On-line Carton Printing: Realistic Solutions at Last

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Abstract

The demand for flexible printing of secondary packages has grown dramatically in recent years and this is now recognised as one of the most promising markets as one of the most promising markets for flexible printing in an industrial context. The increasing interest in the application arises both from increased need, and from the emergence of a satisfactory technical solution in the form of the new generation of Drop on Demand inkjet printers.

This paper reviews the reasons for the growing pressure for flexible printing in this deceptively complex market and discusses the problems that have to be overcome and the emerging solutions to them.

Introduction

The requirement for flexible printing of outer cartons has been around for many years, but until recently a fully satisfactory technical solution has not been available.

The underlying demand for this capability arises from two sources:

1. The need to put information on the carton, which may vary according to circumstances. The number of items in the pack, freshness date or destination would be examples of this.
2. The wish to control the proliferation of cartons that must be held in inventory. Many factories produce a wide range of products in variable size batches and for a range of destinations and languages. The logistics and stockholding costs of coping with pre-printed boxes and cartons can be formidable.

Of recent years the demand for on-line carton printing has intensified because of the explosion of different types of variants of products in the market place which leads to greater costs and difficulty in handling the diversity of packages. This has given greater impetus to the idea that manufacturers would buy and stock a restricted range of packages and customize them on or near the production line. In addition the powerful retail outlets now require high quality barcodes giving increasingly variable information for their own logistic chains. This not only puts pressure on suppliers to provide variable printing but also sets high standards for the printing itself – standards that the retailers police vigorously.

The demand for flexible secondary carton printing has previously been met by labels, by low-resolution valve-jet printers or more recently by the first generation of high-resolution inkjet printers. Each of these has had its advantages and disadvantages. Labels are a straightforward means of customising packages. They give excellent clarity and definition of print and can be applied to any surface including shrink-wrap (for which application they face little competition). Their main disadvantage is cost, which increases steadily with the size of the label.

Low-resolution inkjet is a suitable low-cost solution for basic alphanumeric information although the results are seldom very attractive visually. However, the low resolution means that these printers are not all capable of printing machine variable information such as bar codes and dot codes and this is increasingly a disadvantage as demand for these capabilities grows.

The first generation of high resolution inkjet printers have already had some success in the secondary packaging market particularly where high-quality substrates can be guaranteed.

The intrinsic resolution of these printers is typically not high, perhaps only 32 or 64 channels per head, but it has proved possible to make acceptable barcodes in well-controlled circumstances by adopting one of two strategies. The first is to provide several nozzles for each ink chamber so that each firing produces a short vertical line of dots. This produces good vertical lines, suitable for barcodes but the resolution of alphanumerics and graphical images is low because they must be made out of vertical lines or blocks of print. The second strategy is to orientate the printhead at an angle to the direction of surface movement reducing the height of the print and increasing the vertical resolution. Several printheads may now be needed, and maintaining registration between them can be problematic, especially if the product bounces or moves irregularly along the production line. Nevertheless perfectly acceptable barcodes are possible provided the motion of the substrate is well controlled and the print surface is of good quality. The challenge for the second-generation technologies has been to improve resolution and to make the printers more robust and reliable in a range of more demanding on environments.

In the last couple of years or so this market has seen the start of a major upheaval with the arrival of high resolution printing systems that can provide the flexibility and quality the market needs. These systems

are based on Drop on Demand printheads from suppliers such as Spectra, Xaar and Aprion, capable of operating the industrial conditions.

Printing Issues

The biggest problem in secondary package printing is the variable quality of the material. Cartons are often made from recycled board and this material tends to be darker and more porous, and to contain more blemishes than virgin material.

Experience has shown that the quality of the board used in secondary cartons is liable to considerable variation from batch to batch. The printing system must accommodate this to a considerable degree. Moreover, different countries recycle to different degrees: the USA uses relatively little recycled packaging, perhaps because they have plenty of trees while Australia, a less well wooded continent, recycles a great deal. Europe is in between. Porosity is very important in non-contact printing because it affects edge definition as the ink seeps into the board. On darker boards it may be difficult to achieve the contrast level required by barcode readers even if the inked image is very black; and blemishes in the board may look like blemishes in the print.

A carton printer suitable for the international market has to be able to cope with at least the larger part of this variation, as shown schematically in figure 1.

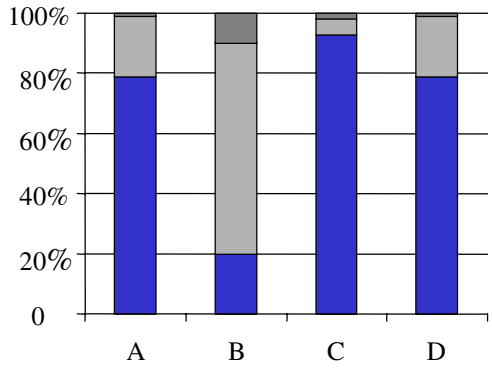

Figure 1. Variation of Board Grade by market (schematic) Bleached Board (top); Virgin; R ecycled (at bottom)

The variation of porosity is particularly important because liquid ink tends to spread sideways after printing to an extent that varies with the quality of the board. There are four solutions to this problem:

1. Use high-viscosity inks that do not tend to migrate through the board.
2. Use prigment-based inks in which the pigment tends to be left behind on the surface while only the carrier solvent percolates.
3. Use hot-melt inks that solidify on contact and so do not flow.
4. Compensate dramatically for ink spread by varying the image dimensions to accommodate the effects.

Only the last 3 solutions are available for inkjet printers because the inks are fundamentally of low viscosity. The Spectra printhead uses the hot melt solution; others a combination of pigment inks and dynamic compensation

Barcodes place the most stringent, and certainly the most objective, requirements on print quality. There are, of course, many different types of barcodes, each with its detailed standard on dimensions, edge clarity, contrast etc. ITF 14 is one of the less demanding in this respect, EAN 128 perhaps the most. Here again one finds a considerable variation in requirements from one national market to another, as shown schematically in figure 2. The powerful retail chains require, and police, a high standard of conformance to barcode standards.

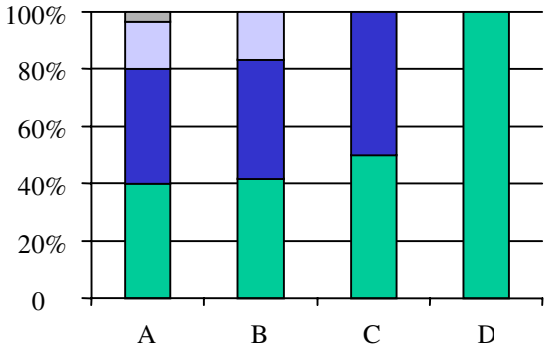

Figure 2. Barcode requirements by market (schematic) EAN 128 variable (top); EAN 128; ITF14 (bottom)

The Packaging Supply Chain

Flexible package printing can in principle be done at several points in the supply chain: at the Converter's plant where the basic board is cut, printed and shaped into cartons; or at the product factory, either on-line when the cartons are already filled with product, or off-line earlier in the process. The issues and benefits are different at each stage.

Printing the whole carton online gives the greatest benefits because it reduces the number of different types of package to manage to the absolute minimum. Line speeds will be at a minimum at this point – secondary packaging lines seldom operate above 1 metre a second – but the operational difficulties are greatest.. Printing must be done on erected and filled cartons moving on a production line in a more or less ill-controlled way; vibration, dust and other environmental factors must be considered; and operating staff may be relatively unfamiliar with printing.

Injecting the flexibility at the Converter's requires the highest line speed but the process is easier to manage: the substrates are flat and under control and

their quality known; the factory staff will be familiar with the printing concepts. However the logistics are the least favourable because all the downstream operations have to handle the full diversity of product.

An intermediate possibility is to print cartons in the factory but before the production line. This provides most of the logistics benefits since the main stock holding can be of generic unprinted cartons. The cartons can be printed in relatively controlled conditions, before they are erected.

In many ways this appears to be the ideal positioning and it was here that Domino introduced its Packtrack mimeographic printer in 1993. (figure 3) This variable contact printer gave large very high quality images which could be varied in less than one minute. It did not allow variation from box to box but was ideally suited to print short runs. The product was only a moderate success, however because factory managers resisted the idea of introducing an extra stage into their production process. Rightly or wrongly the extra complication this caused was seen to outweigh the benefits of reduced carton stocks.

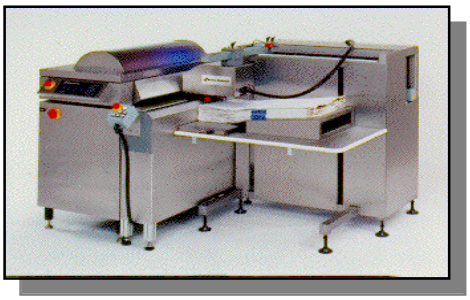

Figure 3. Domino Packtrack Mimeographic Printer

Demand for flexible carton printing is undoubtedly stronger now that it was 7 years ago but the Packtrack experience was salutary and led us to believe that the correct approach is to work to overcome the technical difficulties and provide a genuine on-line printing product capable of printing erected and filled cartons on a normal production line.

The Domino G7000 Product

The Domino G7000 (figure 4) is a simple and robust printer designed for printing onto erected cartons on a factory production line. It uses a Xaar XJ500 printhead, which gives 70mm of fully variable printing at a resolution of 180dpi.

This provides good quality graphics as well as full-specification bar codes (figure 5) with sufficient resolution to cope with different porosities of board by fractionally adjusting the width of bar codes to compensate for any spreading of the ink. Using black pigmented ink this printer meets the requirements of the most demanding users such as the high-density distribution hubs of the large European retailers.

Figure 4. Domino G7000 showing electronics unit and pressurised ink container

Figure 5. Barcode and graphics on the Secondary Carton

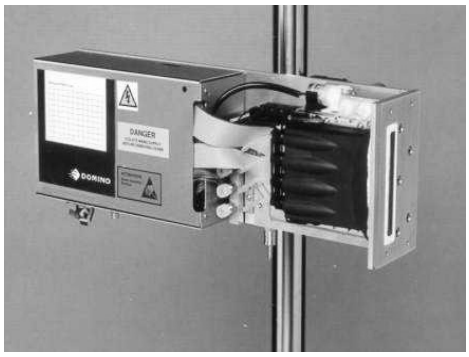

Figure 6. Domino G7000 Unit showing Xaar XJ500 Printhead

The product is fully networked. A single PC based controller can control up to 30 printers through RS485 and connect to Ethernet or other factory networks as required. The basic label design can be done on the controller in a user-friendly Windows environment. The labels are then stored in the G700 printers which can separately inject product-by-product variability such as times, dates and serial numbers into the label in alphanumeric or barcode format. The printers can also

connect to local input such as check-weighers or barcode readers and vary the label accordingly.

As already noted, the quality and capability of the DOD printhead (figure 6) is a key factor in the performance of such printers, although the ink system and electronics also play important roles. The specific design of the G7000 makes it particularly resistant to knocks and vibration (previously on Archilles' heel of industrial DOD printers) and the configuration of the head makes it quite tolerant of uncontrolled movement of the product.