NexPress moves to modularity and upgradeability and improves productivity

Detlef Schulze-Hagenest; NexPress GmbH, a Kodak Company; Kiel, Germany

Abstract

The Kodak NexPress 2100 digital production color press, available in 4/5 colors, based on electrophotographic print technology was first introduced at Drupa 2000 and has been improved since then. One of the highlights was the introduction of the Kodak NexPress fifth imaging unit solutions to extend the color gamut and image wise apply clear toner in combination with a near-line glossing unit.

Meanwhile the machine platform was redesigned regarding productivity, modularity, upgradeability and open input/output resulting in the two new products, the Kodak NexPress 2100 plus and 2500 presses. The technical solutions to achieve these optimizations will be discussed in detail. The productivity was improved by higher speed and enhanced disposition of paper on the paper transport web resulting in print efficiency close to that of continuous web printing with same process speed. The print format size and the paper capability were improved as well. The paper feeding area is modular now allowing 2 – 4 feeder with up to 11.000 sheets capacity. On the output side, there is now a new standard delivery unit that can be exchanged to one or two optional high-capacity delivery units using rotating stacker technology with proof tray. The 2100 plus is field upgradeable to the speed and other capabilities of the 2500 as well.

Introduction

The NexPress 2100 press was first shown at the DRUPA 2000[1] and introduced into the market in the following year[2]. The design of the press was based on industrial trends and customer needs, like[3]:

Application	Definition
Quick Turn-Around	Now – less than 24 hours
Short Run	Less than 500
True on Demand	Print what you need, when you need, where you need it
Simple Personalization	Mail Merge
Versioning	Targeted lots by demographics
Customization	Unique assembly static pages by individual with annotations
Fully Variable	True one to one database publishing

Kodak NexPress 2100 press Basic Architecture and Design[3]

The print engine architecture (Figure 1) resembles very much that of a lithographic press, with one heavy-duty printing module for each of the colors.

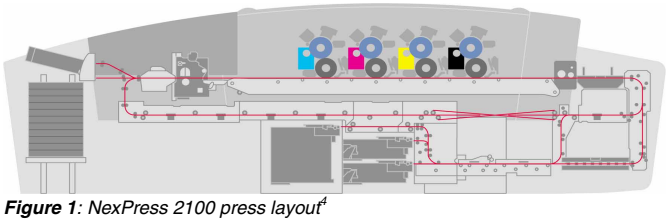


***Figure 1**: NexPress 2100 press layout[4]*

Within a printing module (Figure 2), a 600dpi, 8-bit LED array exposes a charged imaging cylinder. The photoactive element of the imaging cylinder is an organic photoconductor. After exposure, the latent image is developed in a toning station with rotating magnets, using a two-component developer with DryInk. The toned image is transferred to a blanket cylinder and then to the receiver, using electrostatic transfer at both nips. The blanket cylinder insulates the imaging cylinder from being worn by paper roughness or edges, and from paper debris related failures. In addition, the blanket is compliant, which improves the robustness of transfer to a wide variety of receivers, including rough receivers.

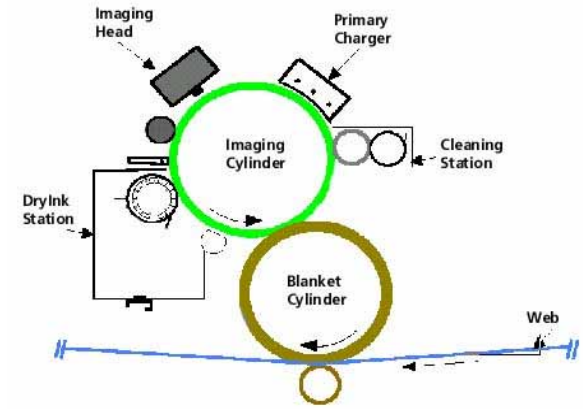


***Figure 2**: Print module of NexPress 2100[4]*

The receiver starts at one of the three input trays, and immediately travels past a sensor that checks for double sheets. The receiver is then placed on a transport web, and passes through the four imaging modules, where it picks up the four separation images in register.

The image is fused using heat and pressure. Robust design of the fuser ensures no productivity loss for coated and uncoated papers in the specified range of weights, from initially 80g/m² to 300g/m². (Note that this range was extended later; see chapter: NexPress 2100 plus and 2500 architecture).

For duplex printing, the receiver is guided to the duplex paper path underneath the imaging modules after the first side is printed. Front-to-back registration is ensured by using the "Same Edge Perfector" (SEP) technology (Figure 3), where pages are flipped on the long edge, so that the same edge of the receiver is used for registering the front and the back side. Robustness of the paper path is ensured by minimal start-stops or direction changes of the receiver. After printing, the job is output to a proof tray or to a high volume tray.

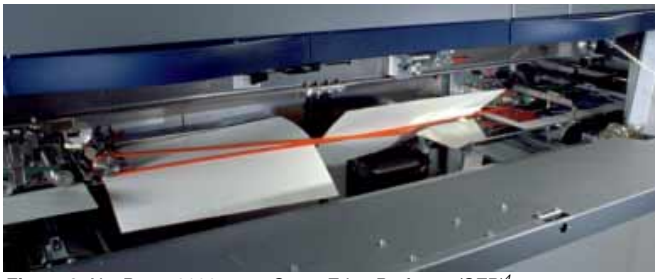


***Figure 3**: NexPress 2100 press Same Edge Perfector (SEP)*[4]

One design principle used in the NexPress 2100 for maximum uptime is the use of "Operator Replaceable Components" (ORC's) for the components that are intended to be replaced. The operator can replace these easily in minutes, thereby eliminating the need for service calls for these failures.

The brains behind the 2100 is the NexStation™, a multi-functional digital front-end that serves as a complete workflow solution, houses the diagnostics system and provides press management. It supports 100% variable-data printing at full speed.

The NexPress 2100 press has a simplex speed of 2100 A3 pages per hour, or 4200 A4 pages per hour.

Kodak NexPress 2100 press: Image Appearance Enhancements via fifth imaging unit solution

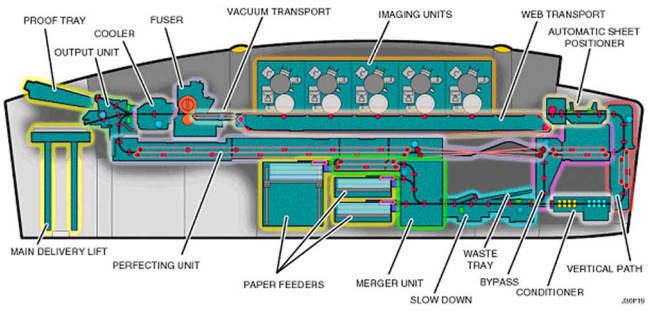


***Figure 4**: NexPress 2100 press with 5 print units*

The NexPress 2100 press with Kodak NexPress fifth imaging unit solutions (Figure 4) was introduced at the Drupa 2004. Many new applications and solutions were now possible[5,6].

In a four-color printing process, only a fraction of popular corporate identity colors and spot colors are reproduced accurate enough for acceptable commercial usage. The 2100 equipped with 4 colors already delivers an almost 20 % wider color gamut than standard offset printing. Dedicated spot colors have been used in offset printing and some digital presses to deal with the issue. With a changeable 5th color station and Red, Green and Blue DryInk™ to choose from[7], using a pentachrome five-color multi-level halftone color managing process, the NexPress 2100 expanded the available color gamut and spot color coverage to match ~85% of standard spot colors for acceptable commercial usage in the NexPress Intelligent Color printing solution[5] (Table 1 and Figure 5).

Table 1: Effects of Various 5th Color Toner in the Pentachrome Process of the NexPress 2100 press[7].

Condition	Gamut Volume	# of Std Spot Colors within Gamut	% of Standard Spot Colors in Gamut
CMYK	475070	593	52%
CMYK + 3 dE	595890	746	65.60%
CMYKG + 3 dE	682390	805	70.80%
CMYKR + 3dE	661655	795	69.90%
CMYKB + 3dE	673312	804	70.70%
CMYKRGB + 3dE	870779	972	85.50%

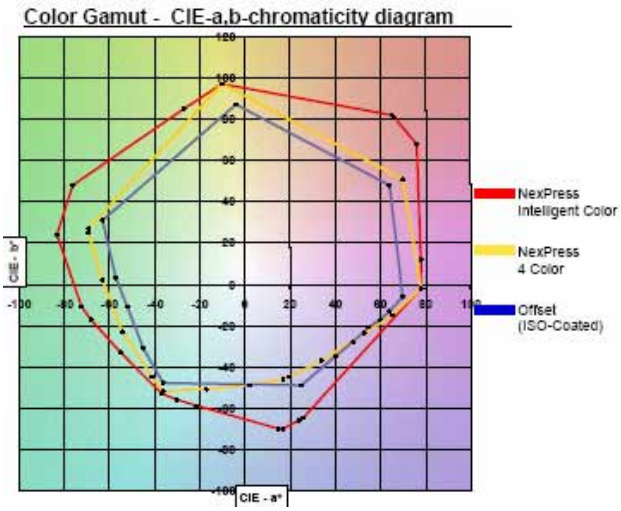


***Figure 5**: Color gamut comparison Offset, NexPress 4-color and NexPress 5-color printing*

If a clear DryInk (CDI) is used in the 5th station, along with the standard CMYK DryInk in an Intelligent Coating process that apply CDI in selective areas of the image, significant improvement on image abrasion resistance has been demonstrated[5] (**Figure 6**). The end result exceeds the capability of offset printing with aqueous coating for image protection.

Further reduction in differential gloss and color granularity is also a benefit[5]. For digital output, the image gloss is low even on a highly glossy paper in areas where the print density is low. This is caused by the scattering due to islands of toner present on a smooth surface. At higher densities, islands of toners grow bigger until uniform high gloss is obtained. As a consequence, the differential gloss that is commonly observed even in uncoated offset images can be overcome with the use of a clear toner overcoat. The clear

overcoat provides a uniform gloss on all types of media because a uniform coating is applied over the entire image (Figure 7).

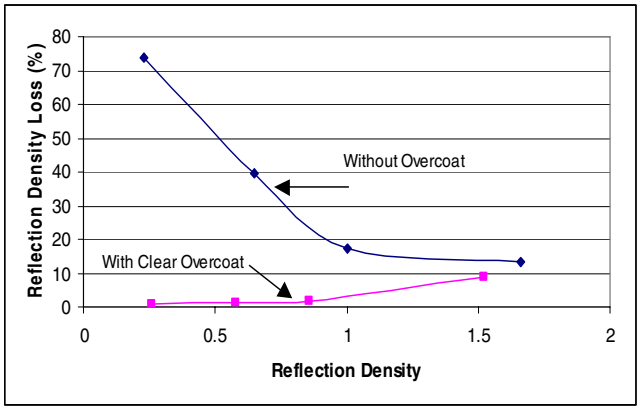


Figure 6: *Results from Taber Abrasion tester showing increased image protection provided by clear overcoat*[5].

Other applications for CDI in the fifth station of the Kodak NexPress 2100 are e.g. spot coating or clear watermarking for design or security purposes.

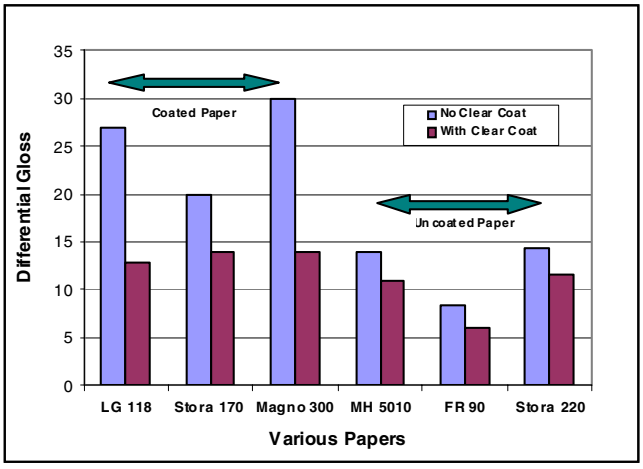


Figure 7*: Improvement in differential gloss is demonstrated with the clear toner overcoat on various paper surfaces.*[5]

With the introduction of a near-line Kodak NexGlosser glossing unit, the CDI image with clear overcoat can be further glossed up to a very high and uniform gloss (G20 =~90 can be achieved) in the glossing process for photo-rich applications[8]. The main components of the Kodak NexGlosser glossing unit are shown in Figure 8. The printed substrate for glossing begins at the Feeder (1). It goes through the Transport (2) and then enters the Belt Glosser (3) where a nip is formed between the heater roller and pressure roller assembly.

The substrate is attached to the fuser belt by the heated dry ink. Heat, pressure, and the Fuser Belt produce the high gloss on the substrate. Finally, the substrate is cooled by the cooling plate assembly, separated from the fusing belt, and transported onto the Stacking Platform (4).

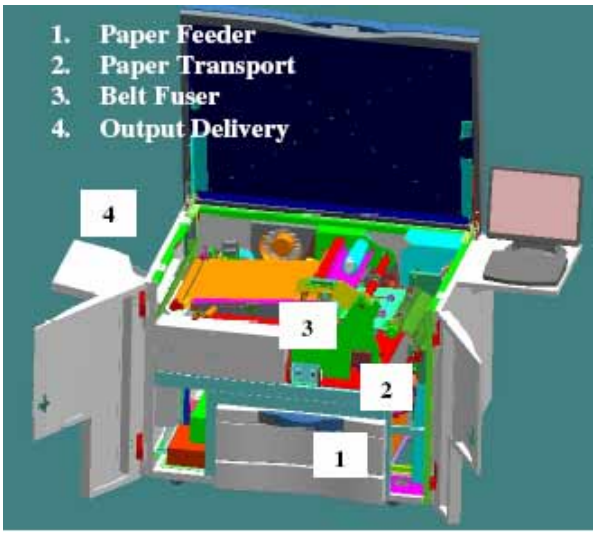


Figure 8*: View of Kodak NexGlosser glossing unit with the front and the top doors open*[8].

Placing the simplex glossed prints back in the feeder tray and repeating the glossing process accomplish duplex glossing. The Belt Glosser is shown in more detail in **Figure 9**. The glossing belt is a thin seamless web made of heat resistant polymeric material such as polyimide. It is further coated with low surface energy wear resistant coatings to improve print release without image interruption and the durability of the belt surface. The glossing belt is entrained around the heating roller, which is driven by a motor, and the release roller. The release roller is also used for steering the glossing belt.

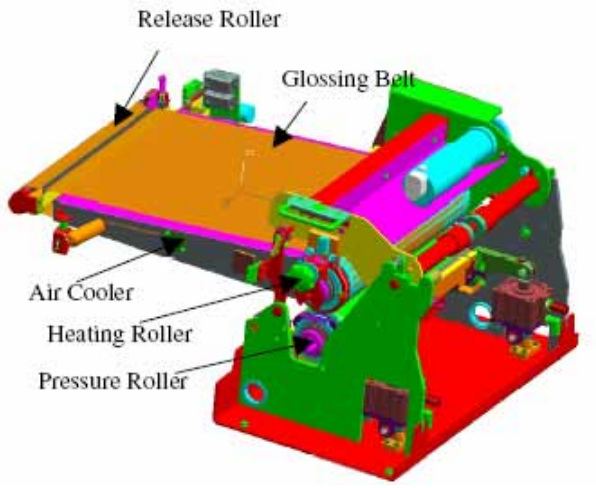


Figure 9: *Side view of the glossing belt assembly*[8]

In addition to that, it has been shown that the optimized process can increase the color gamut of the entire printing system for many substrates (typically in a range of 10% increase in gamut volume)[6]. Figure 10 compares the cross-section (a*, b* plots) of the color gamut of a regularly fused image and an image that went through the Intelligent –Glossing process with the glosser finisher

using a 270g/m^2 coated matte paper. The cross-sections are shown at the L* values of 20, 40, 50 and 80.

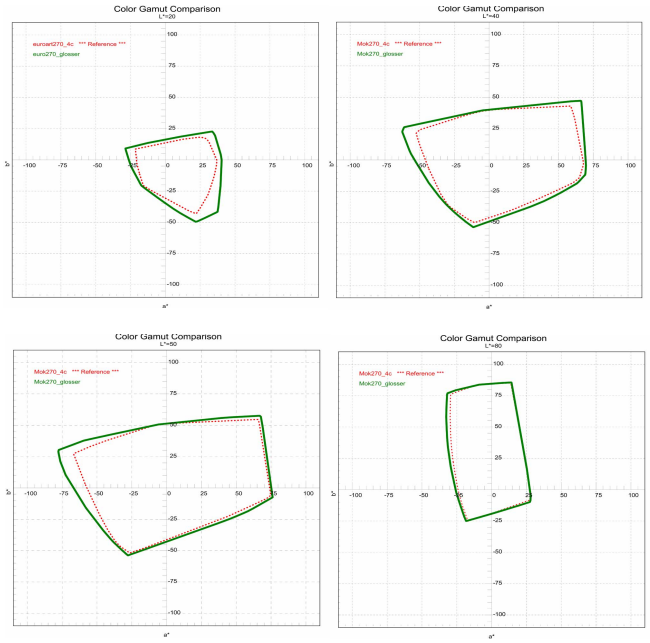


***Figure 10**: Cross-section plots (a*, b*) of color gamut (dotted line for 4-color regular fusing, solid line for glosser output) at L* of (20, 40, 50 and 80*

As one can see, there is substantial increase in the color gamut, especially in the red, green, blue and other darker color regions of the color gamut due to the Kodak NexGlosser glossing unit process.

***Figure 11**: Paper pass of Kodak NexPress 2100plus and Kodak NexPress2500 equipped with four paper deliveries and high capacity delivery*

Kodak NexPress 2100 plus and 2500 Architecture

At Print 05 in Chicago, Kodak announced[9] two new color offerings: the NexPress 2100 plus and the NexPress 2500. The NexPress 2100 plus was available immediately and the NexPress 2500 has been introduced at IPEX 2006.

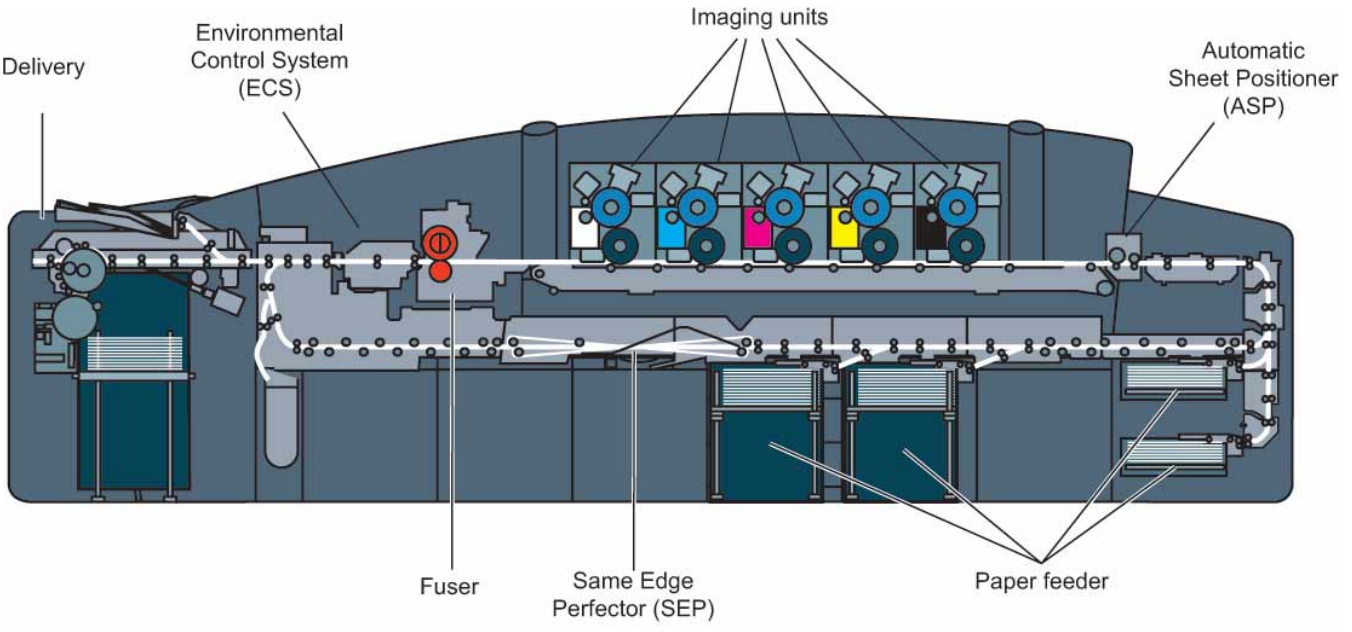
The NexPress 2100 plus and the NexPress 2500 are differentiated from the NexPress 2100 by a number of factors, including a

- larger print format size (up to 356 x 520 mm),
- broader substrate capability (60 to 350 g/m², up to 0.4 mm thickness),
- expanded feeding & finishing capabilities and options (two to four paper feeders (with up to 11,000 sheet input capacity with four), new standard delivery or new single (or dual) high-capacity delivery, inline finishing architecture)
- an expanded number of operator-replaceable components (ORCs), and
- an improved throughput feature called "Productivity Optimizer."

The 2500 also offers a faster speed (2,500 4/0 & 5/0 A3 sheets per hour) in relation to the 2100 and 2100plus (2,100 4/0 & 5/0 A3 sheets per hour). In addition, the 2100plus is field upgradeable to the speed and other capabilities of the 2500.

Redesigned Paper Path

Kodak has redesigned the paper path on the underlying architecture for its new products (see Figure 11). The duplexing area has been moved up, creating additional space for paper. Two paper feeders are standard. With the maximum four feeders, the total input capacity is 11,000 sheets. On the output side, there is now a new standard delivery unit. An optional high-capacity delivery unit with proof tray (490mm pile stacker capacity/50mm proof capacity) can replace the standard delivery unit. The devices can accommodate one or two of these high-capacity delivery units.



The high-capacity formation can hold up to 6,000 80g/m² text sheets per unit. Kodak has also redesigned the output cart to facilitate moving printed output from the device. The redesign of the paper path allows running 60 – 350 g/m² paper up to 0,4mm thickness.

Broader Format Capability

The increased format size of the 2100 plus and 2500 adds 50mm on length and 5mm on width. The smallest printable sheet size is now about 10mm smaller, which opens up some new opportunities, particularly multi-up postcard applications

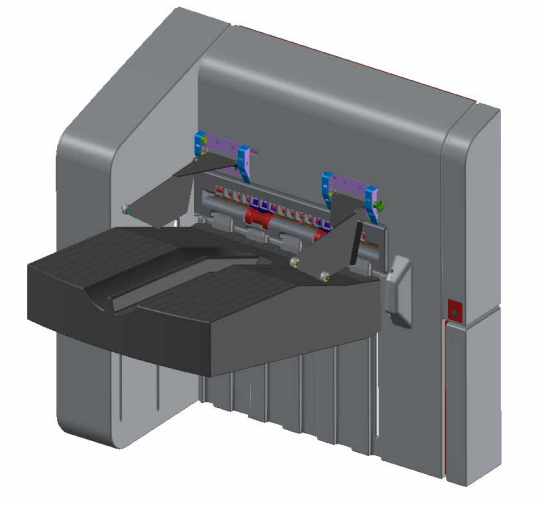


***Figure 12**: Standard delivery of the Kodak NexPress 2100 plus and 2500 presses*

Standard Delivery

The standard delivery (Figure 12) was newly developed and allows a delivered paper stack of 200mm pile height. Profiled paper transport roller and movable lateral side guides direct the paper into the right position.

High Capacity Delivery

The high capacity delivery (Figure 13) is newly developed using a specific proprietary rotating stacker or flipping wheel technology. The stacker allows a maximum pile height per unit of 490mm, which is equivalent up to 6,000 80g/m² text sheets. The proof tray on top of the stacker has a pile height of 50mm.

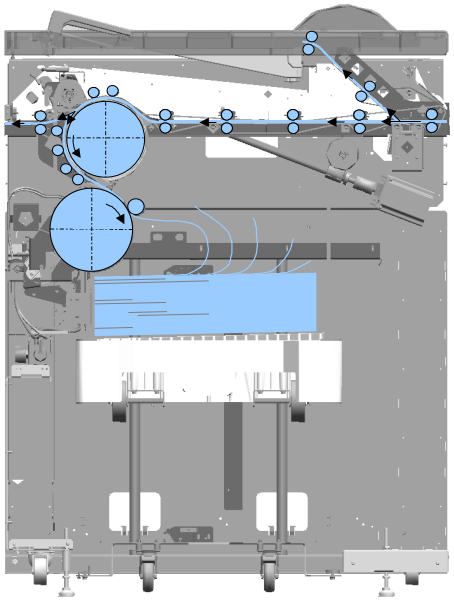


***Figure 13**: High capacity delivery of the Kodak NexPress 2100 plus and 2500 presses with proof tray*

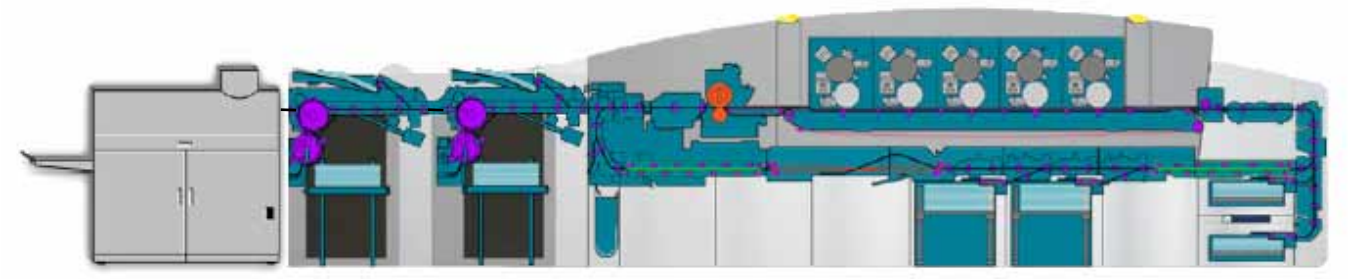
Inline Finishing

The Kodak NexPress 2100 plus and 2500 presses have a document finishing architecture (DFA) that facilitates the integration of third-party finishing devices. This creates new opportunities for inline finishing options, the first of which is a booklet maker (Figure 14).

Productivity Optimizer[10]

The new "Productivity Optimizer" feature improves throughput on non-standard paper sizes by positioning the paper more effectively on the belt, which automatically adjusts for different sheet sizes during the printing process to provide greater efficiency and throughput (Figure 15). This is achieved by using dynamic instead of static frames for the paper in the paper path and specifically on the paper transport web. The distance between the sheets is kept more or less constant resulting in print efficiency of large formats close (up to 92%) to that of continuous web printing with same process speed.

***Figure 14**: Kodak NexPress 2500 press schematic showing redesigned paper path, four paper feeders, two high-capacity delivery units with proof deliveries, and inline booklet maker (far left)*[9]



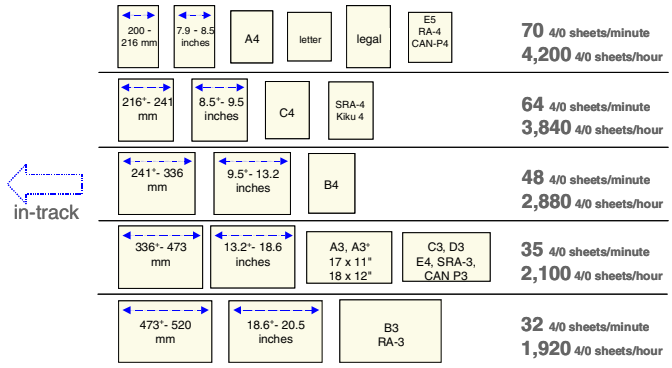


Figure 15: *Throughput as a function of sheet size*

Figure 16 compares the productivity of the Kodak NexPress 2100 plus and 2500 presses with former Kodak NexPress generations and with other presses in the market. Paper sizes where large benefits are seen include those between A4 and A3, as well as C4 and B3 (8.5"-13.3" and 18.6-20.5") sizes. As one can see from this picture the productivity of a digital press for direct printing of A4-pages cannot directly be extrapolated to large formats, which are most relevant for digital production printing.

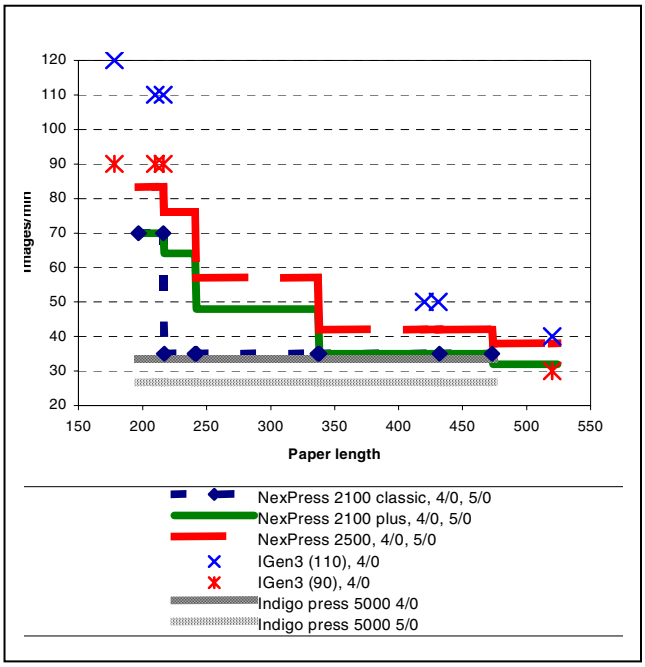


Figure 16: *Productivity comparison of different digital color production presses in relation to paper format length and number of colors printed. Note that there are differences in format width as well which are not discussed in this paper. Data for Indigo und IGen3 presses from suppliers data sheet.*

Summary

The Kodak NexPress digital production color press platform was redesigned regarding productivity, modularity, upgradeability and open input/output resulting in the 2100 plus and 2500 products. The technical solutions to achieve these optimizations have been discussed in detail.

The productivity was improved by higher speed and enhanced disposition of paper on the paper transport web. The print format size and the paper capability were improved as well. New standard delivery and optional high-capacity deliveries were introduced.

Finally it was deduced, that the productivity of a digital press for direct printing of A4-pages cannot directly be extrapolated to large formats, which are most relevant for digital production printing.

References

[1] Josef Schneider and Ralf Schlözer, New Products and Technologies at DRUPA 2000, DPP 2001: Eye on the Future, Antwerp, Belgium; pg. 4-12 (2001)

[2] Mark W. Fleming, High-Volume Production: The Next Test for NexPress, The Seybold Report September 17, 2001

[3] Arun Chowdry, Digital Color Printing and the NexPress Approach, IS&T NIP 17: Int. Conf. on Digital Printing Techn., pg.267 (2001)

[4] Detlef Schulze-Hagenest, NexPress2100: A solution for high quality digital color printing, MET 25 (Munich's Electrographers Meeting) 26.02.2002

[5] Dinesh Tyagi, Peter Alexandrovich, Yee Ng, H.T Tai, Rich Allen, and Diane Herrick, Enabling Expanded Color Gamut and In-line Coating Processes, IS&T NIP20: Int. Conf. on Digital Printing Techn., pg.135 (2004)

[6] Image Appearance Enhancements via NexPress 2100 5th Module Applications, Yee S. Ng, DPP 2005 International Conference on Digital Production Printing and Industrial Applications, Amsterdam, The Netherlands; pg.137 (2005)

[7] Materials for In-line Protection and Expanded Color Gamut of Electrophotographic Prints Using Fifth Imaging Module, Detlef Schulze-Hagenest, Dinesh Tyagi, Chris Reece, Jeffrey J. Wang, DPP 2005 International Conf. on Digital Production Printing and Industrial Applications, Amsterdam, The Netherlands; pg. 198 (2005)

[8] NexPress Glosser Process for Photo-Rich Applications, Muhammed Aslam and Yee S. Ng, IS&T's NIP21: International Conf. on Digital Printing Techn. pg.607 (2005)

[9] Kodak Unveils NexPress 2100plus and 2500, Jim Hamilton, Info-Trends/CAP Ventures, September 9, 2005, www.capv.com

[10] Detlef Schulze-Hagenest, Architectural Optimization of 5-Color Digital Production Press, Printing Technology SPb´06, St. Petersburg State University of Technology and Design (Russia), 204 (2006)

Author Biography

Detlef Schulze-Hagenest studied physics and intellectual property law in Hamburg and Berlin and received his PhD in physics from Kaiserslautern-University. Since 1980 he is working in the field of platforms, processes and materials for digital printing with special focus on electrophotography and ink jet. He is currently Senior Engineer Advanced Technology at NexPress GmbH, Kiel, Germany, a subsidiary of Kodak. He is author of 46 patent families and enjoys classical music and gardening. He is a member of the IS&T and serves as European Program Chair of this conference.

Acknowledgment

The author thanks the staff of Eastman Kodak Company, 2600 Manitou Road, Rochester NY (USA) and of NexPress GmbH,, Am Kiel Kanal 2, Kiel (Germany), a subsidiary of Kodak, which have worked directly or indirectly at the solutions described in this paper specifically the authors of the Kodak/NexPress papers cited in the review part of this paper particularly Dinesh Tyagi and Yee Ng from Rochester and Dirk Dobrindt and Eckard Bauer from Kiel. The author thanks Arun Chowdry, Art Carroll, Christian Compera and Sönke Dehn for making this paper a reality.