, etc.

Output profiles are more complex. Unfortunately, most output devices have smaller color gamuts than either the input media or the PCS. This means that the transforms contained in the output profile must also accomplish all of the tone scale and color gamut compression that is necessary to fit the colors of the original into the reproduction. A simple way to understand an output profile for graphic arts, is to note that it accomplishes most of the functions that the scanner operator does when setting up a traditional CMYK scanner.

Output profile creation requires characterization data which relates CMYK values to the printed color. Using this data, the transforms are created to accomplish gamut and tone scale compression as well as the determining the individual tone values for each color separation, given a specific set of UCR and GCR aims. Until recently, these profiles were primarily developed by vendors based on press testing. Some user output profile generation tools are now becoming available with tools to tune existing profiles to accommodate small differences between printing conditions.

In the simplest application of color management, an input profile and an output profile are used as part of the scanning process and CMYK data is prepared directly. All subsequent operations are done using CMYK data. Except for some improvements and convenience in generating the CMYK data, no other advantages of color management are gained. Typically, all images are brought in “as is” and all image correction is done in the CMYK data space of the software package used.

A more color-managed workflow would carry both the input profile and output profile along with the input data. The application package would edit the raw data to achieve the desired “look” of the image. In the color managed case, CMYK input profiles (they relate CMYK data back to the PCS) and monitor profiles would be used to display the expected appearance of the image. When an image is transferred to the publisher, or printer, this virtual CMYK data (edited raw data plus input and output profiles) would be the information exchanged. Using this approach, the raw data could be re-targeted for another application by the simple substitution of a different output profile – Web RGB, multimedia, CD, etc. In addition the edited raw edited could be archived with the input profile so that subsequent uses of the same image could take advantage of different image manipulation or editing.

Under this scenario it is critical that whatever profile was used to generate the proof for customer approval, also be used to generate the actual printing data. Remember, the output profile contains the tone and gamut compression information and color separation aims. Profiles, like font data, must be capable of being sent with the image data.

Back to Other Printing Conditions

Another workflow issue that must be addressed is the issue of printing condition aims. Conceptually, printing characterization and output profiles could be established for every press, or group of presses. However, for that to work those profiles would have to be made available to every prepress organization sending printing to that press. In addition, each proofing vendor would need to have a separate calibration setup for each of those printing conditions. Probably an impractical solution, even in the emerging electronic world.

An alternative being seriously considered is the establishment of a limited number of reference printing conditions that could be used as the basis for both proofing and data exchange. The necessary characterization data would be established by industry trade or standards groups and provided to all users. Color management vendors and proofing system vendors could then establish output profiles and proofing aims to match each reference printing condition. Possibly four or five printing gamuts, properly spaced with respect to each other, might be adequate differentiation for proofing and data exchange.

The first of these reference printing conditions is in existence and proving very effective for both offset and gravure publication printing in the United States. That is SWOP and the associated ANSI/CGATS standards – CGATS.6 for process control aims and TR001 for the actual characterization data itself.

Using the reference printing condition approach, the press to be used would be adjusted to match the gamut selected. The CMYK data received from prepress would be adjusted to accommodate the actual press performance, based on press characterization data. The received CMYK data would therefore be customized for the press. This allows prepress and printing to both work to common reference printing aims, yet still gives the printer the ability to customize the performance of his press. This kind of CMYK to CMYK transform is already part of the color management toolkit provided by some vendors and is often used to match proof to press. In color management parlance this is a device link transform. In practical terms this is also the type of transform that is accomplished on a routine basis by the gravure industry every time it uses halftone data to engrave cylinders.

While this type of CMYK to CMYK transform is routinely used by gravure with actual CMYK data, in the future it will be easier to apply as an additional transform in the overall color management process. This suggests that ideally the exchange of virtual CMYK data will be preferable and that color computations should be done close to film, plate or cylinder making.

What other standards data exists in this area?

Within ISO/TC130 two sets of standards provide the foundation for printing process definition. These are ISO 2846, Graphic technology — Colour and transparency of ink sets for four-color-printing, and ISO 12647, Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints. Both of these are multi-part standards with sections covering sheet-fed and heatset web offset lithographic printing, coldset offset lithographic printing, gravure printing, screen printing, and flexographic printing.

Printing tests have, and are being, conducted at a number of sites to provide data for additional characterization data sets which will become the basis for a family of reference printing conditions.

What else is the standards community doing?

While this paper has focused on data exchange, color management, and printing definition, standards work is also going on in a number of other areas. Topics such as metrology, ink testing, paper definition, compression, test targets, reference images, characterization data sets, etc. all play a critical role in providing the tools needed to support the industry. Rather than trying to cover these here, a complete listing of the ISO TC130 standards, completed or in process, is attached.

The primary focus of all of these standards is to enable the printing and publishing industry to be flexible and responsive to ongoing changes in technology though better and more meaningful communication about both the processes being used and the content matter of the work itself.

These are exciting times and considerable work is being accomplished. Many of the IRAGAI community are involved, but there is always need and room for more. If you or your organization are not involved, please consider becoming involved in this work which is critical to the future of our industry.

For further dialogue on these issues the author can be reached at:

David Q. McDowell, Eastman Kodak Company, Rochester, NY 14650-1913, 716-588-2160, or E-mail mcdowell@kodak.com

ISO TC 130 STANDARDS
(Approved or in Preparation)

ISO 2834:1981	Printing inks — Preparation of standardized prints for determination of resistance to physical and chemical agents (Under revision by WG 4)
ISO(DIS) 2834	Printing inks — Preparation of standardized prints for determination of resistance to physical and chemical agents (Revision of combined ISO 2834:1981 and ISO 5737:1983)
ISO 2835:1974	Prints and printing inks — Assessment of light fastness
ISO 2836:1974	Prints and printing inks — Assessment of resistance to water (Note 1)
ISO 2837:1996	Prints and printing inks — Assessment of resistance to solvents
ISO 2838:1974	Prints and printing inks — Assessment of resistance to alkalis (Note 1)
ISO 2839:1974	Prints and printing inks — Assessment of resistance to soaps (Note 1)
ISO 2840:1974	Prints and printing inks — Determination of the resistance of prints to detergents (Note 1)
ISO 2841:1974	Prints and printing inks — Determination of the resistance of prints to cheese (Note 1)
ISO 2842:1974	Prints and printing inks — Determination of the resistance of prints to edible oils and fats (Note 1)
ISO 2843:1974	Prints and printing inks — Determination of the resistance of prints to impregnation by wax or paraffin wax (Note 1)
ISO 2844:1974	Prints and printing inks — Determination of the resistance of prints to spices (Note 1)
ISO 2846-1:1998	Graphic technology — Specification for colour and transparency of printing ink sets — Part 1: Sheet-fed and heatset web offset lithography printing (Revision of ISO 2846:1975)
ISO(CD) 2846-2	Graphic technology — Specification for colour and transparency of printing ink sets — Part 2: Coldset web offset lithographic printing on newsprint
ISO(NP) 2846-3	Graphic technology — Specification for colour and transparency of printing ink sets — Part 3: Gravure printing
ISO(WD) 2846-4	Graphic technology — Specification for colour and transparency of printing ink sets — Part 4: Screen printing
ISO 4218-1:1979	Printing machines — Vocabulary — Part 1: Fundamental terms (reconfirmed in 1994)
ISO 5736:1983	Prints — Determination of resistance to sterilization of prints on metallic substrates (reconfirmed in 1994)
ISO 5776:1983	Graphic technology — Symbols for text correction (Under revision by WG 1)
ISO 5776:1983	Graphic technology — Symbols for text correction

ISO(WD) 5776	Graphic technology — Symbols for text correction (Revision of ISO 5776:1983)
ISO 6716:1983	Graphic technology — Text-books and periodicals — Sizes of untrimmed sheets and trimmed pages (reconfirmed in 1994)
ISO 10755:1992	Graphic technology — Prepress digital data exchange — Colour picture data on magnetic tape
ISO 10756:1994	Graphic technology — Prepress digital data exchange — Colour line art data on magnetic tape
ISO(DIS) 10757	Graphic technology — Prepress digital data exchange — Geometric data on magnetic tape
ISO 10758:1994	Graphic technology — Prepress digital data exchange — Online transfer from electronic prepress systems to colour hardcopy devices
ISO 10759:1994	Graphic technology — Prepress digital data exchange — Monochrome image data on magnetic tape
ISO 11084-1:1993	Graphic technology — Register systems for photographic materials, foils and paper — Part 1: Three-pin systems
ISO 11628:1995	Graphic technology — Prints and printing inks — Assessment of resistance to acids
ISO(DIS) 12040	Graphic technology — Prints and printing inks —Assessment of light fastness using filtered xenon arc light
ISO(DIS) 12218	Graphic technology — Process control — Offset platemaking
ISO(DIS) 12632	Graphic technology — Prints and printing inks — Assessment of resistance to hot alkali solutions
ISO(DIS) 12634	Graphic technology — Determination of tack of paste inks and vehicles by a rotary tackmeter
ISO 12635:1996	Graphic technology — Plates for offset printing — dimensions
ISO(FDIS) 12636	Graphic technology — Blankets for offset printing
ISO(WD) 12637-1	Graphic technology — Multilingual terminology of printing arts — Part 1: Fundamental terms
ISO 12637-2:1996	Graphic technology — Multilingual terminology of printing arts — Part 2: Screen printing terms
ISO12639-1998	Graphic technology — Prepress digital data exchange — Tag image file format for image technology (TIFF/IT)
ISO 12640-1998	Graphic technology — Prepress digital data exchange — Standard CMYK color image data (CMYK/SCID)
ISO 12641:1997	Graphic technology — Prepress digital data exchange — Colour targets for input scanner calibration
ISO 12642:1997	Graphic technology — Prepress digital data exchange — Input data for characterization of 4-colour process printing
ISO 12644:1996	Graphic technology — Determination of rheological properties of paste inks and vehicles by the falling rod viscometer
ISO(DIS) 12645	Graphic technology — Device for opaque area percentage calibrationof transmission densitometers

ISO(CD) 12646	Graphic technology — Colour proofing using a colour monitor
ISO12647-1:1996	Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods
ISO 12647-2:1996	Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 2: Offset lithographic processes
ISO 12647-3:1998	Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 3: Coldset offset and letterpress on newsprint
ISO(WD) 12647-4	Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 4: Gravure printing
ISO(CD) 12647-5	Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 5: Screen printing
ISO(WD2) 12648	Graphic technology — Safety standard — Printing press systems
ISO(WD) 12649	Graphic technology — Safety standard — Binding and finishing systems
ISO 13655:1996	Graphic technology — Spectral measurement and colorimetric computation for graphic arts images
ISO(DIS) 13656	Graphic technology — Application of densitometer and colorimeter measurements in the graphic arts
ISO 13928:1994	(TR) Application guide for ISO 10755, ISO 10756, ISO 10757, ISO 10758 and ISO 10759
ISO(NP) 14671	(TR) Application profile for JPEG compressed tag image file format
ISO(DIS) 14672	(TR) Technical report — Statistics of the natural SCID images defined in ISO 12640
ISO(NP) 14684	Graphic technology — Page assembly for graphic arts electronic data exchange
ISO(CD) 14981	Graphic technology — Process control — Optical, geometrical and metrological requirements for reflection densitometers for graphic arts use
ISO(NP) 15076	Graphic technology — Prepress digital data exchange — International colour profile format
ISO(NP) 15790	Graphic technology — Reflection and transmission metrology — Documentation requirements for certified reference materials, procedures for use, and determination of combined standard uncertainty
ISO(NP) 15930	Graphic technology — Prepress digital data exchange — Use of PDF for composite data

ISO(CD) 15994	Graphic technology — Testing of prints and printing paper — Determination of the visual gloss number
ISO(NP) XXXX	Graphic technology — Process control — Digital target for platesetters
ISO(NP) XXXX	Graphic technology — Symbols for graphic arts equipment

Note 1 Will be combined with other 1974 “resistance to” standards to form a new standard