With Jon's permission below you will find a post he made on the Piezo list, http://groups.yahoo.com/group/piezography3000/, that outlines the evolution of grayscale inkjet printing over the last decade. For those of us relatively new to this field I think it is extremely informative. Jon also discusses the goals and theories of his soon to be released ICC software for printing with PiezoTone inks on Epson and Canon printers.

I will also put a copy in the Files section of the group homepage

Martin Wesley

From Jon Cone:

I think that a little history about how all this came about may put things into perspective as well as displace any misconceptions about the new products which are not so new in some ways and are new in other ways.

PiezographyBW plugin was not the first Cone quad system and much of what seems special about it has been in my products for a very long time and will continue to be in my products for a long time. While it is very comfortable to us, the technology may be difficult to grasp for many. What follows will probably be a long read and I hope it does not raise more questions than it answers.

1. HOW QUADS CAME ABOUT

I first created a quad black ink and media profile system for IRIS Graphics in 1996. It was not only the first full quad system for any inkjet, but it was also the first "visually dotless" b&w inkjet system. By 1997 it had fully matured into a split-toning system which needed no more than 3 inks in order to print full linearized tonality. The forth ink was used in conjunction with two other positions to produce split toning. It was called DigitalPlatinum for IRIS and is still the most visually beautiful quad system ever developed. Prior to these two quad black ink and table systems, I produced a reduced gamut ink and media table system for IRIS. I also produced a monochromatic system which using color inks was able to print any number of monochrome hues. This last one was the most popular system I sold in the 1990s. All of these systems used ink which I created in a small lab.

There were a total of 4 monochromatic inkjet systems produced by Cone Editions for IRIS Graphics from 1993 to 1998 and only two were quad inks systems, yet all were capable of making fine monochromatic prints. The reasons for using the color inks was because IRIS printers cost $123,000 and owners were very reluctant to dedicate a single printer to quad inks. The system with color inks which produced mono hues was obviously the most popular because it could also be used for making color prints. It also produced a very good b&w print which was many times better than when using the IRIS and SCITEX supplied software and inks.

2. HOW INCREASED RESOLUTION AND DOTLESSNESS CAME ABOUT

Printers have fixed capabilities and yet when creating monochromatic systems, I could "increase" the perceived resolution of a STANDARD driver by re-specifying where dithering patterns occurred. This can just as easily be done when using a CUSTOM driver. It is not a complicated affair really. It is not a function of the dithering as much as

it is a function of an ink table. You do not need to worry that we are not bringing this benefit forward - we are. My first dotless quad IRIS prints were seen by George DeWolf and John Custodio at a tradeshow in 1998 who both urged me to begin experimenting with EPSON printers. I found in 1999 I could achieve this on a 3000 within just a few weeks by producing input/output tables for it using CMYK drivers. The total ink percentage in an EPSON is frightfully low compared to an IRIS. So it took a slightly more complicated approach, but after a little training, anyone can do this. And in 1999 I taught two workshops in how to do it at Cone Editions. They were well attended. Within 2 days attendees were making input/output tables for specific media. (3 however nearly expired from the trauma of the experience). They mutinied! We often remember them to others who attend our workshops.

How the Cone Methodology for quad inks was accomplished was by using dilutions of ink at greater printing densities than usually expected. Increased "dithering resolution" was accomplished while partitioning the inks at the same time. Therefore - it is not a "dither" in the traditional sense (mixing inks) but rather used to increase the perceptual resolution by using a single ink and squeezing the dots closer together. You can not do this in color because obviously increasing the "dithering resolution" would darken the colors and move everything up the density chain. You need lots of distance between dots of ink in light colors, otherwise the paper white will not contribute to the perception that the ink is a "light" color. That's how pink is made! (with lots of white...)

Imagine having only black ink in a printer and having to produce a gradation. A very light sprinkling of dots spaced widely apart would assimilate the 10% tone and of course tighter dithering would be used for the middle tone and the dithering would be so close together in the darkest tones as to be virtually impossible to differentiate as a dither. This is how the standard EPSON dither driver works. As the tone increases the dithering gets tighter. Dots of ink assimilate density as well as color which explains why you can sometimes see dots in the highlights in your color prints and rarely or never in the mid to dark tones. The thing that you are most seeing is separation between dots and tiny dark dots which are being used to make a light color.

We see dither patterns usually only in the light tones because the dots are spaced so far apart that we can individually resolve them. The resolution of a printer may be described as a 300dpi printer or a 720dpi printer - but in highlights there are far fewer than 300 or 720 dots being printed per inch. I hope you are still with me on this. Even though the printer can move 1/300th of an inch does not mean it is going to lay a dot down every notch it can move. In a solid black in theory it might do that. But in a very light color such as pink, don't count on it! It would need light pink ink in that tone and density in order to have to put down 300 per inch! I hope you are still with me...

Imagine diluting the black ink so that it was a very light gray. In order to print a 10% tone with a very light gray ink dilution, a dithering density which was used in the black ink example would hardly be visible so that perhaps 40% or greater might be used in order to compensate for the light ink dilution. (The actual number is dependent upon several factors, but the idea should be enough to explain here.) This is how Cone Methodology works for quad printing and how resolution is effectively increased and why it appears to be dotless. The dot pattern (dither) in a 40% density is of course, spaced much closer together than a 10% density. By using this method we have been able to increase the

perceived resolution of ConeTech quad products. Others use this method as well now. With mono inks, one does not have to follow the conventions that the use of color ink forces.

It does not take a special printer driver to do this though it usually is done on EPSON printers with special drivers because the EPSON driver is used as a color engine. It can not be done with conventional ICC profiles such as what LYSON has released because they make no attempt to. Their dilutions kind of correspond to the color densities and therefore only a gamma curve is resident within the profile and a hue setting for the color proof.

But it can be done with the PiezographyyBW ICC profiler which is an application we have recently completed at Cone Editions. We treat the EPSON driver as a monochromatic engine which we think is very clever and has not been attempted successfully in the past.

Dithering quality is less of an issue in monochromatic work than is perceived by most users. Wha??? Yes, big statement to make there, but when ink is very diluted it is actually very difficult to see individual dots as they are moved closer together. Even with a loop it requires a dithering programmer to differentiate and only then if he can actually "see" it. "Cross-overs" or where ink tone is handed off from one ink to another is far more important and that is where someone will perceive dithering when dark inks are printing where they combine with the lighter dilution before it, and that is where programmers can see the dithering and know precisely what is occuring. You can easily run color inks in a quad system and then very easily see the quality of dithering if one is curious. In fact that is one of the ways we have had to trouble shoot PiezographyBW in some banding cases, or to prove printer problems. The PiezoBW uses a very good dither.

EPSON's own dither is proprietary and the best in the industry. Having their dither is a God-send. It will mean less banding and artifacts. We are very happy to be riding on top of EPSON with the ICC profiles. It has resulted in smoother transitions from ink to ink.

3. HOW THE SWITCH FROM IRIS TO EPSON QUADS CAME ABOUT

IRIS Graphics and Cone Editions had a mutually benefiting development relationship throughout the 1990s. I was the Development and Marketing Partner for Fine Arts and all fine art IRIS systems sold from 1994-1996 were sold through Cone Editions and installed by Cone, or IRIS or SCITEX on our behalf. Often these printers were installed by IRIS or SCITEX for use with my inks. Always they were installed with my interface and software tables. I was the leading seller of IRIS 3047 printers (that is how they benefited). IRIS began to introduce a competing art system about 1997 which was sold in place of the Cone system and eventually there were other systems. Only Cone systems offered monochromatic inks and software in addition to color inks and software. Also, the first IRIS archival inks were a disaster. Wilhelm rated them for something like 25 years and they faded in 3 months! In any event, IRIS Graphics went out of business and IRIS printers which we supported were no longer manufactured by 1998. It was a sad day to see that happen. We still have four of their printers and one is in an unopened crate and we consider it a museum piece. We are saving it for something many many years from now. What the something is, I have no idea. But I can not help but think it will be really

cool to crack open an IRIS printer 10 or 20 years from now and actually print with it. I can still make ink for IRIS printers.

I thought EPSON to be a stable development platform because unlike IRIS Graphics which produced $123,000 printers for a little, tiny specialty market, EPSON was into the mass market. I thought that they would have a long commercial life ahead of them. However, after the 1200 was released, EPSON began the practice of protecting its ink market and a much more rapid release of new models occurred.

Anyway, in 1999 I began to develop monochromatic systems for EPSON printers that paralleled my IRIS work. Prior to releasing the PiezographyBW driver I taught people in our workshops how to make quad black ink tables for EPSON printers using CMYK drivers. As I mentioned earlier, this either drove them insane or put them on the roadmap to monochromatic success. I also created RGB ICC profiles that would neutralize EPSON 3000 color inks and do so in many different hue tones. The latter I understand is still in use by some of our early customers, and can be used to print color if they want. Both of these systems were developed for use with LYSON archival color and quad dye-based inks.

PiezographyBW represented a product which would allow a no-brainer approach to quad printing. While it did not have the quality of the DigitalPlatinum for IRIS product, it was none-the-less, visually superior to a standard IRIS print (which was the benchmark of the day in 2000). The plugin driver brought quad printing to a wider audience than those willing to fiddle with CMYK RIPs and creating their own tables.

But PiezographyBW did not really have the time to mature and there are many reasons for that, not the least of which is that as a third party developer it is difficult at best to keep up with EPSON ink delivery systems and intellichips. While my early IRIS systems were fully supported by IRIS and SCITEX including warranty and financing, we did not have that type of relationship with EPSON.

In retrospect, the stable platform of EPSON was a misconception on my part. The platform is actually completely impossible to pin down. The changes are quantum and rapid. EPSON thwarts all attempts at stability by constantly discontinuing printers. But then there was no longer the ability to produce quads on IRIS printers. I could have chosen a different printer manufacturer. All things being considered, it was a good move. HP would have jailed me by now.

4. WHY WE ARE CHANGING TO ICC INDUSTRY STANDARDS

EPSON changed about 2 years ago from a hardware/ink solution company to an ink company. The changes may have occurred at the corporate level much earlier. But it was clear when they began to introduce ways by which they could protect their inks revenues through intellichipping, and reducing the price of their printers, that they were profit motivated to sell ink. And no one should fault them for that. However, they have not been so gracious to developers recently and we learned that they will no longer support third-party ink guys with their printer development codes. They have several levels of codes which they make available. We were on a high level and they even provided us with a development printer at one time. Their best dithering codes on the other hand were never ever shared with ink guys, and it is widely known that their proprietary dithering is the

best in the industry. A few RIP guys have been given codes such as these but are not in any way associated with inks and are licensing from EPSON and EPSON goes in effect, into partnership with them. The EFI Fiery has EPSON dither. Bad color management but good dither! ;) But it can only really be used with EPSON inks.

So we made a decision after our dev status was cut to rather than make one last driver based system (plugin or stand-alone), instead we would put all our resources into writing a PiezographyBW ICC profiler for their drivers and achieve OEM independence. We also decided that we would build this profiling app so that it could be used with any driver, and which could be used to start a next generation of Cone products in the coming years. We proved its worth by profiling Canon printers at first for the PMA event. In any event, our decision has given us the ability to quickly develop without regard to EPSON decisions or Canon decisions. If they can make printers which we can put ink into, we can now produce a PiezographyBW system for it. Just don't bank on an HP system anytime soon. ;)

Having a standard allows us to offer the system to those who either can not afford Photoshop or have no desire to run it. It allows us to piggy back on top of other's great programming efforts as the OSX imaging apps which are beginning to sprout are really quite innovative. Also Corel has a large Windows base. Perhaps the most important aspect of the new system is for our users ability to utilize the power of ColorSync, ICM and other CMMs to express their monochromatic work. It completes the visualization process in a very elegant manner. That is probably the first new contribution to a Cone quad product since the mid 1990s.

5. WHY A PLUGIN IS NOT NECESSARY

The plugin took a long time to develop for each new printer we supported because it was a third-party printer driver. A wheel had to be reinvented each time a new printer was released. The PiezographyBW ICC profiler on the other hand, is able to do what the plugin driver accomplished as well as much of what my original Cone Methodology accomplished which the plugin could not. Inks can be partitioned, and each ink crossover is precisely handled, and the resolution is effectively increased so as to appear dotless, and black is supported with under ink. Of course each profile will provide a linearization from dMin to dMax with sensitive separations in the hard to print areas of highlights and shadows. These have always been the quality associated with our IRIS systems and then our manual method and of course with PiezographyBW who's users make up this list.

The PiezoBW ICC profiles however offer some new advantages. If a user has experienced printer banding with the plugin and not with the EPSON driver, then they will not be likely to band with the profiles. The ink crossovers in the new ICC profiles are handled much closer to the Cone Methodology of IRIS days. We believe we are building a more mature system as a result. The control now fully in our hands is closer to the "quad" ideal.

The profiles will allow a user in Photoshop 6 or 7 to preview (SoftProof) the paper white color, inks in their true tonal range and color, and the black point in its maximum density and color. That is an enormous improvement to the process. Of course the file is still in single channel grayscale although the preview is full color. So it is still very convenient and efficient.

Finally, there are some advantages to eliminating the plugin in favor of using the "print" command because it opens up a world of software to imagers who print grayscale images. Even the way that Photoshop allows image to paper placement is rather convenient so that their is improvement within Photoshop itself.

Resolution is still effectively increased as it was in the plugin and in the original Cone IRIS quad blacks system. Also, resolution if files is still taken advantage of because of the dither compression. It is still visually dotless. The plugin is not necessary in order to achieve these qualities. The EPSON driver of course can not do it on its own, because EPSON does not give you tools to do this. But it is more than capable with the right tools. The PiezographyBW ICC profiles are our way of giving users the tools to do this, the ability to do this without having to use a Photoshop plugin or a third-party quality printer driver.

6. STATE OF THE ART

We are coalescing our efforts into a standard which we believe is the highest possible quality level. It supports the greatest number of operating systems and software, allows full image previews, dotless linearized prints and is uniquely matched to PiezoTone inks which have the highest performance of any quad ink in the industry.

When EPSON cut us off dev status, they effectively allowed us to produce a system which could be created for any printer they create as long as we can put inks into it. While we are just releasing the 1160 bottle beta this week - we are only a few weeks out now from full release for Canons and 1280s.

You will probably read the first user reports in about 14-21 days.

I am sorry about the delay of this system and that it has only been made available to a few long-term testers and those attending our workshops. But we believe that the extra time we have taken has allowed us to consider ink efficiency and to perfect certain things which users will benefit from.

In the time I took to wrote this the arguments have turned to insults. Please be civil or you get the boot!

---------- may your highlights be dotless and your tonal scale smooth,

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