StudioRIP inkjet technologies

In 2012 the StudioRIP R&D team has invested considerable efforts on getting the best of the Epson printers used as CTP/CTF devices. The result is a set of technologies that makes StudioRIP probably the highest quality inkjet CTP/CTF software available on the market. This document is an overview of these technologies.

Inkjet technology issues

By specifications, the inkjet printers are capable of high resolutions (up to 2880x2880 dpi), above what the laser devices (imagesetters, CTP machines) commonly use (2400–2540 dpi). On the other hand, inkjet priners are known as having worse quality than the laser devices. Very few pre-press specialists understand in depth the reasons of this contradiction.

Basically there are 4 more parameters, beyond the resolution, where the inkjet printers are considerably worse than the laser devices:

- **Dot size:** the typical spot size of a capstan laser device is around 20 microns, while drum machines go down to 7.5 microns or even less. Inkjet devices generally define their droplet size (in picoliters) rather than the actual dot size on the media, because that depends very much on the quality of the media.
  The smallest droplet that an Epson Stylus Pro series printer can print is 3.5 pl, which on a typical good quality media is around 35 microns. This is considerably worse than what a laser device can achieve.
- **Saturation:** laser devices have no problems with saturation, while inkjet devices must often limit the printed ink quantity in order to avoid ink flow problems. On 2880×2880 dpi a typical good quality media can’t accept a 100% tint, about 50% of the droplets need to be removed in order to avoid ink flow.
- **Dot placement precision:** a major problem of the inkjet devices is that the distance between the intended and actual position of a dot is typically in the range of 10-20 microns (with fine tuned settings), up to 50-100 microns if the media feed isn’t set up well enough. Even on cheap capstan laser devices this error is not more than 1-2 microns.
- **Speed:** before the new Epson Stylus Pro 7900 (and its smaller and bigger variants) appeared, talking about 2880×2880 dpi resolution was rather academic, due to the printing speed (about half an hour per A3 page). Lower resolutions were not good enough to produce laser quality halftones.

On the other hand, there is a significant difference between an Epson printer and a laser device: Epson printers give a considerable amount of freedom to the RIP to control the print head and media feed (as well as various other mechanical parameters), so within certain limits the RIP can control when and which nozzle to print a given pixel. Also, it’s up to the software how the ink density reduction is performed, which again has a great influence on the print quality. In consequence, the various RIPs can print the same 1-bit TIFF in very different ways, achieving better or worse quality.

Less moiré and banding, larger printable area with software interlacing

The native resolution of an Epson Stylus Pro printer is 360×720 dpi (H×V). Achieving 2880×2880 dpi is done by performing 32 head passes per inch, interlacing the 360×720 dpi passes to build up the 2880x2880 dpi image. The Epson printers have the so-called *Microweaving* technology built into the printer that does this automatically: the RIP sends the 2880 dpi data to the printer, and the printer internally splits this into 360×720 dpi head passes.

The problem is that Epson's microweaving was primarily built for contone (fine stocastic) color printed on the highest possible speed, and it's not perfectly suitable for high lpi halftones, for two reasons:

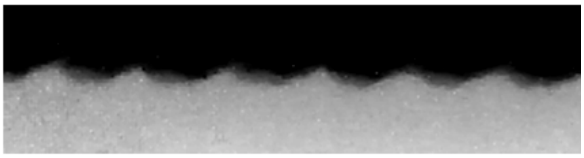
- the placement errors of the dots are organized into regular patterns, which may interfere with the halftone pattern, producing moiré;
- similarly, the placement errors tend to be organized into horizontal bands.

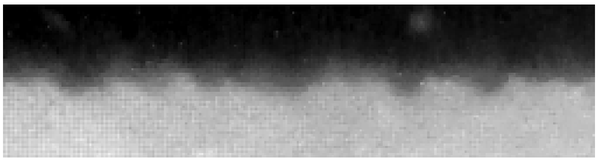
The answer of StudioRIP for this problem is that it has its own host based interlacing module – as far as we know, this is unique on the RIP market, all major competitors relying on the built-in Microweaving module of the printers.

StudioRIP's interlacing technology has two major advantages:

- allows the operator the freedom of increasing quality by reducing speed, in a wide range (up to 3× slower);
- it is optimized for suppressing any regular patterns; the slower the printing speed is, the less patterning will show on the result (due to the stochastic algorithm we use for choosing the nozzles).

The picture below shows the bottom edge of a horizontal line, printed with Epson Microweaving and StudioRIP interlacing.


Regular pattern – Epwon Microweaving


Irregular pattern – StudioRIP interlacing

Using just 15–30% lower speed is, in most cases, enough for suppressing the moiré, but in certain resolution/angles/frequency combination higher values are necessary.

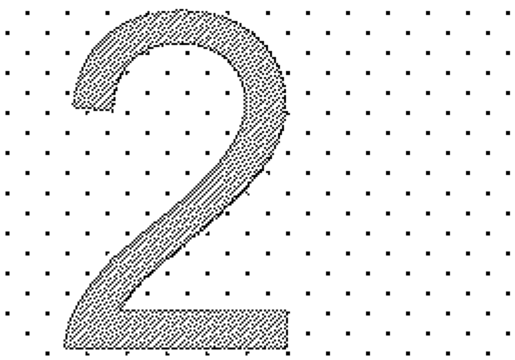
Another advantage of using StudioRIP's interlacing technique is that it can maximize the printing area on the plate. While other RIPs can't use the first inch and last inch and half of the plate (as the quality is generally worse on those areas), StudioRIP users can use those areas; although we don't recommend those areas to be used for critical quality halftones, they can be useful for crop and registration marks, density pathces etc.

Sharper edges with smarter density reduction and small dot protection

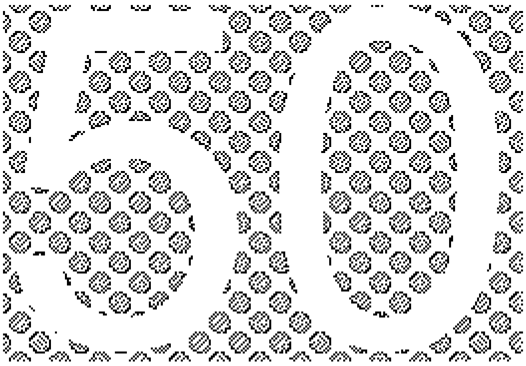
A full 100% tint on 2880×2880 dpi would inevitably cause ink flow problems on almost any media type. Therefore a droplet removal strategy must be implemented – a certain percentage of the pixels are stochastically removed to achieve a density level that the media can handle without ink flow problems.

All the competitors we had the opportunity to compare our technology with use a simple, uniform pixel removal strategy, while StudioRIP allows to:

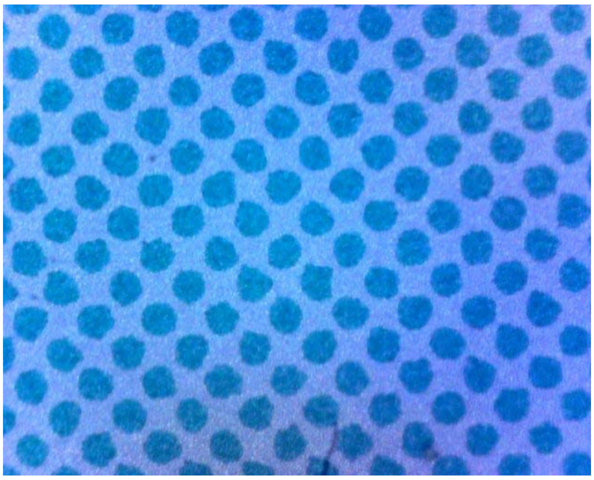
- Improve edge sharpness by applying a different removal percentage for the outlines of user definable width. We recommend that on 2880×2880 dpi the 1 pixel outlines to be printed on a higher density (about 70% of the dots to be printed), while the main density is around 25%. Having a large number of droplets on the edges will cause a big dot gain (see later how we compensate for it), but in the same time very sharp, smooth edges.
- Protect small screen dots by allowing the user to use a higher density on screen dots below a certain size. We recommend that 100% density to be used on screen dots of 4-5 pixels, the density being progressively decreased on bigger screen dots.



2% hlftone: no density reduction on dots, edge protection visible on the number



50% halftone, edge protection visible on the screen dots



170 lpi halftone on conventional plate

Ink spread compensation

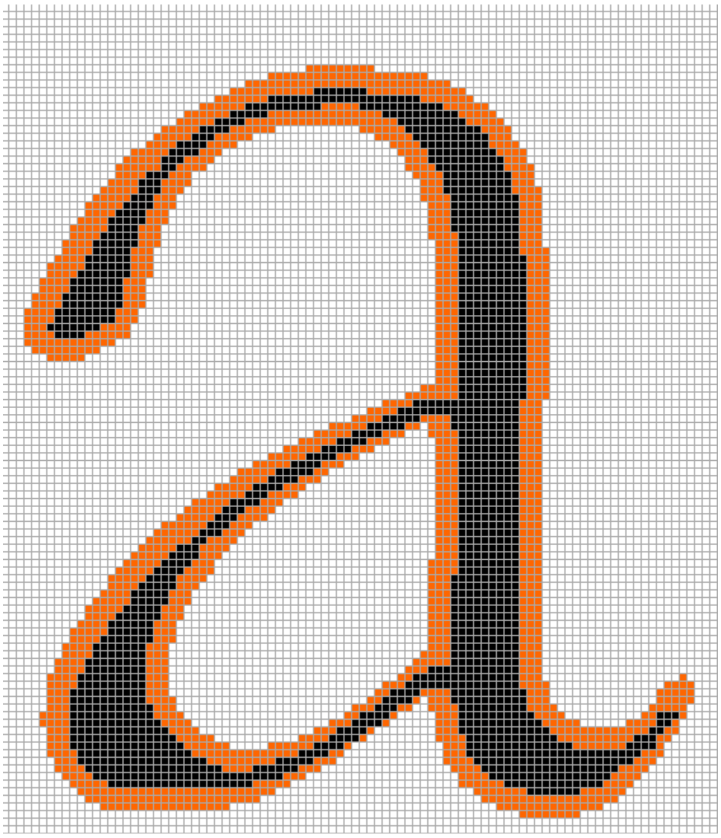
While dot gain compensation is a common practice, it only applies a curve on the halftones in order to match a desired dot gain. However, it can't compensate the ink spread on the vector objects, such as the thicker black texts on white and the thinner white texts on black. This is acceptable with laser devices, where the dot gain is relatively low, and the ink spread on the vectors is small enough to live with.

However, on inkjet devices the dot gain is much bigger, so this problem needs a solution. On first sight, the solution is as simple as removing an outline of a given width from all objects. However, there are several things that make this algorithm very difficult:

- If the outline removal would be applied after the halftoning, the fine balanced pixel structure of the screen dots would be compromised. Therefore the algorithm must be done in an earlier phase, either on vectorial level, or on contone raster data.
- Thin lines need protection, otherwise the outline removal would remove the object itself. This makes vector implementations extremely dificult.
- Raster implementations will have to deal with roughly 2 000 000 000 pixels per plate. Finding an efficient algorithm that deals with this quantity of information on acceptable speed and quality is challenging.

StudioRIP has developed an algorithm that performs this processing on the contone raster data on very high speed (typically the processing speed decreases by just 20% when the ink spread compensation is turned on), but delivering high quality as well. Note that the traditional dot gain compensation will still be available for fine tuning the halftones in order to get the right color.

This picture shows how the ink spread compensation removes an outline of 3 pixels from this small text (removed pixels in orange), while the thin line protection keeps the minimum line thickness on 2 pixels by reducing the width of the removed outline on thin lines. Note that both parameters (removed outline with and minimum line thickness) are user adjustable.



StudioRIP will print the pixels shown in black, then the cumulated dot gain of the plate making and printing process are expected to spread the ink in a similar way as is shown in orange.

Speed improvement by StudioRIP's twin channels feature

The head of the Epson Stylus Pro 7900 (and the other similar models) were built in a way to allow certain models to work on double vertical resolution (i.e. printing 720×720 dpi in one pass, instead of just 720×360 dpi). The possibility to use this higher speed mode was only used in the discontinued Stylus Pro 7700 and 9700 series, then in the SureColor SC-T series, on the price of having just 4 colors (as the higher speed is achieved by using two channels with the same ink).

However, StudioRIP is able to do this on regular Stylus Pro models. For example:

- 4900/7900/9900 users can use the orange and green channels with black ink or any other special plate fluid, achieving double speed for monochrome jobs, but in the same time using the printer with the entire set of light inks for proofing.
- 7890/9890 users can sacrify their LK chanel for plate/film printing (having black ink in it), printing proofs with the entire set of light ink except LK (but LLK still available).

Using this twin channel mode, 2880×2880 dpi becomes a real alternative, allowing an A3+ plate to print in 7–10 minutes. Without this technique, 2880x2880 meant at least 15 minutes per A3+ plate, which wasn't suitable for real production.

Further quality improvement by narrowing the head

The two main causes of the nozzle placement inaccuracy are:

- The media doesn't stay perfectly flat under the platen (mostly due to feed problems). The parts of the media that are closer to the head will have the droplets shifted towards the carriage home position (as the droplet reaches the media quicker).
- The feed inaccuracy will cause the misalignment of the scanlines.

Both phenomenons can be significantly improved by using a narrower edge of the 1 inch print head: having a shorter distance between the first and the last nozzle will mean smaller media-head distance difference and smaller feed error between the first and the last nozzle.

The Epson R&D staff has discovered this effect, and allow in their firmware to use either all or only half of the nozzles. The advantage of StudioRIP's quality enhancement feature is that it allows a more continuous setting, such as 2/3 or 1/4 of the nozzles. Therefore StudioRIP users have the choice of maximizing the quality of their printer by slowing it down: for example printing an A3 page in 30 minutes instead of 7 minutes is still acceptable for super high quality jobs (producing smoother tints and shaper dots than any other RIP), while regular production jobs can work on maximum speed.

Conclusions

The right combination of the technologies allows StudioRIP to print offset quality halftones on the right quality plates. The StudioRIP R&D team has printed real offset jobs using conventional offset plates with inkjet coating on 150, 170 and 200 lpi. The quality was so amasingly good that printers could hardly tell without a loupe or microscope whether the plates were made by a laser device or an inkjet printer.

Our experiments show that the following speed/quality combinations are worth to try:

- 150 lpi, 1440×1440 dpi: about 3 minutes/A3+ plate, newspaper quality
- 170 lpi, 2880×2880 dpi: about 7-10 minutes/A3+ plate, commercial quality
- 200 lpi, 2880×2880 dpi, 2× slower mode: 15-20 minutes/A3+ plate, highest quality

The best plate/film types are the ones that can accept high quantity of ink as photo papers. Plates that can’t absorb ink will certainly have less sharp dots, though with the right fine tuning of parameters a good commercial quality can be still achieved.

For a detailed guide on setting up the parameters see the following chapters.