Color Management Comes of Age

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Introduction

Most industry analyst seem to agree that the phenomenon known as desktop publishing occurred as the result of a serendipitous emergence of the three "A" companies at the right point in time: Apple, Adobe and Aldus. Apple's user friendly operating system provided a vehicle for the traditional graphic designer to migrate from the prevalent tools of the trade to the emerging electronic medium. Adobe provided a rendering language which could rasterize the file and be interpreted by a high end print device as well as a number of existing desktop solutions such as Photoshop™ and Illustrator™ that emitted into the language. Finally Aldus offered the first integrated layout package, Page Maker™. Thus was born desktop design and publishing and the link to the traditional publishing industry with Apple's Macintosh FX model the platform of choice.

It is critical to note that these tools were not the tools of the amateur or occasional user. These were the tools of professional publishers which formed the front end to complete, proprietary publishing systems from companies such as Linotype-Hell, Scitex and Agfa. An industry was in transition from high end publishing in which the graphic artists concepts and builds were constructed into plates by a cadre of professional publishers. The transition was one in which the pathway to direct to press fell more and more in the hands of the designer. Note that on the UNIX platform, Silicon Graphics made significant inroads as a high powered platform for publishing but never was able to head off the lead enjoyed by Apple. Today, of course, SGI is very successful in providing the tools for three dimensional graphics and animation. DOS and Windows never played a major role in the publishing arena, although Microsoft, as is discussed below, is making tremendous inroads into the domain.

With this brief background, the focus of this presentation is on the migration of more and more capability for graphic design and layout to the hands of computer users as opposed to the migration of computer tools into the hands of the publishing professional. Today most computer owners are capable of producing the most sophisticated graphic design and publishing solutions: Output which rivals that of professionals only years before. Naturally the quality of such output may not always live to the standards of the graphic design and publishing professional, but the output is often remarkably sophisticated. So what has fostered this transition initiated by the three "A"-Companies 10 years ago and what are the directions that are emerging that will structure the future.

Color Monitors

Although the technology for color displays and monitors was not new—Color television was well understood in the late 50's—the dramatic reduction in cost and the availability for the Macintosh platform created the first of the agents of change in the graphic and publishing worlds. Certainly color monitors had appeared in the mainframe world of the early eighties but the lack of publishing SW and tools rendered them to a very small niche in the market. The demand from graphic designers for color and the availability of sophisticated SW opened a critical opportunity to make color mainstream on the Macintosh. In fact a number of small companies perceived this opportunity, among them SuperMac, E-Machines, RasterOps and Radius, and brought out high resolution, large screen monitors with graphics accelerator cards and 24 bit color support. Apple's Quickdraw graphics system provided the backdrop for critical SW to provide a broader range of tools to a large constituency. Apple itself recognized the need and introduced a line of large screen monitors and graphic cards to support them. While as late as 1990, a wide range of monochrome monitors was available for the Macintosh platform, by 1992 almost 100% of monitors sold were color. The transition was swift and complete.

Color Printing and Proofing

The widespread availability of color printers occurred rapidly on the heals of the availability of high resolution monitors and accelerators. The transition, at least in the home market appears to have been equally rapid. According to the BIS Strategic, 80% of the home printers sold today are color. The vast majority of those coming from Hewlett Packard. Initially the focus of the graphics professional was on rasterizing their creations in the form of PostScript files and outputting those to the professional publisher. The publishers, through a complex set of steps refined the output and created the printing plates from which the final runs were generated. The process was costly and involved many complex steps. For the amateur publisher, monochrome and gray scale printing was sufficient and the cost of laser printers kept dropping. For cost reasons, however, color was the domain of the lowly ink jet printer which kept improving in performance and quality. Other technologies were making inroads such as thermal transfer, subliminal dyes and eventually color laser.

Color scanning had always been the pervue of the high end publishers. Drum scanners could capture, rasterize and

render complex images in relatively short periods of time. They were, however, very expensive and required a trained professional to obtain acceptable output. Today 24 bit color scanners operating at 300 and 600 dpi are approaching the sub thousand dollar point. Still the penetration of desktop scanners is small. Sheetfeed scanners selling for under $500 and providing Image capture SW as an integrated part of the solution are proliferating. Their market growth is posted at over 30% per year.

Color Management Applications

In the late 80's Tektronix introduced one of the first color management application solutions. The release, known as TekColor™ shipped with all of Tektronix's color printers and was available as a SW solution for the Macintosh computer line. TekColor consisted of a set of algorithms which would calculate the color gamut of a given printer and monitor and display these gamuts on an interactive user interface. The interface provided the user with a view of a series of color hue leaves which showed the range of lightness and saturation levels that the printer and monitor were capable of producing. Out of range colors for either device were easy to recognize. Perhaps the greatest value TekColor offered was that it provided an excellent educational tool for users to discover the relation ship between printable and displayable colors. Underlying the TekColor user interface, which replaced the standard Apple Color Picker, was a human vision based color model, called HVC, which described color in device independent, human terms. The color space was constructed so that all geometric distances in the space produced equally perceptible differences in color.

In the early 1990's several full function color management programs appeared on the market. Most notable of these was Electronics for Imaging (EFI) color solution known as EFIColor™. Kodak introduced ColorSense™ and more recently, Agfa began shipping Fotoflow™. Each of these programs had a unique approach to color management. At the same time each attempted to solve color management issues such as color editing, color matching etc. with a set of proprietary tools. EFIColor's strength was in two key areas: User Interface and Device Profiles. As for the User Interface, the user of the program could show a series of color images on the screen simultaneously and set one which based match their notion of how they would edit their own color images. Along with customization tools, EFIColor made it very easy for the user to approximate the correct appearance of a scanned image and edit it with final corrections. Color matching between devices occurred via complex lookup tables that correct the image for display or print on a selected output device. Em hand crafted the look up tables for each device and supplied these profiles with their program.

Kodak's ColorSense began shipping in a similar time frame. ColorSense, like EFIColor used proprietary technology to perform color matching and offered a broad color editing tool kit. As with EFI, Kodak built device profiles using a proprietary methodology. These tables ship with the program and are upgraded periodically by Kodak. One of ColorSense's strengths was the close tie to the Macintosh graphics system, QuickDraw, which made it easy to access the color management capability from a wide variety of standard Macintosh applications. In addition a standard calibration target ships with ColorSense which allows a user to perform a closed loop calibration of their system if the user has a color scanner, color monitor and color printer configured as a system. The SW allows the user to scan the test target and then automatically updates the profile tables for all device to match the test target. A weakness of ColorSense was the lack of support of CMYK as an output format for pre-press.

Agfa's Fotoflow is clearly focused on the pre-press world and provides all of the required outputs in CMYK to meet the pre-press requirements. Fotoflow, scheduled for introduction in March of 1996 after many years of development, ships with profiles for a wide variety of devices as well as specific profiles for Agfa's line of color scanners. Standardized calibration targets (IT-8 Standard) ship with the product so that users can calibrate and link scanners other than those sold by Agfa.

Color Management in the Operating Systems

With it's strong focus on publishing and graphics design, Apple recognized the need to move color management capability to the level of the operating system. Color Management applications were memory intensive, expensive and based upon closed and proprietary approaches to device independent color. An OS level convention was clearly required.

ColorSync™ is a system extension that provides color matching capabilities to the existing QuickDraw graphics model. ColorSync color matching is just one of the new capabilities that is part of Apple's new imaging platform—GX. ColorSync adds the capability to define colors independently of the device creating the colors, and to initiate matches of colors on different devices. Because Apple wanted to provide an architecture where third party developers could add value, ColorSync utilizes the Component Manager. This was developed in conjunction with QuickTime™ to link a series of Apple or third party color management resources and utilities.

The architecture of ColorSync in the existing QuickDraw world provides three important features;

1) System level support for color matching
2) Support for existing applications
3) Opportunities for third parties to add value

The model is shown graphically in Figure 1.

The initial release of ColorSync offered only low level color management capability. The most recent release, introduced by Apple in the spring of 1995 is tightly integrated into the Macintosh operating system—most notably within Quickdraw GX. It also ships with an improved color matching module developed for Apple by Linotype-Hell in Germany. This system is very fast and delivers excellent color matching capability. Apple also extended ColorSync to better support pre-press requirements such as CMYK output, Hi-Fidelity color support and multiple color space transforms. On the low end side, 3D lookup tables and transforms for color printers are supported by ColorSync 2.0

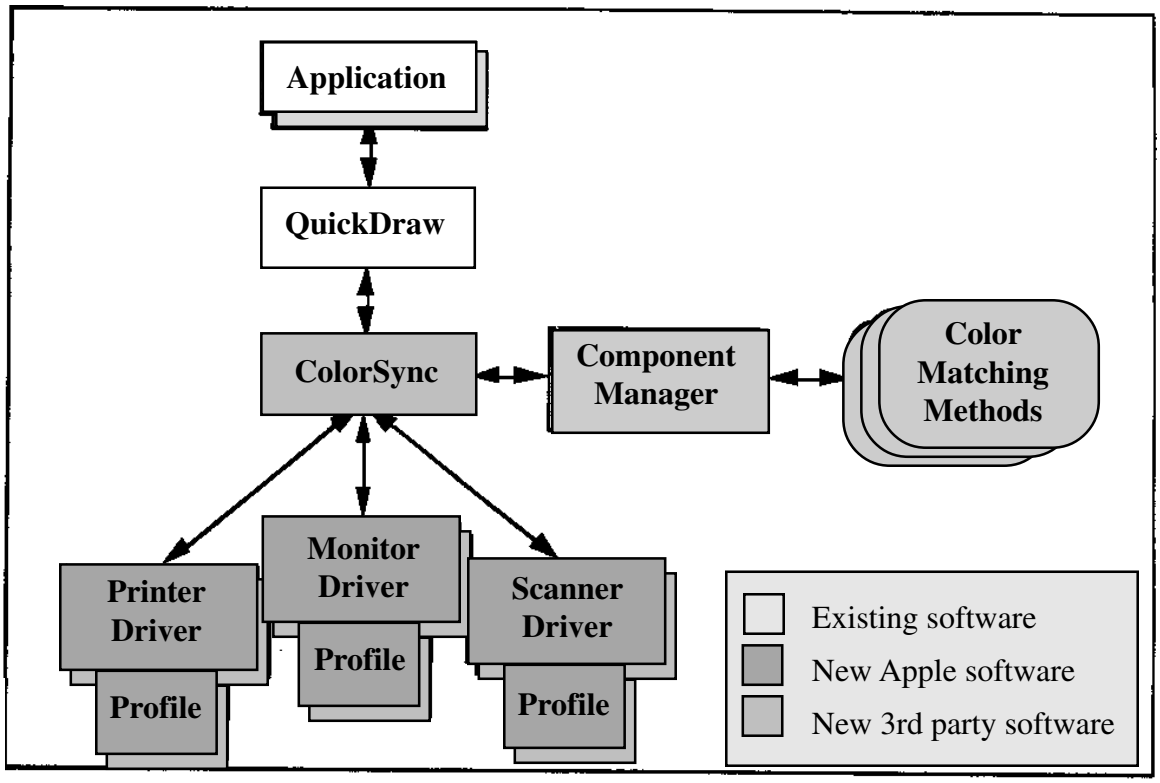

Figure 1.

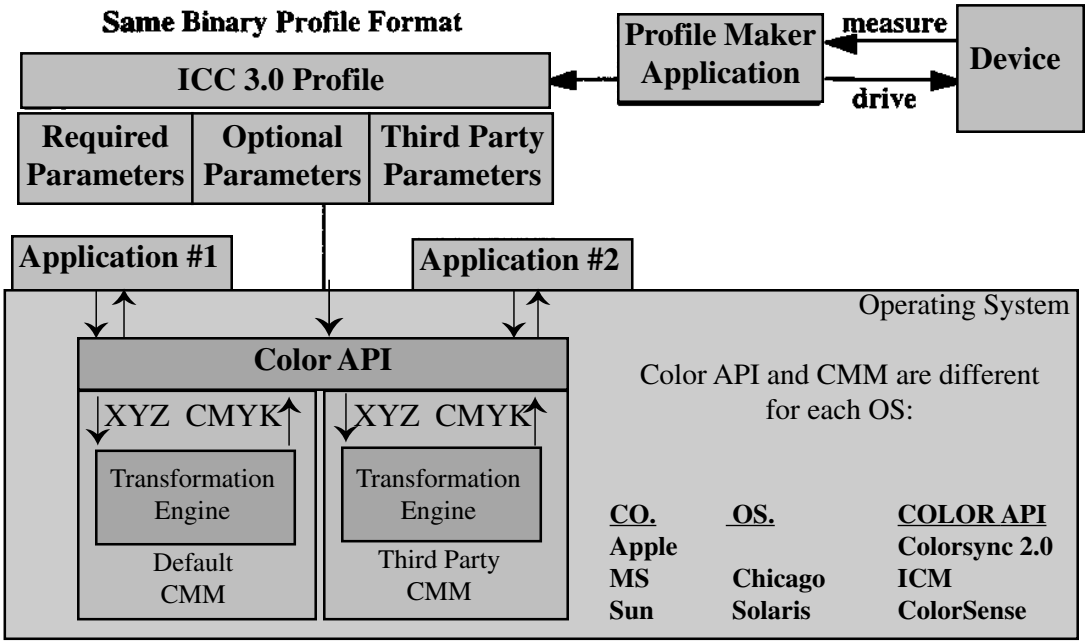

Figure 2.

Microsoft is pursuing a similar solution to Apple's ColorSync with it's Independent Color Matching (ICM) module as a key component of Windows 95. As with Apple's solution, Microsoft provides an API for developers that allows applications to call on color processing facilities directly from applications. Microsoft has teamed with Kodak for the color matching capability and 1 provides a default color matching solution developed by Kodak for Microsoft. The default is tailored for high speed and small memory requirement so that it will work on all Windows systems irrespective of RAM size. The default engine provides an g-bit transform which will provide adequate color matching for a typical users. ICM does provide for the addition of higher accuracy color matching modules which can be supplied by Kodak. These drop in replacements for the default module offer full 32 bit capability and are derived from the Kodak Precision Color Matching capability. The ICM model is shown in Figure 2.

On the UNIX side of the operating system world, SUN Microsystems has aligned itself with Kodak in a similar move to Microsoft. SUN will extend it's Solaris operating system to support color matching modules supplied by Kodak. The system will be extensible in that color matching modules from other suppliers such as EFI, Agfa as well as Kodak can be used to replace the default matching method. While SGI has not announced the details of their color matching solution, it appears that it will be very much like Apple's ColorSync. In fact, it may use Apple's proprietary color matching method as the system default.

Color Standards

In developing the operating system level color management extensions, Apple, Microsoft and others have attempt to incorporate suggestions from standards developing groups as well as from key third party SW developers. Most notably Apple has tried, as much as possible, to be sensitive to the recommendations of the Association of Color Developers (ACD), which has put great effort into improving the Macintosh platform for device independent color. Additionally they have incorporated many of the notions offered in the draft standard ISO 8613 Open Document Architecture.

All of the major manufactures of color capable products - peripherals, applications, operating systems etc. have banned together in the International Color Consortium (ICC) which seeks to develop and promote a standard for color profiles. The standard, now in it's third release, provides detailed instructions on the development of device profiles and plug ins that can be accessed by the major operating platforms. The concept is shown in Figure 3.

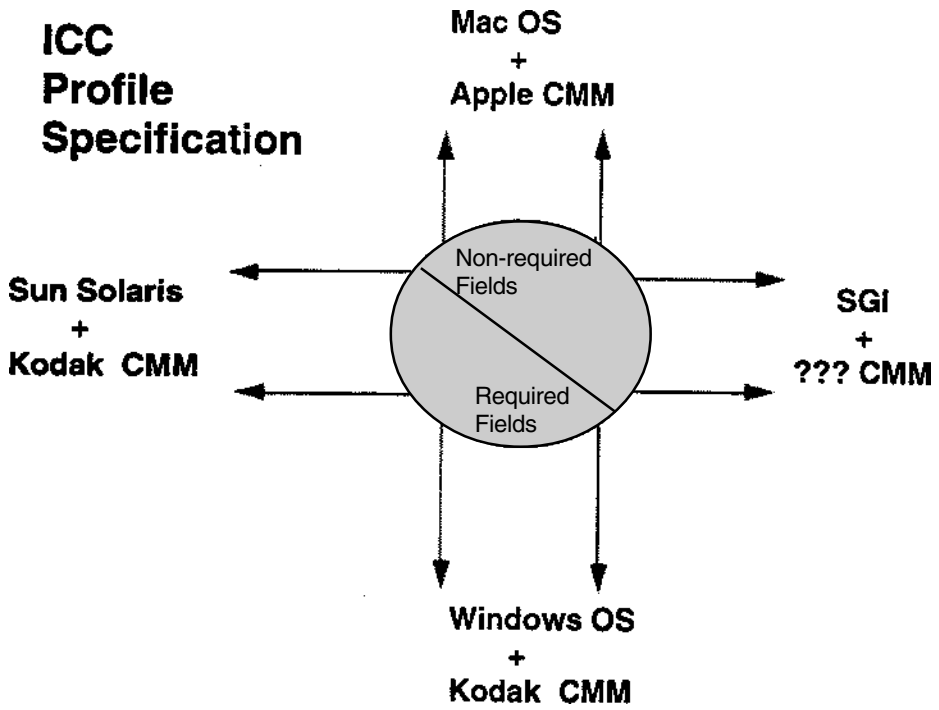

Figure 3.

With the entrance of color plug in solutions such as Light Source's Fantasia and the recently introduced Pantone POCE system, color management systems have completed a full development cycle. With color management tools first appearing as SW extensions offered by device manufacturers such as Tektronix, to full fledged SW applications offering all manor of color management like EFIColor to color management capability built into the operating system as in Apple's ColorSync and Microsoft's ICM the migration path to the user seems clear. For the future the trends are obvious with extensions to the operating system such as Light Source's Fantasia and Pantone's POCE which will broaden and strengthen the level of color management offered by the OS and through SW applications calling on the OS level color management solutions directly.

Worldwide WEB Distribution

Robust color solutions on the desktop link very well into the emerging direct to press efforts in which a desktop file can be exported to a high speed press or proofing system directly. Perhaps the next step in the color management revolution will be away from the seamless linkage of press and desktop and into the distribution of color images across the Internet. An entirely new set of problems such as small file size and multiple compression schemes faces the industry and this new media offers broad distribution and viewing requirements for compound documents and rich color images.

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