The History of the ICC

Michael Stokes
Hewlett-Packard Company, Palo Alto, California

Abstract – The History of the ICC

In recent years hopes of resolving the chaos of color reproduction in open systems and the World Wide Web have slowly become focused on de facto industry standards. Apple Computer led an initiative starting in the spring of 1993, known as the ColorSync™ Consortium, to resolve this chaos. Over the next eighteen months, this initiative produced an open, cross-platform device color characterization profile format specification based on the Apple ColorSync™ profile format and set the groundwork for unambiguous interaction among color devices and vendors in open systems. The following year was spent transforming this informal consortium into the International Color Consortium (ICC), a formal, non-profit organization. The next eighteen months were spent establishing clear goals for the consortium and struggling with intellectual property issues. Following this effort, the last six months have seen the genesis of new work to inventory all known problems with the ICC specification, create a set of reference implementation and establish guidelines for conformance testing. If these initiatives are successful, it appears that the ICC might finally meet many of its ambitious initial goals.

As founding chairperson of the ColorSync™ Consortium, color architect for ColorSync™ 2 and recent past chairperson of the ICC, I have been intimately involved in all of the developments described above. I have also been involved in other related open color standards activities. This paper represents my personal viewpoint on these developments and the ICC in general. It does not necessarily represent the official position of the International Color Consortium, Apple Computer or Hewlett-Packard Company.

Introduction – Before ColorSync™

In recent years hopes of resolving the chaos of color reproduction in open systems and the World Wide Web have slowly become focused on the de facto industry standards.

It might help to understand the current status of digital color reproduction by briefly examining how this field has evolved. The field of digital color reproduction is a congruence of several much older industries merging together. Each of these industries has their individual aspects of color reproduction that have evolved within the constraints of their particular production workflows. These industries include; broadcast television, motion pictures, slide reproduction, still photography, photofinishing, computer graphics, desktop publishing, paint formulation, presentation graphics, multimedia presentation and graphic arts. Color Science has provided a scientific foundation for all of these industries with varying degrees of significance, but each industry has extended this foundation with empirical results that are specialized to its particular needs. Thus, each of these industries individually encompasses a significant body of knowledge with respect to color reproduction issues. Much has been previously written about the traditional aspects of each field, usually from an analog point of view. In addition, researchers in color science have continued to advance the scientific foundations over the last several decades quite independently from any of these industries. Unfortunately until quite recently most of these efforts have also been independent of modern computer operating systems and digital networks. This has caused significant transition problems between the traditional methods and the constraints imposed by open computing environments and in particular the World Wide Web.

The advent of digital color processing applications in open systems, and in particular the World Wide Web, has forced all of these industries into working within open computing environments and with each other. This created a new technology field—digital color reproduction. This relatively new field has inherited many of the methods and standards from each of its contributing industries. This is in addition to contributions from researchers in the color science community and in combination with the constraints imposed by the various software operating systems, networks, applications and devices that compose the digital computing environment today. The tensions between the traditional industries with each other, and along with the new digital technology, have created an interesting and often conflict-filled new technical environment for digital color reproduction. Most of the current practitioners trace their experience directly to either one of the color or computer industries listed above and many claim authority in setting direction and standards in this new field. Some traditional imaging companies feel threatened by the control of color by operating system venders or other traditional imaging industries. There has been a great reluctance to open up solutions for the betterment of the end-users. This has created an amalgam of solutions for end-users, none of which have fully answered the desire to have transparent, predictable color reproduction and most of which are incompatible with each other.

In particular, the current chaos in this new field can be attributed to a few companies who had control or near monopolies in a single one of the many traditional analog imaging industries. In this new digital color reproduction field, these companies are fighting to survive. These same traditional analog companies are often the most vocal opponents to open standards for digital color reproduction. This is exemplified by attacks on open standards activities without constructive counter-proposals. Some of this resistance is due to a strong business strategy based on pro-

prietary solutions instead of open technology. Many traditional industries have thrived on using trade secrets and patents to protect small niche markets or monopolistic positions. The U.S. Patent Agency's lack of control and expertise in granting software patents in the fields of digital color reproduction has also hampered progress in this field. Today, many companies seem to be as concerned about protecting or violating intellectual property rights as they are about creating technical breakthroughs. Whether this is due to the huge unreturned investment in digital technology or simply to their entrenched attitudes of traditionally being in control and monopolizing their markets will probably never be known.

This chaos and dissention are not new to the color reproduction industry. Adrian Cornwell-Clyne[1] summarized a similar set of conditions in the motion picture industry in 1951 with the following statement, "The public history of 'processes' of colour cinematography is on the whole discouraging and disconcerting, but the reader may be assured that the private history is hardly credible, and will, if ever it be made known, constitute a singular commentary upon the least rational aspects of our society and its culture."

The ICC initiative circumvented many of the traditional standards processes. This was done intentionally after several previous efforts on standardizing open color communication within the ISO/IEC processes failed, including OSCA, GACDI and ODA. It has been found that there exist strong contingents within the international standards organizations that seem opposed to open standards that can be used and shared by all on a royalty-free basis. ISO and IEC standards committees are based around traditional industries and strongly support their industry's needs and perspectives. While JTAG2 has been formed to consider some cross industry concerns, it has proven slow relative to the pace of industry needs and still limited to its representative industries of professional photography, graphic arts and paper. The CIE would seem to provide an ideal forum for these issues, but has shown no active interest in color management and has formal timelines that are at odds with color digital product development cycles. There seems no representative of desktop publishing or home publishing industries within the ISO, the traditional graphic arts concerns dominate this forum and have successfully published many excellent standards for this industry. Yet this is still inappropriate to web publishing in many cases.

Still, this initiative has publicly committed to pursue the traditional standardization process after proving their validity in the open marketplace despite some resistance from the traditional standards community. The story behind the development of these initiatives provides some insight into the fundamental technical, legal and business barriers to revolving color reproduction issues in open systems. By late 1992, there were a number of proprietary, non-compatible color management solutions, including those offered by Adobe, Agfa, EFI, Kodak, Hewlett-Packard, Linotype-Hell, Pantone, Tektronix and Xerox.

The ColorSync™ Consortium

In the Spring of 1993, Apple Computer led an initiative to resolve this chaos that became known as the ColorSync Consortium. Over the next eighteen months, this initiative produced an open, cross-platform device color characterization profile format specification based on the Apple ColorSync profile format and set the groundwork for unambiguous interaction among color devices and vendors in open systems.

In late January of 1993, Apple Computer introduced the first operating system-based color management system, ColorSync™. Gerry Murch of Apple presented an overview of this product and architecture at the FOGRA Symposium in the March of 1993 in Munich. Officials of FOGRA convinced representatives from Apple and Adobe (and others) to meet and discuss the possibility of providing open color management in the operating system based on Apple's ColorSync™ architecture. At Seybold (April of 1993), Seybold officials, in collaboration with FOGRA officials, convened a second meeting with an attendance of around fifteen people. At this meeting Apple and Kodak presented competing architectures for consideration as the foundation of a new, cross-platform, cross-vendor open color management solution. It was agreed by those present to support Apple's architecture, but to reserve final judgement until the end of Summer and conditional upon Apple's commitment to put this work in the public domain. By August, in conjunction with SIGGRAPH, Apple presented a complete architecture to an audience of about 30 companies. Apple restated that they were willing to put this work in the public domain. This work addressed most of the previous technical reservations of many developers. Prior to the next meeting in September, after discussions with Kodak and Microsoft, Apple agreed to concentrate initially on just the profile format specification and not a cross-platform API. In September of 1993, just prior to the Seybold Conference, Apple presented a complete architecture, API and profile format specification to approximately 60 imaging companies. As with previous meetings, this meeting did not exclude anyone from attending and encouraged everyone to provide feedback into the process and specifications. There was overwhelming support from those in attendance to continue this effort. At this point, it was felt that limiting the number of active participants would enhance the implementation of the actual profile format specification. During his presentation the following week at Seybold, Gerry Murch announced the formation of the ColorSync™ Consortium to create an industry standard profile format. By this time, the profile format specification had been through twelve revisions. During the next three months, Apple worked closely with Kodak, and Adobe, to insure a mutually acceptable specification was created. In January of 1994, the first consortium meeting was held and the founding members were established. Since this effort had been operating system centric, all of the major operating system vendors were invited to participate. Apple, Sun, SGI and Microsoft agreed to actively participate. IBM, Hewlett-Packard and Digital declined to participate. Adobe was invited to participate since PostScript was viewed as an application platform. Agfa and Kodak were invited to attend to offer expert advice from the graphic arts standpoint since both had publicly stated support for the new profile format. Finally, a representative of FOGRA was invited to acknowledge their ongoing contributions to this effort. From the beginning there existed strong disagreement over the scope of the consortium, but all agreed to attempt to implement the profile format specification as a starting point.

The founding members strongly felt that a key missing concept from previous color management and communication solutions was a clear definition of all the variables involved in characterizing a device. The consortium defined a working concept called a profile connection space (PCS). This concept explicitly describes all of the relevant parameters involved in describing colors in a color space. Simply because this effort originated in the graphic arts and desktop publishing field, a set of graphic arts standards was chosen as the basis of the profile PCS. The central importance of the PCS is due to its role in profiles. All input, display and output profiles connect between the canonical device space and the ICC PCS.

One member strongly felt that a fixed, D50, ideal print PCS was the only possible choice that would work, despite strong opposition and proof to the contrary in successful product offerings from several other member. Adobe brokered a compromise whereby the issue could be revisited at a future date. The fixed PCS created the possibility of a color management module (CMM) that simply interpolated between source and destination profile. Unfortunately, it also mandated a fixed color appearance model that has since been shown to be significantly flawed.

From it's inception, a close association with Adobe's PostScript™ Level 2 color processing pipeline has been an explicit guideline for the profile format development. In particular, the input and display models of ColorSync™ were combined with Adobe's PostScript™ Level 2 printing model to form a robust profile format specification. Finally, three-dimensional support was added to the input and display profiles for future extendibility. By June of 1994, the twentieth revision was presented to the founding consortium members and deemed acceptable to base product development on.

Founding the ICC

The following year was spent transforming this informal consortium into the International Color Consortium (ICC), a legal, formal, non-profit organization. The ICC bylaws state that "the International Color Consortium was established in 1993 by eight industry vendors for the purpose of creating, promoting and encouraging the standardization and evolution of an open, vendor-neutral, cross-platform color management system architecture and components." The ICC has produced a specification that "describes the International Color Consortium Profile Format. The intent of this format is to provide a cross-platform device profile format. Such device profiles can be used to translate color data created on one device into another device's native color space. The acceptance of this format by operating system vendors allows end users to transparently move profiles and images with embedded profiles between different operating systems. For example, this allows a printer manufacturer to create a single profile for multiple operating systems.

In order to accelerate the legal formation of the ICC, the OpenGL Consortium bylaws and membership agreement were taken as a guideline. Despite this, the creation of a new consortium by competing companies proved to be an arduous and lengthy process that involved many revisions of the bylaws and membership agreement by each company's legal team. The result was a formal organization led by some of the most power operating system and color management system vendors in the world. This clearly established the authority of the ICC and membership was opened up to all that supported its goals and paid the nominal membership fees. Today, over fifty of the world's premiere color imaging companies have chosen to become members with even more companies choosing to support the ICC profile format in their products.

In parallel to this legal development, many minor technical corrections to the profile specification format were made.

ICC Goals and Intellectual Property Policy

The next eighteen months were spent establishing clear goals for the consortium and struggling with intellectual property issues. Several ICC meetings were devoted almost completely to crafting clear and forward-thinking goals for the consortium. The broad industry adoption of the ICC profile format has provided a good first step into clarifying the unambiguous communication of color information in open systems that are now prevalent throughout industry. The ICC goals provide a good indication of the future direction of this consortium. These goals were formally adopted at July 1996 meeting in Palo Alto and are stated below:

1. The color management system should scale from automatic to sophisticated user intervened conditions.
2. The ICC will incorporate new technology and standards in a timely manner. ICC work will be offered to the relevant standards body for consideration as an International Standard
3. To create, promote, and encourage the standardization and evolution of an open, vendor-neutral, cross-plat form color management system architecture and components.
4. The ICC will define a baseline CMM model and baseline CMM implementation that can be part of the specification that will provide the same results with the same numerical data.
5. The ICC will standardize on an appearance model(s) to get from source to PCS and PCS to destination.
6. Colorimetric reproductions (absolute and relative) should be exact within the tolerance of the device within the device's gamut.

Current ICC Status and Direction

The last six months have seen the genesis of new work to inventory all known problems with the ICC specification, create a set of reference implementation and establish guidelines for conformance testing. There are several other working groups within the ICC to address specific technical issues.

The Problem Assessment Working Group is led by Microsoft and chartered to list and prioritize all known problems with the ICC specification and, if possible, suggest solutions to these problems.

The Reference Implementation Working Group is led by Hewlett-Packard and charted to create a reference CMM and profile creation implementation from the specification, taking input from the Program As sessment Working Group for suggested solutions and priorities.

The Conformance Testing Working Group is led by Polaroid and chartered to create guidelines for conformance testing of profiles and investigate conformance testing for CMMs.

Together, these working groups provide the potential for the ICC to overcome most of the current problems and resistance to universal adoption by users and developers. Unfortunately, not all color management problems can be addressed by embedding a profile or having the user explicitly choose a profile. Hewlett-Packard and Microsoft proposed to the ICC a complementary color management solution to deal with this, the sRGB standard default color space. Since many questions have been raised about the relationship between this color standard and the ICC, an appendix has been included to clarify the complementary nature of the two color management standards.

Conclusion

In conclusion, it seems that de facto standards will continue to flourish and where appropriate transition into ISO/IEC formal standards. With the continued fast pace of progress of innovation in digital color reproduction, this is a necessary process to attempt to test real world solutions in a relatively quick and efficient manner. Unfortunately, consensus appears to be a luxury in these circumstances. What must not be lost is the active solicitation of and serious consideration given to feedback and comments for all parties.

If these working groups are successful and sRGB can be formally integrated into the ICC framework, it appears that the ICC might finally meet many of its ambitious initial goals.

Appendix - sRGB

Hewlett-Packard and Microsoft have recently proposed the addition of support for a standard default color space, sRGB, within their entire product lines, the World Wide Web and the ICC. The aim of this color space is to complement the ICC color management strategy by enabling a well-defined implicit ICC profile to be used when no other color management information is available. It utilizes a simple and robust device independent color definition that provides good quality with minimum transmission and system overhead. Many other technical experts have significantly contributed to this standard, including Charles Poynton, Roy Berns, and experts from Kodak, SGI and SONY. While Microsoft, Hewlett-Packard, the World Wide Web Consortium and others have adopted this standard, the ICC has chosen to not support it at this time.

Currently, the ICC has one means of tracking and ensuring that a color is correctly mapped from the input to the output color space. This is done by attaching a profile for the input color space to the image in question. While this is appropriate for many users, there are a broad range of users that do not require this level of flexibility, quality and control. Additionally, most existing file formats do not, and may never support color profile embedding. Finally, there is a broad range of uses that actually discourage people from appending any extra data to their files. The sRGB color space addresses these issues in a manner compatible with the ICC framework. Therefore, both Hewlett-Packard and Microsoft view the sRGB initiative as an integral part of their ICC-based color management solutions.

References

1. Adrian Cornwell-Clyne, Colour Cinematography, (1951)

☆ This paper was previously published in *IS&T/SID 5th Color Imaging Conference Proc.,* p. 266 (1997).