Applications for On-Demand Flatbed Print & Cut Combination System

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Abstract/Concept

To enhance the possibility of direct on-demand printing on a wide range of finalized materials, we have developed a Flatbed Print & Cut Combination System. (FPCCS)

In addition to the printing system, we have developed the software, ***Print & Cut,*** which incorporates printing and cutting simultaneously in one function. This software has the capability of producing prototype samples of prints and decals, which need both printing and cutting.

The purpose of Color-by-Color Printing Process on packages and cardboard is to print high quality images directly on materials without the need of coatings or protective layers. By utilizing this technology you are able to produce samples of direct printing on package boards and carton boxes in a cost effective way.

1. Introduction

Existing inkjet printing technology has a wide variety of applications. Simple synchronization of media, inks, and printing processes affects the way we print on many materials.

The unique combination of a flat bed inkjet printer with a cutting mechanism allows your on-demand color ability to be complemented by a cutter. Now your finalized prints can be cut and prepared therefore, removing unnecessary steps.

Printing high-quality images directly on plain cardboard eliminates the image-reception coating process and enhances the Color-by-Color Printing technique.

An example of this process could be a prototype garment design. By utilizing the Flatbed inkjet Printer and Cutter Combination System (FPCCS), you can create a pattern of one garment then you can print the pattern, and cut it simultaneously.

Another example of Color-by-Color printing technique is the creation of package samples from cardboard or pasteboard. Using the FPCCS you can print the sample, cut it and then create the sample for evaluation.

Below is an introduction to the technique of printing and cutting on the Mimaki FPCCS and its characteristics:

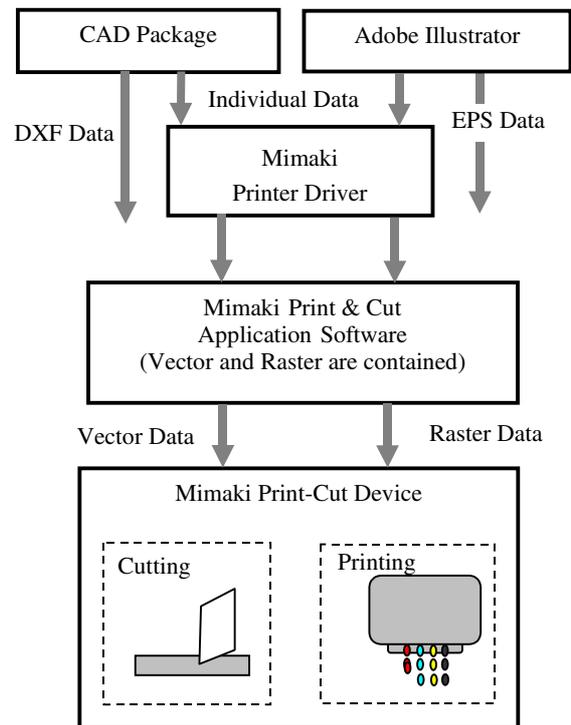## 2. Overall Specifications of FPCCS

2.1 System Configuration

Figure 1. Block Diagram of Mimaki Print & Cut System

Fig.1 shows the block diagram of FPCCS with Print & Cut application software installed.

The software permits printer and cutter functions to work simultaneously in one unit. The package, labeling, and decal design software *Print & Cut,* allows both functions of printing and cutting after detecting crop marks in order to determine printing and cutting origins.

2.2 FPCCS Overall Specification
Table1 shows the FPCCS overall concept.

2.3 Composition of Printing & Cutting Unit
Fig. 2 shows configuration of the Printing & Cutting Combination Machine. FPCCS. New Technology of Flat Bed Printer3
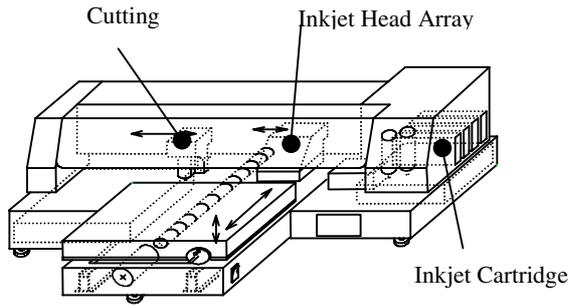
Cutting   Inkjet Head Array

Inkjet Cartridge

Figure 2. Flatbed Print & Cut Combination System (FPCCS)

3. Flatbed Inkjet Technology

3.1 Printing on Plain Paper

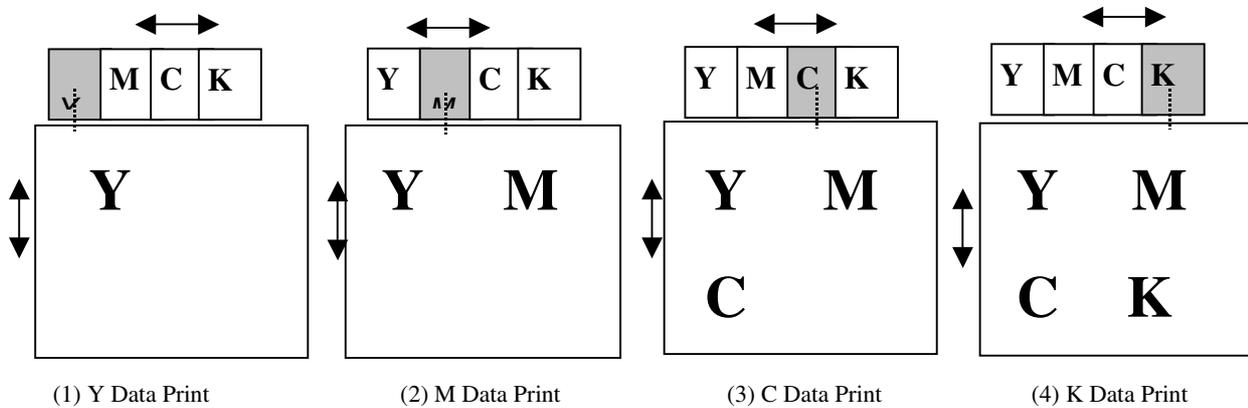Conventional inkjet printers require special media with a coated layer to absorb the ink. However, on our flatbed design we have developed a Color-by-Color Printing Process that will print on plain presentation paper without any type of ink-reception layer.

There has been a strong demand in the industry for the ability to print on plain paper, but with traditional inkjet printing it is cost prohibitive to do so. Now with our Color-by-Color Printing Process on our inkjet printer, it is possible to obtain brilliant colors on plain presentation paper without an image-reception coating.

Fig.3 shows its procedure in a diagram. The print flow of CCP process is as follows.

(1) Y head prints only Y data as an image on one page.After printing Y data Y head returns to origin.
(2) Then M head prints only M data in the whole image.
(3) Using same method print C, K data, resulting in a full four color printing upon completion.

| | M | C | K |
| Y | | | |
| **Y** | | | |

(1) Y Data Print

Y		C	K
	M		
Y		**M**	

(2) M Data Print

Y	M	C	K
Y		**M**	
		C	

(3) C Data Print

Y	M	C	K
Y		**M**	
		C	**K**

(4) K Data Print

Figure 3. Print Flow of CCP. Next Color is Printed after print head returns to the Origin position.

In CCP process there is ample time for one color to dry before next color starts printing. In such a process, brilliant colors can be obtained on presentation paper such as glossy art paper where traditional inkjet printing process would not work.

Fig.4 shows the difference between traditional inkjet printing process and our CCP process. Both samples were printed on a Top Coated Paper manufactured by Oji Paper with water based pigment ink of 3.3 plus/minus 0.2CP viscosity. It is evident that traditional inkjet printing process has bleeding and beading on it, and image quality is not satisfactory. On the contrary, in our CCP process bleeding and beading do not occur, and the image quality is excellent. In our CCP process the paper only has to be absorbent for one color; meaning that most of the papers currently in use are acceptable for our process. All FPCCS users can select either the CCP print mode or the traditional print mode depending on their applications.

3.3 Cutting Technology
(1) Cutting methods

Table 2 shows 2 major methods of cutting.

Table2 Major Methods of Cutting

Contact Type	— Swivel Cutter	┬ **Auto Cutting Depth Control**
		Reciprocating Cutter
		└ **Ultrasonic Cutter**

| **Non-Contact Type** | | **Water-jet Cut** |
| | | **Laser Cut** |

(2) Swivel Cutter

X and Y-axis movement of the plotter control the cutting direction. Controlling cutting direction without motors on is possible utilizing the swivel function of the cutter. This method is used for cutting thinner materials at high speed.

Major users of these applications are:
- Sign industry: Half-cut of marking film
- Labeling industry: Half-cut of labeling, decals
- Apparel industry: Perforation cut of patterns
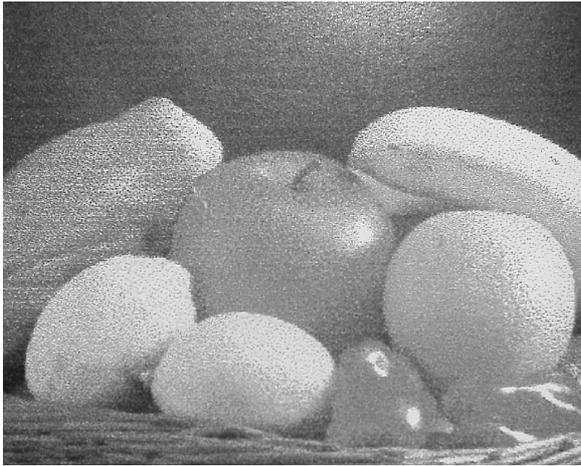
(a) Printed by CCP
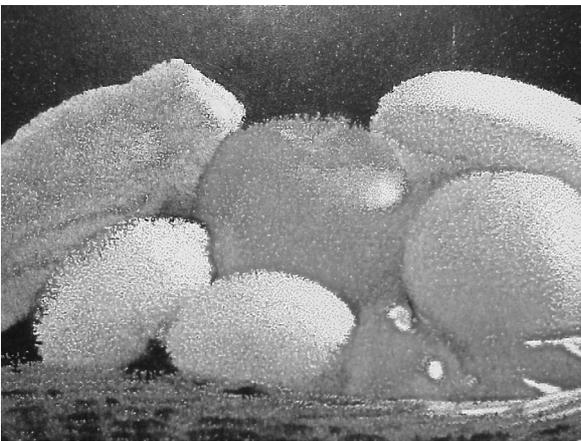
(b) Printed by Conventional Printing Process

Figure 4. Comparison of Printed Samples On the Coated Paper.

(3) Tangential Cutter

In addition to X and Y axes movement of the plotter, motor on the cutter controls cutting direction. This method is used for cutting thicker materials. Methods of controlling the cutter, and their applications are:

- Auto blade pressure control cutter: industrial rubber, asbestos, artificial leather, PET film, carbon fibers, etc.
- Reciprocal cutter: cardboard, clear package, sponge, etc
- Ultrasonic cutter: hard vinyl chloride, P-tile, plastics plywood, fabrics, etc.

On FPCCS we use tangential cutter adequate for cutting cardboard for packages of less than 2mm thickness.

(4) Mimaki's Cutting Technique and Application

3 kinds of cutting methods shown in Fig5 are available on FPCCS.
- Half-cut
- Die-cut
- Perforation-cut

(a) Half-Cut.
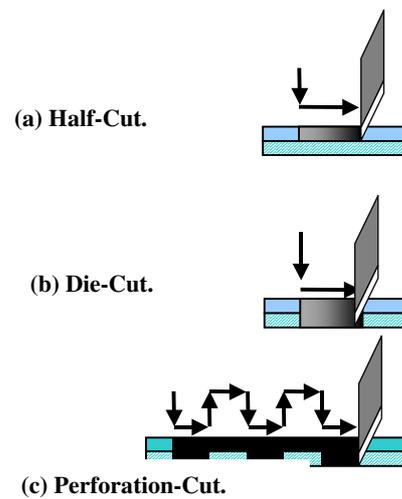
(b) Die-Cut.

(c) Perforation-Cut.

Figure 5. Cutting Methods Applied to FPCCS.

4. Utilization of FPCCS

Utilizing FPCCS in appropriate processes can produce several kinds of products in small volumes such as samples of packages, cartons and boxes.

4.1 Package, Carton Boxes Design
(1) Design shape of packages (or carton boxes) by CAD.
(2) Graphically design packages with applications such as Adobe Illustrator.
(3) On FPCCS print the design directly on boards and cut it using CAD data.
(4) Fold up and complete the package sample as shown in Fig.6.

Figure 6. CD Case Sample Made by FPCCS.

4.2 Labeling, decals
(1) Graphically design decals (or labeling) with application such as Adobe Illustrator.
(2) Create cutting data with detection of cutting edge and modification of the shape using data created in item (1).
(3) On FPCCS print the data directly onto sticky back sheets and then implement half-cut using cutting data.

4.3 Post Press
(1) Set flat paper sheet or envelope without inkjet receptive layer on FPCCS.
(2) Create images and letters to print on them and configure the cutting origin using registration marks

and paper edges with an application such as Adobe Illustrator.

(3) FPCCS detects the registration marks and media size to determine the cutting origin and prints on designated area.

5. Conclusion and Future of FPCCS

Future improvement of the CCP printing technique I have introduced here as FPCCS to print on media without an inkjet receptive layer and cutting technique will lead the way for introducing direct inkjet printing into most of the various printing industries. But first, for further improvements, we need to pursue following topics. :

(1) Development of inkjet head
   - High quality, high speed head at low cost (>20 sq.m/min)
   - High viscosity durable head (>10 to 20 cp)
   - Water /oil /solvent base pigment ink adaptable head

(2) Development of inkjet ink
   - High quality, high speed ink at low cost (equivalent to press ink)
   - High viscosity ink (>10 to 20 cp)
   - Water /oil /solvent base pigment ink
   - High brilliance UV curable ink

Biography

After studying electrical engineering, Mr. Ikeda had participated in several projects to develop NC controller, POS, data terminal, and so on at OKI Electric Industry Co., Ltd. In 1981, he joined MIMAKI ENGINEERING Co., Ltd. As a chief development director, he had conducted developments of plotters such as flatbed pen ink plotters, pencil plotters, cutting plotters, and some more. Mr. Ikeda took his post as Chif Director President in 1997 after serving as an executive director and a managing director since 1988.

Table 1. FPCCS Overall Specification

Area		Item	Spec	Remarks
Mimaki Print & Cut Integration S/W			1.Print from Illustrator 2.Cut using datum of CAD, Illustrator	Vector data and raster data are processed separately
Print & Cut	Both	Maximum size of usable media	Width: 24.8 inches(630mm) Length: 17.7 inches (450mm) Thickness: 2 inches (51mm) Maximum cutting depth: 0.08 inches (2mm)	Registration mark detector installed
		Effective print area	630 x 450mm	
	Printer area	Inkjet head	192 nozzles DOD piezo head	To be changed to high-speed head
		Distance accuracy	Distance accuracy between each color when each head returns to origin: Our system achieved less than plus/minus 50 micron m on flatbed system	
		Resolution (DPI), printing speed Ink	360 x 360: 5 min/sq.m 720 x 720: 14 min/sq.m	2pass, bi-direction print mode
			4 colors (YMCK)	
	Cutter	Maximum cutting speed	320mm/sec	
		Cutter Head	Tangential type Cutter	