Digital Print Entering B2 Format: Challenges & Solutions

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Abstract

To allow the digital print revolution, digital press must extend the format to B2. This paper presents the challenges we had when we extend our digital printing technology format from B3 to B2 format (more precisely, from 12.5”X18” to 29”X20”), and the solutions we came up with.

Introduction

For nearly 20 years (1993-2012) our presses supported ~B3 format (more precisely, max image 12.5”X18”). Moving to B2 format (max image 29”X20”) was a natural step, as B2 format is much more common in the offset world, and it offers better imposition and many additional applications. Obviously, moving to B2 also increases the press productivity.

So out target was to take our fundamental technology – liquid ink electrophotography – and extend it to B2 format. To understand the challenge we shall first briefly describe the liquid ink electrophotography, on a B3 press (the previous generation):

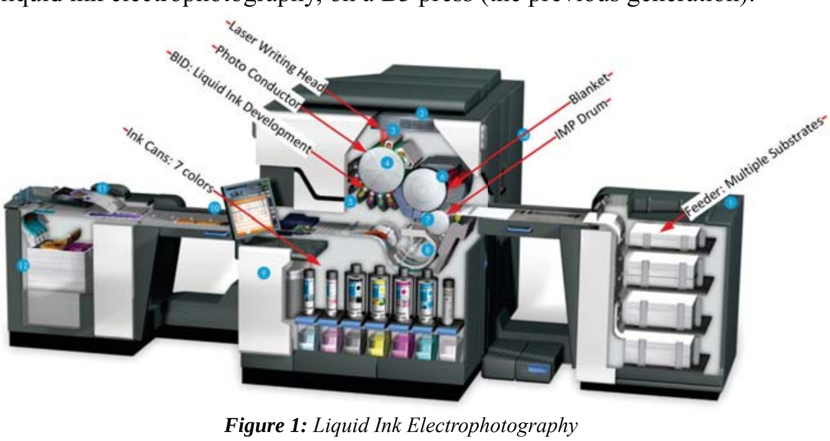

Figure 1: *Liquid Ink Electrophotography*

Hewlett Packard, Indigo Division

The charged photoconductor is selectively discharged by the writing head. Next a development unit (BID) is engaged, and develops a single separation of liquid ink. Liquid ink is what gives the print its offset quality. The separation is then transferred to the blanket drum, where the oil is evaporated from the liquid ink. The hot and dried ink film is transferred to the substrate wrapped on the IMP drum. The press supports 7 colors (YMCK plus special colors). The press supports multiple substrates, which can be switched automatically during print – a single job could be composed of different substrates. This technology is used for commercial printing, labels and packaging, and is used both for sheet fed and web fed presses.

Landscape or Portrait

The first question we asked was whether to print the B2 landscape or portrait. There is a tradeoff here: portrait is easier, since the stations would have to support 20" width rather than 29", however the landscape provides higher productivity (given the same process speed). We chose in favor of the productivity, so our challenge was to extend the process stations by X 2.3 (from 12.5" to 29").

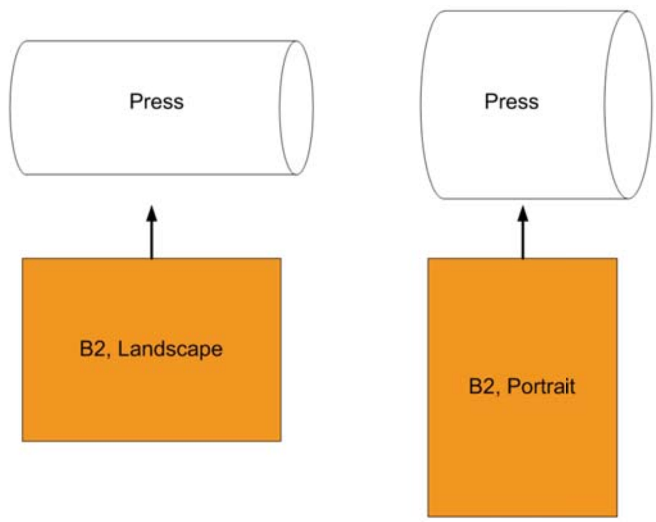

Figure 2: *Landscape vs. Portrait*

Laser Writing Head

The B2 writing head should write ~ 2000 Mega-pixels per sec, at high resolution, with a precision of microns across the format. 2 basic architectures were considered: single writing head scale-up, and double writing heads, stitched together.

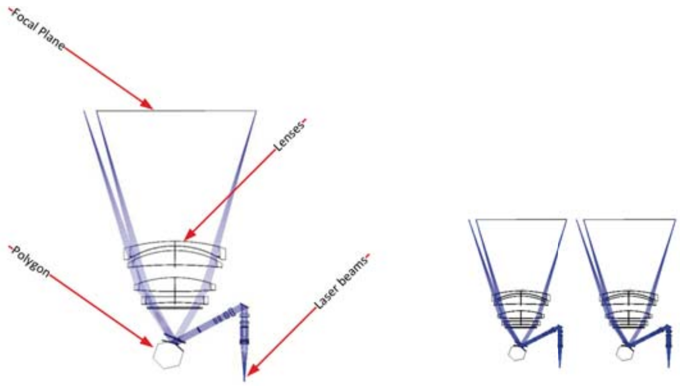

Figure 3: *Single vs Double Writing Heads*

The main concern with the double writing heads was the visibility of the stitch line between the two WH's. The main concern with the single writing head was resolution – if we scale it by X 2.3, the laser spot at the focal plane will also increase by X 2.3. Our choice was in favor of the single writing head. To gain back the resolution we used laser of shorter wavelength, and we increased the size of the polygon. The polygon is rotating at very high speed such for the laser to scan the photoconductor from front to rear. Hence, larger polygons are more subjected to centrifugal stress deformation. By increasing the number of laser beams, we were able to reduce the polygon speed. Increasing the number of lasers has its own penalty – as the lasers are not fully identical, there is a concern that the laser beams periodicity would be seen on the print as a disturbing band. The solution for this challenge was to construct an automatic calibration, using the in-line scanner, which keeps the laser beams uniform.

Ink Development Unit (BID)

The BID is required to put an ultra-thin layer upon the photoconductor, at uniformity of few 10's of nanometers (otherwise the color uniformity would be affected). Figure 4 describes the cross section of the BID.

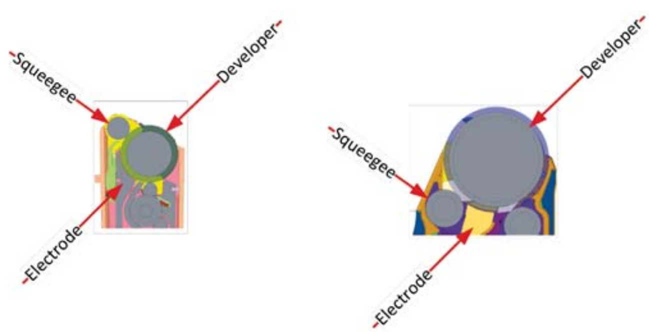

Figure 4: *BID of B3 Press (left) vs BID of B4 Press (right)*

The developer roller is the roller which presses against the photoconductor, and transfers ink to it. As it increased in length by X 2.3, we faced a challenge of rigidity – if the developer would bend, the ink layer thickness would not be uniform. The solution for this was to nearly double it in diameter. However, this forced us to completely change the cross section. The large diameter took a lot of space, so we had to move \ shrink other components, which are building the ink layer on the developer roller (electrode, squeegee).

Another major change was forced by serviceability: The B2 BID is large and heavy, so we designed the unit such that the operator can replace the developer alone, without replacing the entire unit. Obviously, this also reduces cost.

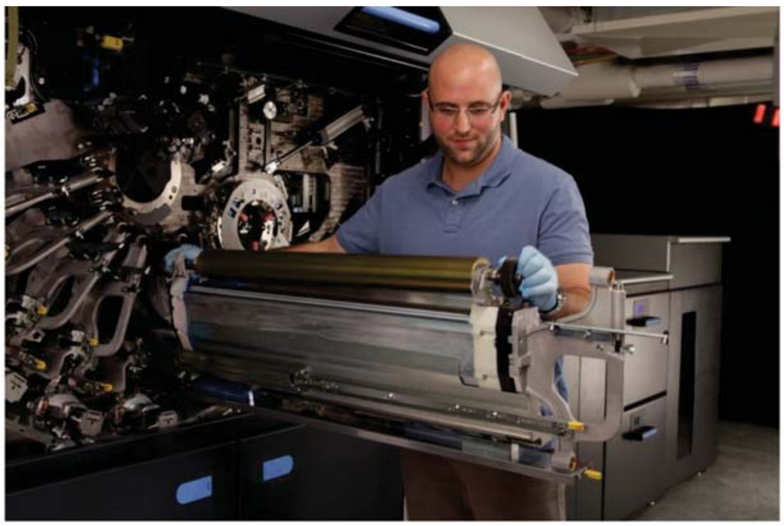

Figure 5: *Replacing Developer Roller*

Paper Transport

The paper transport is built to support versatility, which is the key factor in digital printing: We should support multi substrate jobs, with weight ranging from 70 to 400 gsm, at different sizes, special substrates (synthetic, metallic, etc.), and all at various printing modes from 1/0 to 7/7. See figure 6 below, you can see that the feeder supports 3 types of substrates simultaneously. In the future we shall allow 5 substrates simultaneously, and also multi stacking.

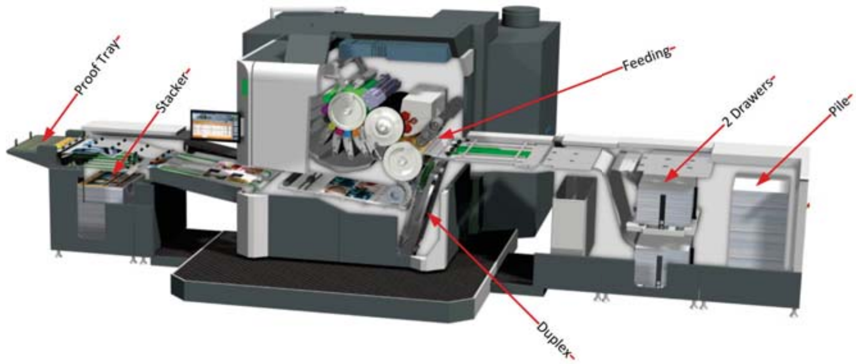

Figure 6: *Paper Transport, B2 Press*

One of the challenges was to allow change of substrates without manual adjustments. To allow this, we are changing automatically paper transport parameters according to the substrate properties – the vacuum level of conveyor belts, the rotation speed of various blowers, etc.

Another challenge is to have accurate duplex feed with various substrates – this is needed to get fine simplex to duplex registration. To solve this we made the duplex conveyor flat, such that the entire sheet can stabilize on it before it is fed back to the IMP drum.

Color

Naturally, when increasing the format, one has to put special emphasis on color uniformity. The customer is expected to position many copies on a given sheet, and all have to look the same. Basically, there are 2 approaches to this:

a) Make sure the physical parameters (temperatures, pressures, flows, etc.) are uniform – this should make the color uniform.
b) Measure the color non-uniformity, and compensate for it.

As this topic is considered critical for quality, we adopted **both** methods.

On figure 7 you can see an example of design for uniformity of physical parameters – in this case it is the temperature of the blanket drum. The nominal temperature of this drum is 110°C. Non-uniform temperature might affect the drying and the color. You can see in the simulation that within the printing area we reach uniformity of 3°C, which we consider good.

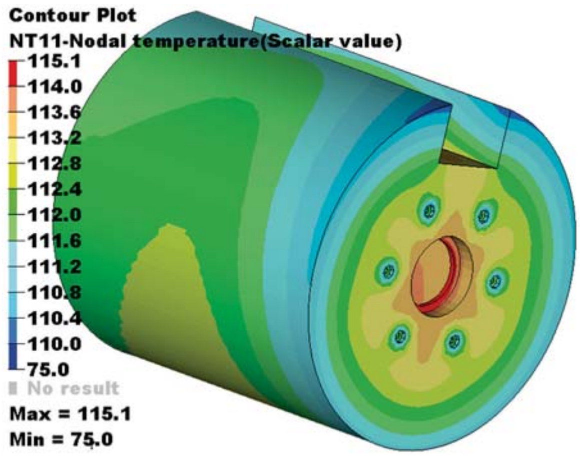

Figure 7: *Temperature Simulation of the Blanket Drum*

The 2nd approach is to measure the color non-uniformity, and compensate for it. We measure the color non-uniformity with the ILS (In Line Scanner), shown at figure 8. We use an automatic wizard, where we print multiple color patches on the pages, and run it through the ILS. The lasers are then modulated accordingly, such that more laser power is given in areas with lighter color. Note this feature will be released to the customers during this year.

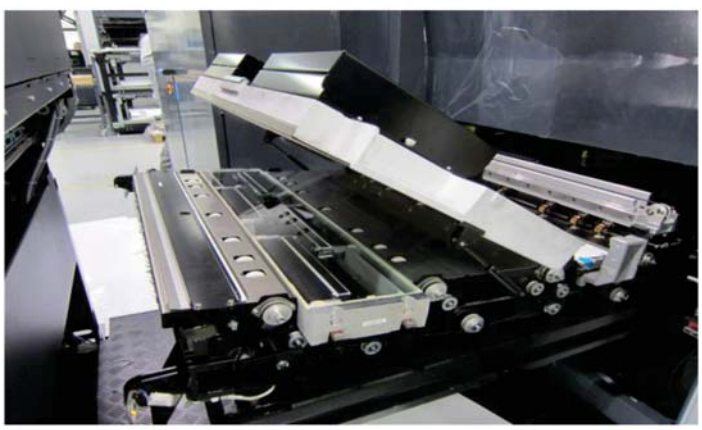

Figure 8: *ILS (In Line Scanner)*

Registration

With large substrates, we are more susceptible to registration issues. We solve this by having both automatic registration wizard and continuous registration compensation during print.

The automatic wizard is using again the ILS. The continuous registration compensation is using special registration cameras (see figure 9). There are 2 cameras measuring registration marks printed at the sides of the page. The cameras are moveable, to adjust to the variable size of the substrate. The data from the cameras is analyzed, and feedback is delivered to the writing head. Note that, unlike offset printing, we are able to compensate for non-rigid deformation (i.e. not just shifts and rotations).

Figure 9: *Registration Camera (left), Registration Marks on Paper (right)*

High Concentration Ink

Our ink is a solution of solid ink particles mixed with oil. Increasing the format implies higher ink consumption – and we don't want to ask the press operator to replace the ink cans too often. The natural solution is to increase the content of the ink in the can – however, we don't want the can to be too heavy. The solution to this was to increase the solid concentration inside the can from ~20% to ~35%. This also has environmental and cost benefits – as we are saving the shipping of excessive oil to the customer, and shipping back the captured oil to the recycling sites.

With 35% solid concentration the ink particles tend to agglomerate, so we had to design an intermediate dispersion unit (see figure 10). The dispersion unit takes the 35% ink and mixes it with ink solution from the tank, before sending the diluted ink back to the ink tank. The high concentration ink will be delivered to our customers during this year.

Figure 10: *Ink System*

Photo-Conductor Automatic Replacement

Our photo-conductor is a brittle foil, wrapped on a drum. On the B3 presses the press operator is loading it manually. However, with B2 size the concern was that manual installation would be very hard, and might damage the photo-conductor. Hence, we designed an automatic replacement unit, which is unloading the used photo-conductor, and loading a new one. On the movie below you can see the installation process: First we clean the drum, next we wet it with oil to improve adherence, and last we push the foil to its holder and rotate the drum, such that the foil is wrapped.

Summary

Moving to B2 was not trivial – we faced many challenges, and had to come up with many creative solutions – but it was achievable. Our B2 press, the HP-Indigo 10000 was presented at the Drupa 2012 exhibition, and was released as a product at March 2013. By now, we have more than 100 presses installed worldwide.

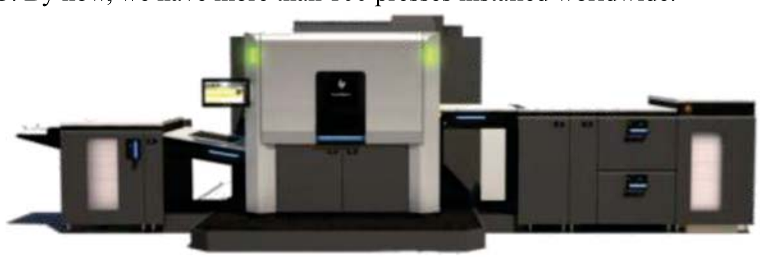

Figure 11: *HP-Indigo 10000*

As a new technology, some topics still needed improvement after the release of the press. We addressed this by releasing SW & HW upgrades, implemented at the customers sites.

The B2 technology described above is used as a platform for a line of products: Following the HP-Indigo 10000 came the HP-Indigo 20000 which is printing on web, and the HP-Indigo 30000 which is printing on heavy media.