



## Eliminate Horizontal Banding Defects? Intelligent Interweaving Technology

Advances from Mutoh that Dramatically Eliminate Banding Defects





Front cover photograph: Mutoh Spitfire

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Ten years ago solvent inkjet printers produced primarily billboards and banners; namely signage that was so far away you could not see the defects.

The typical defects were

- Horizontal banding lines all the way across the image
- Heavy dot pattern
- Mottle (what I call splotchy appearance).
- And the reeking carcinogenic odor and VOCs for which full-strength solvent ink is infamous for.

In 2002, eco-solvent inks were introduced. Although the first two generations had infamous issues widely discussed in user-forums in the Internet, the third generation eco-solvent ink that is available since 2006 is popular among end-users. We have interviewed end-users that have experience with the third-generation eco-solvent inks and they accept it as a viable ink choice. As a result the third-generation eco-solvent ink chemistry has been accepted by FLAAR as a viable chemistry that is capable of well documented quality.

Parallel to the development of eco-solvent inks came the evolution of mild-solvent inks (also called lite-solvent inks or low-solvent inks). Mild-solvent inks are less aggressive than full solvent and hence easier to use when legislation prohibits full solvents (or when you want to protect your health). One example of a successful mild-solvent ink would be the Seiko ColorPainter 64S.

For the last ten years FLAAR, an independent research and educational institute, has dedicated itself to the evaluation and reviews primarily of wide-format inkjet printers that are capable of producing high quality images. To be blunt, if a print is good enough quality to hang in a museum exhibit, then this is the quality we are interested in working with.

In the past solvent ink printing machines produced too much banding, splotchiness, and unbearable odor. So our evaluation and FLAAR Reports publication programs were primarily on Epson, Canon, HP and water-based Mimaki, Mutoh, and Roland. Recently we have spent several years covering UV-curable inkjet flatbed printer technology. But for 2007 we are devoting our energies and experience to looking at the new technology and ink chemistries that are evolving in eco-solvent and mild-solvent.

As UV-cured ink chemistry began to offer photo-realistic output, we have spent several years covering UV-curable inkjet flatbed printer technology. But for 2007 we are devoting our energies and experience to looking at the new technology and ink chemistries that are evolving in eco-solvent and mild-solvent. What attracted us to eco- and mild-solvent solutions was a new breakthrough in eco- and mild-solvent wide-format printer technology that happened in the last few months. Mutoh Europe was able to utilize Mutoh Japan's invention and configure its capabilities to additional printers (Spitfire and Rockhopper 3). In early 2007 it was possible to experience this advanced technology, specifically on these two models of printers, at the Belgium headquarters of Mutoh Europe during one entire week at the main factory demo room and adjacent test facilities.



*Mutoh Europe Headquarters 2007*

## This new FLAAR Report on Intelligent Interweaving

For the past ten years horizontal banding has been a perpetual headache for inkjet printers. Roland had significant issues with banding from 2000 through 2003. Their printers have improved since then but banding still pops up. Banding plagues all printer brands and models at one time or another, especially with industrial printheads used in solvent and UV-cured kinds of printing. Why?

Banding can be caused by a many reasons, some of which include:

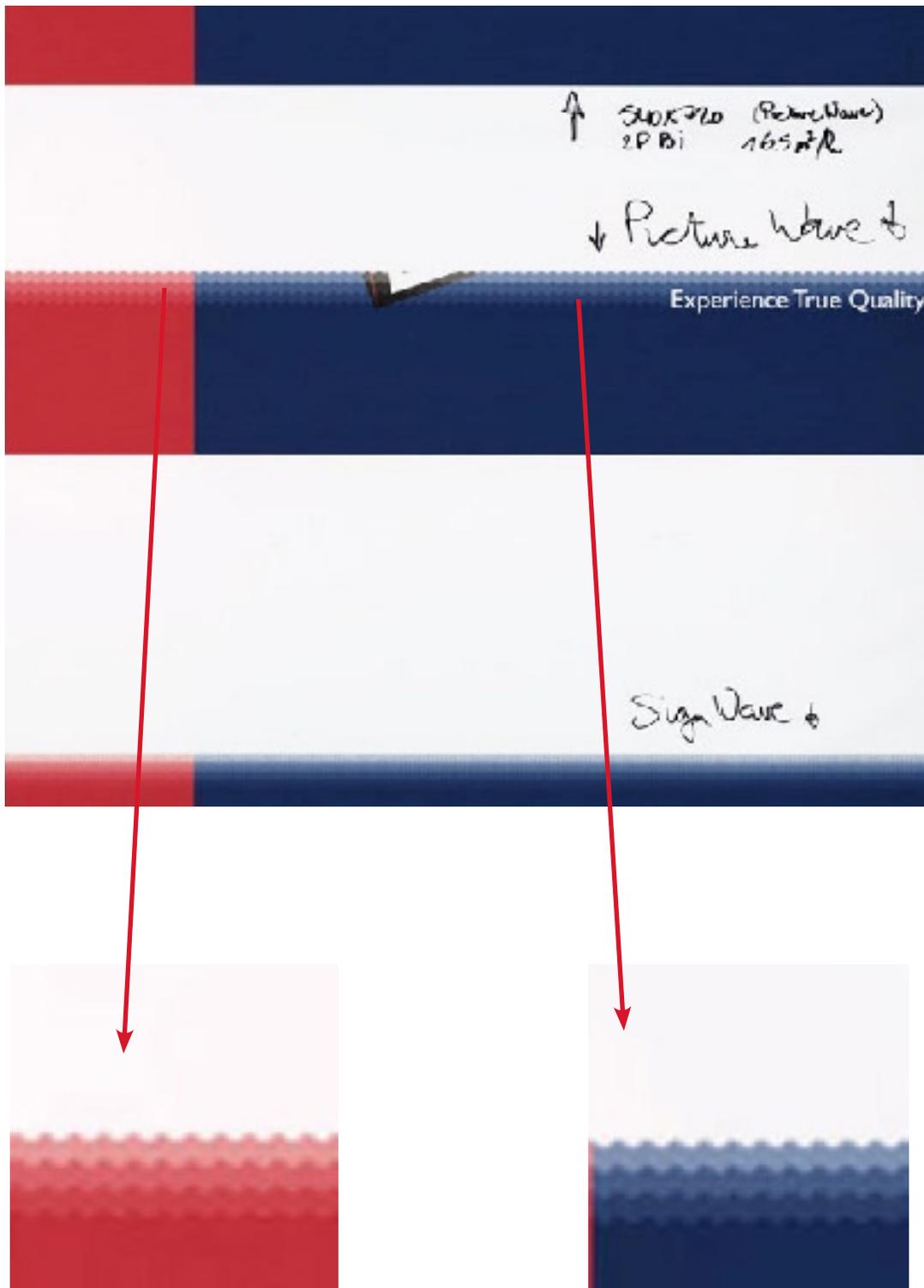
- A blocked nozzle or a nozzle that is otherwise dead
- A deflected nozzle that fires in the wrong angle
- When the ink lines and printhead become contaminated by air
- If the heater(s) are set too high.
- When the media feeds incorrectly.

If the media feeds too fast, it leaves a white line.

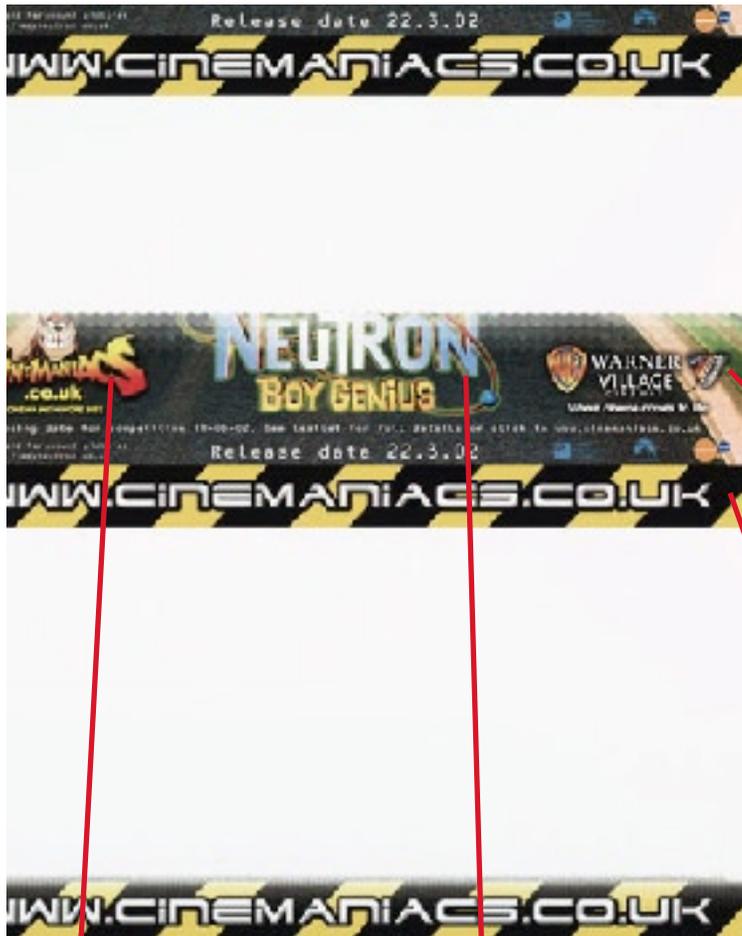
If the media feeds not far enough, then the new printing path overlaps and prints on top of the previous printing path. This leaves a dark line across the print. These banding lines form a regular pattern, so they are painfully evident.



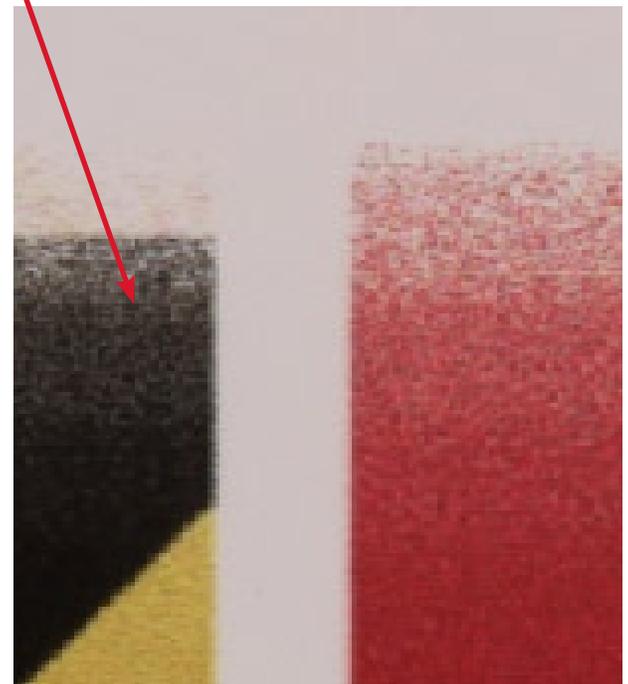
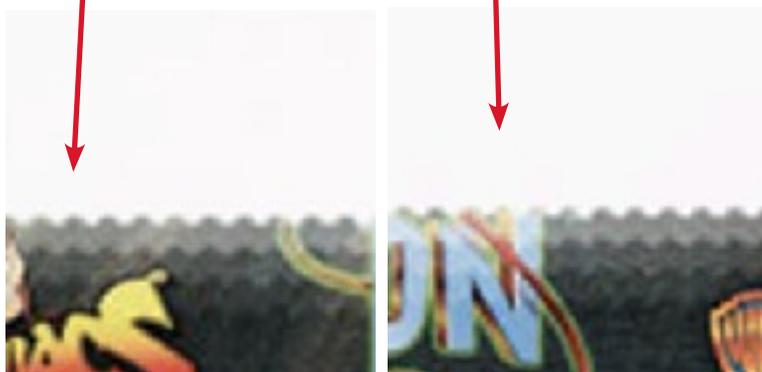
*Banding*



*These are closeups of the Intelligent Interweaving in action. If you are a computer whiz, and a Nobel Prize in software, you could try to figure it out, but we are not ourselves into the business of reverse engineering anything, so for us what counts is that it works, well, and quickly.*

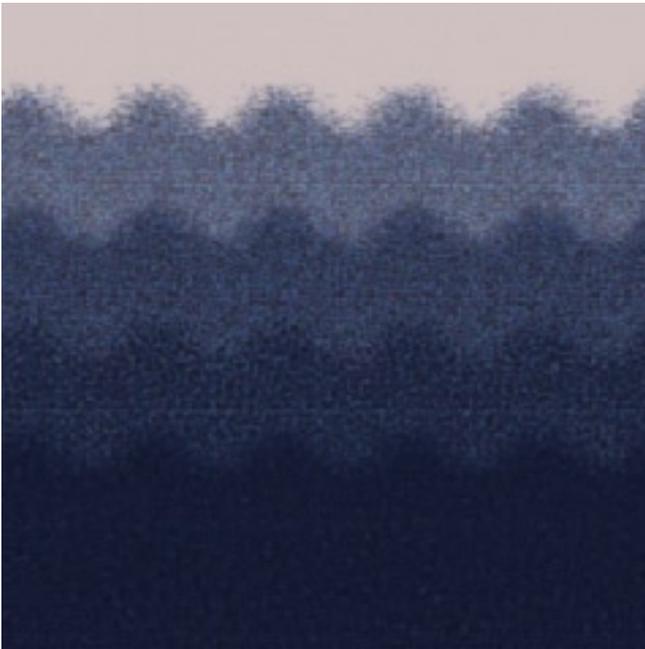


*Intelligent Interweaving option on*



*Intelligent Interweaving option off*

*These are scans taken with our 80-megapixel Cruse reprographic digital camera/scanner.*



*Here are two different forms of the interweaving: wavy and non-wavy.*



*Before*

*The samples of the Mutoh prints were scanned by the \$75,000, 80-megapixel Cruse digital camera, one of the many high-tech features of the FLAAR facilities. Scans at this quality enabled us to see details.*

**Mottle with solvent inks**

Mottle is the splotchy pattern especially on glossy materials (but not limited to smooth vinyl). Mottle is a tell-tale sign that solvent ink is being used (water-based ink does not often mottle and when so not in the same pattern that is common with solvent ink).

Anything that gets rid of mottle and banding is given high marks by FLAAR.

**How do you get rid of these kinds of banding?**

You get rid of clogged nozzles by cleaning them (purging, sucking, wiping, etc).



*Cleaning the Mutoh Spitfire Extreme is simple and fast*

You overcome dead or otherwise defective nozzles by assigning a replacement nozzle. But this is possible primarily with HP, Ricoh, and a few other heads and printer firmware. Gandinnovations has software to replace nozzles-out on their Spectra heads, as but one innovative example. ColorSpan uses a “Buddy nozzle.” But most other printerheads lack a way to bring in a replacement nozzle: there are no replacement or backup nozzles on Epson printheads.

If the banding is caused by improper advance of the media or substrate, then you can dial-in a correction to the media feed rate. This implies that you have the patience to dial in the numbers and do a print test. This also implies that your printer facilitates this correction: Epson 7500 and 9500 printers did not allow the end-user to make this correction.

But to find which of the thousands of tiny nozzles is out, and to try to repair, replace, or overcome them, is time consuming. Not all printer operators are trained how to do this; and most that are trained don’t have or don’t take the time to run the maintenance procedures.

So banding persists; most printer operators ignore it, saying that “no one notices when the banners or billboards are viewed from large distance.

But banding, along with an ugly dot pattern, and mottle, are many of the issues that cry out, “this is an inkjet print and not a continuous tone image produced by a Durst Lambda or an Oce LightJet.”

## Intelligent Interweaving (I<sup>2</sup>), the first solution offered in the Inkjet industry



*At the top, before Intelligent Interweaving is turned on; there are horizontal bands. The lower half (after the scissors), Intelligent Interweaving is turned on, and no more visible banding.*

When I first heard about Intelligent Interweaving I was skeptical. I assumed it was another buzz word. For years Encad had invented cover words, such as “Intelligent Mask Technology” to obscure the fact that it’s Lexmark printheads were something special (Lexmark are the worst thermal printheads ever made, if you compare them with more advanced Canon and HP heads of the same time). Apple Computer conjured up cover words for its Motorola chips to try hard to make them sound better than Intel chips.

You only found out the subterfuge when Apple switched from G4 to G5 and the ads for the G5 told you all the advances over the G4. Why in the era of the G4 did no one tell you all the features that were missing? Then Apple simply switched to Intel chips, without admitting that the former Macintosh chips (from IBM by then) simply were inadequate.

It’s the same in the inkjet world: most inkjet printer manufacturers make up utter nonsense to describe some imaginary benefit that is usually smoke-and-mirrors.

So please understand why I assumed that Intelligent Interweaving was fluff-and-puff, and invented solely to distract the potential buyer from a printer’s deficiency. Remember, all these silly advertising slogans are to keep you from noticing that the product is slow or merely average.

So the first thing I did was to check around, and ask other people. I was told that the Intelligent Interweaving was actually a viable technology. So I accepted the invitation by Mutoh to visit their factory, their headquarters demo rooms and training facilities in Oostende, Belgium.

Once I was inside the factory, and saw the care and effort put into manufacturing the machines, I realized they did not need smoke and mirrors. These printers are professionally designed and precision engineered: this is not cheap low-bid off-brand printers. These are not what you get resulting from Made-in-China factories.

Once I saw the end-results of the printers output I realized that Mutoh did not need to hide anything by inventing nonsensical PR blather. The Mutoh Spitfire Extreme, the Rockhopper 3 Extreme, and the Mutoh ValueJet are each capable of printing true photographic quality: I call it “exhibit quality,” meaning worthy of being exhibited in a museum. One factor in producing this exhibit quality is the combination of Intelligent Interweaving technology to the firmware that controls the placement and sequence timing of the placement of the multiple droplet sizes from the advanced piezo printheads.



*Mutoh Spitfire Extreme*



*Mutoh Rockhopper 3 Extreme*



*Mutoh ValueJet*

**Testing I<sup>2</sup>**

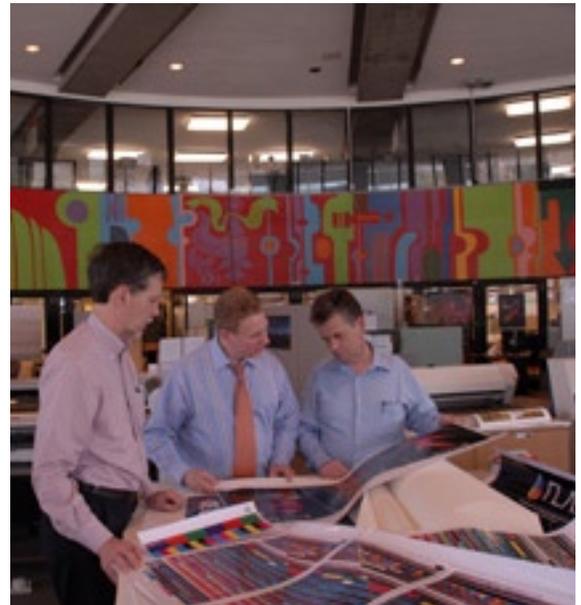
Until it becomes possible to have a Mutoh printer with I<sup>2</sup> at our FLAAR facilities, the most practical place to evaluate this new technology is at Mutoh Europe headquarters in Oostende, Belgium.

The process also involved evaluating the Mutoh Spitfire Extreme printers and also the Mutoh Rockhopper 3 Extreme printers, so that occupied much of the week, as did two lengthy factory visits (inside every part of the factory, see the separate FLAAR Report on the factory).

Once I saw the test prints It turned out that the results were better than I expected, so much so that when the former FLAAR manager visited Oostende that week, I asked if two framable fine art photographs of mine could be printed for her (she worked with FLAAR precisely during the years when we began to evaluate wide format inkjet printers in general and printing fine art giclee in particular). She assisted in the evaluations of our Encad NovaJet Pro 36 in the US office and with an HP Designjet 2800cp in Germany. In those years (1997-2001) no solvent printer was capable of true photographic output.



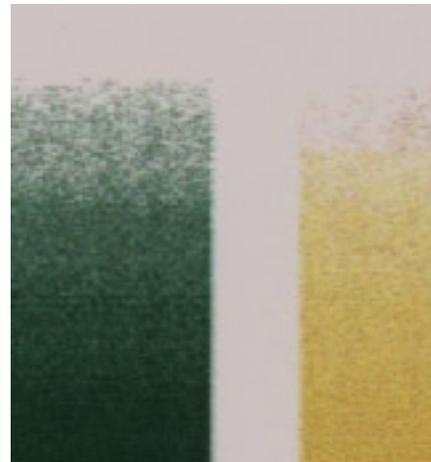
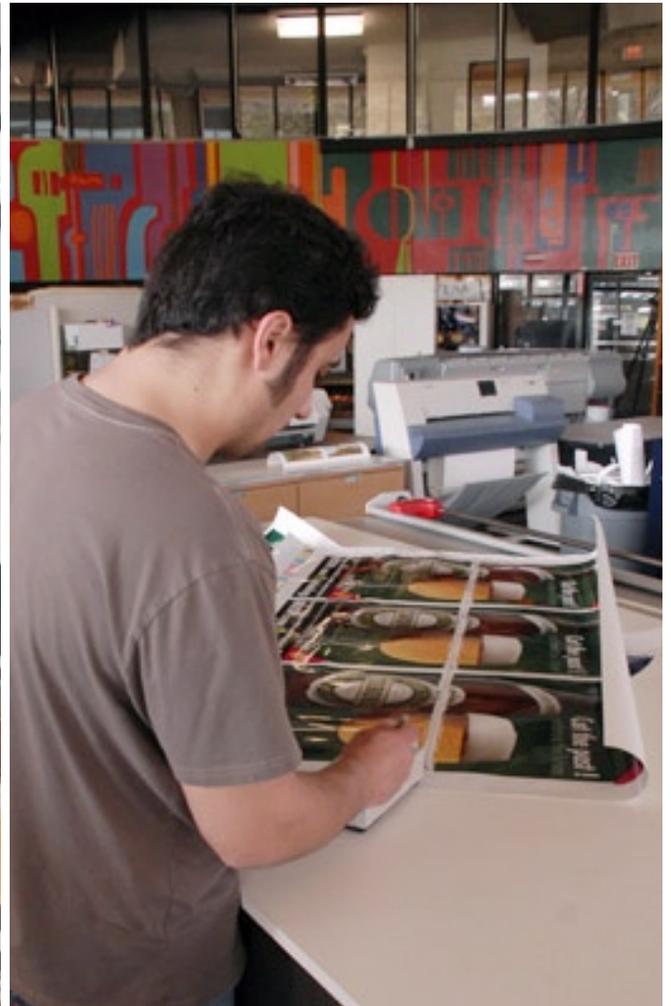
Yet now, in 2007, with Intelligent Interweaving, it was possible with eco-solvent and mild-solvent inks to produce museum quality giclee printers with images taken with a 30 MB PhaseOne digital camera system.



*William Birkett, Print Quality Consultant of Doppleganger LLC (center on first picture) and Professor Charles Spontelli of BGSU (College of Technology, VCT), viewing the samples showing Mutoh’s Intelligent Interweaving. Dr Nicholas Hellmuth, FLAAR at BGSU, had these test samples sent from the Mutoh Europe factory demo room in Oostende, Belgium. These are some of the samples printed during Hellmuth’s one week study of Intelligent Interweaving on the Mutoh Spitfire Extreme (mild-solvent inks) and Mutoh Rockhopper 3 Extreme (eco-solvent inks).*



*Bill Birkett, who specializes in press room calibration, production workflow (including wide-format inkjet printers and offset presses), and color management, said he felt the results were excellent, and that the dpi looked equivalent to 1400 dpi (these were 720 dpi prints using Intelligent Interweaving). He expressed interest in learning more about this technology.*



*In the FLAAR+BGSU lab, using the QEA instrument, and 80-megapixel scan from the Cruse, you can see the weaving pattern at the left, and the other pattern at the right. One pattern is for “pictures” (the waves); the other pattern is for large areas of dark colors (“signs”). Please understand, this is a cross-section of a deliberately unfinished weave, to reveal the pattern before it is finished. The purpose is to show that there are two forms of the pattern.*



*Portion of the black background scanned by the 80-megapixel Cruse digital camera*

*The photo of the purple heliconia flowers on a solid black background would tend to show banding defects on almost every printer, whether an HP Designjet 5500, an Epson 7800, or most solvent printers. Here the print was done with Intelligent Interweaving on a Mutoh eco- or mild-solvent printer at Oostende demo center. Using a \$10,000 QEA inkjet dot analysis instrument, Armen records that the image has no banding. I could not see any banding on the print with my eye, but figured we could spot banding if we looked at it microscopically:sorry, no banding.*



*Does that mean banding has disappeared? Well, if your printer is not properly maintained, if jets are out, deflected, or otherwise not firing properly, if you try to use the wrong media, inappropriate temperature, or try to use steroids to print too fast, you can probably get banding no matter what. But with Intelligent Interweaving technology, you can escape most banding, as you clearly see here.*

## Currently two generations of Intelligent Interweaving

If I understand correctly, I<sup>2</sup> has initially been developed by Mutoh Japan. The evaluation by FLAAR, since it took place at Mutoh Europe, was based on Intelligent Interweaving specifically tuned for the Spitfire Extreme and Rockhopper 3 Extreme.

## Increased User Friendliness

Printer operators don't have so many decisions to make if they understand Intelligent Interweaving. So tech support does not have to explain complex options.

With my car, I can select HI 4WD or L4WD or regular D (two wheel drive). As an operator of my car, I don't have time, patience, or understanding of gear ratios and drive shafts to select 32 different options. If I am crossing a creek in Missouri, on the typical unpaved roads there, I may prefer HI 4WD because you don't want to drive too slowly or you will sink in the sand or loose gravel.

If I am driving up a steep Ozark hill, with lots of large rocks exposed, I don't want High 4WD because the vehicle can't take that many jolts. I would select Low 4WD (two wheel drive won't get me up the hill without burning rubber off my tires).

It's comparable with an inkjet printer: you can set the drive shaft and gear ratios if you wish to get into this depth of patient understanding. But if you want to print while you are attending to customers and running other machines in your shop simultaneously, it's a lot easier to let the Mutoh software engineering department provide you with easy options: set viewing distance, set whether this particular image is a Sign (where you need print quality to overcome banding on dark areas) or Picture (where you can produce your photographic or busy pictures faster).

## Summary

The idea with I<sup>2</sup> is to achieve faster printing with better quality simultaneously. The intent is to make it easier for printshop operators to consistently create acceptable output for their clients by simply telling the software interface whether the output is a picture or a sign, and what viewing distance the client or viewer will be seeing the output at in the real world. Ease of use is crucial especially in the American market where printer operators (at places like Kinkos) may be high school students or first-year college students. And the changeover in employees is high in the US, so not many companies have incentive to invest in training their operators more than the basics.

Recently our Epson printer had a spasm of banding defects. The people coming to the university printshop politely but firmly said they needed images with no banding. No Epson has I<sup>2</sup> technology, so we had to tweak everything by hand (media advance rate, for example). Intelligent Interweaving makes it easier to consistently produce a level of quality that your client will appreciate.

We could go on all day, page after page, with geek-speak about I<sup>2</sup>. But I am not a computer software geek (no patience). All I want is a usable image of quality that makes me proud and the client happy. I need such a print that won't fade too quickly in the sun (especially not in tropical Guatemala). I did not believe any eco-solvent ad in 2002, I was still skeptical in 2004 (because too many people told us their headaches).

Now at last I have found a product that meets my personal and professional expectations. The next step is to do a site-visit case study to learn how end-users find this technology. But for me, it's more than I expected.

That's a compliment because I am a fine art photographer and many of my exhibits are in museums. They won't accept banding or excessive mottle.

## Conclusion

During ISA 2007, the owner of a successful printshop went with me from booth to booth. I took him to many displays, including the Mutoh booth and the Océ booth (where the Mutoh printers are rebranded as Océ). The Océ people handed him a sample print with eco-solvent ink. Frankly the quality was unexpected for him. It was a sample of a map, with precise text down to at least 6 pt and some text looked like it was probably 4 pt (and still legible).

Five years ago even on a \$400,000 solvent printer you could not achieve this quality. And the Mutoh or Océ printer costs less than \$40,000 today.

## Bibliography

75% of what is on the Internet is either a direct repeat of corporate PR or simply the PR release reworded. The other 25% are either Success Stories, sort of formula-like PR releases, or PR-like comments in trade magazines. So I have not yet found any outside reports.

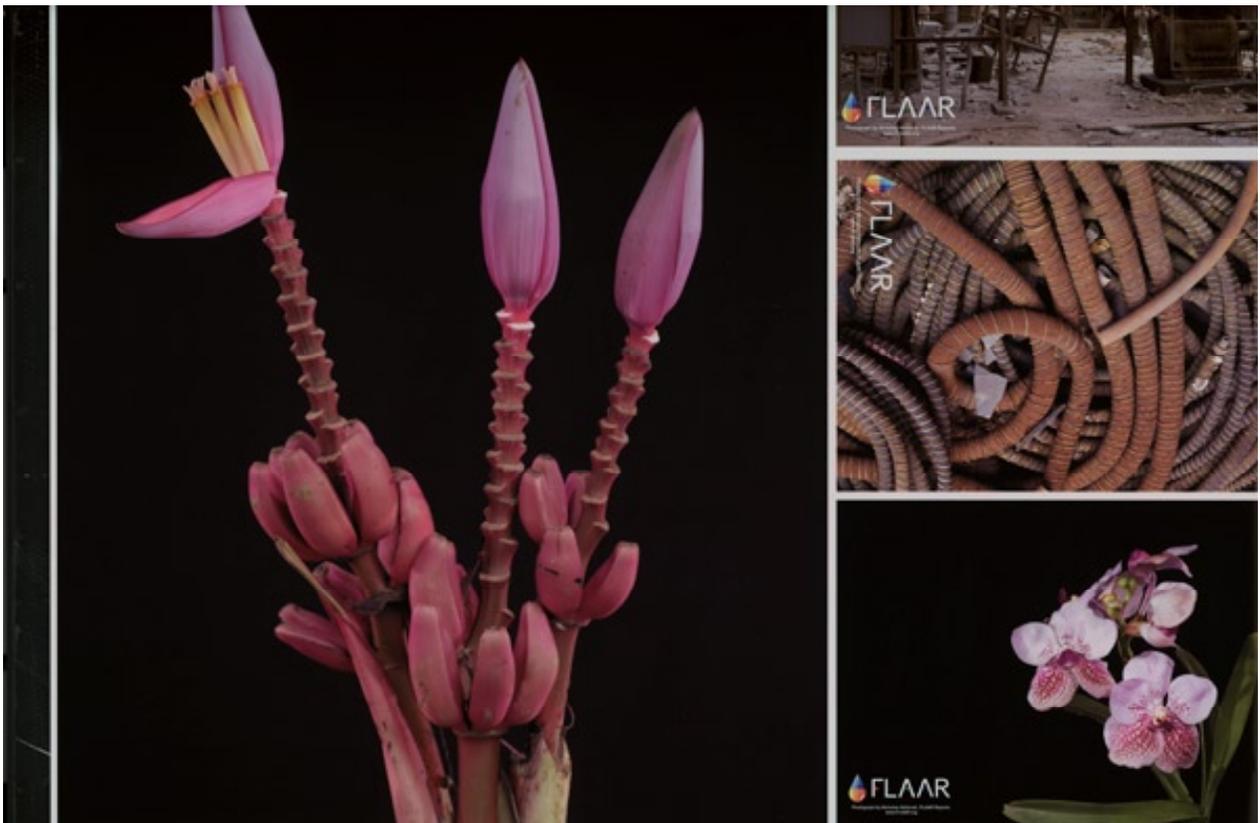
***Most recently updated June 22, 2007***

***First posted April 2007***



*These photographs, taken with a \$32,000 digital camera, would normally be printed on a fine art giclee printer. But the Mutoh Spitfire Extreme did a capable job of rendering these images at outstanding quality.*

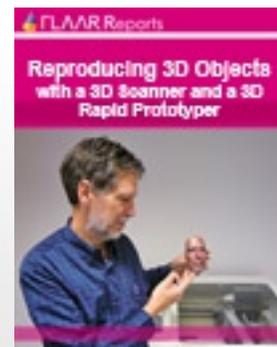
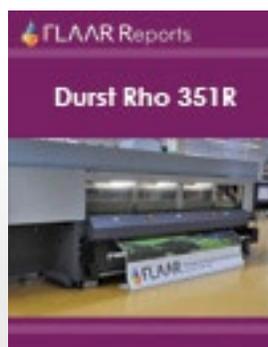
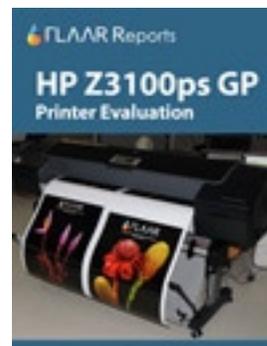
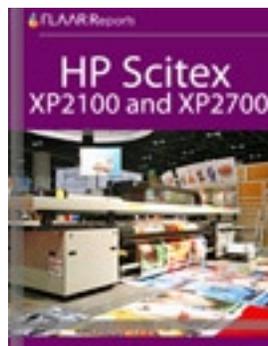
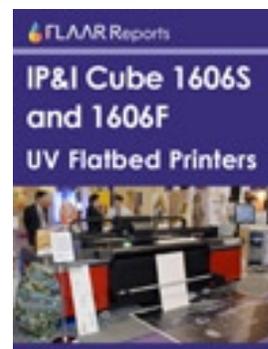
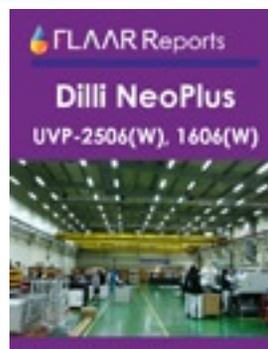
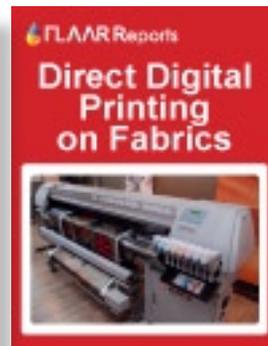
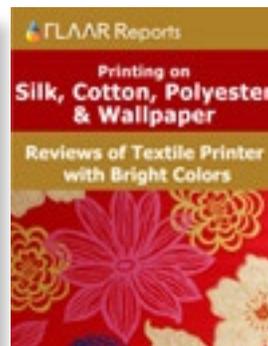
*Look at these blacks: pure black, with no ugly banding defects.*



Free Sample Publications

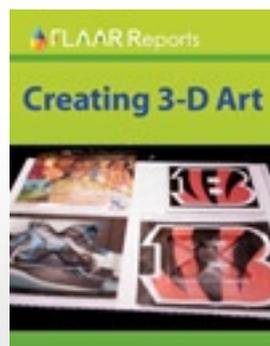
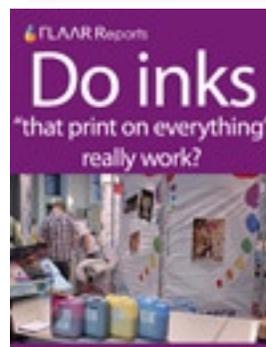
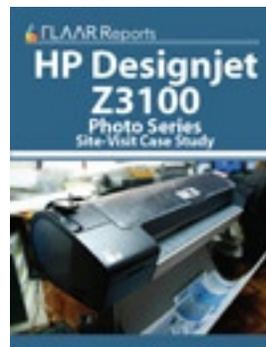
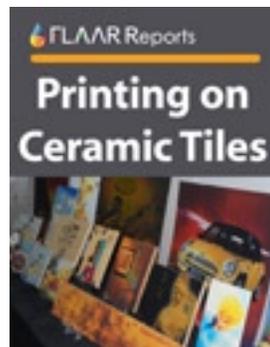
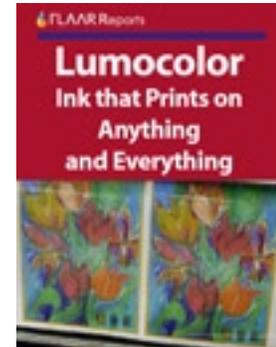
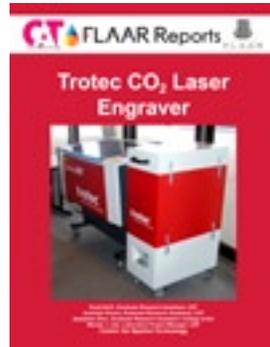
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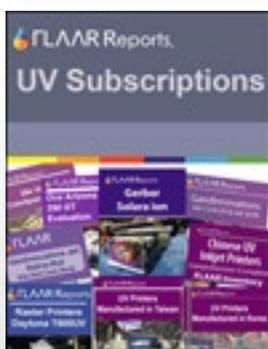
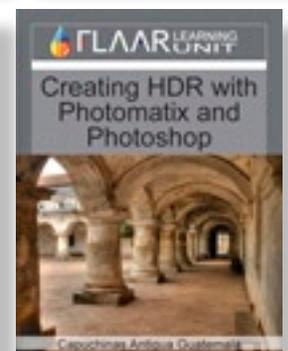
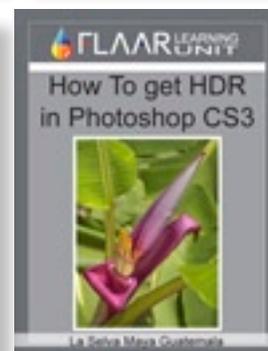
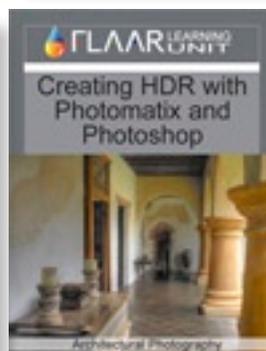
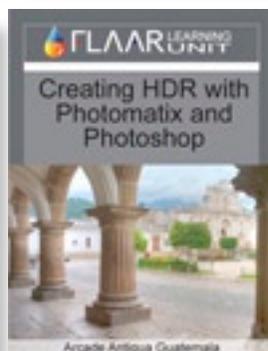
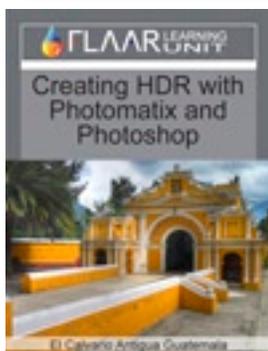
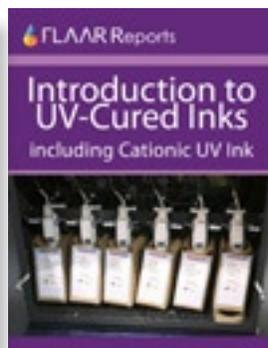
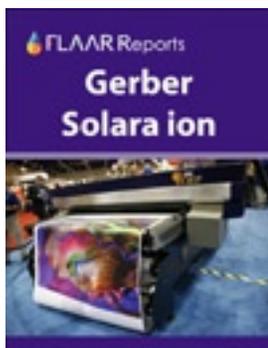
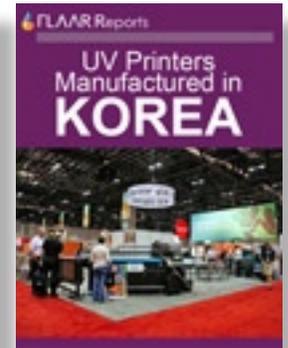
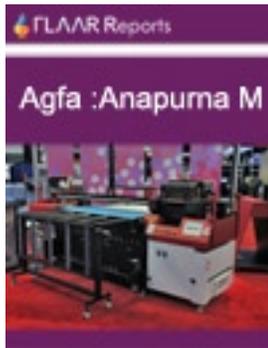
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Each month Dr Nicholas Hellmuth travels around the world to investigate and learn more about the new technology.

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