FUTURE TRENDS IN REPRODUCTION- ORTHOGONALITY

Dr. E. M. Granger, Ontario Beach Systems

The term orthogonal used in this article has the mathematical sense that each element of a system has no effect on any other element of the system. Current printing workflows have multiple dependencies. The characteristics and limitations of these multiple elements each must be measured and these measurements communicated clearly to the succeeding parts of the workflow. If they are not, correct reproduction becomes as much a matter of luck as of skill and art. There are many elements to measure and formats to consider, such as color spaces, document formats, device profiles, document scale, etc. In the future, it is important that each of these elements be orthogonal or independent.

An ideal workflow will eliminate as many dependencies as possible, so that the workflow from creation to final can be streamlined. This will be done by focusing our efforts on three areas:

a) Defining device neutral color spaces for each step of the workflow
b) Improving the user experience of the tools through every stage of the workflow
c) Automating the color measurement and feedback of workflow devices so that they become invisible to the average user

The most important element is the customer and the customer's expectations. There are a wide variety of users that range from the casual user to the heavy duty professional. All want the same results from the reproduction system, namely that the input, display, and output have equal appearance. The elements of the system should be independent from the point of view of the customer. We need to be able to structure applications so that elements can be added to accommodate greater complexity. After all, the average user only wants what George Eastman would have promised in a modern age, namely " You click the mouse, and we will do the rest".

Device independence is not new. A team at Kodak, led by Chuck Reinhart, developed a scanner evaluation target called the Q-60. Chuck presented the new concept at the 1988 TAGA meeting. The Q-60 was the first test target to offer a set of patches that were organized in an orderly fashion. The target patch organization was original in spacing the color samples in orthogonal and equal CIE-Lab steps of hue, chroma, and lightness.

The Q-60 was originally developed as a diagnostic tool for scanner evaluation. The novel construction of the target led to the beginnings of device independence. Before device profiling, the transfer of data was accomplished by converting scanned RGB values to printer CMYK values using proprietary conversions. At that time the reproduction systems locked the scanner and press into a closed system. The Q-60 offered the promise of calibrating a scanner to produce device independent CIE-Lab output that could be passed on to a CIE-Lab calibrated press. For the first time, in theory, color data could be shared in an open system.

Apple Computer introduced ColorSync as a method of connecting system elements. The color space corrections or profiles could be added to a document so that the chain of required transformations were imbedded in the document. For the first time, the system organized color space transformations so that a document could be accurately managed from input to output.

This system works reasonably well in the hands of experts, but is unnecessarily complex for the average user. Although the system produces good results, it requires expert training and expensive tools to deliver its best performance. The designers of much of the hardware and especially of the software seem to have made it a point to make their tools more difficult than necessary to use. In particular, until very recently, user interface design in profiling software, if considered at all, was done with the apparent intent of being as obscure as possible.

Worse yet, in the current workflow, the dependencies are either embedded (Photoshop 5 and Acrobat 4) or are communicated with pointers or links to the profiles. CIE-Lab three-dimensional profiles with a limited number of steps in each dimension have led to the need to connect the input profile directly to the output profile. As a result, we're back to our original problem of complete device dependence. Should users neglect to send a profile or profiles with their job to a printer, the printer is hamstrung, as most documents do not embed profiles for all pieces of a fully composed document, similar to the printer not having all the fonts needed to complete the job. We have gained some flexibility and a good deal of accuracy by using profiles but the current system has its limits.

New thoughts are beginning to emerge about how to reconfigure the system so that the elements are truly orthogonal. New color spaces are being proposed to replace CIE-Lab as the profile connection space. An RGB profile connection space is required if we want to build a system that has the proper orthogonal principles.

The sRGB color space works well with current cathode ray tube displays but may not be as useful for flat panel displays. Not only are the primaries of the flat panels different from those of the cathode ray tubes, but future flat panel displays may incorporate more than three primaries. What is important is to get industry agreement on some RGB definition that can be used as the industry standard. All color data would be stored in this standard format. sRGB, with its current limitations as far as four color process output is concerned, may not be the ideal answer. With gamut extensions and increased precision, it may be worth the compromises. Alternately, a wider gamut color space which retains more color information may be used for input/working space but only if the elements of the display and output segments of the workflow are considerably more orthogonal than they are now.

Gary Starkweather of Microsoft has offered an excellent analogy of what needs to be done for all future system elements. Although his talk concentrated on the output side of the reproduction process, his analogy could lead us to the best future state. Gary used an automobile analogy to illustrate his point. He spoke about the complexity of the automobile transmissions before the 1990's. They were a mess of interconnecting hoses, valves, fluids and channels that were used to change the gear ratio from the motor to the rear wheels. As he pointed out, this old transmission is exactly like the current workflow and color management system.

The solution for the automotive transmissions was to add a computer and measure, independently, all the elements required to make the shift point decision. The new transmissions measure air temperature, torque, oxygen level, etc. to make the decision about how to set the transmission. Gary's question was "Why not color devices?"

He gave an example of how a small colorimeter could be attached to a printer. The colorimeteric information could be fed back to the host computer. The host computer could then change the profile to optimize the printer. This information would be used to correct the profile not just for the ink, but also for the ink-paper combination, the humidity and other atmospheric conditions affecting the output, etc. In a system like this, the output device would auto-profile the paper for its characteristics. The original images and spot color information, already coming from auto-calibrated and profiled input and display devices, would automatically relate to the intended destination substrate at the final point of impression. The average user would not need to know, nor care, what color space the scanner had used to acquire the image, nor what profile was being chosen by the computer. This would be automatically selected by the devices for the best possible reproduction. Advanced users could look "under the hood" to fine tune specifications.

Apple Computer built monitors that were automatically self-calibrating. Regrettably, the price Apple had to charge for the enhanced technology meant the average user, not understanding nor valuing the additional cost technology, declined to purchase the smaller ColorSync monitors which were then discontinued. Autocalibration technology is currently only available in the 21" model. An industry breakthrough is needed to make autocalibrating monitors so affordable that they're ubiquitous; this has critical implications for the future of web commerce.

The best future state for color space is to have all input devices convert their RGB data directly to an agreed upon RGB metric space. All output devices would be treated as printers. Monitors, printers and all other output devices would have a single profile to convert the PCS to the local color space. To have true orthogonal operation the workflow requires that the profiles belong to the devices and not to the document. The orthogonal system would not imbed profiles in a document. This new system would allow last-minute adjustments to be made in any device at any stage of the reproduction process. There is no need for the document to be involved in the reproduction process. Once we have agreed to a universal RGB space, we can concentrate on the updating of the capture and reproduction processes.

Orthogonality applies to other aspects of a document. An efficient workflow requires that the document be independent of the operating system, of the scale the document, and the state of editing. Adobe has gone a long way toward producing documents that are independent of the operating system. The Adobe Acrobat PDF file structure has done for the document what the ICC has done for color data.

Adobe Postscript gives us the ability to embed scalable type and line art elements into a document. AltaMira Group, Inc. has added this ability for scanned data. It is able to convert the scanned picture into fractal vectors. Fractal vectors are excellent for data compression. These vectors have the advantage that they are scalable just as the type and line art elements are in Postscript. The joining of fractal vectors with PostScript produces a new document that can be scaled to any magnification without exhibiting the artifacts that are common to other data compression techniques. This image storage format is an analog to the universal RGB exchange format used to control color. Moving document structures to be entirely vector based is a requirement that allows last minute changes in the use of the document.

For users, the bottom line is that they want the system to work, and work well. It should deliver high quality color reproduction from varied original sources onto multiple output devices, without requiring nearly as much work as the systems currently necessitate. With autocalibrating devices in the workflow and universal standards for the exchange of documents, this can be done. The important question becomes "Who will lead the way"?