PDF Workflows for the Real World

Jason Lisi* and Christopher Smyth*

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Abstract

The PDF/X ISO standards based on the Portable Document Format (ISO 32000) have recently evolved significantly from the initial PDF/X-1a:2001 (ISO standard 15930-1) format that was developed over ten years ago.

Initially, PDF/X-1a was developed to address the needs of a "blind" file exchange in the publishing industry, for advertising material. It also offered benefits for other print focused workflows, because if offered an accurate, predictable, method of exchanging content.

However the latest advancements, when partnered with new workflow technologies like the Adobe PDF Print Engine, ("Print Engine"), have the potential to significantly change the landscape for the wider graphic communications industry. Used in tandem, they enable organizations focused on different industry segments to economically and efficiently move their processes beyond those based on PostScript, as well as offer the opportunity to potentially reach out to new markets.

The most recent advancements in PDF standards occurred in the summer of 2010, with the ratification of three new standards: PDF/X-4:2010 (ISO 15930-7:2010), PDF/X-5:2010 (ISO 15930-8:2010) and PDF/VT (ISO 16612-2:2010). These standards have significant implications for various facets of the industry, including, but not limited to, commercial printing, publication printing, packaging printing, variable data printing, and cross media publishing.

PDF/X-4 files are based on a more recent version of the Adobe PDF language than PDF/X-1a:2001, version 1.6 as compared to 1.3. This means that the newer

*Ryerson University, School of Graphic Communications Management

PDF/X ISO standards allow for native support of transparency in artwork, ICC-based color management, and optional content (layers). They also support 16 bit image workflows. PDF/X-4 files do have some restrictions, to ensure that they are predictable to work with; fonts must be embedded and OPI (open prepress interface) workflows are disallowed. As well, the files are prevented from including annotations in the bleed area, or any non-printing cross media functions.

PDF/X-5:2010 is built on the capabilities of PDF/X-4. It is designed to allow for uniquely identified, externally referenced, images, as well as externally referenced ICC-profiles, text and vector based objects. Referencing this information outside of the individual main content file can allow for smaller PDF files.

ISO 16612-2:2010, PDF/VT, is an additional format developed to offer the advantages of a PDF/X workflow – reliable, predictable file exchanges, that are accessible throughout the workflow, but is designed specifically for variable data and transactional (VT) projects. It is designed to enable variable printing in a variety of environments, compared to other existing variable data formats, which tend to be processes specific. Members of the ISO sub-committee included a spectrum of software, hardware, and end users, including Adobe, Callas Software, Global Graphics, Kodak, Xerox, and RR Donnelley.

The Adobe PDF Print Engine was developed to support a native PDF workflow. This allows it to process PDF files without converting, or translating, them into other formats, which in turn reduce the potential for processing errors. As well the Print Engine is designed to support JDF (Job Document Format) throughout the workflow, which in theory allows for the clear separation of page content from processing instructions. This step should allow for streamlined processes (all file processing within the Print Engine environment is controlled by JDF), as well as offering a solid foundation to other workflow systems.

A significant opportunity for printers and publishers may lie in the combination of the adoption of a Print Engine based workflow, and the use of PDF/VT. Version 2.5 of the Print Engine was released in the first half of 2010, at IPEX in Birmingham UK. One of the main differences with this version of Print Engine is the integrated support for the new PDF/VT format. This integration is accomplished through support for Document Part hierarchy and metadata, combined with the existing process of caching elements that repeat between different iterations of a variable job.

Caching of static page content in variable projects can be a challenge in conventional PostScript based workflows. Processes are developed to separate repeating from changing elements, which can be proprietary, or have constraints on possible integration throughout the project environment.

The Print Engine is not the first, or only, native PDF solution in the marketplace, or the only one that can cache repeating elements. However, it is important to analyze and review the potential of a workflow based on v2.5 of the Print Engine, and driven by PDF/VT files, given the relative market reach of Adobe, and the support of other industry members in the development of the new standard.

It is also important to note that PDF is a format that is generally well understood and supported by all stakeholders in the graphic communications workflow. Participants have the authoring applications and the readers to generate and consume these files. A workflow built on a structure with these benefits could be a key success factor for organizations focused on process improvement and automation.

Through interviews and discussions, the authors explore perspectives on the relative impact that these technologies have for different industry channels, such as catalog and magazine printers and publishers, packagers, as well as variable data based workflows. These discussions include a breakdown of the "traditional" or conventional Adobe CPSI workflows, and highlight the potential process benefits of a Print Engine v2 workflow over traditional PostScript processes.

Promising tools are emerging into the market, such as the PDF/X-4 test files being developed by the Ghent Workgroup (www.gwg.org) to test files and workflows for compliance with the new standard(s). The tools are considered and discussed for their ability to check for transparency, fonts, color spaces, output intents and ICC color spaces.

This paper is significant for several key areas within the graphic communications industry. The late binding workflow aspects of PDF/X and Print Engine have the potential to impact printers across all areas, and have implications for cross media distribution. The optional content group (OCG) supported by the PDF/X-4:2010 standard also has the potential to impact many different industry channels. The paper also reiterates the immediate process benefits to the new workflows, identifies some potential barriers to uptake, and makes solid recommendations on addressing the concerns.

Introduction

The PDF/X framework has evolved considerably since the ratification of the PDF/X-1a:2001 standard (ISO 15930-1) over a decade ago, especially in relation to optional content, variability, and blind content exchange. Where PDF/X-1a:2001 served to provide predictability, reliability and consistency through limitations on what could be included in a final file, newer PDF/X standards seek to offer greater flexibility and versatility by allowing for increased use of such things as optional content groups (layers), transparency, and referenced x-objects.

Over the years, the PDF/X group of standards has grown to include several iterations. PDF/X-2 (ISO 15930-5) and PDF/X-3 (ISO 15930-3) have variations and uses that vary from PDF/X-1a:2001 and each other. The ratification of PDF/X-4 (ISO 15930-7) and PDF/X-5 (15930-8) in 2008 brought about even more significant changes for PDF/X because both of these standards were based on PDF 1.6. Unlike their predecessors that were limited by constraints of the older PDF 1.3 architecture, PDF/X-4:2008 and PDF/X-5:2008 allowed for more versatility through the support of native transparency and the ability to recognize optional content groups. These advancements were, and continue to be, significant when processing these files using a PDF native RIP, such as the Adobe PDF Print Engine, or other comparable products, that are optimized to support native transparency, and optional content.

Since their release in 2008, both the PDF/X-4 and PDF/X-5 standards have undergone further changes and refinements, resulting in second edition standards being ratified for both, in the summer of 2010. In addition, a new PDF standard, PDF/VT, was also ratified later in the summer of 2010. These three standards, and their derivative standards, build upon the concept of flexibility and versatility within a PDF standard, and continue to exploit the inherent features of the Adobe PDF Print Engine (Print Engine), and other PDF native workflows. Table 1 summarizes some key elements of each of these standards.

Table 1. Summary of PDF/X-4:2010, PDF/X-5:2010 and PDF/VT.			
	Dissemination of Print Format Digital Data	***Elements for Final Print***	***Printing Characterizations***
PDF/X-4	ISO 15930-7:2010 specifies the use of PDF Version 1.6 for the dissemination of digital data intended for print reproduction.	All elements necessary for final print repro-duction are contained within the file (it is designated as PDF/X-4). If a required ICC profile is externally supplied and unambiguously identified, it is desig-nated as PDF/X-4p.	Color-managed, CMYK, gray, RGB or spot colour data are supported, as are PDF transparency and optional content. Files can be prepared for use with gray, RGB and CMYK printing characterizations.
PDF/X-5	ISO 15930-8:2010 specifies the use of PDF Version 1.6 for the dissemination of digital data intended for print.	All elements necessary for final print repro-duction are either included or provision is made for unique identification of externally supplied graphical content or n-colorant ICC profiles (X-5n only).	Color-managed, CMYK, gray, RGB or spot colour data are supported in any combination; as are PDF transparency and optional content. Files can be prepared for use with gray, RGB, CMYK and n-colorant printing characterizations.
PDF/VT	ISO 16612-2:2010 specifies the use of PDF Version 1.6, as restricted by PDF/X-4 and PDF/X-5, for the representation of documents.	All elements necessary for final print repro-duction are included or provision is made for unique identification of externally supplied graphical content or ICC profiles.	Constructed to enable its use with JDF or similar job ticket formats.

Overview of the Research Project

This research paper explores the implications of the newly ratified PDF/X-4:2010, PDF/X-5:2010, and PDF/VT:2010 standards as they relate to specific facets of the graphic communications industry (primarily commercial publication, packaging, and variable data printing). The benefits and drawbacks of these new standards are explored and contrasted against current technologies that are presently being used, and their relationship with Print Engine and other PDF native workflows will be described in detail. Through discussions with industry professionals, this paper will also document the experiences of early adopters of these technologies and the results they have seen to date.

A Brief History of PostScript and PDF

The latest iterations of the PDF/X-4, PDF/X-5 and PDF/VT standards are quite different from the restrictive, blind exchange PDF model for final output-ready files that has been adopted in the commercial print and publishing industries for the past ten years. The less flexibility a final file had, the less editable it was, and therefore the more predictable, repeatable, and accurate the outcome would be. With a "blind" exchange, the supplier and receiver would not have to communicate in advance of exchanging material (advertising material for publications was a major concern).

For this reason, file formats like PostScript, TIFF-IT, and even PDF/X-1a have been very popular options used by printers to accept supplied material for processing with less risk of incorrect reproduction. Although this model has proved very successful, the newest PDF standards deviate from this model of blind exchange to offer greater versatility. To better understand the reason for this shift, it is worth looking at the historical development of PostScript and PDF and the differences between a Configurable PostScript Interpreter (CPSI) RIP and PDF native RIP, such as the Print Engine.

The Beginning of PostScript

PostScript is a Page Description Language (PDL), and as such describes the final appearance of a printed page in an abstract format, rather than only using bitmapped data. Released in 1984 Adobe's PostScript Level 1 was unique from other solutions at that time, in that that was not tied to a specific output device. PostScript was designed to "provide a uniform way to represent visual elements on any raster device" (Adobe Systems Incorporated, 1988 p. 6). PostScript was removed from "the level of rasterization to ensure true device independence" (Adobe Systems Incorporated, 1988 p. 54).

The PostScript language is designed for two purposes: "it provides an imaging model for describing and printing complex text and graphics, and it is a complete and general programming language" (Adobe Systems Incorporated, 1988, pp. 57). While about "one-third of the PostScript language is devoted to graphics", "the remainder makes up an entirely general computer programming language" (Adobe Systems Incorporated, 1985 p. 4). An imaging model can be considered as an abstract concept, through which graphics are rendered. It is a set of rules that are used by output devices. A sophisticated imaging model "enables applications to describe the appearance of pages containing text, graphical shapes, and sampled images in terms of abstract graphical elements rather than directly in terms of device pixels" (Adobe Systems Incorporated, 2006 p. 34). This kind of high-level detachment "frees application software from having to make device-specific rendering decisions" (Adobe Systems Incorporated, 1988, p. 6), and allows PostScript to be device independent.

Specifically, PostScript page content is specified in terms of straight lines and cubic Bézier curves, utilizing a Cartesian plane coordinate system of 'x' and 'y' pairs. This vector flexibility allows for "arbitrary page transformation such as scaling and rotating, and also allows the file to be output at a variety of resolutions" (Adobe Systems Incorporated, 1985). The PostScript imaging model also uses a concept of a "Current Page," on which PostScript draws content. To begin with, the current page is blank; PostScript uses painting operators (such as fill or stroke) to "place marks on the current page, each of which completely obscures marks that they may overlay" (Adobe Systems Incorporated, 1985, p. 10). This is a significant aspect of PostScript since painting is opaque in the PostScript imaging model (Adobe Systems Incorporated, 1985). Any new marks knock out whatever was underneath it; consequently, PostScript cannot directly output pages created with partial transparency effects applied.

PostScript is an imperative type programming language, which means that a PostScript file defines a sequence of commands for the interpreter to resolve (Adobe Systems Incorporated, 1988). PostScript is interpreted and stack based, which allows files to be of varying lengths and complexities (Adobe Systems Incorporated, 1988). This is important to note, because, a "showpage" command is used in the program, which triggers final output, but only after the entire page has been read. There is no random access to page contents in a multipage document; all pages must be processed in sequence in order to determine any one pages final appearance (Adobe Systems Incorporated, 1999). PostScript was designed for output, not interactivity.

The Evolution of PostScript

PostScript Level 2 was released in 1991, and included several improvements: improved speed and reliability (caching reusable content), support for in-RIP separations, image decompression (for example, JPEG images could be rendered by a PostScript program), support for composite fonts, and improved screening algorithms (Adobe Systems Incorporated, 1991).

PostScript was further developed, and in 1998 Adobe released PostScript 3. Some important feature in this version was output support for more than 256 gray levels per color (12-bit screening allowed for up to 4096 gray levels per color). This helped address visible banding in blends. PostScript 3 also offered improved support for in-rip separations (DeviceN), as well as support for PDF files (Adobe Systems Incorporated, 1999).

Portable Document Format (PDF) and the PDF Imaging Model

Adobe released the Portable Document Format (PDF) in 1993. It was designed as a tool to allow people to exchange electronic documents independent of the original authoring environment, portable across all platforms and operating systems (Adobe Systems Incorporated, 1999). The imaging model of PDF at this point was opaque, similar to the PostScript imaging model.

PDF is a subset of the PostScript Page Description Language, however unlike PostScript, PDF is not a programming language. It provides resolution independence, but it also includes a document structure that supports navigation within the file. This allows content to be included as objects, for example annotations and external links, and be cataloged into a cross-reference table, which is included at the end of a file (Adobe Systems Incorporated, 1999). As such, a PDF file can be compared to a database, allowing for direct access to each object, and each page of a PDF document is independent of the others (Adobe Systems Incorporated, 1999). This lets the content objects be accessed randomly by a software reader, as opposed to PostScript, where objects need to be processed sequentially (Adobe Systems Incorporated, 1997).

While the mechanisms for the imaging model are similar, PDF significantly differs from PostScript in the following ways (Adobe Systems Incorporated, 2006):

- PDF has a defined file structure that allows an application to access parts of a document in arbitrary order.
- PDF does not include programming language features such as procedures, variables, and control constructs.
- Font metrics are included in PDF files for accurate viewing and output
- A PDF file may contain non-imaging data, such as hyperlinks and logical structure information for document interchange.

In 1996, Adobe released Acrobat 3.0, and the PDF 1.2 specifications. PDF 1.2 was the first version of PDF that was generally considered suitable for a commercial prepress environment, because it included support for; Open

Prepress Interface (OPI), CMYK color space, spot colors, as well as halftone functions and overprint information.

Commercially available in 1999, Acrobat 4.0 and PDF 1.3 extended support for the print industry by including support for color management, International Color Consortium (ICC) profiles, as well as DeviceN color spaces (Scribus, 2008).

In 2001 Adobe released Acrobat 5 and PDF 1.4, which included a significant change: support for native vector transparency. This change would later prove to be very significant, and is one of the main reasons why the PDF/X standards have moved away from the restricted, blind exchange model. In 1993, Acrobat 6 and PDF 1.5 brought another key feature, Optional Content Groups (layers) (Adobe Systems Incorporated, 2003), which would also prove to be significant to the present-day PDF standards.

Transparency and Its Relationship to File Production

Transparency in layout applications is the ability to control the opacity of an object so that it is translucent, or semi opaque, allowing any objects beneath it to be visible (Adobe Systems Incorporated, 2007a). This is done through a process where objects can be overlaid, or "composited," with the previously existing contents of the page; "producing results that combine the colors of the object and its backdrop according to their respective opacity characteristics" (Adobe Systems Incorporated, 1999). Partial transparency is always simulated at some level by mixing colors. The simulated effect is achieved by applying a variety of blending effects, which softens the edges of an object by smoothly fading the object from opaque to transparent (Adobe Systems Incorporated, 2007a).

Transparency must be "resolved" before final output for print because screened output can't be translucent for offset printing. This process is referred to as flattening.

At its simplest, flattening converts all overlapping areas in a stack of transparent objects (atomic regions), plus all text and graphics that interact with transparency, into smaller opaque regions (complexity regions) that simulate the appearance of the original transparent areas. Flattening cuts apart transparent art to represent overlapping areas as discrete pieces that are either vector objects or rasterized areas. As artwork becomes more complex (mixing images, vectors, type, spot colors, overprinting, and so on), so does the flattening and its results (Adobe Systems Incorporated, 2007a).

Transparency flattening can, under certain conditions, can be problematic. The output of transparency in Adobe CPSI workflows has led to some documented reproduction concerns: (Adobe Systems Incorporated, 2007b).

- Spot colors may display colors on process plates or convert to process.
- Transparency flattening can include the process of executing the overprint attribute manually assigned to spot objects. When this occurs, overprinting instructions are not preserved after flattening; however, the objects look correct when printed because the overprint is taken into consideration when transparency is flattened.
- Vector objects may get rasterized at a resolution that's too low for the output device.
- Artifacts may appear along the edges of atomic regions.
- Hairlines and strokes may fatten. While this is generally understood to occur on lower-resolution output devices (preliminary proofs), it can cause delays while the anomalies are investigated.
- Type may be converted to filled strokes, thickening characters. Again, this problem usually occurs on low-resolution devices. It is less of a problem on high-resolution devices.
- Open Prepress Interface (OPI) is not compatible with transparency. Low-resolution images must be replaced with high-resolution images before flattening. If they aren't replaced and low-resolution images are flattened, the results will be low resolution.

The transparency effects within PDF files were developed using extensions to the PDF language, however this also meant that PDF applications designed for earlier versions of the specification might display and output significantly different results than applications that could fully support transparency (Adobe Systems Incorporated, (2007a). Adobe designed transparent elements to appear opaque in earlier versions of PDF. Also, even later versions of PDF files that are RIPped using a CPSI (PostScript) RIP must be flattened at some point prior to imaging because a PostScript RIP can only function within an opaque imaging model. Unfortunately these issues have led to situations where files were output, and reproduced, that were different from the intended end result. This had a significant impact on the print industry because "when PDF files are used to prepare work for professional printing, transparency issues could cause millions of printed copies to be incorrect, and have to be destroyed" (Adobe Systems Incorporated, (2007a).

Recently, native PDF interpreters have been developed to take advantage of the additional functionalities of the PDF imaging model not supported in the PostScript model, thereby reducing or eliminating errors associated with flattening transparency. Global Graphics' "Eclipse Release" of their Harlequin was available in 2002. Adobe introduced their Adobe PDF Print Engine (Print Engine) in 2006, and released version 2.5 at IPEX in 2010.

The major benefits to a native PDF interpreter based workflow are support for more advanced PDF functions such as transparency and layers, as well as fewer overall interpretation errors through less file conversions. A native PDF renderer should allow for a late binding workflow, where transparency can remain unresolved, or native, until imaging. This should improve processing time, reduce output errors and limit "time and materials wasted in troubleshooting, proofing, and reprinting in the production process" (Adobe Systems Incorporated, (2007b p. 2).

Optional Content Groups and Their Relationship to File Production for Print

PDF version 1.5 introduced the concept of "Layers" to PDF files; however, the concept of layers in PDF files is not the same as layers in layout authoring applications. Referred to as Optional Content Groups (OCGs) in PDF, PDF layers were designed to provide a mechanism to incorporate related optional content into one PDF file. Layers in the application file can be "preserved" when creating a PDF 1.5 (or later) file, becoming Acrobat layers (OCGs). OCGs could have useful benefits for various types of printing. For example, publishers and catalogers could use OCGs for language or regional versioning. Similarly, packaging workflows could use OCGs for versions, dielines, printer's marks, and folding information. Variable data workflows could use OCGs for promotional marketing materials (Adobe Systems Incorporated, 2003).

It is interesting to note that despite the fact that the PDF/X-4:2008 (ISO 15930-7) standard is based upon PDF 1.6, the Adobe PDF Preset for PDF/X-4:2008 available in the Adobe CS4 application suite uses PDF.1.4. When a PDF/X-4 file is created using this PDF Preset, the application layers are processed into an Optional Content Configuration Dictionary (OCCD). An OCCD is a set of OCGs in one fixed group (Prepressure.com, 2009b). This approach was taken in an effort to adhere to the "blind exchange" philosophy of PDF/X files. The layers could not be ambiguous, or the receiver would have to contact the supplier to determine which layers should be output.

With PDF/X-4:2010, authoring and consuming applications will have direct access to the OCG's. Currently this is supported in Adobe Acrobat X. However there are issues with backwards compatibility—optional content created and visible in Acrobat X may not be visible in Acrobat 9, and vice versa. Overall this issue should resolve itself in the marketplace, as more users adopt the latest version of Acrobat. Generally, it could be expected that uptake of Acrobat X will be somewhat limited, until it is included in a future update/release of Adobe's Creative Suite.

PDF/X-4, PDF/X-5, PDF/VT and Their Relationships to Current Industry Sectors and Practices

With the versatility and flexibility built into all three standards, PDF/X-4, PDF/X-5 and PDF/VT can serve many purposes and be adapted to many situations; however, there are specific market sectors and application strategies that can be strategically aligned to optimize the unique characteristics of each standard. To illustrate this point, each of the three standards will be discussed in detail, and real-world application of these standards will be explored.

PDF/X-4:2010

The introduction of the ISO standard 15930-7:2008 (PDF/X-4) was a departure from earlier PDF/X standards in that it was the first PDF/X spec based on PDF version 1.6. Earlier PDF/X standards were confined to the limits of PDF version 1.3, making them well suited for restricted blind exchange of documents, but limiting their use of transparency and optional content.

PDF/X-4:2008, as a standard, provided several key elements that still allowed for control over output, yet at the same time allowed the resulting file to maintain transparency, and even allowed for limited optional via an Optional Content Configuration Dictionary (OCCD). As mentioned earlier in this paper, even though PDF/X-4 is based upon PDF version 1.6, the PDF/X-4:2008 job option supplied by Adobe for their Creative Suite products defaults to PDF version 1.4, not 1.6. This means that a PDF/X-4 file created using the Adobe PDF/X-4:2008 job option can maintain transparency, but cannot have Optional Content Groups (OCGs) in the form of Acrobat Layers. It would be logical to assume that later releases of Adobe software will be updated with a PDF/X-4:2010 preset that will take full advantage of PDF 1.6 as restricted by the PDF/X-4 standard.

In the summer of 2010, the PDF/X-4 standard was revised to ISO 15930-7:2010. This revision is considered, technically, to be a minor revision, and includes some modifications to the wording and structure of the standard document. However this revision also includes a couple of significant changes that can impact how the standard is used in industry. First, ISO 15930-7:2010 has been updated to include changes to transparency blend mode algorithms provided by Adobe Systems; and second, the restrictions previously applied to the Orders key in Optional Content have been removed (ISO, 2010a). The removal of the restrictions with regard to Optional Content is quite significant.

A requirement of PDF/X-4 is the inclusion of a defined characterization of the printing condition for which the PDF/X-4 file is intended. The ISO 15930-7 standard identifies two conformance levels for PDF/X-4 that addresses how the target print condition information is included. The first conformance level, PDF/X-4, requires that the target print condition information (ICC profile) is embedded with the file itself. The second conformance level, PDF/X-4p, allows for reference to an ICC profile for target print conditions that resides separate (external) from the PDF file. The logic behind PDF-X-4p comes from scenarios where either the inclusion of the ICC data within the file would drastically increase the PDF's size, or there are multiple PDF files that need to reference the same profile. In addition, the ability to reference an external ICC profile can offer a workaround solution for situations where profiles cannot be embedded due to licensing restraints (ISO, 2010a). It should be noted that the ISO 15930-7 standard clearly states that PDF/X-4 conformance should be chosen over PDF/X-4p unless there is an advantage or necessity to use PDF/X-4p.

Key Features of a PDF/X-4 Compliant File

There are several variations to object and key status in a PDF/X-4 file when compared to the 5th Edition of Adobe's PDF Reference document (Adobe, 2004). A detailed list of which keys are prohibited, restricted, and required for PDF/X-4 can be found in Annex B of the ISO 15930-7:2010 document. While it is useful and important to review and understand these restrictions and variance, the discussion of such is out of the scope of this paper. There are, however, details about the makeup and composition of a PDF/X-4 file that require addressing.

A PDF/X-4 file can contain both print and non-print elements. Any part of the PDF/X-4 file that is intended for final print is classified as a print element, and anything not associated with final print is classed as a non-print element. The restrictions imposed on non-print elements are not as severe as those placed on print elements, since the non-print elements do not affect the final output of the file. However, any PDF feature that could potentially modify the rendered appearance of the file cannot be used with non-printing elements. For example, neither Actions nor JavaScript can be used in conjunction with non-print elements as they both have the ability to affect the outcome of the rendered file.

All print elements within a PDF/X-4 file can be color managed colorimetrically or through the use of output device code values. Regardless which one of these methods (or both) is used in the file, all the print data is mapped to a single characterized print condition, which must be identified in the PDF/X-4 output intent. This characterized print condition can have one, three, or four color channels. It should be noted that there are clear rules as to how color spaces such as DeviceGray, DeviceRGB, and DeviceCMYK are interpreted by a conforming reader in relation to the specified output intent. Special attention should be taken to ensure that these interpretations do not create in unexpected overprint results from an overprint mode that is set to 1 (OP1). The PDF/X-4 standard also allows for the use of Separation and DeviceN color spaces for process colors, spot colors, and non-color-related information.

Document trapping is allowed in PDF/X-4, provided the entire document is trapped. Partially trapped documents are not allowed. Also, the use of metadata is allowed in a PDF/X-4 file, provided the metadata conforms to XMP specifications. More detailed information about trapping and metadata within a PDF/X-4 file can be found in sections 6.9 and 6.10 of the ISO 15930-7:2010 document respectively.

As mentioned earlier, one of the most significant features of a PDF/X-4 file is the inclusion of PDF transparency. This means that native transparency does not need to be flattened (rasterized) during the PDF creation. The ability to maintain transparency has many benefits in terms of reproducibility and flexibility as will be discussed later, but also means that the colors resulting from overlapping transparent objects must be rendered and viewed correctly. The ISO 15930-7:2010 standard describes how color is assessed for transparent objects:

> If there is no **CS** key in the transparency group's attribute dictionary that is the value of the **Group** key in a page object, or if a page object does not contain a **Group** key, then the colour space implicit in the PDF/X output intent … shall be used as the transparency blending colour space for the page group, rather than the blending colour space being derived from the environment in which the file is being rendered. If there is a **CS** key in the transparency group's attribute dictionary, its value shall conform to the restrictions on colour spaces set out in 6.4.3. Only blend modes that are specified in the *PDF Reference* shall be used for the value of the **BM** key in an extended graphic state dictionary.
>
> A PDF/X-4 conforming reader shall implement all blend modes defined in the *PDF Reference*. (pp. 18-19)

Another significant aspect of a PDF/X-4 file is the ability to include optional content in the form of layers. The ISO 15930-7 specification refers to variants of a single file. A variant, by definition, can contain one or more optional content groups (OCGs). An optional content membership dictionary (OCMD) keeps track of how OCGs are grouped together to create the file variant(s).

PDF/X-4 in the Real World: Potential Benefits of Using PDF/X-4 in Standard Production

The ability to retain PDF transparency and include PDF layers within a PDF/X-4 file can benefit industry segments currently using older PDF/X standards based on PDF version 1.3, as well those segments currently not using PDF/X due to its inherent limitations. It should be noted, however, that the benefits discussed in this paper would be best realized if the PDF/X-4 file is consumed through a PDF native workflow, such as the Adobe PDF Print Engine (Print Engine), Global Graphics' Harlequin RIP, or similar workflow.

One market segment that has potential to benefit from PDF/X-4 is the magazine publishing market. In Canada, for example, several large magazine publishers and printers have migrated their editorial page workflows from PDF/X-1a:2001 to non-flattened PDF 1.4 files. One such company is Transcontinental Media in Toronto Ontario. According to John Palmeri, manager of Production Technologies and the Toronto Production Centre, the driving force behind Transcontinental Media's switch from PDF/X-1a:2001 to non-flattened PDF 1.4 was issues surrounding transparency. Although PDF/X-1a:2001 has proven to be a very reliable format, issues can still arise when transparency is flattened and the resulting rasterized data does not accurately reflect what the file looked like prior to flattening. Using non-flattened PDF 1.4 files in conjunction with the Print Engine has greatly reduced rendering errors that were generally encountered using the flattened PDF/X-1a:2001 files (John Palmeri, personal communication, February 22, 2011).

The magazine publishing sector has been using PDF/X standards for quite some time. Due to the sometimes unpredictable nature of files that are sent to magazine publishers by advertisers, the PDF/X-1a:2001 standard is has been successfully used as the file submission standard for digital ads. The PDF/X-4 standard has the potential to further benefit the magazine publishing sector with its ability to include optional content and support PDF transparency. For example, PDF/X-4 could be very useful for regional versioning and/or splits in issues. When this feature was discussed with Palmeri, he indicated that there was a potential benefit to his workflow, when advertising drives "split" issues (where the editorial is consistent, but the ad material varies). Sometimes the ad that changes is not a full-page ad, but rather a partial ad within an editorial page. Acrobat Layers could hold the different partial ads for versioning, allowing for one file to be processed instead of having a new PDF file created for each versioned page (John Palmeri, personal communication, February 22, 2011).

It should be noted that although PDF/X-4 has some tangible benefits to offer the magazine publishing sector, Palmeri and other publishing industry members expressed some reservations. In particular, it may be some time before advertising material submissions by clients are accepted as PDF/X-4 files. Currently the majority of advertising material is being submitted as PDF/X-1a:2001 or PDF/X-1a:2003 files, with a very high degree of stability and success. The PDF/X-1a format is more restrictive, but offers consistent and accurate results. When asked about moving the advertising workflow over to PDF/X-4, Palmeri indicated that he was open to the idea, but would have be able to ensure that PDF/X-4 ad files could run through the workflow with as little manual intervention as the current PDF/x-1a files require. Palmeri indicated that workflows would have to be able to extract standardized metadata from a PDF/X-4 file, and use it to control issues like versioning. For example, in the case of regional versioning where partial ads on editorial pages change, the layers could be activated or deactivated based on naming convention to correlate the correct ad for the correct regional version (John Palmeri, personal communication, February 22, 2011).

Another market segment that has the potential to benefit from PDF/X-4 is the packaging industry. The use of Acrobat layers would make it an efficient method to communicate instructional information, as well as optional content such as dielines, prior to output. Also, complex trapping done in Illustrator using specialized plugins like the ones offered by EskoArtwork can be retained as separate layers in the PDF/X-4 file, allowing for last minute changes. PDF/X-4 files created for packaging would benefit from the portability, accessibility, and managed color associated with the PDF/X strategy, without the risks associated with generic PDF files.

PDF/X-4 has the potential to benefit the packaging industry; however, there are challenges involved with full adoption of PDF/X-4 as a file format. One of the biggest issues is that digital files generated for packaging end use generally require some degree of hands-on manipulation by the prepress department, before the job can be plated and printed. The need to fix or adjust dielines, create step-and-repeat layouts, adjust to complete trapping, change colors and modify vignettes usually necessitate the need for application files to be given to the printer/prepress so that additional work can be done efficiently.

Joseph Banich, Prinect Support Specialist at Heidelberg Canada provides a unique perspective on using PDF/X-4 as a file format for packaging printing, as Banich has extensive experience dealing with both commercial printing and packaging printing. Considering PDF/X-4 as a common standard for packaging production, Banich echoed the concerns listed above as potential roadblocks, or barriers, for the adoption of PDF/X-4 in packaging. He indicated that one of the reasons that “closed,” or end to end dedicated packaging systems, like those offered by EskoArtwork, are so successful is because of the unique and demanding nature of files created for packaging. Banich did indicate that there are some trends beginning in the industry that could make PDF/X-4 adoption easier. First, more traditional commercial print workflow systems are attempting to enter the packaging market, through packaging extensions to their existing product lines. If more packaging printers migrate away from closed proprietary systems to commercial systems that are more flexible and adaptable to open standards, the ability to process and utilize PDF/X-4 will increase (Joseph Banich, personal communication, February 25, 2011). Banich also suggested that for PDF/X-4 to reach its full potential as a file format for packaging, it would be ideal to have a full suite of editing tools available in Acrobat that mimicked the capabilities of the tools used in Illustrator to manipulate packaging files.

It is worth noting that the PDF format was not originally designed to be as flexible a native application file; however, several developers have designed tools which allow for content to be modified within the PDF file. These are either stand-alone applications, or “plug-ins” that work with Adobe Acrobat.

PDF/X-4 offers many opportunities in a packaging workflow. Stephan Jaeggi of PrePress-Consulting, discussed a project he is working on with an international pharmaceutical company, which is adopting the PDF/X-4p format for their processes.

This particular subset of the PDF/X-4 standard was selected for this end use, because the print characterization can be referenced externally. For a pharmaceutical company working with a large variety of deliverables, which are not necessarily reproduced using CMYK, an externally referenced output intent is a minimal risk. A direct benefit for the workflow is that the reduced file sizes allows for easier file exchange and collaboration across multiple sites. PDF/X-4p also allows the client to standardize on a common denominator for their projects, a platform that will allow for integrated quality control processes—comparing raw text files to final PDF files, or final files to bit mapped PDF files.

Jaeggi is taking a pragmatic approach to the issue of layers, using a system where everything is built on pre-determined and specified spot color layers until the “layering and metadata issues” are sorted out in the greater PDF/X-4 community. Once that occurs, and he is confident it will, it should be a straightforward process to convert all legacy files.

That is a solution that works for one company generating packaging content, which is delivered to multiple service providers. Another position to consider is that of a multinational graphics provider providing thousands of deliverables to a variety of multinational accounts. Igor Pavlesen, Workflow Manager for SGS International Inc., Canada, has to contend with delivering a wide variety of formats (native Adobe Illustrator, vector DCS, 1-bit tiffs), supplying cylinders and plates for multiple facilities.

The challenge an organization such as SGS faces is the one of legacy materials. While he believes there are clear benefits to the new processes (specifically some of the concerns with transparency), it has to be balanced against the risk of compromising existing work. Scale is also a factor; SGS is a large and diversified organization that has evolved through a combination of organic growth and acquisitions. As a result they have a myriad of different workflow, management information, and data asset management systems and processes, and subsequently have taken on an initiative to standardize, if not platforms, at least processes across different sites. This framework should serve as a solid foundation for adopting new technologies and workflows in the near future.

PDF/X-4:2008, the original incarnation of the standard, did not address the direct needs of the packaging industry for a stable, standardized, digital file format, according to Steve Carter, Vice President of Technology for Phototype, and a member of the Ghent Workgroup. The packaging industry needed a file format that could support non-printing layers, which could be used for dielines, embossing for brail, and information layers. PDF/X-4:2010 with its changes for optional content group support offers this functionality.

Carter sees value in the new format, especially for late changes to complex designs involving extensive transparencies. PDF/X-4 allows workflows to maintain flexibility as late in the process as possible. However he is also realistic about the speed of any transition, commenting on investments that firms have made in tools, workflow processes, and people, and that it takes time to convert to a new approach. This is notable in packaging, where there can still be the perception that standardized processes aren't applicable because of the nature of the work that is done to the files. However economies and efficiencies through best practices will gradually demonstrate their advantages, similar to what happened in magazine publishing with the advent of computer to plate ten to fifteen years ago.

PDF/X-5:2010

The PDF/X-5 standard, as defined in ISO 15930-8, has three different conformance levels: PDF/X-5g, PDF/X-5n, and PDF/X-5pg. These X-5 conformance levels are referred to as expansions and extensions of PDF/X-4 and PDF/X-4p within the ISO 15930-8 documentation (ISO, 2010b, p. vi). None of these three conformance levels require a complete exchange of information within the PDF file; that is, all three PDF/X-5 conformance levels have links to external data. Additionally, PDF/X-5n allows for the use of external output intent ICC profiles for n-colorant print characterizations that conform to ISO

15076-1. Table 2 summarizes they key differences between PDF/X-4, PDF/X-4p, PDF/X-5g, PDF/X-5n, and PDF/X-5pg.

There are a couple important things to consider when discussing PDF/X-5. First, None of the PDF/X-5 conformance levels allow for the use of n-colorant printing conditions in conjunction with externally referenced graphical content. Second, ISO 15930-8 clearly specifies, "PDF/X-4 is preferred to any of the PDF/X-5 conformance levels where there is no significant benefit in the use of the latter" (ISO, 2010b, p. vii).

Table 2. Key Differences between PDF/X-4 and PDF/X-5.

	Raster and Vector Image Data Handling	***Print Characterization Space Support***	***Exchange of Printing Data***
PDF/X-4	Must be within the single file being exchanged	Supports Gray, RGB, and CMYK print characterization. Print Characterization must be embedded in the file	Complete exchange of Printing data (everything resides within the file)
PDF/X-4p	Must be within the single file being exchanged	Supports Gray, RGB, and CMYK print characterization. Print Characterization is externally referenced	Partial exchange of Printing data (file relies on externally referenced data)
PDF/X-5g	Can be externally referenced	Supports Gray, RGB, and CMYK print characterization. Print Characterization must be embedded in the file	Partial exchange of Printing data (file relies on externally referenced data)
PDF/X-5n	Must be within the single file being exchanged	Supports output intent ICC profiles for n-colorant print characterization. Print Characterization must be externally referenced	Partial exchange of Printing data (file relies on externally referenced data)
PDF/X-5pg	Can be externally referenced	Supports Gray, RGB, and CMYK print characterization. Print Characterization is externally referenced	Partial exchange of Printing data (file relies on externally referenced data)

PDF/X-5 in the Real World: Potential Benefits of Using PDF/X-5 in Standard Production

Due to the similarities between PDF/X-4 and PDF/X-5, the benefits of PDF/X-4 are also applicable to PDF/X-5. There are also benefits to using PDF/X-5 that are not inherent to PDF/X-4. The ability to use externally referenced graphical content in a PDF/X-5g and PDF/X-5pg files opens up the possibility of a workflow comparable to that of traditional Open Prepress Interface (OPI). Such a workflow can decrease time-to-market for products that are image intensive by allowing designers to place low-res proxy images into the page at the same time that the hi-res images are being color corrected and processed. In addition, externally referenced graphic content can aid in the successful operation of late-binding workflows. For example, "in a publication or newsprint workflow, they allow advertising and editorial submissions to be composited together late in the workflow, without requiring that files submitted by third parties be amended in any way before the final prepress processes" (ISO, 2010b, p. vi).

It is worth noting that the PDF Reference 5th Edition does not permit n-colorant ICC profiles to be embedded in a PDF File. ISO 15930-8 specifies that externally reference n-colorant profiles be allowed, so long as they are not used in conjunction with externally referenced objects. Because of these two exclusions, only PDF/X-5n meets the criteria for using an n-colorant ICC profile. It should also be noted that n-colorant profiles conforming to early versions of ICC.1 are not supported for use within the ISO15930-8 standard.

When using externally referenced data, there are some important considerations to keep in mind. For one, the ISO15930-8 standard disallows optional content groups within the target documents being referenced by the PDF/X-5g/pg file. Also, all print content within the PDF/X-5 file and any externally referenced files need to adhere to the same characterized print condition (ISO, 2010b).

PDF/VT

The ISO 16612-2 document released at the end of the summer in 2010 outlines the specifications for the newest PDF standard, PDF/VT. Unlike the PDF/X standards that are geared towards more conventional printing applications, PDF/VT is targeted towards variable data and transactional printing, as defined by ISO 16612-2 document:

> [ISO 16612] defines the PDF/VT document format and methods to enable reliable document exchange for variable data and transactional (VT) printing. It uses the Portable Document Format (PDF) Version 1.6, as restricted by

> PDF/X-4 and PDF/X-5, for the representation of such documents. It allows the specification of document structure and layout, content data, and interaction of graphical objects in a graphics model that supports transparency and both device-dependent and device-independent colour spaces. All elements are either included or provision is made for unique identification of externally supplied graphical content or ICC profiles (ISO, 2010c, p.1).

There are three main characteristics that make PDF/VT plausible for variable data/transactional printing. First, PDF/VT takes advantage of PDF's object-based nature. This allows repeating objects to be processed once and stored for repeated use, reducing RIP times. Second, PDF/VT separates page content from production and device information. A PDF/VT file does not include production information; rather, the PDF/VT file interacts with a job ticket format, such as the CIP4's Job Document Format (JDF). Last, PDF/VT files follow the same color management structures of the PDF/X-4 and PDF/X-5 formats, which means that PDF/VT is color managed, allowing it to be late stage targeted to different color output devices with consistent rendered appearance.

Key Features of a PDF/VT Compliant File

The PDF/VT standard is based upon the ISO 15930 standard, and specifically on PDF/X-4 and PDF/X-5. ISO 16612-2 define three conformance levels for PDF/VT as outlined in Table 3. Note, Table 3 is adapted from ISO 16612-2, section 5.1 (ISO, 2010, p.5).

Table 3. PDF/VT Conformance Levels.

	Conforms To	***Admissions and Restrictions***
PDF/VT-1	PDF/X-4	Complete data exchange — All objects, resources and metadata representing graphical content must be defined in the PDF/VT-1 file, and guided by PDF/X-4
PDF/VT-2	PDF/X-4p, PDF/X-5g, PDF/X-5 pg	Partial data exchange — One or more objects representing graphical content and/or ICC profiles required for the file can be externally referenced in a PDF/VT-2 file, as guided by PDF/X-4p, PDF/X-5g and PDF/X-5pg
PDF/VT-2s	PDF/X-4p PDF/X-5g PDF/X-5 pg	Same structure as PDF/VT-2, but allows multiple compound entities representing graphical content to be streamed before the entire PDF/VT instance has been generated

Because PDF/VT-1 files are self-contained, they are somewhat easier to manage than their PDF/VT-2 counterparts. In fact, the only real restriction is that they conform to PDF/X-4 only (not PDF/X-4p and/or PDF/X-5 conformance level). This of course is due to the fact that there cannot be any external referencing in a PDF/VT-1 file.

When working with PDF/VT-2 files, there are more variables to consider because not only do you need to consider the PDF/VT-2 file that is being created, but also the files that are being referenced. ISO 16612-2 specifically states that a PDF/VT-2 file cannot reference in whole or in part PDF/X-5g, PDF/X-5n, PDF/X-5pg, or another PDF/VT-2 file (ISO, 2010c). These restrictions prevent secondary reference to graphical objects, so that the only secondary reference that could exist would be to an ICC profile. Table 4 summarizes the restrictions on referenced files used with PDF/VT-2 files.

Table 4. Referenced Files Used With PDF/VT-2.

File Type	***Allowed as Primary Reference File***	***Allowed as Secondary Reference File***
PDF/X-1a	Yes	No
PDF/X-3	Yes	No
PDF/X-4	Yes	No
PDF/X-4p	Yes	No
PDF/X-5g	No	No
PDF/X-5n	No	No
PDF/X-5pg	No	No
PDF/VT-1	Yes	No
PDF/VT-2	No	No
ICC Profile	Yes	Yes

PDF/VT files have been streamlined for maximum efficiency in variable data and transactional print scenarios. For example, PDF/VT files can deviate from the structured access to page objects via the pages tree defined in the PDF Reference 5th Edition by allowing a PDF/VT conforming reader to access page objects indirectly through the DPart leaf nodes of the document (ISO, 2010c). PDF/VT conforming writers have the option to generate a bookmark structure in the PDF/VT file that corresponds to the DPart structure; PDF readers can rely on this bookmark structure for interactive record, document part and page presentation. The DPart structure allows a reader efficient random access to pages relative to the record and component context to which they belong, and “provides an ideal page content resource format for job-ticket-based workflows where the order of page processing by a conforming reader can be different from the order presented in the PDF/VT data” (ISO 2010c, p.9). It is important to mention that the DPart structure is dependent on the pages tree, and the PDF/VT standard requires the order of the pages defined by the pages tree to match that of the DPart tree leaf nodes. This enables legacy PDF readers to present pages in a reasonable order without the need to consult the DPart structure (Tim Donahue, personal communication, March 4, 2011). The PDF/VT standard also requires that “the individual page object contain a reference to its referencing DPart node definition. This allows the conforming reader (e.g., imposition engine / RIP processor) to consume pages relative to the pages tree and identify their relationship with other pages and associated document part metadata (DPM)” (Tim Donahue, personal communication, March 4, 2011).

As mentioned earlier, PDF/VT separates page content from production information. In order to comply with job ticketing formats such as JDF, PDF/VT uses Document Part Metadata (DPM) that can contain important information about the document that can be conveyed to a downstream production workflow. For example, DPM could be referenced by JDF to vary process attributes during production. One example of this would be using DPM to identify different parts of a book being printed on a digital press so that the paper feed will change to accommodate a different stock for the cover as opposed to the inside pages (Tim Donahue and Mark Lewiecki, personal communication, February 22, 2011). ISO 16612-2 suggests that a PDF/VT with DPM, along with a document part hierarchy is “analogous to a structured database of final form variable content pages. This structuring and use of DPM allows a job ticket to refer to the PDF/VT pages in a way that is conceptually similar to a structured database select or query” (ISO, 2010c, p.9).

Another significant part of what makes PDF/VT suitable for variable print applications is how XObjects are used to manage recurring graphical content. ISO 16612-2 recommends that all graphical objects that are referenced more than once should be encoded as XObjects. For variable data printing, render times must be fast as every single page has the potential to be a unique render. When dealing with variable data image objects, the render is even more CPU intensive than text only renders. Based on PDF/VT XObject recurrence hints, a PDF/VT optimized RIP can then cache recurring XObjects so that they do not need to be re-RIPped for each occurrence. Furthermore, XObjects that are used frequently by multiple PDF/VT files can be stored indefinitely in a cache by the RIP and recalled on demand for even better performance.

XObjects can be contained within the file, as is the case with PDF/VT-1, or they can exist within a referenced target file, as with PDF/VT-2 and PDF/VT-2s. In addition, PDF/VT further takes advantage of XObjects through the use of encapsulated XObjects.

An encapsulated XObject is defined as "an XObject having a well-defined limited interaction with the current graphics state… at the point of invocation" (ISO, 2010c, p.14). Graphic states within an encapsulated XObject are not overridden by the inherent state of the file that the encapsulated XObject resides in. Specifically:

> An encapsulated XObject, including any content streams referenced from its definition, shall explicitly set all graphic state parameters that influence the appearance of path painting, text showing, XObject and inline image operators… used in that encapsulated XObject, except the current transformation matrix (CTM), clipping path, soft mask (SMask), current fill opacity (ca), current stroke opacity (CA) and transparency blending mode (BM) graphic state parameters. (ISO, 2010c, p. 15)

This can be very significant when resolving transparencies, as it can minimize the computations that are necessary to derive the result colors of a blend space.

When working with PDF/VT-2s files, it is worth noting that the partial data being streamed (called a PDF/VT instance) consists of one or more PDF/VT chunks encoded within a MIME (Multipurpose Internet Mail Extensions) package. This MIME packaging ensures that the PDF/VT chunks are processed in the right order. It is also necessary for all PDF/VT files within a PDF/VT-2s stream to share a common characterized printing condition.

PDF/VT in the Real World: Potential Benefits of Using PDF/VT in Standard Production

PDF/VT has many useful applications for all types of variable data printing; however, there is a potential for PDF/VT to fill an existing need in the high volume transaction output (HVTO) sector. Currently, much of the variable transactional print is being driven by Advanced Function Presentation/Intelligent Printer Data Stream (AFP/IPDS), which has been the most widely accepted variable printing architecture for decades, though originally designed for monochrome, spot, and highlight color printing. AFP is actually a collection of various document object architectures, which collectively allow the representation of images, vector graphics, fonts, barcodes, and text in a device-independent format. IPDS is the device-dependent bi-directional communication with printers created by any number of IPDS host services products driving AFP data to IPDS printers. AFP is device independent and object oriented (Brooks Internet Software, 2011). AFP data streams are converted to IPDS data streams via the software product called Print Service Facility (PSF) when ready to print. IPDS is device dependent.

The ability to variably produce color accurate CMYK graphics is very desirable for variable data printing in general, and recently, there has been growing interest for color management within the HVTO market as well. This can be seen by the recent advancements made to AFP. Through the efforts of the AFP Color Consortium, AFP has been enhanced to include optional support for ICC based color management. The Color Management Object Content Architecture (CMOCA) Reference describes the Color Management Object Content Architecture (CMOCA) as an architecture that "defines objects that provide color management in presentation environments" (AFP Color Consortium, 2006, p.7).

Currently, separate color inserts, or leaflets often accompany transactional documents, such as credit card statements. Because these color inserts are physically separated from the transactional document, there is a chance that they will not be read, and quickly discarded. The transactional document, however, is likely to be read over carefully by the recipient, and would generally be kept for extended periods for record keeping purposes. The concept of "TransPromo" integrates targeted marketing content (based upon customer data) directly onto transactional documents. When marketing content from traditional inserts is variably printed in a color managed way directly on the transactional documents, it reduces the cost of production, reduces postage rates, and can increase response from the target market. Marketing material printed directly on the transactional statement is more likely to be visible and read by the target audience. A recent study done by Epsilon Data Management showed that North American consumers between the ages of 18 and 34 prefer receiving marketing information via offline sources such as mail and newspapers 2 to 3 times as much as receiving the same information via email or social media (Epsilon, 2010). This is a very important statistic for the High Volume Transactional Output (HVTO) market, which is interested in getting that promotional material to be printed color accurately on transactional statements.

PDF/VT could prove beneficial in the HVTO market because of its well-established color management features. Unlike AFP, where color management is optional, PDF/VT requires color management be used. Furthermore, PDF/VT is capable of representing high quality color/design content, given its support for a color managed transparency based graphics model that is not available in AFP. Also, PDF/VT file can be verified as conforming using standard, non-specialized PDF tools.

Using PDF/VT for variable data would mean that graphically intense, color accurate variable data elements could be processed at similar production speeds as traditional AFP/IPDS data streams. Since PDF/VT is an open standard, and the PDF document format has been a trusted document format in static and variable data print for some time, it is reasonable that PDF/VT will be adapted for use in HVTO printing, especially for newer applications involving color.

AFP/IPDS is very well established as an integral component of a robust and secure high volume transactional print architecture. Workflow implementations based on AFP/IPDS, for example, have rigorous error detection and recovery capability in place. PDF/VT has the necessary verification features to be adapted for the HVTO market, but time and effort will be required for this adaptation to proceed. There are, however, indications that PDF/VT will grow as a standard for variable data printing. PDF/VT is still in its early stages of adoption, but it has already received positive endorsements by key vendors in the VDP market. VDP players such as Callas Software, Kodak, EFI, Global Graphics, GMC Software Technology, HP, Konica Minolta, Pageflex (Bitsream), Printable, Screen, Ultimate Technographics, Xerox, and XMPie in a press release published on WhatTheyThink.com on October 1, 2010. It is clear by the statements made by the representatives of these companies that they are interested in the ability to expand the richness of the VDP content currently being produced, and that they feel that PDF/VT is a vehicle in which this can be achieved.

Conclusion

PDF/X4, PDF/X-5, and PDF/VT are open standard file formats, and each provides unique opportunities to the general print market as well as specific targeted benefits for specific market segments.

With support for transparency and Optional Content Groups, PDF/X-4 shows promise for industry areas such as publishing and packaging. Interest in the developing PDF/X-4 standard has grown, and organizations like the Ghent PDF Workgroup (GWG) are working on test suites for PDF/X-4 files.

The Ghent Workgroup (www.gwg.org) is an international organization of key stakeholders in the printing and publishing industries. Members include a wide spectrum of end users, vendors and developers, as well as industry associations. Numerous subcommittees address the requirements of various industry sectors with regards to best practices in data and file exchange, as well as overall processes. One important development from this group was the Ghent Output Test Suite, which was developed to provide end users with an intuitive method for evaluating final results from their workflows. A collection of patches was devised to check for a variety of functions in PDF based job processing, including elements such as embedded ICC profiles and a variety of overprint conditions. Currently version 3.0 is available, however the group is developing a variety of new patches to help test for compliance with the new PDF/X standards. This includes patches to check for other concerns such as transparency basic blend modes for ICC based CMYK and RGB, flattened object rendering precision, different compression algorithms, as well as a test for 16-bit image support.

The GWG approach differs from the work of organizations such as the European Color Initiative, and their Altona Test Suite (http://www.eci.org/doku.php?id=en:projects:ats) in that the Ghent Output Test Suite is a collection of individual patches, as compared to a comprehensive test target. The Ghent targets are developed for end users wishing to check specific aspects of their configurations, while the comprehensive tests are perhaps more useful for manufactures and vendors.

While the use of PDF/X-5 will likely be limited, there may be opportunity for this file format in workflows that rely on OPI, or require n-colorant output printing conditions. PDF/X-5 will satisfy the needs of users that require the external referencing flexibility for graphics and ICC Profiles, as well as the needs of users that rely on n-colorant output.

When comparing the three revised standards, PDF/VT appears to have the greatest potential to a significant and transforming impact to an existing market segment. At a time where the High Volume Transactional Output market is looking for ways to intensify the richness of its variable data output, PDF/VT offers many features that could potentially make that a reality. One of the challenges PDF/VT will face is competing with deeply entrenched and successful VDP workflows using the AFP/IPDS model. Given its interest and endorsement by leading VDP companies, it is plausible that PDF/VT will succeed to influence significant change in this market segment as it matures.

In conclusion, The three newest PDF standards, ISO 15930-7:2010, 15930-8:2010 and 16612-2:2010 offer end users reliable PDF file formats with enough versatility to meet changing client demands, combined with the stability and predictability of an ISO standard file format. All three of the file formats defined by these standards are in early stages of their lifecycle, and widespread adoption has not yet occurred. It will be worth monitoring the climate over the next 18 months to see how industry uptake will progress.

Areas of Further Study

Authoring and Consuming Application Support for PDF/X-4

Adobe Creative Suite v4 and v5 support a variant of PDF/X-4:2008, and do not yet support PDF/X-4:2010, or PDF/X-5:2010. It is plausible to assume that later updates to the Creative Suite will include PDF Presets for the new standards. When these presets are available, further study can be conducted on how these standards are being used as uptake will likely rise once these presets are available.

Acrobat X, which Adobe released as a "standalone" product in the fall of 2010, does include support for PDF/X-4:2010; however, many customers in the graphics communications industries elect not to upgrade Acrobat individually, preferring to wait until it is bundled with other popular Adobe applications.

A key difference between Acrobat 9 and Acrobat X, with regards to support for PDF/X-4 (2008 and 2010 respectively), is in how Adobe addressed the issue of optional content. Adobe changed how layers are addressed in the latest version. The net result of this is that the optional content material created in an Acrobat 9 file is not accessible in an Acrobat X file, and vice versa. According to Stephan Jaeggi, principal of PrePress-Consulting, a leading Pre Press consultancy based in Switzerland, the best approach in this situation is to "stay away from layers for the next year or two." His advice is to allow the overall industries upgrade their software versions, and the layer interoperability problem will become a legacy issue of the past.

The PDF/X-4:2010, PDF/X-5:2010, and PDF/VT:2010 standards have only been ratified for eight months or so. It should be expected that it will take time for vendors and manufacturers to incorporate them into software updates and releases. Given Adobe's support for PDF/X-4 in Acrobat X, it is reasonable to presume that a future update or version of Creative Suite will support the updated standard. Other software vendors are updating their solutions to support the new ISO standards as well. For example, Enfocus software recently updated their popular PitStop Pro plug in for Acrobat to support PDF/X-4. (www.enfocus.com/pressrelease.php?id=6999).

Publishers and Automated Advertising Workflows

Several large publishers in North America and Europe have migrated towards comprehensive advertising material submission solutions in the past few years. These advertising materials "web portals" allow publishers the ability to have suppliers upload their creative, associate the material with a specific title and insertion and apply metadata through a Ghent Workgroup job ticket, or similar tool. In addition the portal will convert supplied PDF files into an ISO standard (usually PDF/X-1a:2001). The portals also visually and dynamically alert the suppliers to potential concerns with the files, based on supplier-determined criteria. Popular advertising portal solution providers include Send My Ad (www.sendmyad.com), Vio Ad Send and Ad Express (www.vio.com), as well as systems from other industry partners such as Quad Graphics, HudsonYards, and Fry Communications.

Importantly, from a publisher's perspective, the portals offer them the ability to clearly move responsibility for the final file content and integrity back onto the suppliers, something that was basically "lost" to them in the transition to digital files from analog film. The original transition to digital files effectively resulted in an increase in "make-goods" to advertisers, to compensate for a wide variety of final file reproduction concerns, regardless of where the issue originated.

The portals also allow publishers to remove several touch points from their workflows—full page advertisements are submitted directly to a title, positioned correctly relative to the trim page, with all the required production information associated with them. This can be integrated directly into production and workflow systems (pagination and prepress systems), allowing for further automation and efficiencies.

A concern with some publishers about adopting a PDF/X-4:2010 workflow for advertising material, is that they would have to "give up what [they've] gained" in terms of accurate, predictable reproduction and efficient workflows, based on PDF/X-1a formatted submissions from portals. The opportunity for receiving advertising files from suppliers with ICC/RGB color spaces, a variety of optional content groups, and/or unresolved transparency would require great attention to detail through each sub process of the workflow. Currently, rather than adopting a system with little perceived value, it is better to have an early binding workflow and not leave an opportunity open for reproduction concerns.

It is reasonable to assume that there would be some advantage to suppliers through adopting a PDF/X-4 workflow, such as digital masters for color, the ability to have regional material differences addressed through layers, and the elimination of transparency flattening concerns; however they would have to request this support from the publishers. Perhaps in time, creative agencies will be begin to push for support of these features, but without this pressure, the new PDF/X-4 and X-5 standards appear to offer little immediate benefit for publishing advertising workflows.

With regards to publishing editorial workflows, however, the PDF/X-4 standard does offer clear advantages. In addition to supporting native transparency, the color management aspects allow publishers to consider later binding workflows, which have potential to help drive cross media workflows. As well, the optional content layers can be considered for regional, demographic, and geographic versioning, as required. In addition the format offers a solid foundation, and the assurance of an accredited standard, for further workflow automation and integration, when compared to a "house specification." For example, Hearst Magazines is currently using PDF/X-4 for its editorial workflow, but according to Hearst's Director of Technology Ken Pecca, using the system for advertising material at this point would be a "huge liability" (Pettas, 2008 p 5).

As the PDF/X-4 standard becomes more familiar with users, it will be interesting to see if it can be adopted as a standard for digital ad submission when used in conjunction with ad submission portals that can be refined to help reduce some of the variability that would be inherent in a PDF/X-4 file. This would allow for native transparency and OCGs, but still provide some predictability in output.

Authoring and Consuming Application Support for PDF/VT

As of early 2011, there are only limited authoring and consuming applications on the market for PDF/VT. Bitstream Inc. Pageflex (http://www.bitstream.com/publishing/index.html) announced support early on, and several other vendors are listed as endorsing the new Standard, and could therefore be expected to release updates that author and consume the format.

Generally there are too many contextual variables (hardware and network configurations, operating and application software combinations and versions) to gain much practical data from a direct comparison of formats and workflows, with regards to overall speed, efficiency, and quality of color output. However benchmark testing could demonstrate the capabilities of the new standard. It could also serve as useful proving ground for the printers with the capability, but not currently active in the variable print market space. This could be useful for information purposes, helping to demonstrate to stakeholders, clients and customers, marketing and creative agencies, as well as solution providers, tangible realities for manufacturing potential for mass customized communications.

Established companies operating in the variable market would have proven background and experience in working with the database information required to build a successful variable print project. Basic variable generally only involves generic customization such as name and address. Versioning variable data generally includes varying collections of assets, determined by market segmentation. In contrast, full variable data work can involve a complete change for each recipient on a distribution list.

Print providers new to the market should perhaps consider partnering with a Marketing firm experienced in database analysis and behavioral analytics. Marketing research has demonstrated an overall "lift" to campaigns that combine a variety of channels (online, mobile, and print) that is greater than the sum of its parts. Current research indicates that young adults strongly value print for marketing communications (http://www.epsilon.com/pdf/med_pref_report_081610_FINAL_DRAFT.pdf). An experienced Marketing partner could work with a client's collection of their customer's combined demographic and purchase history, combined with available behavioral data, to generate unique and compelling messages.

Education and Support for New Technologies and Processes

An additional area of opportunity to be addressed in order to support wider adoption of both the new PDF/X standards, and PDF/VT is overall education and training.

Other native PDF rendering technologies have been in the market since at least 2002 (Global Graphics Harlequin RIP), and Adobe released the first PDF Print Engine in 2006. The second version of the Print Engine was released in 2008, and version 2.5 introduced in May 2010. This technology is included with a variety of OEM solutions, such as Heidelberg Prinect, Kodak Prinergy, and FUJIFILM's XMF.

While the technology is available, and it could generally be expected that most sites would have upgraded their systems in the past five years, and therefore have access to the technology, anecdotal evidence suggests that numerous users have not configured their workflows to take advantage of the new architecture. Concrete numbers are difficult to come by, however Joseph Banich, Heidelberg Canada, estimates that 80% of the sites he visits have access to the "new" RIP architecture. Less certain is how many of these customers are using the workflow, and for what volume of their work.

Stephan Jaeggi, PrePress-Consulting, expresses concern over the number of sites he visits where the technology is available; however, both the vendor's install teams and technicians, as well as their customers, don't always understand that it is available, or appreciate the implications and benefits to the workflow. It remains underutilized.

An educational initiative from the vendors, and to the industry at large, could serve to help with the transition. Case studies and best practices for conversion, the capabilities and benefits, as well as strategies for supporting creative groups and approaches to working with legacy material, could help with the overall adoption rates.

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