The Impact of In-Press Imaging and Erasable Forms on Press Design

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Abstract: The main structuring factor of today's printing industry is not the print process itself, but the printing form preparation and the change-over characteristics. Innovations in the form preparation process bear the potential of having a big impact on the printing industry. This paper would like to show the new opportunities in mechanical engineering and for the general press concept which have been made possible by in-press imaging in combination with erasable printing forms.

Introduction

When talking about the printing industry and printing trends, we generally group or classify by the printing processes itself. Traditionally the most influential factor is not within the press, it has been in front of the press, sometimes in a completely different company – the preparation of the printing form.

A comparison of the plate making costs of the most important printing processes are summarized in the graph on the next page.

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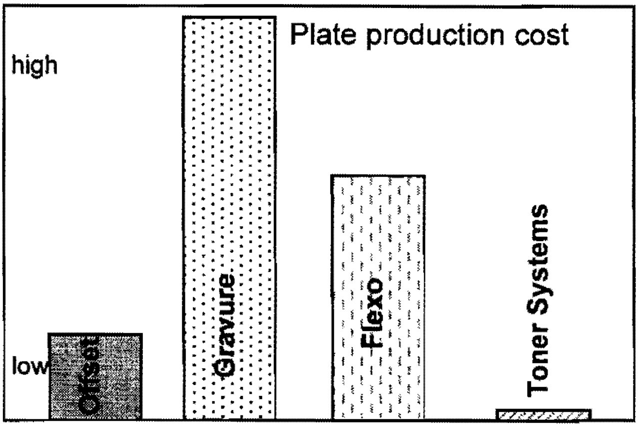


Figure 1: Comparison of Plate making cost of different printing processes

Compared to other permanent master printing processes, a special advantage of the lithographic printing process, has been its fast, relatively inexpensive and high quality forme making process. One of the main properties of offset plate making is the small amount of material transfer needed to generate a printing form. Therefore the printing form is light, easy to handle and easy to process, even for high quality applications. In fact the forme making process has been so advantageous, that despite difficulties in handling the printing process, especially the sensitive water and ink balance, offset printing became the most popular printing process.

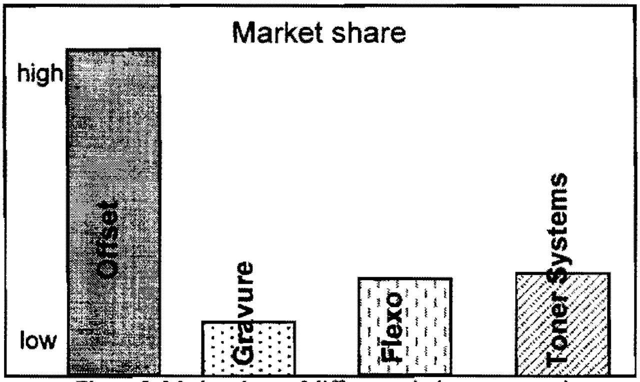


Figure 2: Market share of different printing processes in commercial printing

The advantage of conventional printing processes, compared to electronic printing, are the low printing and consumable costs, once the printing has started. This becomes important, as multiple copies are produced and the high costs of variable printing consume the advantages of the masterless printing process particularly if the additional cost can not be made up by personalization. In competing for very high run lengths, even smallest the differences in production cost are important and we see some differentiation in the preferred conventional printing processes. But in the center run length range, where most print products are produced today, both factors are equally important.

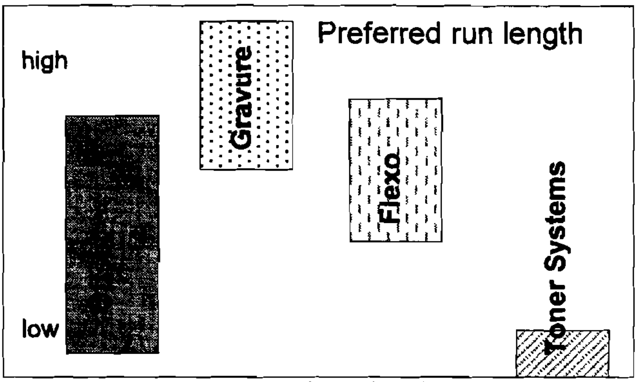


Figure 3: Most economic run length of printing processes (not to scale)

It can be seen, that the forms production process, together with print production costs, determines the choice of the printing process and the preferred run length of application. In this situation it can be expected that changes in the forme making process will have a big influence on the choice of the printing processes. Furthermore, the forme making process influences the printing process itself and the press design. Especially because in-press imaging methods interact directly with the printing unit and have a great potential to alter and modify the design of new print production systems.

In-press imaging technologies

The first permanent master printing technology, which saw the introduction of the commercial in-press imaging products was not surprisingly offset printing. The simplicity of its forme production promoted the development of in-press imaging applications for offset printing. A variety of in-press imaging methods and products have been developed so far and the first commercial product was introduced already in 1993. After years of ongoing developments several solutions from different manufacturers have been brought to market and more have been announced for this year. In general two methods can be distinguished:

1. In-press imaging using a plate or similar permanent carrier
2. In-press imaging processes with an erasable printing surface

In case one an image forming-layer linked to a forme carrying material, commonly called plate, is used. The image-forming layer does not contain any printing information when fed into the press. Inside the press, the forme can be imaged first and then moved to a position for production printing, where inking of the forme and transfer to the blanket takes place; or can be moved to the latter position first and be imaged there. In both cases, a plate or other carrier material gives the printing image its stability during the print run. After the print run the image-forming layer, and with it the carrier material, has to be discarded.

In case two the image forming components do not have a base material or they do not have an intermediate carrier which is suitable to be directly printed from. During the imaging process the image forming substances are transferred to the forme cylinder surface, where later on the printing process takes place. The printing image resides directly on the forme cylinder surface. The dimensional stability of the printing image during the print run is achieved by the forme cylinder itself. After the print run is completed, the image forming substances have to be removed or covered.

The fundamental differences of the in-press imaging methods is the erasability of the image inside the press. So far three methods have been made public:
- Thermal transfer
- Spray on polymer
- Laser induced copper deposition

For a better insight on the effects of erasable in-press imaging technologies, one of the three technologies is explained in brief: The thermal transfer process.
The process comprises of three major steps

Step one:
The imaging material is a thermal transfer polymer coated on a transfer ribbon. This ribbon is brought into close contact with a forme cylinder surface. As the forme cylinder spins, the ribbon is unwound from a cartridge. A high power IR-laser heats the thermal transfer ribbon according to the desired image. The polymer is transferred to the cylinder surface and adheres to it. Ribbon and laser traverses the cylinder width to cover the complete printing area. The transferred polymer is ink receptive, the uncovered cylinder surface is water receptive.

Step two:
After imaging a fixing and conditioning step is applied to improve the printing conditions. A contactless heating element heats the forme cylinder and the transferred polymer. The effect can be roughly compared to baking a conventional offset printing plate to increase its run length durability. During the conditioning process a conditioning liquid is applied to improve the water receptivity of the image-carrying cylinder and to ensure excellent printing conditions. Afterwards the

printing process can start using conventional wet offset inks. All copies of the run are identical, since the imaging process only takes place between print runs,.

Step three:
After the desired number of copies has been printed, the press is stopped. Residual ink has to be removed with an organic solvent. Than a de-imaging liquid is sprayed onto a cleaning cloth. The cloth removes the polymer from the forme cylinder surface, similar to a blanket-washing device After the de-imaging step, the surface of the forme cylinder is totally clean and ready to be re-imaged.

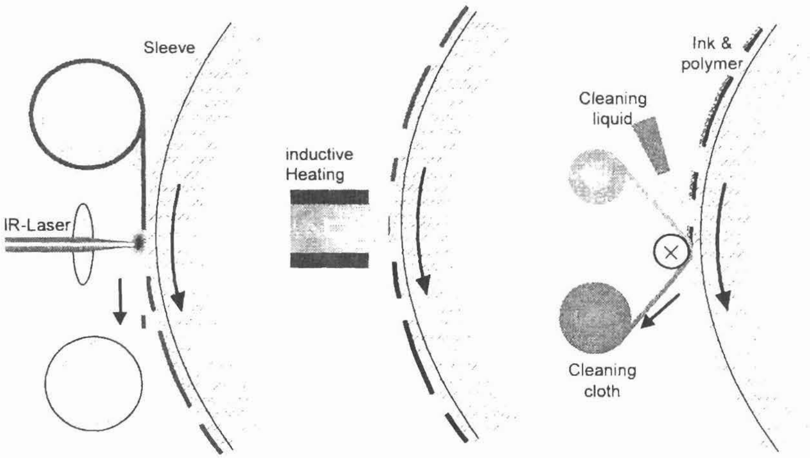


Figure 4: Thermal transfer process
Imaging Fixing Erasing

Additional consumables used for an imaging cycle besides the thermal transfer ribbon, are the de-imaging liquid, the conditioning liquid, and the cleaning cloth. The thermal transfer ribbon can be supplied as a cartridge and each cartridge contains enough thermal transfer ribbon for multiple images.

Considerations for a short run press design

The potential of in-press imaging is to automate and streamline the change-over process and subsequently to reduce the makeready cost significantly. This is vital for the economic printing of short runs. On the other hand an in-press imaging device is less suited to handle very high runs, as the imaging subsystems are idle during the print run. Therefore the most economic run length is confined to a distinct run area: where off-press imaging fixed costs are too high fixed cost and electronic printing systems are too expensive due to their high cost per printed sheet.

This logical field of application of the in-press imaging method determines the optimal design of the printing unit. Additional requirements, which are not directly related to the imaging, should therefore also be considered for a new press design as a short run print production tool. Such as:

- high flexibility in production capabilities
- fast press set-up
- low number of waste sheets
- high degree of automation
- high availability
- high degree of workflow and production-flow integration
- instant availability of a finished or partly finished product
- fast and easy service and maintenance

These requirements are desirable for nearly every printing press but are especially important for short run applications. For the most favorable press design, the in-press imaging system can not be seen as a separate factor, but as an integral part of the press. By integrating an in-press imaging system, some new conditions and possibilities arise for the printing unit.

Influence of in-press imaging on press design

The application of in-press imaging technologies had some distinctive requirements on the printing unit design and on the change-over characteristics compared to traditional off-press imaged plates. However equally important is the further potential of erasable in-press imaging methods compared to plate based in-press imaging methods. Some specific issues should be discussed.

Plate based printing presses, with or without in-press imaging, require a plate feed and eject mechanism. The plates have to be moved onto the forme cylinder and held by a mechanism in a fixed position. To accommodate the transport and gripping mechanism, a gap in the forme cylinder is needed. To automate the change-over process, especially for in-press imaging, it is preferred to have a stock of plates inside the press. Erasable in-press imaging methods do not need any plate holding mechanisms and can print from a gapless cylinder surface. On the other hand, they require mechanisms to apply and to remove the imaging material. As the volumes of the imaging materials are relatively small, or consist of liquids, it is relatively easy to transport them and to store enough material for multiple images.

The volumes of the transferred material also influences the price for a new printing forme. Avoiding a plate as a carrier material and merely using the functional image forming substance has the potential of reducing the material cost, as well as storage and handling costs.

In principle a registering mechanism should not be necessary with in-press imaging technologies, since the image is produced in exactly the position, where the printing process takes place. The imaging lasers achieve a much better registration than it would be possible by mechanical registration. But mainly due to the sometimes "unpredictable" behavior of the paper a side and a circumferencial register especially for larger formats and high quality printing becomes advisable. Additionally front to backside register should be controlled. But since the printing image is firmly connected to the forme cylinder, a change of the image angles in respect to each other is impossible, therefore a diagonal registering mechanism is not needed.

With erasable in-press imaging technologies, the image can be directly produced on the surface of the forme cylinder. In this case, the surface of the cylinder has to be capable of holding the imaging material and performing other tasks necessary for the printing process (e.g. water receptivity) and it has to be durable enough to endure multiple imaging, printing, and erasing cycles. In our research, we found that a sleeve surface, directly on top of the forme cylinder is much more advantageous than using the surface of the solid cylinder itself. This has been required by the erasing process to a much smaller extent than initially expected. We discovered that the wear of the cylinder surface during the normal imaging and re-imaging cycles is minimal. However due to mechanical handling of the cylinder or inattentive operating by the printer in the printing press, the forme cylinder surface can be damaged, particularly scratched. These damages can affect the quality of the printing image. Whereas a complete cylinder is difficult and expensive to replace, a sleeve with a functional surface is easy and quick to replace. Other reasons for using the sleeve technology are a bigger choice of surface materials without having to manufacture a complete cylinder out of a specific material. And a heat insulating layer can easily be incorporated to speed up the thermal fixing step.

Feature	Off-press imaging	In-press Plate based	In-press erasable
Plate loading & extracting mechanism	+	+	-
Gap in forme cylinder	+	+	-
Cost of carrier material	+	+	-
Application and Erasing device	-	-	+
Danger of wear and damage of forme cylinder surface	-	-	+
Amount of material moved for each forme change	+	+	-
Diagonal register	+	+/-	-
Potential for seamless printing	-	-	+

Table 1: Influence of forme preparation on press design

The printing unit concept

As outlined before, the development of a press with integrated in-press imaging, in this case the thermal transfer process, has a big influence on the press design. For us the task has been to identify a press design for a web-fed offset printing press, optimized for erasable in-press imaging and short run color applications. As a printing unit design, three different basic unit designs have been investigated

- Conventional printing unit design
- Single sideframe design
- Linear movement with two sided bearings

In a conventional design the forme, blanket and impression cylinders have an essentially fixed position with minimal movements to throw impression on and off. The cylinders are mounted on both sides in eccentric bushings to achieve this movement. Massive sideframes support the bearings and also support all necessary components in the printing unit, e.g. inking, dampening, in-press imaging (if applicable), sensors and washing devices. All elements have a fixed position and are built into the sideframes. This design is proven and reliable and is applied today from small offset duplicators to the largest and fastest offset presses. Unfortunately the requirements in flexibility and expandability that are associated with in-press imaging and short run production, make this design seem to be not especially advantageous.

In a single sideframe design the forme, blanket and impression cylinders have only bearings on one side and these are mounted in one single sideframe. The operator side of the cylinders has no support. In order to take up the static and dynamic forces during the printing process, the drive side support has to be very stiff and solid. Also the cylinders have to be very rigid to absorb the pressure without deformation. We have applied the single sideframe design in our very narrow web testing presses with great success. It offers easy access to the components in the printing unit and allows for a quick exchange of cylinders and sleeves. However due to the high demand for an equal pressure in the printing nip, the printing width is limited and the demands for the pressure control are getting increasingly high. An increasing printing width would make the press components become increasingly difficult to attach, service or to replace.

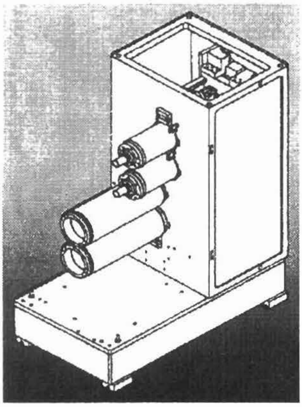
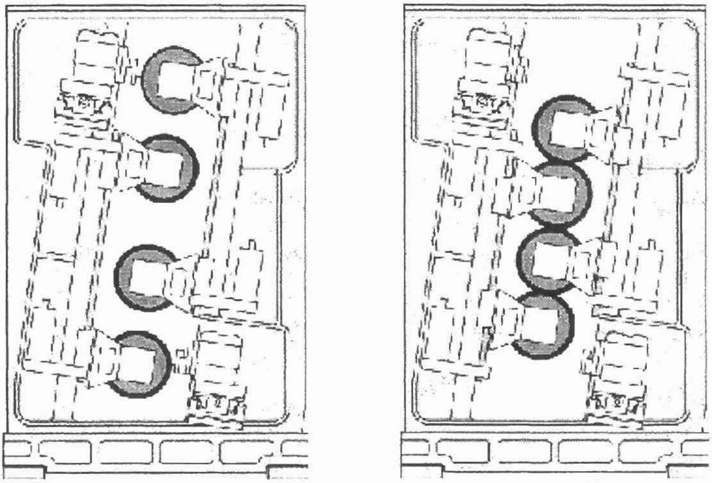


Figure 5: Example of single sideframe press design

In the linear movement concept the cylinders have bearings on both sides, however instead of having bearings built into a sideframe, they are mounted on linear slides. The cylinder bearings are themselves on ball bearings on the slide and are driven by a spindle to move up- and down in a linear fashion. The function of holding the cylinder bearings in position is not taken up by a sideframe, but by the linear slides and a driving spindle. Rotation of the spindle causes the ball bearings to move accordingly. The driving spindle takes up the pressure during the printing process, and there is no bearer contact between the printing and blanket cylinders. As both forme and blanket cylinders can use sleeves, there is also no danger of dynamic excitation by the channel impact. In this case excessive wear or strain of the spindle is not expected.

The slides are tilted on a small angle from the vertical axis to achieve a certain angle of wrap for the web between the blanket cylinders, to ensure a safe substrate transport.



Imaging position Printing position

Figure 6: Example of linear movement design

To change the sleeves for blanket and forme cylinders, the operator side bearings can be unlocked and moved away on the linear slides, while the bearing on the drive side stays stationary. During this operation the cylinder is held in position on one side only. Without putting impression on, the strain on the one bearing is not critical. The sleeves can be pulled axially from the cylinder core.

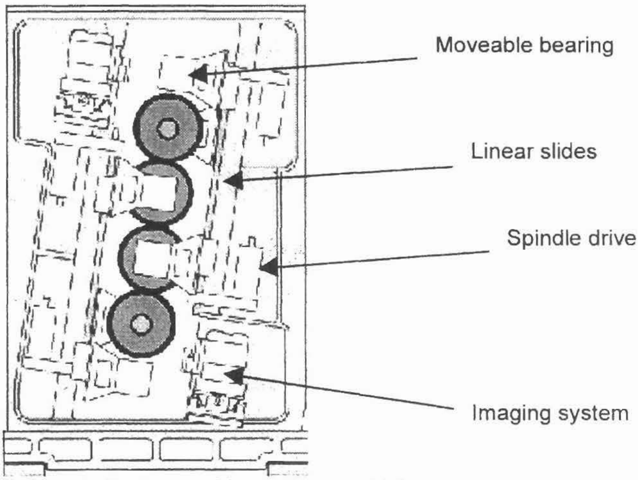


Figure 7: Exchange of forme sleeves with linear movement design

If the bearings on both sides of the cylinders are locked, their movement must be in absolute synchronicity to avoid cocking the cylinders. This is achieved by determining the exact angle of rotation of the driving spindle. The pressure in the printing nip is adjusted by moving the cylinders on the slides. At any time the pressure can be directly set at the control console and these settings can be reproduced exactly. Very fine increments are possible. Also the thickness of the substrate can be taken into account, meaning that changes of the substrate type or thickness do not need any manual adjustments in the printing unit.

Furthermore, since the distance of the axis of each cylinder in the printing unit is not fixed, the linear movement concept has the capability to change the printing format. This can be achieved by exchanging sleeves with different wall thickness' or by exchanging the cylinders. An exchange of sleeves is relatively easy to perform, as they can be made out of light weight materials, but the maximal wall thickness is limited. The components in the printing unit, which have contact to the forme cylinder during the printing operation have to be positioned according to the position of the axis. This means they have to adapt their position to the circumference of the cylinder. Other components (e.g. the imaging device) can be arranged in a distinct position while the cylinders have to be moved to the corresponding location to have a certain function performed (e.g. imaging). In fact it can be advantageous, to keep different functions spatially apart (e.g. imaging and printing). Additionally it enlarges the space in which components can interact with the cylinder inside the printing unit. Of course additional actuators for the components are needed and the requirements relating to the press control concept are higher.

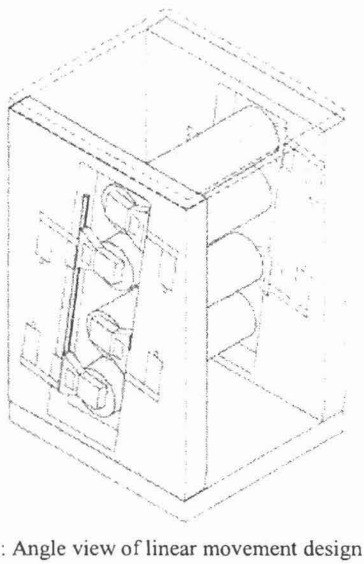


Figure 8: Angle view of linear movement design concept

In the linear movement design the sideframes act more like a framework or suspension for the cylinders, than like a fixed case in the conventional design. The components do not need to be built into the sideframe structure. It is possible to put all components between the frames and have separate connectors to the sides. For example the inking can sit on a horizontal slide and does not need to be integrated into the sideframe. This is the basis for the modular printing unit concept and being able to adapt to different size and processes It also simplifies the customizing the printing unit according to the customer's needs. Moreover the press components can easily be removed from the printing unit for servicing and replacing. The latter can be important for components with short innovation cycles, like the imaging system, where a new and more powerful generation can be integrated. Additionally press components can be exchanged in order to adopt to new and changing print production requirements of the customer.

Feature	Conventional	Single sideframe	Linear movement
Large format achievable	+	-	+
Easy replacement of press components	-	-	+
Easy customizing of printing unit	-	-	+
Accessibility of components	-	+	-/+
Space to arrange components inside the printing unit	-	-	+
Higher requirements for control	-	+	+
Amount of drives and actuators	-	-/+	+
Format variability by sleeve change	-	-	+
Automatic paper thickness adjustment	-	-	+
Wide choice of substrates	-	-	+
Suitable for high press speed	+	?/-	?
Proven design	+	-	-

Table 2: Comparison of potential features as set forth by the press design

Summary

Through our investigating the linear movement design we detected some factors, which prevented the use of this technology in the printing industry so far. The in-press imaging technology with erasable image has been one of the major enabling factors to realize the linear movement unit design. The avoidance of plates enabled sleeve technology for both the forme and the blanket cylinders without the need for a frequent exchange of the sleeves. As a result of the gapless sleeve technology we have perfect rolling conditions and nearly no vibration in the printing unit. Also a plate feeding and adjusting mechanism can be avoided, which would need to be mechanically adjusted to the cylinder position.

The other major enabling factor for the linear movement design is the consequent single drive technology with individual drives for each cylinder. Each cylinder has its own drive and a decoder to identify its exact position. A single drive is not absolutely needed for in-press imaging, but it has several advantages. These are exact imaging position, no backlash effects during imaging, ideal speed for each operation regardless to other press components and the possibility of paralleling of operations during the change over (e.g. blanket washing and erasing). The single drive also works as circumferencial register. During the imaging the exact position of the cylinder is always known and can be maintained during the print run resulting in very high registering accuracy, especially from front to back. In addition to that, the single drive can work as a sensor during the change-over process. The power usage and the torque of each separate drive can be recorded. This correlates to the friction of the cylinder surface during erasing. The usage of cleaning liquid can be optimized and the progress of the erasing operation can be detected.

Feature	Erasable in-press imaging	Single cylinder drive
Reducing vibration during printing	Sleeve technology	Gearless, shaftless
No bearer contact	Sleeve design	
Linear arrangement of cylinders	Sleeve design	
No plate feeding mechanism	In-press imaging	
No gear contact possible		Single drive, gearless
Variable position of cylinders	Electronic	Single drive
Perfect front to back register	In-press imaging	Single drive

Table 3: Enabling factors and key advantages regarding linear movement unit design

And in turn the linear movement concept has some special advantages for the application of erasable in-press imaging

Feature	Conventional	Single sideframe	Linear movement
Quick change of sleeve	-	+	+
Decoupling of imaging and printing position	-	-	+
Utilizable space around cylinder	-	-	+
Simple exchange of components	-	-	+
Width of imageable area	+	-	+
Management of high number of different press variants	-	-	+

Table 4: Advantages of the linear concept for in-press imaging

As a unique property, the printing unit design is not limited to a single imaging technology or printing process. The unit can also accommodate other plateless or sleeve-based in-press imaging processes for offset lithography. Also other printing processes can be applied, preferably with in-press forme production.

In combining erasable in-press imaging with the linear movement printing unit design a new solution for some of the major challenges of economic short run printing has been created.

References

Material contained in this paper is the result from internal research at MAN Roland and MAN Roland market studies.

Other references used for this paper but not explicitly cited:

Cost, F
1997 "Pocket guide to digital printing", Delmar Publisher Inc.

MacPhee, J.
1998 "Presses – Past, Present, and Future", TAGA proc. 1998

GAIN
1996 "The viability of short runs in offset printing", survey by GAIN

NPES Study,
1998 "The Current and Future U.S. Markets for Printing Presses Part One: Offset"

Tanaka, Y.
"Short Run Color Printing in Japan", proc. NIP12 IS&T conference 1996

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