Implementation of a Hard Copy Remote Proofing Workflow

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Abstract

One of the major bottlenecks in the prepress and print production workflow is the printing and approval of proofs. By implementing the ability to distribute proofing data in electronic format and printing the proofs remotely (in the approver site) the approval cycle time can be dramatically reduced. The most important requirements for this type of remote proofing workflow to be reliable are ensuring the consistency, accuracy and integrity of the remotely printed proofs. In the hp Remote Proofing solution, these requirements are achieved by the combination of several technologies and standards. Device closed loop color calibration ensures a stable and consistent color behavior of the proofing devices. This technology, combined with ICC profile based characterization and image color management achieves the required color consistency and accuracy of the printed proofs. Data integrity and consistent proof printing is achieved by the use of an "electronic proof" data format, based on the combination of the PDF/X blind exchange standard and the JDF job ticketing standard. The resulting remote proofing workflow combines the advantages of hard copy proofs with the speed and convenience of electronic data transfer and computer based collaboration.

Introduction

In commercial printing and, in general, "print for pay" workflows the term ***proofing*** refers to the prediction and verification of the final printed product(s) that have to be produced.[1] In most of the cases, the proofs are printed in a different device than the production device; in this case, the proofing device must simulate the behavior and characteristics of the production device. The requirements in terms of accuracy of the simulation will depend on the particular application and the type of proofing being done (color content proofing, color contract proofing, halftone contract proofing, imposition proofing...).

The introduction of digital technologies, both in the production devices (digital presses, CTP) and the proofing devices, has required changes in the proofing systems and their integration in the prepress and print production workflows.

Although current prepress workflows have adopted digital proofing, they are not making use of the advantages that the data communication technologies provide. Instead, even when the proofs are produced digitally, they still must be sent to be approved by customer through the traditional methods (courier, signed proofs…).

In contrast with these traditional methods, ***remote proofing*** systems make use of the electronic transfer of design proofs over standard data communication infrastructure, such as ISDN, private networks or the Internet. This allows cutting the proofing and approval cycle from days to hours.

There are two types of remote proofing systems: soft remote proofing systems display the proof contents on a screen, while hard copy remote proofing systems allow printing the design proofs on remote proofing devices.

This paper describes the implementation of a digital hard copy remote proofing system for the hp Designjet proofing devices (Designjet 10ps, 20ps and 50ps). First, we describe, in general terms, the proposed remote proofing workflow and analyze the detailed requirements for the system. Then, we describe the basic technologies implemented in the devices and software front ends that enable the accurate and consistent processing and reproduction of color in these devices. Finally, we describe the system architecture and, in particular, the Remote Proofing File (RPF) format that, through the use of industry standards, achieves the data integrity and reliability requirements and enables the integration of the remote proofing systems in prepress and print production workflows.

Remote Proofing Workflow Model

The workflow reference model used to design the remote proofing system is depicted in figure 1.

There are two participants in the remote proofing workflow:

- ***Proof originator***: this is the site where the proof file is created; usually, the proof is also printed at the originator site to check its correctness before sending the proof file.
- ***Proof consumer***: this is the site where the proof file is received and printed with the intention of checking and approving or rejecting it.

Depending on how the remote proofing system is integrated in the print production workflow, the proof originator and the proof consumer may be different players in the workflow. For example, in the case of contract proofing, the proof originator is the prepress entity that has prepared the content for final production, while the proof receiver is the final client and/or the content designer that must approve the contract proof before the job is produced.

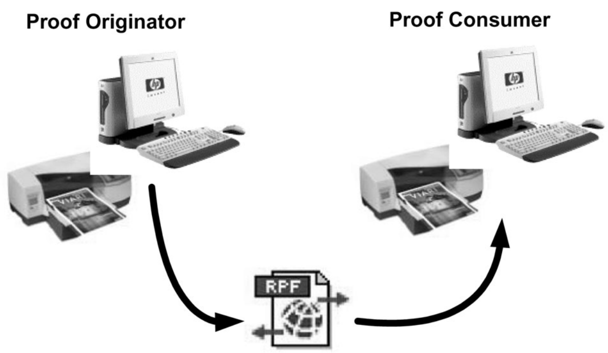

Figure 1.Remote Proofing Workflow Model

System Requirements

The requirements for a remote proofing system are described in this section:

- ***Output consistency***: this is the key requirement for any remote proofing system. It is crucial that the proofs printed at the originator and consumer sites are consistent in terms of contents, layout and color because the approval is going to be done on the proof printed at the consumer site.
- ***Flexibility***: the proof originator should have enough flexibility to configure and create the different types of proofs that may be needed in different cases and different steps in the workflow (content proof, contract proof, imposition proof…). It is also important that the proofing system has the flexibility to emulate the different systems and configurations that may be used in the final production of the printed materials (i.e. different technologies and types of presses, different processes, inks…).
- ***Ease of use***: as any other application, ease of use is a key design requirement In this particular case, it is specially important at the proof consumer site, where the configuration and actions required to print a consistent proof should be extremely simple and error proof.
- ***Trust***: it is very important the different participants have trust the remote proofing system. In order to build this trust, the system must be designed so it requires a minimum of maintenance, it is safe to device failures or user errors and it provides information on the expected results, status and errors.
- ***Easy integration in the workflow***: the remote proofing system is not an isolated piece in the design-prepress-production processes. It must integrate easily with the other processes and systems involved in the end-to-end workflow.

Proofer Device Color Stability

In any imaging system, color *accuracy* or fidelity begins with a marking engine that delivers *repeatable* color -- that is color consistency over time, environments, etc. In remote proofing, it is even more critical that each printer in the remote proofing network not only be repeatable itself but also accurate and consistent in the reproduction of color. The 10/20/50ps achieves this via a unique closed-loop color calibration system, which allows recalibration of every system to the same reference state, which is generic to the all the devices in the family and factory defined. Thus, by ensuring this kind of repeatability within a printer as conditions change, the Designjet 10/20/50ps system enables the implementation of a remote proofing system that ensures end-to-end consistency.

The color calibration process is designed to compensate for the lack or excess of primary ink density (black - cyan - magenta - yellow - light cyan - light magenta) in a particular condition (i.e. printer, environmental condition, media or print heads) so that the colors reproduced by any 10ps, 20ps or 50ps printer are consistent. The basis of the color calibration system is the principal of measuring the reflected energy from primary color tiles, which are illuminated with a narrow-band light source (i.e. an LED). It works much the same way a classical densitometer works. In the calibration process, a pattern like the one shown in Figure 2 is printed. This pattern is scanned with the embedded sensor as shown in Figure 2. The reflected energy measurements made during this scan are used to calculate new and unique linearization curves for each of the six color channels. Calibration of the six primary channels ensures that composite colors (colors printed with a combination of the primary colors) are also repeatable.

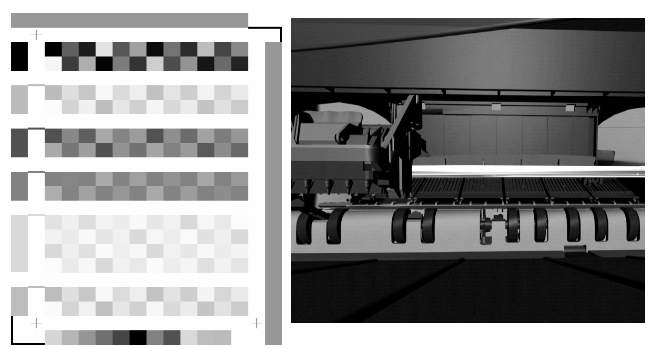

Figure 2. Calibration pattern and scanning process.

These repeatable colors permit the creation of accurate device class generic ICC profiles that characterize the color behavior of any 10/20/50ps device that has been properly calibrated. The use of these profiles allows the Designjet 10/20/50ps to be not only repeatable but also accurate to whichever proofing standard required by implementing the color management model described in the next section.

Color Management

In order to achieve color consistency, all the devices participating in the remote proofing system must use the same proofing color management model. The model is based on the ICC paradigm[2]: device specific color spaces are characterized using ICC profiles and transformations between color spaces are done through a profile connection space (PCS).

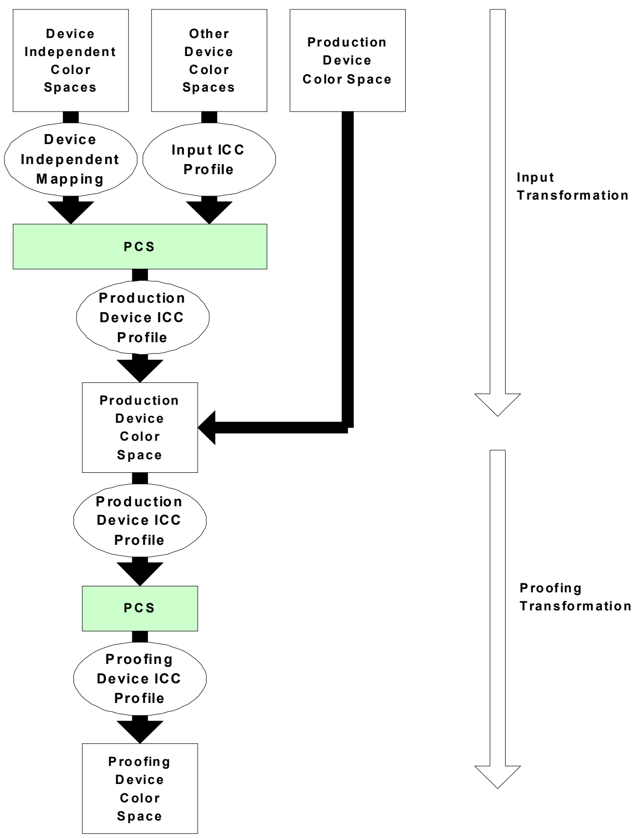

Figure 3. Proofing Color Management Model

As described in the introduction, proofing requires printing on the proofer device emulating the result of the production device. In terms of color management, this means that in the proofing workflow there must be two color management stages: the input transformations and the proofing transformation. It is possible that, in a specific implementation, the processing required for these two transformations is combined in a single algorithm; but this is only an implementation artifact to enhance the system performance; conceptually there are still two color transformations.

Input Color Transformations

The document contents may have been designed in different color spaces. These contents must be mapped to the process color model of the production device (the press), that usually is a CMYK color space, although some production devices may use other processes such as Pantone® Hexachrome® or any other HiFi printing process.

Using the ICC paradigm, each color space mapping conceptually involves two steps:

- In the first step, the input colors are mapped to the PCS. For device specific color spaces, such as RGB, this requires the use of an input ICC profile.
- Then the colors in the PCS are mapped to the production device color space using the production device output ICC profile.

These transformations are applied to all the color spaces used by the contents data, except for the production device color space. For contents directly encoded in the production device color space, no mapping is required.

For each transformation, a different rendering intent may be applied, depending on the intention of the content designer and the desired results.

Proofing Color Transformation

Once all the document contents are described in the production device color space, a second color transformation must be performed to convert them to the proofing device color space, in which the proof will be printed. To perform this transformation, the production device ICC profile must be used as input profile and the proofing device ICC profile (stored locally at each proofing device) must be used as output profile.

Because the proof must emulate the color appearance of the final printed product, this transformation should be done using a colorimetric rendering intent. Usually, the absolute colorimetric rendering intent is used to take in consideration the possible difference in color of the medium (stock) used to print the proof and the one used to print the final product. However, in certain cases, a relative colorimetric intent is used, for example, when the color difference between proofing and production medium are minimal.

Handling of Spot Colors

Special care must be taken on how spot colors are handled in the color management chain. It is important to differentiate the spot colors used by the content designer in two groups:

- Spot colors that are going to be printed with a specific ink on the production device. In this case, the input transformation must not map the spot colors to the press color space because this would limit the spot color to the gamut of the press process colors. The spot color must be mapped to the proofer process colors in the proofing transformation since, in most of the cases, proofing devices do not support the use of special spot color inks.

- Spot colors that are going to be emulated in the production using press process inks must be mapped in the input transformation to the press color space.

Color Management in the Remote Proofing System

When this color management model is applied to a remote proofing system, there must be a proofing transformation performed for each device on which the proof has to be printed, while the input transformation can be done only once.

An important decision in the design of the hp Remote Proofing system is that the proofing transformation is always done at the device where the proof has to be printed. This decision allows the use of different devices, with different color characteristics, without having to share the proofing device color characterization information between the participants in the remote proofing exchange.

System Architecture

The ***Remote Proofing File*** (RPF) format[3] is the data format used to convey all the proof information from the originator to the consumer site. In order to ensure consistent output, the RPF file must contain all the information required to be able to properly process and print the proof in any of the sites participating in the remote proofing exchange; without having to do any assumption on the specific device characteristics or environment in which the proof is going to be printed. The interpretation of the data embedded in RPF must be unambiguous.

This information can be divided in two groups:

- Graphic contents data: describes the graphic contents (text, images, layout, color…) of the documents that have to be proofed. The graphic contents information must be complete in the sense that all the data required to reproduce the proof is included and there is no reference to external data that is not included.
- Proof processing and printing configuration data: describes how the content data has to be processed and printed by any system participating in the remote proofing exchange.

A consequence of the color management model described in the previous section and, specially, the decision of keeping the proofing transformation local to the proofing device is that the RPF format is independent of the proofing device(s) used.

The requirement for a device (or device–front end system) to be part of a remote proofing system is that it processes the RPF format according to its specification and that it can ensure a consistent output, especially in terms of color, by applying the proofing color management model.

After exploring different possibilities, we decided to use a combination of already existing industry standards to define the RPF format: the graphics contents are described using PDF/X-3[3,4] and the processing and printing configuration is described using the JDF job ticketing format.[6] These two parts are packaged using a MIME Multipart/Related package.[6,7] The characteristics of each one of these standards and the advantages of using them in the RPF are described in detail in the following subsections.

PDF/X-3

PDF/X-3 is an ISO standard[4] based on Adobe's Portable Document Format (PDF).[3] It defines a subset of PDF to be used for complete and reliable interchange of prepress data suitable for color management. The specification defines both the PDF constructs and commands that can be used and how applications that create or process PDF/X-3 files should interpret and process the content data.

The decision to choose PDF/X-3 as the graphic contents portion of RPF was based on several advantages:

- ***Industry standard***: PDF in general and specially PDF/X are gaining acceptance as the industry standards for prepress workflows.
- ***Completeness and reliability:*** a PDF/X-3 file is complete in the sense that all the information required to reliably and consistently print the contents are included in the file; no additional external data is required.
- ***Unambiguity***: following the definition of PDF and the PDF/X-3 specification, the interpretation of the document contents data is unambiguous.
- ***Flexible color management model***: the fact that PDF/X-3 is intended to be used in workflows with color management provides flexibility to describe the document contents in different color spaces. On the other hand, PDF/X-3 supports the proofing color management model described in this paper.
- ***Integration in workflows***: by using a PDF based format, we gain access to a large set of applications and tools to generate, preflight, view and annotate the graphic contents in the proof. The remote proofing system can also be integrated in PDF based printing workflows solutions.

JDF

The ***Job Definition Format*** (JDF)[6] is an XML based job ticket standard format defined by the CIP4 organization. The JDF paradigm provides the means to describe print jobs both in terms of the products to be created (intent) and the steps to produce the products (processes).

In particular, for the remote proofing system and the RPF format, the JDF *Proofing* process is used to describe how the content data has to be processed and printed to achieve a consistent proof. The model for this process is general enough to allow describing the proofing settings independently of where the proof is going to be printed; so, again, no specific information on the proofing device to be used to print the proof is required to create the job ticket.

Some of the parameters defined in the JDF portion of the RPF file are the stock (medium) type on which the proof has to be printed, the rendering intent for the proof, the human readable information (slug line) that has to be included in the proof and the behavior of the proof consumer when exceptions or errors occur.

By using the JDF standard for the job ticket portion of RPF we facilitate the integration of the remote proofing solution in a complete prepress and print production workflow. In fact, from the point of view of the workflow management systems, the remote proofing generator becomes, according to the JDF terminology described in Ref. [6], a proofing agent, i.e. a system that creates proofing job tickets; and the remote proofing consumer becomes a proofing device, i.e. a system that consumes proofing job tickets.

JDF also opens the possibility of extending the remote proofing system to address other steps in the workflow, specially the collaboration, annotation and approval or rejection of the printed proofs.

MIME Multipart/Related

The graphic contents (PDF/X-3) and the job ticket (JDF) portions of the RPF file are packaged using the MIME/Multipart/Related format,[7] with the restrictions and enhancements described in the JDF specification.[6]

The combination of the IETF standard with the JDF restrictions, specially the use of the content length tag, allows a simple and efficient packaging of the two portions of the RPF file.

Conclusion

This paper has described the requirements, issues and decisions involved in the design of the hp Remote Proofing System; currently implemented on the hp Designjet10ps, 20ps and 50ps proofing devices.

The learnings in the implementation of the system are being used in the development of new proofing products and solutions that better support de remote proofing workflow requirements.

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Biographies

Albert Such got his “Licenciado en Informatica” from the Universitat Politecnica de Catalunya in 1988. He joined Hewlett-Packard in 1992 where he has been working in the design and development of printing products and solutions for the technical, graphic arts and prepress markets. He is an active member of the CIP4 prepress working group and the Hewlett-Packard representative in the CIP4 Advisory Board.

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