

HOW TO PRINT ON GLASS WITH WIDE-FORMAT INKJET PRINTERS UV-CURED FLATBED PRINTERS



Glass Workflow Reality Check



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Glass Workflow Reality Check

90% of the brochures for flatbed UV-curing inkjet printers list glass as a suitable material for their printers to print onto.

Yet in reality, I doubt if many of these printers can actually handle glass accurately. I would be surprised if many of these companies really know the workflow for handling digital printing of glass.

The analogy would be with printers for textiles. For the last eleven years, there have been lectures, workshops, and PR releases promising that printing on textiles would be a billion-dollar business. One person essentially gives the same lecture every conference, every year.

But in reality I doubt if even half of the predicted boom actually happened.

Why is there so much hype on textile printing? Why is there so many claims that “our printer can handle printing on glass”?

To learn the reality of printing on textiles I have spoken with the leading manufacturers of textile inks and of specialized printers for textiles. In other words, I have factual data from the real world. I also speak with end-users (print shop owners, managers, and printer operators).

The same with printing on glass: I have visited the manufacturing plants and demo rooms of more than 25% of all the UV-curable flatbed printer manufacturers around the world, including long term discussions with WP Digital, EFI VUTEK, Durst, and Sky AirShip. SkyAir Ship is the #1 seller of flatbed UV printers within China and also sells their printers around the world, specifically for glass.



Samples printed on glass by the SkyJet GlassMaster UV flatbed printer. SkyJet factory visit China, 2009.

I would rate Durst, WP Digital and VUTEk as experienced in glass printing at the high end and SkyAir Ship at entry-level for glass printing. I would estimate that other UV printer manufacturers are gradually gaining experience with glass printing, but the brands mentioned here already have a proven track record. This particular report is based on a site-visit case study in Vietnam in early 2010, plus a visit to a glass printing company in Seoul, Korea, in late 2009. I will have other site-visit case studies as access to additional glass printing locations becomes available.

Work flow: for printing on glass

The glaring issue with printing on glass is that not many printer manufacturers dare to mention the real facts of the workflow in their sales brochures (this is why FLAAR Reports are successful).

It is the same with printing on fabrics other than polyester: there is a complex workflow before and after printing. Not many people want to admit all the steps that are necessary since they want to sell primarily the printer (and sell the workflow equipment later!).

Plus, the workflow is different depending on what you or the client wish out of the final product. If you are printing on glass for a trade show exhibit most UV printer companies use no primer, no heat treatment before and no heat treatment after printing.

Heating after printing

I visited one place in Korea that heated the glass after printing. They used a special oven made for this. Yet in sign and digital trade shows, every booth exhibits prints on glass that have never seen an oven, neither before printing nor after. And I bet half the glass samples at trade shows are not even with a primer.



Oven used to heat glass after being printed on with a UV printer at a sign business in Seoul, Korea. At right you see the rack to put several pieces at the same time.

Don't waste your time with a hybrid flatbed

If you need to print on glass often then the worst kind of UV printer to consider is a hybrid flatbed.

A hybrid flatbed moves materials with pinch rollers atop grit rollers. The ColorSpan 5440uv was a hybrid (subsequently reborn as the HP Designjet 45500).

It is worth pointing out that even Chinese manufacturers have realized that a hybrid UV printer is not a realistic design. At the recent Dongguan printer trade show in China, of the dozens and dozens of UV printers exhibited, there was only one single hybrid. More than 75% of the UV printers exhibited there in 2010 were dedicated flatbeds. This is the kind of printer that can handle glass best.

The ColorSpan acrylic and glass printing guide warned that the grit rollers could possibly scratch the under surface of the material you were printing on. This is another reason not to attempt to use a hybrid style printer for glass or acrylic.



Teckwin TeckSmart at GOA, 2010. The system of pinch rollers is what characterizes a hybrid printer. These types of printers handle rigid media up to a few millimeters thick. This feeding mechanism is not adequate if you need to print small pieces of media such as tiles, because the pressure of pinch rollers is not enough to keep the substrate from skewing.

Be wary of using a moving transport belt

A moving transport belt can move glass through the system, but you should expect skew. And I would not try to do serious production of large plates of glass on a moving transport belt unless the printer was a Durst Rho, WP Digital Virtu or VUTEK. You would have too much potential for skew on a moving transport belt of most entry-level or mid-range transport belt system. And no matter what brand, you need to test for skew by testing with large heavy materials. Most demo room tests are with foam-core or smaller objects; these will not reveal how much a transport belt skews. And, a transport belt may skew more once it is used and abused over time.

Is glass printing impossible on a moving transport belt printer? No, you can do okay, but if glass is the specialty of your company you really need a dedicated flatbed. The WP Digital Virtu RS 25 and RS 35 has a moving transport belt but you can put the belt in a dedicated flatbed mode. In this mode the belt does not move and the printhead carriage moves in both X and Y directions as though the printer were a dedicated flatbed. No other combo printer has such a dedicated flatbed mode.

But even a dedicated flatbed may have skew

It is logical to assume there is no skew with a dedicated flatbed. But in fact there is: the gantry skews in its movement relative to the fixed table. The table does not move (on most flatbeds); so the material does not move. But the gantry moves under the control of two SEPARATE positions: one for the right end of the gantry, the other for the left end of the gantry.

So if you are printing on a glass door that is 2 meters long, by the time the gantry has moved two meters it could have skewed a few millimeters. Once you recognize this, you have to adjust the glass to accommodate for the skew (or buy a \$300,000 flatbed that may not have skew).

I would expand upon his experience: give the printer operator your own file, of a metric grid, the entire size of the bed. See if the printed image is still rectangular by the time the printhead gantry reaches the end of the image. The thing you are looking for is “dedicated flatbed gantry skew on one or more sides.” If the gantry was damaged during shipment or if the gantry was installed a few millimeters off axis it will skew the image. Or if there is only one motor, or even two motors but not adequately synchronized, you will get skew. Yes, even if the material you are printing is not moving one iota, the gantry may move unparallel to the bed. You would see this by printing a grid.

And bring your own grid and do not ask the demo room to print in advance. You want to see the printer doing this test yourself.

There are two or three flatbed printer manufacturers who are long aware of this skewing situation and they design special controls into their printers. First, they have two separate advance motors: one for each side of the gantry. Second, they have a method of adjusting advance of each side of the gantry to maintain it parallel.

Another cause of skew-like error in your image would be if the printhead carriage is not adequately aligned relative to where it stops and starts. But no matter what causes the error, you will only notice it if you print a full-bed-size rectangular image with a grid and see if the grid falls off one edge of the board and is at a slight angle to the other edge.

If you are printing glass panels whose decorations need to line up with each other, if you have skew the printed image in your PDF or TIF file will not be aligned and when the two panels are installed as a door or wall section, the images will be askew relative to each other.

Fortunately, if you are clever, if you have an economical flatbed that has a bit of skew, you simply align your glass sheets to where you know the skew will happen and you can jerry-rig the alignment in some cases.



Glass comes in all sizes and many thicknesses. Thick glass is heavy and not easy to handle until you have experience. So be sure your printer has the ability to handle thick heavy glass.

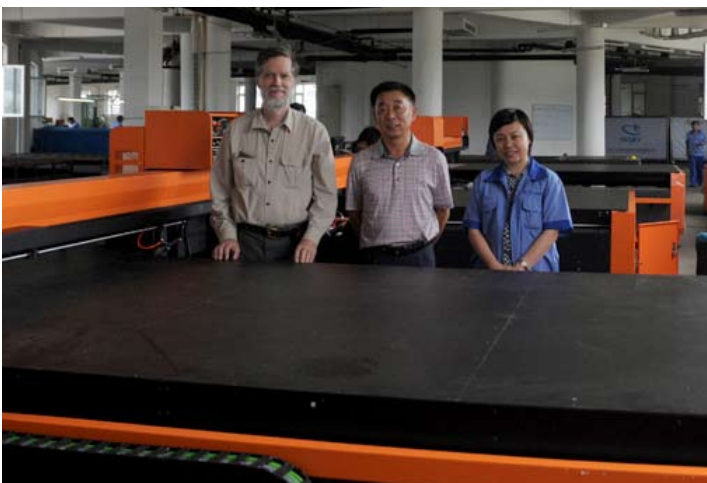
Be sure the flatbed printer you select has features for handling glass

- Glass is heavy.
- Glass is fragile
- Glass can cut you on its sharp edge.

So moving glass onto, and off of, a dedicated flatbed needs to be understood.

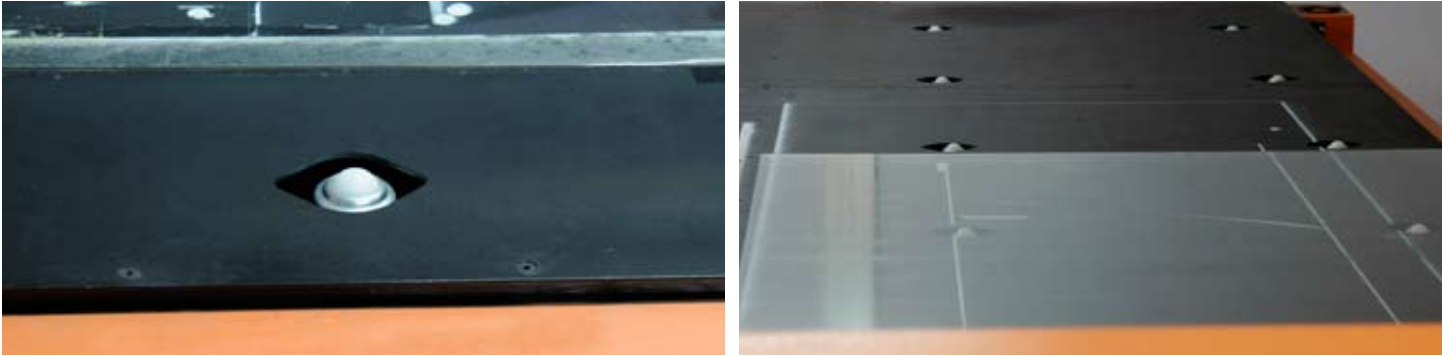
In the ten years that I have been evaluating UV-cured printers, the first time I noticed a flatbed that was specially adapted to handling glass was when I visited the factory of SkyAir Ship in China. There I saw a special adaptation of their flatbed with glass-lifting system. Actually it provides two features.

Rollers so you can easily and effortlessly move the glass across the surface to align it, and the same rollers lift up so you can get your fingers under the glass to lift it up (or set it down).



2009, factory visit to SkyAir Ship, allowed me to learn that they add features to their printers to accommodate glass.

If I was printing glass every week, I would not consider any flatbed printer unless it had such a glass accessory as the SkyAir Ship flatbed. Indeed I suggested they call their model the GlassMaster.



This is one of the units that can be lifted to handle the glass.

If you wish to learn more:

Shenyang **SkyAir-Ship** Digital Printing Equipment Co., Ltd. is the leader of glass printing flatbeds at entry-level. Although their printers are available for all traditional applications they specialize in printing on glass.

#5, A-2, No. 3 Street, Shenyang Economy & Technology Development Zone

Tel: 0086-(0)24-25813966

86-24-25370188-8023

86-24-25370199-8023

Fax: 0086-(0)24-25901127

Easiest way to get information is to ask their sales person, Mark Ma, skyjetsupport@hotmail.com



Here you can see the size and thickness of the kind of glass that is needed for serious office and home decoration. Thien Minh Phat Glass Style Corp.

Be wary of white ink performance

If you will be printing a lot of glass, or Plexiglas or acrylic (or backlit film) you will need (and want) white ink. In theory you can survive without white ink: you can spray paint the white, you can laminate with a layer of white material, or you can top coat (flood coat) with a coating machine. Each has advantages, and disadvantages. But here I will discuss white ink from your own printer's printheads.

I once visited a printshop in Canada. He had a nice expensive Durst Rho 600 printers Durst is one of my favorite brands; I have been to their factories five times (three times to Brixen, twice to Lienz).

The printing company owner said that he had totally given up on attempting to use the spot varnish (this was three years ago, hopefully the varnish option is better today). But what surprised me is that he said the white ink, on a Durst Rho, did not function as well as he had assumed. Today, in 2010, I would expect white ink would work acceptably on any new model Durst Rho (indeed this printshop went on to buy a newer Durst Rho a subsequent year), but it is important to make the point: that learning to handle white ink takes years of experience. Durst, WP Digital and other companies have this experience today. But if a printer company only began offering white ink recently, don't expect its performance to be flawless.

This is why I would be inherently skeptical of the performance of white ink on a low-cost flatbed printer. The issues can be either

- The sequence of printing white ink may require two print runs.
- The white ink itself has chemical issues (pigments settle)
- The delivery system on the printer may be inadequate for the white ink
- The printhead nozzles may be too small. This is why several printers have attempted to use one model of printhead for CMYK and a separate printhead with larger nozzles for white ink.
- Your printer may not have enough printheads of any size or shape. Some entry-level printers offer only one printhead for white: to get adequate saturation you generally need twice as many printheads for white as you do for any other color.
- There may be fluctuation within the ink pumps, nozzle pressure or other causes of uneven jetting of the white ink. The result will be banding of the white area. Banding is more visible on white ink on glass than on normal signage since most glass has lighting from both the front and back.

How do you know if your printer can jet white okay?

John Vu is the specialist in glass printing who deserves credit for this observation: "do not accept samples printed on small size samples. Any printer can do well on a 1 x 1 meter sample. The only way to find out if a printer really functions is to have it print one image the entire size of the whole bed."

The second way to learn if a printer can jet white okay is to visit an end-user who has had the printer preferably at least six months and for sure at least three months. Ask them what issues they have had with white ink.

For white on glass, a “coater” is probably better than a “printer”

When you go to a wide-format trade show and ask around about printing white you get two different kinds of stories. If the person you are speaking with does not need to sell a specific printer brand, they will gently warn you that white ink per se and white inkjet printing in particular may be iffy. To be blunt, jetting white ink with an inkjet printhead may vary from constantly flawed to occasionally acceptable. And in many instances to have acceptable jetting your printer would need an absolutely professional and sophisticated system.

Increasingly people in the industry are suggesting that it is fruitless to attempt to jet white ink consistently in most inkjet printers. It may be more realistic to simply have an in-line top-coating machine and lay down a flood coat of white and get it over with. There are several brands of coater; the one I know the best is from Drytac. These come in several sizes. The same machine can also lay down primer (pre-coating) onto aluminum, glass, and ceramic tiles.



Drytac VersaCoater XL UV at ISA, 2010.

Recognize the difference between an “export model” and a “local model”

Most Chinese manufacturers produce two or more different versions of each model. The “export model” has some European parts, such as motors and pumps. The model for local use has almost entirely Chinese-made parts. Naturally the price difference is considerable.

When a printshop owner is at a trade show they like the sound of the price for the local model, and they like the spec sheet for the export model. It is not surprising that they expect the lower price but with the European motors and Japanese components. But you “get what you pay for.” So if you drive a hard bargain and get a low price, be realistic and understand that not all the components will be Japanese, German or even from Taiwan or Korea.

Summary: Solution to some of the issues

When you are out shopping for a printer you will be shown small samples; the kind you can take home in your suitcase or even your carry-on bag. But no sample this size will reveal skew nor will a small sample reveal other potential issues such as banding in the white flood coat.

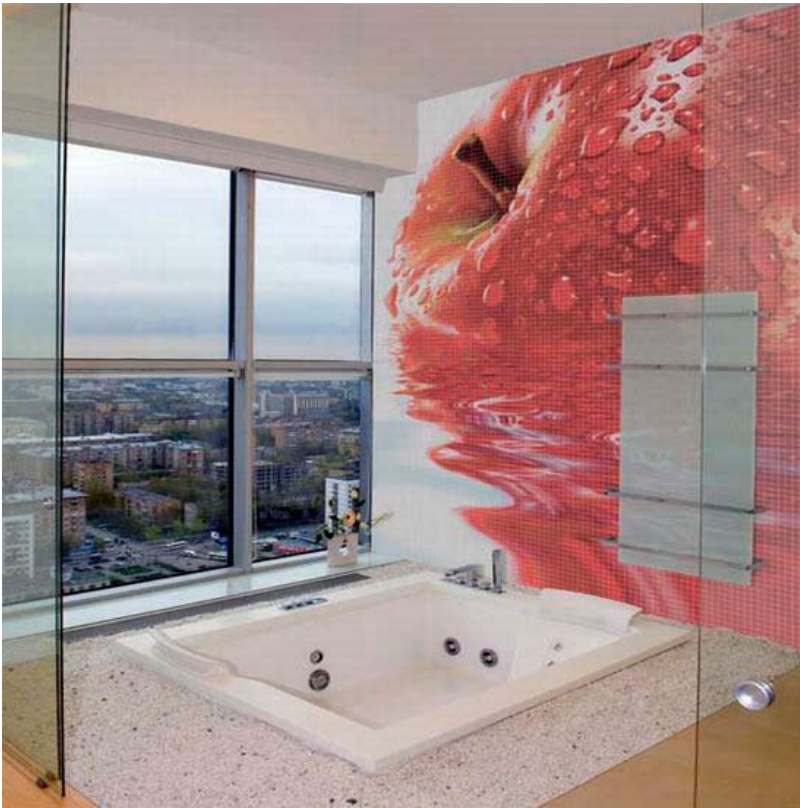
You need to visit the demo room, either of the manufacturer’s factory or of the appropriate distributor. There you need to have an entire bed printed. If your printer has a 2x3 meter bed, then print one single job that is 2x3 meters (not just a bunch of small jobs).

And as one of your test files, print a grid, with 1 cm squares. See if the grid is square from one end to the other.

Summary

It is potentially misleading advertising for spec sheets and brochures on UV-cured flatbed printers to list printing on glass since in most cases these brands of printers either can’t handle glass (if they are a hybrid or combo moving transport belt) or if they are flatbeds the company does not have a glass printing engineer, chemist, or team dedicated to researching glass printing. The other issue of printing on glass is the need for either flawless white ink printing (which is seldom achievable) or facing reality and obtaining an in-line white color coating machine.

Durst has glass printing experience. WP Digital has a team for glass printing, and SkyAir Ship has scores of their flatbeds printing glass all over China and nearby countries in Asia (such as Vietnam, where I inspected one of their models).



If you wish to import decorated glass from Vietnam, the Thien Minh Phat Glass Style Corp. exports glass to many countries. Contact is John Vu thienminh_printing@hotmail.com



New application of SKYJET GlassMaster samples, photos by John Vu. These are some images that were printed on glass mosaic tiles which were prepared for a bathroom. The company imports Mosaic Glass tile "Raw material" without painted back, then we put it into preparation and printing with UV inks. After that we glue the net on, so we glue on wall. It is so wonderful glass!!!

Reality Check

Being a university professor for many years does not mean we know everything. But intellectual curiosity often leads us to enter areas that are new to us. So we do not shirk from entering areas where we are obviously not yet expert. In your years of wide format printing experience have encountered results different than ours, please let us know at ReaderService@FLAAR.org. We do not mind eating crow, though so far it is primarily a different philosophy we practice, because since we are not dependent on sales commissions we can openly list the glitches and defects of those printers that have an occasional problem.

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There is a free PDF that describes the UV-curable inkjet printer Subscription system. Subscriptions are available only for UV-related wide-format printer publications.

FLAAR Reports on UV-curable roll-to-roll, flatbed, hybrid, and combo printers are updated when new information is available. We tend to update the reports on new printers, on printers that readers ask about the most, and on printers where access is facilitated (such as factory visits, demo-room visits, etc).

Reports on obsolete printers, discontinued printers, or printers that not enough people ask about, tend not to be updated.

FLAAR still publishes individual reports on solvent printers, and on giclee printers, but subscriptions on these are not yet available; these FLAAR Reports on solvent, eco-solvent, and water-based wide format printers have to be purchased one by one.

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Legal notice

Inclusion in this study by itself in no way endorses any printer, media, ink, RIP or other digital imaging hardware or software. Equally, exclusion from this study in no way is intended to discredit any printer.

Advisory

We do our best to obtain information which we consider reliable. But with hundreds of makes and models of printers, and sometimes when information about them is sparse, or conflicting, we can only work with what we have available. Thus you should be sure to rely also on your own research, especially asking around. Find another trustworthy end-user of the same make and model you need to know about. Do not make a decision solely on the basis of a FLAAR report because your situation may be totally different than ours. Or we may not have known about, and hence not written about, one aspect or another which is crucial before you reach your decision.

The sources and resources we may list are those we happen to have read. There may be other web pages or resources that we missed. For those pages we do list, we have no realistic way to verify the veracity of all their content. Use your own common sense plus a grain of salt for those pages which are really just PR releases or outright ads.

We are quite content with the majority of the specific printers, RIPs, media, and inks we have in the FLAAR facilities. We would obviously never ask for hardware, software, or consumables that we knew in advance would not be good. However even for us, a product which looks good at a trade show, sounds good in the ad literature, and works fine for the first few weeks, may subsequently turn out to be a lemon.

Or the product may indeed have a glitch but one that is so benign for us, or maybe we have long ago gotten used to it and have a work-around. And not all glitches manifest themselves in all situations, so our evaluator may not have been sufficiently affected that he or she made an issue of any particular situation. Yet such a glitch that we don't emphasize may turn out to be adverse for your different or special application needs.

Equally often, what at first might be blamed on a bad product, often turns out to be a need of more operator experience and training. More often than not, after learning more about the product it becomes possible to produce what it was intended to produce. For this reason it is crucial for the FLAAR team and their university colleagues to interact

with the manufacturer's training center and technicians, so we know more about a hardware or software. Our evaluations go through a process of acquiring documentation from a wide range of resources and these naturally include the manufacturer itself. Obviously we take their viewpoints with a grain of salt but often we learn tips that are worthy of being passed along.

FLAAR has no way of testing 400+ specifications of any printer, much less the over 101 different UV printers from more than 46 manufacturers. Same with hundreds of solvent printers and dozens of water-based printers. We observe as best we can, but we cannot take each printer apart to inspect each feature. And for UV printers, these are too expensive to move into our own facilities for long-range testing, so we do as best as is possible under the circumstances. And when a deficiency does become apparent, usually from word-of-mouth or from an end-user, it may take time to get this written up and issued in a new release.

Another reason why it is essential for you to ask other printshop owners and printer operators about how Brand X and Y function in the real world is that issues may exist but it may take months for these issues to be well enough known for us to know the details. Although often we know of the issues early, and work to get this information into the PDFs, access to information varies depending on brand and model. Plus with over 300 publications, the waiting time to update a specific report may be several months. Plus, once a printer is considered obsolete, it is not realistic to update it due to the costs involved.

For these reasons, every FLAAR Report tries to have its publication date on the front outside cover (if we updated everything instantly the cost would be at commercial rates and it would not be possible to cover these expenses). At the end of most FLAAR Reports there is additionally a list of how many times that report has been updated. A report with lots of updates means that we are updating that subject based on availability of new information. If there is no update that is a pretty good indication that report has not been updated! With 101 models of UV printers, several hundred solvent printers, and scores of water-based printers, we tend to give priority to getting new reports out on printers about which not much info at all is available elsewhere. So we are pretty good about reporting on advances in LED curing. But glitches in a common water-based printer will take longer to work its way through our system into an update, especially if the glitch occurs only in certain circumstances, for example, on one type of media. With several hundred media types, we may not yet have utilized the problem media. While on the subject of doing your own research, be sure to ask both the printer operator and printshop owner or manager: you will generally get two slightly different stories. A printer operator may be aware of more glitches of the printer than the owner.

If a printer is no longer a prime model then there is less interest in that printer, so unless a special budget were available to update old reports, it is not realistic to update old reports. As always, it is essential for you to visit printshops that have the printers on your short-list and see how they function in the real world.

But even when we like a product and recommend it, we still can't guarantee or certify any make or model nor its profitability in use because we don't know the conditions under which a printer system might be utilized in someone else's facility. For ink and media, especially after-market third-party ink and media, it is essential that you test it first, under your conditions. We have no way to assure that any ink or media will be acceptable for your specific needs in your specific print shop. As a result, products are described "as is" and without warranties as to performance or merchantability, or of fitness

for a particular purpose. Any such statements in our reports or on our web sites or in discussions do not constitute warranties and shall not be relied on by the buyer in deciding whether to purchase and/or use products we discuss because of the diversity of conditions, materials and/or equipment under which these products may be used. Thus please recognize that no warranty of fitness or profitability for a particular purpose is offered.

The user is advised to test products thoroughly before relying on them. We do not have any special means of analyzing chemical contents or flammability of inks, media, or laminates, nor how these need to be controlled by local laws in your community. There may well be hazardous chemicals, or outgassing that we are not aware of. Be aware that some inks have severe health hazards associated with them. Some are hazardous to breathe; others are hazardous if you get them on your skin. For example, some chemicals such as cyclohexanone do not sound like chemicals you want to breathe every day. Be sure to obtain, read, and understand the MSDS sheets for the inks, media, and laminates that you intend to use. Both solvent, eco-solvent, and UV-curable inks are substances whose full range of health and environmental hazards are not yet fully revealed. It is essential you use common sense and in general be realistic about the hazards involved, especially those which are not listed or which have not yet been described. FLAAR is not able to list all hazards since we are not necessarily aware of the chemical components of the products we discuss. Our reports are on usability, not on health hazards.

Most inks are clearly not intended to be consumed. Obviously these tend to be solvent inks and UV-curable inks. Yet other inks are edible, seriously, they are printed on birthday cakes. Indeed Sensient is a leader in a new era of edible inks. Therefore the user must assume the entire risk of ascertaining information on the chemical contents and flammability regulations relative to inks, media or laminates as well as using any described hardware, software, accessory, service, technique or products.

We have no idea of your client's expectations. What students on our campus will accept may not be the same as your Fortune 500 clients. In many cases we have not ourselves used the products but are basing our discussion on having seen them at a trade show, during visiting a print shop, or having been informed about a product via e-mail or other communication.

Results you see at trade shows may not be realistic

Be aware that trade show results may not be realistic. Trade shows are idealized situations, with full-time tech support to keep things running. The images at a trade show may be tweaked. Other images make be "faked" in the sense of slyly putting on primer without telling the people who inspect the prints. Most UV inks don't stick to all materials; many materials need to be treated.

Or the UV prints may be top-coated so that you can't do a realistic scratch test.

Both personnel have many standard tricks that they use to make their output look gorgeous. In about half the cases you will not likely obtain these results in real life: in most cases they are printing uni-directional, which may be twice as slow as bi-directional.

Trade show examples tend to be on the absolutely best media. When you attempt to save money and use economy media you will quickly notice that you do not get anywhere near the same results as you saw in the manufacturer's trade show booth, or pictured in their

glossy advertisement. Five years ago we noticed Epson was laminating prints to show glossy output because their pigmented inks could not print on actual glossy media. The same equipment, inks, media, and software may not work as well in your facility as we, or you, see it at a trade show. All the more reason to test before you buy; and keep testing before you make your final payment. Your ultimate protection is to use a gold American Express credit card so you can have leverage when you ask for your money back if the product fails.

Images printed at trade show may be in uni-directional mode: so you may not realize the printer has bi-directional (curing) banding defects until you unpack it in your printshop. Bi-directional curing banding is also known as the lawnmower effect. Many printers have this defect; sometimes certain modes can get rid of it, but are so slow that they are not productive.

You absolutely need to do print samples with your own images and the kind provided by your clients. Do not rely on the stock photos provided by the printer, ink, media, or RIP manufacturer or reseller. They may be using special images which they know in advance will look fabulous on their printer. Equally well, if you send your sample images to the dealer, don't be surprised if they come back looking awful. That is because many dealers won't make a serious effort to tweak their machine for your kind of image. They may use fast speed just to get the job done (this will result in low quality). Check with other people in your area, or in the same kind of print business that you do. Don't rely on references from the reseller or manufacturer (you will get their pet locations which may be unrealistically gushy): find someone on your own.

Factors influencing output

Heat, humidity, static, dust, experience level of your workers (whether they are new or have prior years experience): these are all factors that will differ in your place of business as compared with test results or demo room results.

Actually you may have people with even more experience than we do, since we deliberately use students to approximate newbies. FLAAR is devoted to assisting newcomers learn about digital imaging hardware and software. This is why Nicholas Hellmuth is considered the "Johnny Appleseed" of wide format inkjet printers.

Therefore this report does not warranty any product for any quality, performance or fitness for any specific task, since we do not know the situation in which you intend to use the hardware or software. Nor is there any warranty or guarantee that the output of these products will produce salable goods, since we do not know what kind of ink or media you intend to use, nor the needs of your clients. A further reason that no one can realistically speak for all aspects of any one hardware or software is that each of these products may require additional hardware or software to reach its full potential.

For example, you will most likely need a color management system which implies color measurement tools and software. To handle ICC color profiles, you may need ICC color profile generation software and a spectrophotometer since often the stock pre-packaged ICC color profiles which come with the ink, media, printers and/or RIPs may not work in your situation. Not all RIPs handle color management equally, or may work better for some printer-ink-media combinations than for others.

Be aware that some RIPs can only accept ICC color profiles: you quickly find out the hard way that you can't tweak these profiles nor

generate new ones. So be sure to get a RIP which can handle all aspects of color management. Many RIPs come in different levels. You may buy one level and be disappointed that the RIP won't do everything. That's because those features you may be lacking are available only in the next level higher of that RIP, often at considerable extra cost. Same thing in the progression of Chevy through Pontiac to Cadillac, or the new Suburbans. A Chevy Suburban simply does not have all the bells and whistles of the Cadillac Escalade version of this SUV.

Don't blame us... besides, that's why we are warning you. This is why we have a Survey Form, so we can learn when end users find products that are inadequate. We let the manufacturers know when end users complain about their products so that the manufacturers can resolve the situation when they next redesign the system.

Most newer printer models tend to overcome deficiencies of earlier models. It is possible that our comparative comments point out a glitch in a particular printer that has been taken care of through an improvement in firmware or even an entirely new printer model. So if we point out a deficiency in a particular printer brand, the model you may buy may not exhibit this headache, or your kind of printing may not trigger the problem. Or you may find a work-around.

Just remember that every machine has quirks, even the ones we like. It is possible that the particular kind of images, resolution, inks, media, or other factors in your facility are sufficiently different than in ours that a printer which works just fine for us may be totally unsatisfactory for you and your clients. However it may be that the specific kind of printing you need to do may never occasion that shortcoming. Or, it may be that your printer was manufactured on a Monday and has defects that are atypical, show up more in the kind of media you use which we may not use as often or at all during our evaluations. Equally possibly a printer that was a disaster for someone else may work flawlessly for you and be a real money maker for your company.

So if we inspect a printer in a printshop (a site-visit case study), and that owner/operator is content with their printer and we mention this; don't expect that you will automatically get the same results in your own printshop.

In some cases a product may work better on a Macintosh than on a PC. RIP software may function well with one operating system yet have bugs and crash on the same platform but with a different operating system. Thus be sure to test a printer under your own specific work conditions before you buy.

And if a printer, RIP, media, or ink does not function, return it with no ands, ifs or buts. Your best defense is to show an advertising claim that the printer simply can't achieve. Such advertising claims are in violation of federal regulations, and the printer companies know they are liable for misleading the public.

But before you make a federal case, just be sure that many of the issues are not user error or unfamiliarity. It may be that training or an additional accessory can make the printer do what you need it to accomplish. Of course if the printer ads did not warn you that you had to purchase the additional pricey accessory, that is a whole other issue. Our reviews do not cover accessories since they are endless, as is the range of training, or lack thereof, among users.

The major causes of printer breakdown and failure is lack of maintenance, poor maintenance, spotty maintenance, or trying to jerry-rig some part of the printer. The equally common cause of printer breakdown is improper use, generally due from lack of training or experience. Another factor is whether you utilize your printer all day

every day. Most solvent and UV printers work best if used frequently. If you are not going to use your printer for two or three days, you have to put flush into the system and prepare it for hibernation (even if for only four or five days). Then you have to flush the ink system all over again.

Also realize that the surface of inkjet prints are fragile and generally require lamination to survive much usage. Lamination comes in many kinds, and it is worth finding a reliable lamination company and receiving training on their products.

Also realize that no hybrid or combo UV printer can feed all kinds of rigid materials precisely. Some materials feed well; others feed poorly; others will skew.

Although we have found several makes and models to work very well in our facilities, how well they work in your facilities may also depend on your local dealer. Some dealers are excellent; others just sell you a box and can't provide much service after the sale. Indeed some low-bid internet sales sources may have no technical backup whatsoever. If you pay low-bid price, you can't realistically expect special maintenance services or tech support later on from any other dealer (they will tell you to return to where you paid for the product). This is why we make an effort to find out which dealers are recommendable. Obviously there are many other dealers who are also good, but we do not always know them. To protect yourself further, always pay with a level of credit card which allows you to refuse payment if you have end up with a lemon. A Gold American Express card allows you to refuse payment even months after the sale. This card may also extend your warranty agreement in some cases (check first).

Most of the readers of the FLAAR Reports look to see what printers we use in our own facilities. Readers realize that we will have selected the printers that we like based on years of experience and research. Indeed we have met people at trade shows who told us they use the FLAAR web site reports as the shopping list for their corporate purchases.

Yes, it is rather self-evident that we would never ask a manufacturer to send a product which we knew in advance from our studies was no good. But there are a few other printers which are great but we simply do not have them in our facilities yet.

So if a printer is not made available by its manufacturer, then there is no way we can afford to have all these makes and models in our facility. Thus to learn about models which we do not feature, be sure to ask around in other print shops, with IT people in other corporations, at your local university or community college. Go to trade shows... but don't use only the booth...ask questions of people in the elevator, in line at the restaurant, anywhere to escape the smothering hype you get in the booth.

Realize that a FLAAR Report on a printer is not by itself a recommendation of that printer. In your local temperature, in your local humidity, with the dust that is in your local air, with your local operator, and with disorientation of the insides of a printer during rough shipment and installation, we have no knowledge of what conditions you will face in your own printshop. We tend to inspect a printer first in the manufacturing plant demo room: no disjointed parts from any shipment since this printer has not been lifted by cranes and run over a rough pot-holed highway or kept in smelting heat or freezing cold during shipment.

Taking into consideration we do not know the conditions in which you may be using your hardware, software, or consumables, neither the author nor FLAAR nor either university is liable for liability, loss or dam-

age caused either directly or indirectly by the suggestions in this report nor by hardware, software, or techniques described herein because.

Availability of spare parts may be a significant issue

Chinese printers tend to switch suppliers for spare parts every month or so. So getting spare parts for a Chinese printer will be a challenge even if the distributor or manufacturer actually respond to your e-mails at all. Fortunately some companies do have a fair record of response; Teckwin is one (based on a case of two problematical hybrid UV printers in Guatemala). The distributor said that Teckwin sent a second printer at their own expense and sent tech support personnel at their expense also. But unfortunately both the hybrid UV printers are still abandoned in the warehouse of the distributor; they were still there in January 2009. But Teckwin has the highest rating of any Chinese company for interest in quality control and realization that it is not good PR to abandon a client or reseller or distributor all together.

Recently we have heard many reports of issues of getting parts from manufacturers in other countries (not Asia). So just because your printer is made in an industrialized country, if you are in the US and the manufacturer is X-thousand kilometers or miles away, the wait may be many days, or weeks.

Lack of Tech Support Personnel is increasing

The recession resulted in tech support issues: some manufacturers may need to skimp on quality control during a recession, or switch to cheaper parts suppliers. Plus they are not hiring enough tech support during a recession. So the bigger and more successful the company, in some cases the worse these particular problems may be.

Any new compiled printer may take a few months to break in

Any new printer, no matter who the manufacturer, or how good is the engineering and electronics, will tend to have teething issues. Until the firmware is updated, you may be a beta tester. This does not mean the printer should be avoided, just realize that you may have some downtime and a few headaches. Of course the worst case scenario for this was the half-million dollar Luscher JetPrint: so being "Made in Switzerland" was not much help.

Counterfeit parts are a problem with many printers made in China

Several years ago many UV printers made in China and some made elsewhere in Asia had counterfeit parts. No evaluation has the funding available to check parts inside any printer to see if they are from the European, Japanese, or American manufacturer, or if they are a clever counterfeits.

Be realistic and aware that not all materials can be printed on equally well

Many materials don't feed well through hybrid (pinch roller on grit roller systems) or combo UV systems (with transport belts). Banding, both from poor feeding, and from bi-directional (lawnmower effect) are common on many UV-curable inkjet printers.

It is typical for some enthusiastic vendors to claim verbally that their printer can print on anything and everything. But once you unpack the printer and set it up, you find that it requires primer on some materials; on other materials it adheres for a few weeks but then falls off.

And on most hybrid and many combo printers, some heavy, thick, or smooth-surfaced materials skew badly. Since the claim that the printer will print on everything is usually verbal, it is tough to prove this aspect of misleading advertising to a jury.

Not all inks can print on all materials. And at a trade show, many of the materials you see so nicely printed on, the manufacturer may be adding a primer at night or early in the morning: before you see the machine printing on this material.

We feel that the pros and cons of each product speak more than adequately for themselves. Just position the ad claims on the left: put the actual performance results on the right. The unscrupulous hype for some printers is fairly evident rather quickly.

Be sure to check all FLAAR resources

Please realize that with over 200 different FLAAR Reports on UV printers, you need to be sure to check the more obscure ones too. If a printer has a printhead issue, the nitty gritty of this may be in the FLAAR Report on printheads. The report on the model is a general introduction; if we discussed the intimate details of printheads then some readers might fall asleep. And obviously do not limit yourself to the free reports. The technical details may be in the reports that have a price to them. Our readers have said they prefer to have the general basics, and to park the real technical material in other reports that people can buy if they really want that level of information.

So it may be best to ask for personal consulting. The details of the problems with the ColorSpan 5400uv series are rather complex: namely the center row of the Ricoh printheads. This would require an expensive graphic designer and consultants to show the details. And the design of the printhead would probably be altered by the time we did any of this anyway. So it is essential to talk with people: with other end-users, and with FLAAR in person on a consulting basis.

Acknowledgements

With 19 employees the funding has to come from somewhere, so we do welcome project sponsorship, research grants, contributions that facilitate our educational programs, scholarships for co-op interns and graduate students, and comparable project-oriented funding from manufacturers. The benefit for the end-user is a principle called academic freedom, in this case,

- The freedom of a professor or student to speak out relative to the pros and cons of any equipment brought to them to benchmark.
- The freedom to design the research project without outside meddling from the manufacturer.

Fortunately, our budget is lean and cost effective as you would expect for a non-profit research institute. As long as we are not desperate for money we can avoid the temptation to accept payment for reprinting corporate PR hype. So the funding is used for practical research. We do not accept (nor believe) and certainly do not regurgitate corporate PR. For example, how many manufacturer's PR photos of their products have you seen in our reports or on our web sites?

Besides, it does not take any money to see which printers and RIPs function as advertised and which don't. We saw one hyped printer grind to a halt, malfunction, or otherwise publicly display its incapacibilities at several trade shows in a row. At each of those same trade shows another brand had over 30 of their printers in booths in virtually every hall, each one producing museum quality exhibits. Not our fault when we report what we see over and over and over again. One of our readers wrote us recently, "Nicholas, last month you recom-

mended the as one of several possible printers for our needs; we bought this. It was the best capital expenditure we have made in the last several years. Just wanted to tell you how much we appreciate your evaluations....”

FLAAR is a non-profit educational and research organization dedicated for over 36 years to professional photography in the arts, tropical flora and fauna, architectural history, and landscape panorama photography.

Our digital imaging phase is a result of substantial funding in 1996 from the Japanese Ministry of Public Education for a study of scanning and digital image storage options. This grant was via Japan's National Museum of Ethnology, Osaka, Japan. That same year FLAAR also received a grant of \$100,000 from an American foundation to do a feasibility study of digital imaging in general and the scanning of photographic archives in particular.

The FLAAR web sites began initially as the report on the results of these studies of scanners. Once we had the digital images we began to experiment with digital printers. People began to comment that our reports were unique and very helpful. So by 1999 we had entire sections on large format printers.

FLAAR has existed since 1969, long before inkjet printers existed. Indeed we were writing about digital imaging before HP even had a color inkjet system available. In 2000 FLAAR received an educational grant from Hewlett-Packard large format division, Barcelona, Spain, for training, for equipment, and to improve the design and navigation on the main web sites of the FLAAR Network. This grant ran its natural course, and like all grants, reached its finishing point, in this case late 2005.

In some cases the sponsorship process begins when we hear end-users talking about a product they have found to be better than other brands. We keep our ears open, and when we spot an especially good product, this is the company we seek sponsorship from. It would not be wise of us to seek sponsorship from a company with a sub-standard or otherwise potentially defective printer. So we usually know which printers are considered by end-users to be among the better brands before we seek sponsorship. After all, out of the by now one million readers, we have heard plenty about every single printer out there.

We thank MacDermid ColorSpan (now part of HP), Hewlett-Packard, Parrot Digigraphic, Color DNA, Canon, Gandinnovations, and other companies for providing funding for technology training for the FLAAR staff and our colleagues at Bowling Green State University in past years and for funds to allow us to attend all major international trade shows, which are ideal locations for us to gather information. We thank Caldera, EskoArtwork, EFI Rastek, EFI and VUTEK, OTF (Obeikan), Drytac, DigiFab, Barbieri electronic, Seiko II, Parrot Digigraphic, AT Inks, Sepiax inks, Dilli, Grapo, and WP Digital for providing funds so that we can make more of our publications free to end-users. During 2000-2001 we had grants to cover all the costs of our publications, and all FLAAR Reports were free in those early years. As that early grant naturally expired after a few years, we had to begin charging for some of our reports to cover costs. Now (in 2010), we are seeking corporate sponsorship so we can gradually make another 20% of our publications free to our readers.

Since 2006 we do a major part of our evaluations at a factory and headquarters demo room. Since the university does not fund any of these trips, it is traditional for the manufacturer to fund a research sponsorship. In the US this is how most university projects are initiated for decades now, and it is increasing. In fact there is a university in Austria that is not an “edu” but is a “GmbH”, funded by the chamber of commerce of that part of Austria. In other words, a university

as an educational institution, but functioning in the real world as an actual business. This is a sensible model, especially when FLAAR staff need to be on the road over a quarter of a million miles per year (roughly over 400,000 km per year total for the staff). Obviously this travel is hosted since unless money falls from heaven there most realistic way to obtain funding to get to the demo rooms for training is direct from the source.

It has been helpful when companies make it possible for us to fly to their headquarters so we can inspect their manufacturing facilities, demo rooms, and especially when the companies make their research, engineering and ink chemistry staff available for discussions. When I received my education at Harvard I was taught to have a desire to learn new things. This has guided my entire life and is what led me into wide-format digital imaging technology: it is constantly getting better and there is a lot to learn every month. Thus I actively seek access to improving my understanding of wide format printer technology so that we can better provide information to the approximately quarter-million+ readers of our solvent and UV printer web site (www.large-format-printers.org) and the over half a million who read either our wide-format-printers.org site or our roughly half million combined who read our digital-photography.org and www.FineArtGicleePrinters.org sites.

Barbieri electronic (color management), Caldera (RIP), ColorSpan, DEC, Durst, EFI, EskoArtwork, Gerber, Grapo, IP&I, Mimaki USA, Mutoh, Obeikan, Dilli, Drytac, GCC, NUR, Oce, Shiraz (RIP), Sky AirShip, Sun, Teckwin, VUTEK, WP Digital, Xerox, Yuhan-Kimberly, Zund have each brought FLAAR staff to their headquarters and printer factories. AT Inks, Bordeaux, InkWin, Sepiax and Sunflower ink have brought us to inspect their ink manufacturing facilities and demo rooms. Notice that we interact with a wide range of companies: it is more helpful to our readers when we interact with many different companies rather than just one.

We have visited the world headquarters and demo rooms of HP in Barcelona and received informative and helpful technology briefings from HP about every two years. We are under NDA as to the subjects discussed but it is important that we be open where we have visited. Mimaki Europe has had FLAAR as their guest in Europe to introduce their flatbed UV printer, as have other UV-curable manufacturers, again, under NDA as to the details since often we are present at meetings where unreleased products are discussed. Xaar has hosted an informative visit to their world headquarters in the UK. You don't get this level of access from a trade magazine writer, and I can assure you, we are provided much more detailed information and documentation in our visits than would be provided to a magazine author or editor. Companies have learned that it's a lot better to let us know up front and in advance the issues and glitches with their printers, since they now know we will find out sooner or later on our own. They actually tell us they realize we will find out on our own anyway.

Contributions, grant, sponsorships, and project funds from these companies are also used to improve the design and appearance of the web sites of the FLAAR Information Network. We thank Canon, ColorSpan, HP, ITNH, and Mimaki for providing wide format printers, inks, and media to the universities where FLAAR does research on wide format digital imaging. We thank Epson America for providing an Epson 7500 printer many years ago, and Parrot Digigraphic for providing access to their digital equipment, also for providing three different models of Epson inkjet printers to our facilities on loan at BGSU (5500, 7600, 7800). We thank Mimaki USA for providing a JV4 and then a Mimaki TX-1600s textile printer and Improved Technologies (ITNH) providing their Ixia model of the Iris 3047 giclee printer.

We thank 3P Inkjet Textiles and HP for providing inkjet textiles so we could learn about the different results on the various textiles. IJ Technologies, 3P Inkjet Textiles, ColorSpan, Encad, HP, Nan Ya Pepa,

Oracal, Tara and other companies have provided inkjet media so we can try it out and see how it works (or not as the case may be; several inkjet media failed miserably, one from Taiwan, the other evidently from Germany!). We thank Aurelon, Canon, ColorGate, ColorSpan, ErgoSoft, HP, PerfectProof, PosterJet, Onyx, Ilford, CSE ColorBurst, ScanvecAmiable, Wasatch and many other RIP companies for providing their hardware and software RIPs.

We thank Dell Computers for providing awesome workstations for testing RIP software and content creation with Adobe Photoshop and other programs. We also appreciate the substantial amount of software provided by Adobe. As with other product loaned or provided courtesy of ProVar LLC (especially the 23" monitors which makes it so much easier to work on multiple documents side by side).

We thank Betterlight, Calumet Photographic, Global Graphics, Westcott, Global Imaging Inc. Phase One, and Bogen Imaging for helping to equip our archaeological photo studios at the university and its archaeology museum in Guatemala. Heidelberg, Scitex, CreoScitex (now Kodak) and Cruse, both in Germany, have kindly provided scanners for our staff to evaluate.

We really liked some of the results whereas some of the other products were a bit disappointing. Providing samples does not influence the evaluations because the evaluators are students, professors, and staff of Bowling Green State University. These personnel are not hired by any inkjet printer company; they were universities employees (as was also true for Nicholas Hellmuth). The testing person for the HP ColorPro (desktop printer) said he frankly preferred his Epson printer. When we saw the rest results we did not include this Hewlett-Packard ColorPro printer on our list of recommended printers, but we love our HP DesignJet 5000ps so much we now have two of them, one at each university.

Sometimes we hear horror stories about a printer. The only way we can tell whether this is the fault of the printer design, or lack of training of the operator, is to have the printer ourselves in-house. Of course some printer manufacturers don't understand the reasons we need to have each make and model; they are used to loaning their demo units for a week or so. That is obviously inadequate for a serious review.

Some of the media provided to us failed miserably. Three printers failed to meet common sense usability and printability standards as well (HP 1055, one older desktop model (HP Color Pro GA), and one Epson). Yet we know other users who had better results; maybe ours came down the assembly line on a Monday or Friday afternoon, when workers were not attentive. One costly color management software package was judged "incapable" by two reviewers (one from the university; second was an outside user who had made the mistake of buying this package).

So it's obvious that providing products or even a grant is no shield from having your products fail a FLAAR evaluation. The reason is clear: the end user is our judge. The entire FLAAR service program is to assist the people who need to use digital imaging hardware and software. If a product functions we find out and promulgate the good news. If a product is a failure, or more likely, needs some improvement in the next generation, we let people know. If a product is hyped by what an informed user would recognize as potentially false and misleading nonsense, then we point out the pathetic discrepancies very clearly.

This is what you should expect from an institute which is headed by a professor.

Actually, most of our reviews are based on comments by end users. We use their tips to check out pros and cons of virtually every product we discuss. You can't fool a print shop owner whose printer simply fails to function as advertised. And equally, a sign shop owner who earns a million dollars a year from a single printer brand makes an impact on us as well. We have multiple owners of ColorSpan printers tell us that this printer is their real money earner for example. We know other print shops where their primary income is from Encad printers. Kinkos has settled on the HP 5000 as its main money maker production machine, and so on.

Yet we have documentation of several print shop companies whose business was ruined by specific brands that failed repeatedly. It is noteworthy that it is always the same brand or printer at both locations: one due to banding and printheads then simply no longer printing one color; the other brand due to pokiness of the printer simply not being competitively fast enough. Same with RIPs, we have consistent statements of people using one RIP, and only realizing how weak it was when they tried another brand which they found substantially better. Thus we note that companies which experiment with more than one brand of product tend to realize more quickly which brand is best. This is where FLAAR is in an ideal situation: we have nine RIPs and 25 printers. Hence it is logical that we have figured out which are best for our situation.

Grant funding, sponsorship, demonstration equipment, and training are supplied from all sides of the spectrum of printer equipment and software engineering companies. Thus, there is no incentive to favor one faction over another. We receive support from three manufacturers of thermal printheads (Canon, ColorSpan and HP) and also have multiple printers from three manufacturers of piezo printers (Epson, Seiko, Mutoh, and Mimaki). This is because piezo has definite advantage for some applications; thermal printheads have advantages in different applications. Our reviews have universal appeal precisely because we feature all competing printhead technologies. Every printer, RIPs, inks, or media we have reviewed have good points in addition to weaknesses. Both X-Rite and competitor GretagMacbeth provided spectrophotometers. Again, when all sides assist this program there is no incentive to favor one by trashing the other. Printer manufacturer ad campaigns are their own worst enemy. If a printer did not make false and misleading claims, then we would have nothing to fill our reviews with refuting the utter nonsense that is foisted on the buying public.

It is not our fault if some printers are more user friendly, print on more media than other brands. It is not our fault that the competing printers are ink guzzlers, are slow beyond belief, and tend to band or drop out colors all together. We don't need to be paid by the printer companies whose products work so nicely in both our universities on a daily basis. The printers which failed did so in front of our own eyes and in the print shops of people we check with. And actually we do try to find some redeeming feature in the slow, ink gulping brands: they do have a better dithering pattern; they can take thick media that absolutely won't feed through an HP. So we do work hard at finding the beneficial features even of printers are otherwise get the most critique from our readers. Over one million people will read the FLAAR Information Network in the next 12 months; 480,000 people will be exposed to our reports on wide format printers from combined total of our three sites on these themes. You can be assured that we hear plenty of comments from our readers about which printers function, and which printers fail to achieve what their advertising hype so loudly claims.

An evaluation is a professional service, and at FLAAR is based on more than 11 years of experience. An evaluation of a printer, an ink,

a software, laminator, cutter or whatever part of the digital printing workflow is intended to provide feedback to all sides. The manufacturers appreciate learning from FLAAR what features of their printers need improvement. In probably half the manufacturers FLAAR has dealt with, people inside the company did not, themselves, want to tell their boss that their pet printer was a dog. So printer, software, and component manufacturers have learned that investing in a FLAAR evaluation of their product provides them with useful return on investment. Of course if a printer manufacturer wants only a slick Success Story, or what we call a "suck up review" that simply panders to the manufacturer, obviously FLAAR is not a good place to dare to ask for such a review. In several instances it was FLAAR Reports that allowed a company to either improve their printer, or drop it and start from scratch and design a new and better one.

And naturally end-users like the opportunity to learn about various printers from a single source that covers the entire range from UV through latex through all flavors of solvent.

We have also learned that distributors often prefer to accept for distribution a printer or other product on which a FLAAR Report already exists.

We turn down offers of funding every year. These offers come from PO Box enterprises or products with no clearly visible point of manufacture. Usually the company making the offer presumes they can buy advertising space just by paying money. But that is not what our readers want, so we politely do not accept such offers of money.

Contributions, grants, sponsorships, and funding for surveys, studies and research is, however, open to a company who has an accepted standing in the industry. It is helpful if the company has a visible presence at leading trade shows and can provide references from both end users and from within the industry. Where possible we prefer to visit the company in person or at least check them out at a trade show. Obviously the product needs to have a proven track record too. Competing companies are equally encouraged to support the FLAAR system. We feel that readers deserve to have access to competing information. Competition is the cornerstone of American individualism and technological advancement.

FLAAR also covers its costs of maintaining the immense system of 8 web sites in three languages and its facilities in part by serving as a consultant such as assisting inkjet manufacturers learn more about the pros and cons of their own printers as well as how to improve their next generation of printers. It is especially useful to all concerned when manufacturers learn of trends (what applications are popular and for what reasons). For example, manufacturers need to know whether to continue designing software for Mac users, or concentrate software for PC users. So the survey form that you fill out is helpful to gather statistics. You benefit from this in two ways: first, you get the FLAAR reports in exchange for your survey form. Second, your comments bring (hopefully) change and improvement in the next generation of printers. When we do survey statistics, then the names, addresses, and telephone numbers are removed completely. A survey wants only aggregate numbers, not individuals. However, if you ask about a specific brand of printer, and do not opt out, we forward your request to a pertinent sponsor so you can obtain follow-up from that brand, since we ourselves do not have enough personnel to respond to each reader by telephone. But we do not provide your personal information to outsiders and our survey form has an opt out check-off box which we honor.

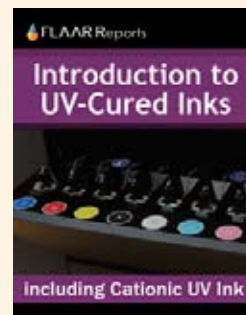
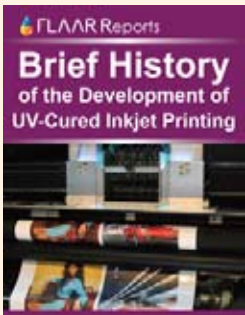
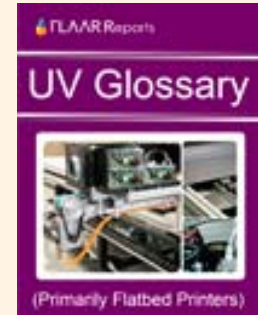
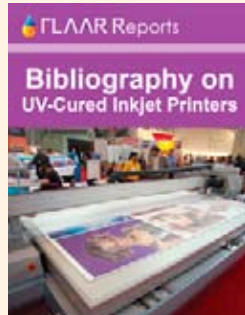
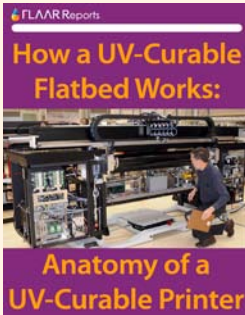
FLAAR also serves as consultants to Fortune 500 companies as well as smaller companies and individuals who seek help on which printers to consider when they need digital imaging hardware and software.

A modest portion of our income comes from our readers who purchase the FLAAR series. All income helps continue our tradition of independent evaluations and reviews of inkjet printers, RIPs, media, and inks.

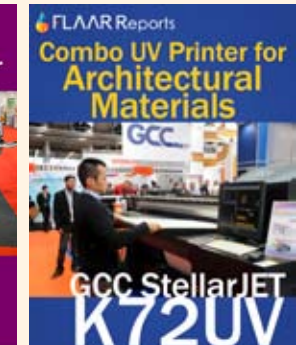
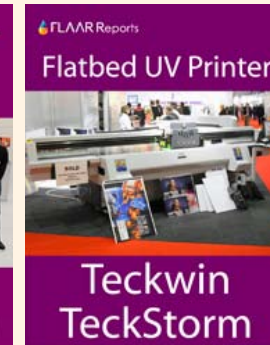
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Comments on UV Inkjet Printers at Major Trade Shows 2007-2009

<p>List of UV Printers Manufactured in Taiwan 2010</p>	<p>UV Market TRENDS</p> <p>Observable at FESPA Digital Europe 2009</p>	<p>TRENDS, Part II: Markets & Technologies</p> <p>UV-cured printers at ISA 2009</p>	<p>TRENDS, Part I: Analysis One by One of the UV-cured printers</p> <p>ISA '09</p>	<p>UV Cured Printer TRENDS at Dubai 2010</p>
<p>TRENDS of UV-Cured Wide-Format Printers</p> <p>Shanghai '09</p>	<p>UV COMBO FLATBEDS</p> <p>Shanghai 2009</p>	<p>TRENDS IN HYBRID STRUCTURE UV PRINTERS</p> <p>Shanghai 2009</p>	<p>UV Roll-to-roll</p> <p>Observable at Shanghai 2009</p>	<p>UV Flatbed Printers</p> <p>at APPEXPO, Shanghai '09</p>
<p>Trends in Wide-Format UV Printers</p> <p>Observable at SGIA '09</p>	<p>UV-Cured Inkjet Printers at VISCOM ITALY 2009</p>	<p>Learning more of UV-Curable TRENDS</p> <p>By visiting viscom Paris '09</p>	<p>UV Printers Trends 2008</p> <p>SGIA '08 PART I</p>	<p>Flatbed & Roll-to-Roll UV Printers</p> <p>SGIA '08 Part II</p>

UV Printers Manufactured in China, Korea and Taiwan

<p>Chinese UV Inkjet Printers 2009</p> <p>Comprehensive FLAAR Inventory</p>	<p>UV Printers Manufactured in Korea 2009</p> <p>Trends, Markets & Applications</p>	<p>UV Printers Manufactured in KOREA 2010</p>	<p>List of UV Printers Manufactured in Taiwan 2009</p>	<p>List of UV Printers Manufactured in Taiwan 2010</p>
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