# A System to Ease the Support of Multiple Media Types for Inkjet Printers*

*Albert Such and Sebastià Castelltort*
*Hewlett-Packard, Inkjet Commercial Division*
*Sant Cugat del Vallès, Barcelona, Spain*

## Abstract

Regardless of the technology used, one of the key factors in the design of a printing device is the interaction between the printing medium and the rest of the printing system. This is especially true in the case of inkjet printing technology, where the interaction between the printing medium and ink is critical to achieve good level of printing and color quality. This means that a large number of printing parameters depend on the printing medium being used and have to be adjusted for each specific substrate. This paper describes the Open Media System, implemented in the HP DesignJet 5500 large format printers, which forms part of the HP DesignJet product family, that allows the support of a wide and dynamic set of media types. It is based on a highly flexible set of software components (print mode engine, contone to halftone imaging pipeline, media selection user interface…) that are configured using a database of *media profiles* that hold all the parameter settings required to configure those components to print on a specific printing medium. Media profiles can be created, downloaded to printing devices and managed using software tools specifically developed for these purposes.

## Introduction

Regardless of the printing technology being used, the specific characteristics of the printing medium are key factors in the design of a printing device and the quality of the final results since any printing system must be able to accurately position and mark the medium. This is especially true in systems based on drop-on-demand inkjet printing technology for several reasons:

- The characteristics of the final printed output have a high dependency on the interaction between the ink drops and printing substrate.
- Because the actual printing is performed in several (possibly overlapping) passes, the dynamics and accuracy of the medium movements through the printing area also play an important role in the characteristics and quality of the final results.

The consequence is that a the design of a drop-on-demand inkjet printing system must be thoroughly optimized considering the specific characteristics of the printing substrates that are going to be used in order to achieve the highest levels of print quality. However, this requirement to optimize the printing system to the characteristics of a specific medium contradicts the important user requirement that it should support a wide set of printing media with completely different characteristics.

In order to conciliate these two contradicting requirements, printing systems based on drop-on-demand inkjet technology usually provide some parametrization functionality that can modify specific aspects of how the printing medium is moved in the printing zone and how ink is deposited on it. Thus, these parameters can be changed in order to accommodate the specific characteristics of the medium to achieve the desired print quality. Some examples of typical parameters that can be configured are printing resolution, maximum number of ink drops per position (ink limit), number of printing passes and minimum margins (non printing area).

However, the configuration of all these parameters to achieve the intended quality and performance on a specific printing medium is very complex, specially if it has to be performed by the final users of the printing device that do not have a deep understanding of the printing technology. This complexity increases as printing systems support higher levels of functionality such as color management and automatic color control.

The system described in this paper, the *Adaptable Media Management Software System*, facilitates the support of a wide range of printing media types by combining a set of highly flexible software components, deployed in the printer controller hardware, which can be easily parametrized with a database that stores the specific configuration and parameters that must be used to print on a specific type of substrate. This database of *media profiles* can be managed and upgraded through the printer user interface (front panel) or using external software tools. This enables the support of a very wide range of media types without requiring the user to know the details on how the printing system must be configured to achieve the desired print quality, color

* Aspects of the technologies described in this paper are covered in pending patent applications in the US and other countries.

accuracy and throughput. It also facilitates the addition of new substrates to the set of supported types, and the upgrade and optimization of already supported media types, without requiring costly software updates.

The system has been successfully implemented in the HP Designjet 5000 and HP Designjet 5500 family of large format inkjet printing devices.

## System Architecture

The architecture of the Adaptable Media Management Software system is depicted in figure 1.

*Figure 1. Desigjnjet 5500PS.*

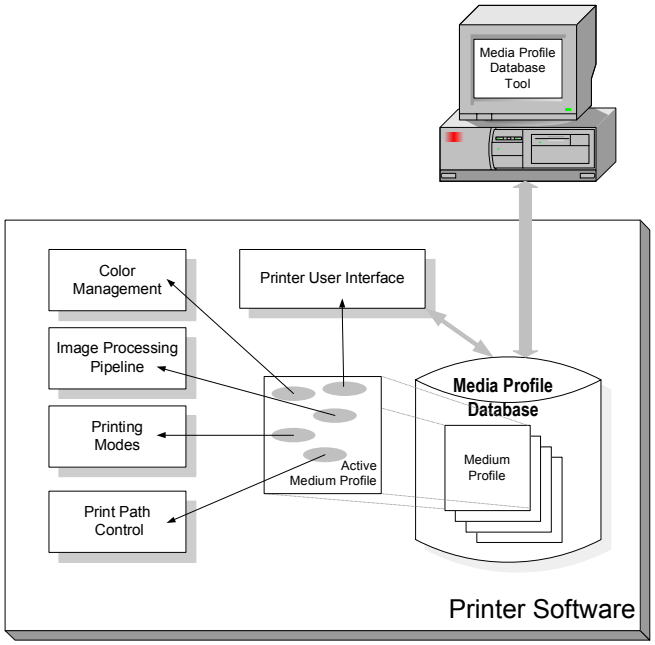


*Figure 2. System Architecture.*

The key components for the implementation of the Adaptable Media Management Systems is a set of highly configurable software components that run in the printer embedded software environment. These components encapsulate all the algorithms, methods and interactions that are, in any sense, dependent of the specific characteristics of the printing substrate. These components are:

- The *Color Management* module provides functionality to perform all the color management operations required by the Page Description Languages to process and transform the contents to be printed to the medium specific device color space; it also controls and stores the information of the color calibrations performed automatically when there is a change in the printing environment, such as when new printheads are installed. The Color Management Module is based on the ICC color management architecture and it makes use of standard ICC profiles[1]; but it also contains some specific algorithms to optimize the color performance, accuracy and consistency of the printed results.
- The *Image Processing Pipeline* module performs a set of transformations to the images before they are printed, such as image and resolution enhancements, conversion from continuous tone to halftone. Some of the algorithms are generic image processing algorithms, while there are also algorithms highly optimized for the specific features of the on-demand inkjet printing technology.
- The *Printing Control* module controls how the image is printed on the substrate: the number of passes that are performed, the masks used, and the configuration and control of the printing heads.
- The *Print Path Control* module manages the movements of the printing substrate: loading the medium from the different possible sources (rolls, cut sheet…), advancing the medium during printing and drying and cutting it.

There is a medium profile associated for each one of the possible medium sources in the device (rolls, cut sheet feeders…), corresponding to the medium type available in each one of them. The selection of the profile associated to each one of the sources is performed by the user, through the printer front panel when the corresponding source is loaded (for example, when loading a roll or a cut sheet feeder).

The Active Medium Profile is the profile corresponding to the source that is going to be used for printing. The profile is used to configure the processing and printing components described previously. The profile also contains information to provide feedback to the user, through the front panel, on the characteristics of the substrate currently being used, such as the last time the printing or color calibrations where performed for that particular substrate. The detailed structure of the medium profile is described in next section.

Media profiles are stored in the Media Profile Database, that contains the profiles for all the media types supported by the device. The database can be managed and consulted by the user through the front panel, that can provide the complete list of media types supported and information about when the different media profiles where created and updated. Through the printer front panel, the user can also create new

media profiles by the customization of generic profile templates.

There is also an external (host based) software tool that provides advanced capabilities to access the media profile database. This tool can be used by the system design team to create new media profiles, manage the profiles loaded in the device and retrieve information on the usage of different media types.

## Media Profiles and the Media Database

The *medium profile* is the data structure that contains all the medium type specific information that is needed by the different components in the printer software.

Given that some of the parameters and information stored in the medium profile depend not only on the characteristics of the printing substrate, but also on the specific interaction between the printing medium and the ink, the information in media profiles is organized in a hierarchical structure:

- the *medium level* stores the information that is medium generic and does not depend on the type of inks used to print. This includes, for example, the configuration of the printing path control module to enable the accurate movements of the printing substrate through the print area.
- the *ink set level* stores information that depends on the interaction between the printing medium and an specific configuration of ink and printheads supported by the system
- the *printmode level* contains the information that is specific to a certain printing mode. A printing mode is an specific method and algorithm to deposit the ink on the medium in several passes of the printheads. It represents an specific trade-off between print speed and image quality.

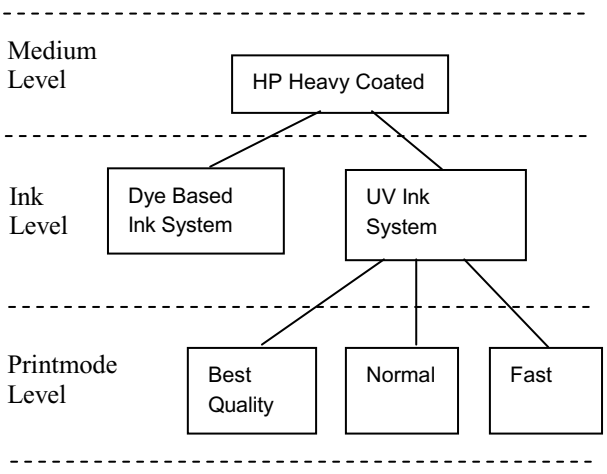


*Figure 3. Hierarchical structure of a medium profile.*

Due to this hierarchical structure, the information in the media database can be accessed using paths similar to those used in a file system. Thus, for example, to access the ICC profile describing the color characteristics of the 'HP Heavy Coated' paper using the UV ink system and printing with the best quality printmode, the following path should be used: /HPHeavyCoated/UVInk/BestPM.

The media database also supports inheritance of parameters between the different levels. This means that if a certain parameter is the same for all the sons of a certain node, it can be stored at the parent node and it is automatically inherited by the sons. This reduces the total size of the profile.

The medium profile data structures can be serialized in a file to enable the distribution through any form of data communication network. This facilitates upgrading the medium specific information for the printer installed base to cope, for example, with changes in the production process and characteristics of a specific printing paper that may cause a slightly different printing behavior. It also enables the addition of new media types to the set of supported media after the printer product has been introduced, without requiring software or hardware upgrades.

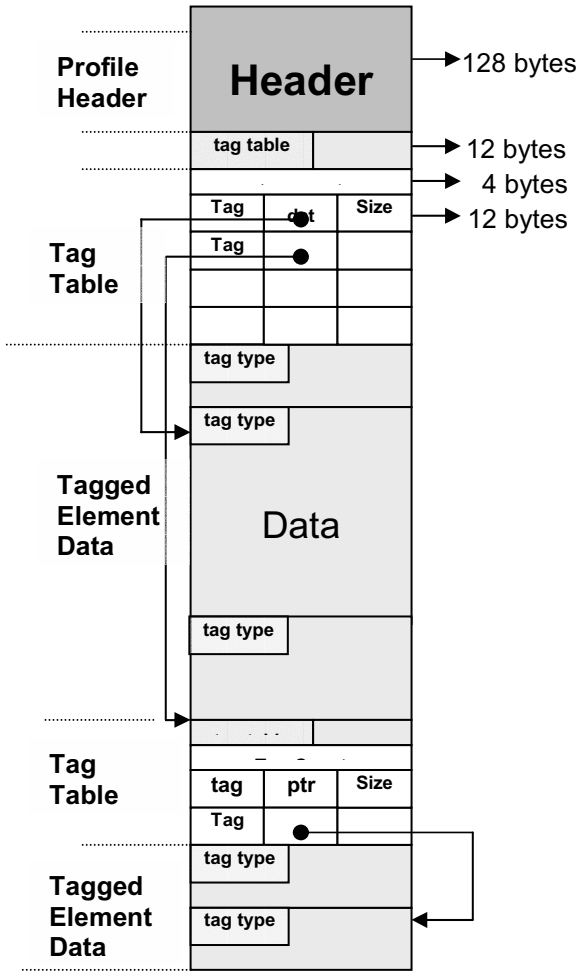


*Figure 4. Medium profile file format.*

As shown in Figure 4, the medium profile file format uses a hierarchical binary tag model to accommodate for the hierarchical structure of the medium information and the different types of information that should be stored for different media types. It can embed information in other formats, for example ICC profiles that characterize the output color space for the specific substrate, ink and printmode combination

## Creation of Media Profiles

There are two methods supported for the creation of media profiles:

- Using the host based tool, HP engineers can create and modify media profiles that can later be distributed to the user community.
- The user can also create her own media profiles for media types that are not directly supported by the device. This is done through the 'Custom Media Type Support' functionality in the printer.

This functionality enables the user to create an specific medium profile for the media she wants to use by customizing one of a set of generic media profiles that come preloaded in the printer system. Through the printer front panel, the user can select the generic profile from which to start the process of customization and then, through a sequence of test prints, she can modify some of the parameters in the profile, such as number of passes for the different printmodes, printing resolution, ink limits and color management settings. The resulting medium profile is stored in the media database and can be accessed by the user whenever she wants to use that specific printing substrate.

## Conclusion

The Adaptable Media Management Software described in this paper has been successfully implemented in the hp Designjet 55000 family of large format printing devices. As a result, this family of devices support a wide range of printing substrates. A total of more than 50 different media profiles are originally shipped with the printing system. Users also have also the ability to create their own media profiles by customizing predefined generic profiles.

The system is currently being ported to other printing systems in the HP large format product line. Some of the areas of improvement that are being investigated are making a wider use of standards in the construction of the media profiles, such as XML and JDF; the development of more sophisticated tools to create media profiles and manage the media profile database and the deployment of the system in low end printing devices with limited resources.

## References

1. International Color Consortium. Specification ICC.1:2001-12 File Format for Color Profiles (Version 4.0.0). ICC, 2001 (http://www.color.org/ICC_Minor_Revision_for_Web.pdf)

## Biographies

**Albert Such** got his "Licenciado en Informática" from the Universitat Politècnica de Catalunya in 1988. He joined Hewlett-Packard in 1992 where he has been working in the design and development of printing products and connectivity solutions for the technical, graphic arts and prepress markets. He is an active member in several standardization consortia and the Hewlett-Packard representative in the CIP4 Advisory Board.

**Sebastià Castelltort** joined Hewlett-Packard in 1996 (Inkjet Commercial Division in Barcelona) where he has been working in the design and development of large format printer and software solutions for the graphics and pre-press markets. Sebastià holds a Degree in computer Science from the Universitat Politècnica de Catalunya