

TECHNICAL GUIDE

AN INTRODUCTION TO PRINTED PACKAGING

Second Edition

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profit for purpose



Why print packaging digitally?

Packaging is undergoing a significant shift as runs get shorter and sustainability concerns go mainstream. Colour and special effects usage is increasing and digitally printed packaging volumes are rising. New dynamic communication models and mobile digital commerce are driving more ordering and purchasing transactions online and expectations for packaging are changing. It all creates new opportunities for short run packaging production and more complex media campaigns that incorporate all media channels right down to sharing an 'unboxing' experience on social media. Commercial environments are also affected as e-commerce and web-to-print workflows take hold: do people buy the goods only, such as clothing, or the whole presentation package as is the case with books and many foods?

The digital and online worlds offer limited new opportunities for print, but packaging is in a uniquely special position as it is where a product reaches

it's buyer. Packaging is a high-growth business sector, primarily for long runs but opportunities for new short run applications printed digitally on demand are clear. The web-to-pack concept for standardised production is taking hold in the folded carton sector and is reaching into other areas of packaging fulfilment. The online business model assumes that goods will be selected, packaged and shipped on demand, in various quantities. The package can be highly customised to an individual's profile, geography and location, and even buying habits.



What is classified as packaging?

Packaging covers a wide range of considerations, most of which can be turned into new revenue sources for printing companies, from embellishments to variable data processing. A package contains, identifies, describes and protects its contents. It's also a key opportunity to display, promote and otherwise make the product desirable. Packaging protects products for distribution, storage, sale, and use, including security measures such as tamper-proofing and childproof caps. And many packages, especially in the consumer space, create a direct line of communication with the buyer. This is particularly true for personalised packaging that links to a broader narrative via online interactions.

A package's purpose is to protect its contents so that they can be delivered to end users without compromising what is inside. This means protection from impacts, weather, static, pests and germs, ensuring hygiene and preventing ruptures. Packaging provides convenience and security and can be used for quantity control.

Packaging materials are used for pretty much anything that needs containing and protecting: food, drinks, healthcare products, and so on. Paperboard, foilboard, microfluted board, plastics and the

like must therefore be suitable for the contents and their likely path through life. Packaging for liquids or clothing and footwear obviously differs. Packaging simplifies the storage, transportation and delivery of goods, which all influence the performance requirements. For instance contents must be safe under pressure when air freighted and in hostile environments such as extreme heat and cold, or with rapid temperature transitions, high humidity or salty air. Hazardous materials such as explosives and inflammable materials must be clearly labelled as should fragile goods or goods that must not be allowed to get wet.

Packaging is often about presentation, communication and information, as well as functional considerations. It promotes brand identity, so it must be effective and comply with regulations as is the case with legally mandated Braille on medicine packages.

A package can extend communications for instance by including a web address or QR codes for scanning with a mobile phone to link to more information and services, and even entertainment. Taking packaging into the realm of transmedia applications is one of the many opportunities printers can pursue for growth in the packaging sector.



Packaging activities

In its simplest form packaging helps get a product securely from A to B. The product could be a wedge of cheese wrapped in waxed paper or high-end cosmetics in multiple layers of glass, plastic, metal, board, paper, tissue and cellophane. Package production involves printing, cutting, folding, gluing, sometimes thermoforming and gathering a range packaging material elements together. The type and value of the goods determine budgets for each stage of the packaging production process. Logistics also matter, and we see improvements in logistics efficiency through better use of data. How often packages are to be moved and transported, say by sea, land or air or a combination impacts the contents and the packaging investment decisions. In recent years we've seen the increased use of RFID (radio frequency ID) tags to track products as the travel, another technological use of printing.

The processes for packaging production are as diverse as the types of packaging. The type of package, its functional requirements and consumer preferences determine how it is produced. For example beer is mostly sold in 330ml brown bottles because beer drinkers prefer them, even though cans are lighter and provide better protection against light.

All packages start with the production of raw materials. These materials include plastics, metals, paper and board, glass and increasingly natural materials, such as wood, vegetable starches and fabrics. The raw materials are then converted into packaging materials which are then turned into containers ready to be packed or filled, for subsequent distribution, sale and use. Once goods are packaged additional packaging is often added to protect the package and for easier transport.

The first layer of packaging, the one in contact with the product or contents, is primary packaging. Packaging that doesn't touch the product but which makes transportation of the goods more convenient is called secondary packaging. This includes things like cardboard boxes and crates and provides branding either printed directly on the board or with labels. Some 30% of European labels by value are estimated to be digitally printed. Secondary packaging packages the packages to ensure that the contents reach their destinations without damage or spoilage. Thus protected, packages will still be attractive once they reach retail displays or their point of use. They will look good on a retailer's shelves, even after a long and taxing journey.



Secondary packaging protects packaged goods so that they look good on a retailer's shelves.

Tertiary packaging refers to cartons, straps and plastic wraps added to secondary packaging for even more protection. Manufacturers of primary, secondary and tertiary packaging materials for everything from food to consumer products follow the BRC Global Standard for Packaging and Packing Materials (BRCGS.com). More than 3,500 suppliers in over 80 countries are certified to this standard.



Packaging market

In all geographies, from food to cosmetics to retail, manufacturing and building, and pharmaceuticals, packaging matters. Technology advances, globalisation, rising purchasing power and the adoption of cold supply chains in developing economies all contribute to steady growth in packaging needs and supply. According to the Food Marketing Institute the average American supermarkets carries from 15,000 to 60,000 Supplier Known Units (SKUs), creating huge demand for fast turnarounds and packaging innovation. However volume packaging production takes considerable investment and requires high volume technologies such as flexo or offset presses, sometimes with integrated inkjet heads, and supply chain and customer development. For most companies taking a first step into packaging, short run and bespoke packaging supply a is far simpler and easier, less risky step.

Short run packages and fast turnaround packaging and prototyping are natural candidates for digital printing. The range of materials available for printing digitally is growing, encouraging more companies to produce short run packaging applications.



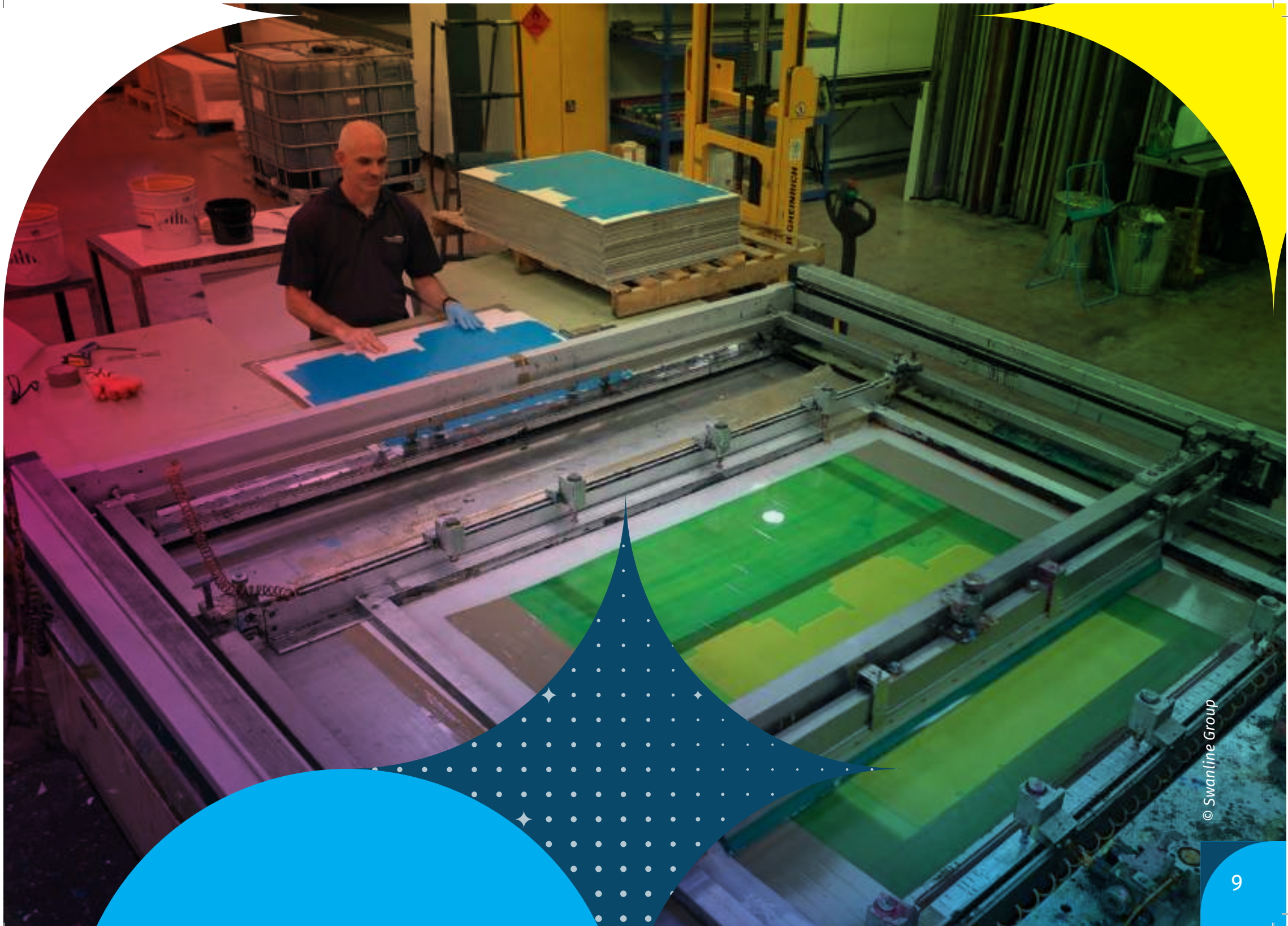
According to the fourth drupa Global Trends report 32% of digital printers around the world now offer packaging printing services, mostly for labels but also for folding cartons and flexible packaging. Flexo and sheet-fed offset, used for long run work, dominate production methods however digital printing is becoming relevant even for long runs as the economics shift in its favour. In the corrugated market some large packaging printers such as DS Smith, leading global packaging printers, have used HP digital printing technologies at plants in the UK and Germany to expand their opportunities. There are a number of high volume market-ready inkjet solutions: Efi offers its Nozomi C18000, Sun Automation has the CorrStream and Barberan offer the Jetmaster are entering the market for corrugated with their single-pass press.

Print Production methods

Commodity printing processes dominate packaging printing with most packages printed on flexographic presses which use thin, flexible photopolymer printing plates with a relief image. Flexography accounts for an estimated 40% of package printing and is poised to grow fast. The method is suitable for printing on a huge range of materials including metallic films and plastics such as cellophane and polythene and is commonly used to print plastic bags.

Offset lithography, which primarily uses metal plates and an offset process, is the print industry's most widely used method. It is used for medium and long run magazine, poster and book printing, plus packaging along with gravure whose domain is that of very long packaging print runs which is no surprise when you consider its running speeds of up to 1,000 linear metres per minute.

Screen printing has an established role in the Point of Sale sector and to a lesser extent in packaging. It is still used in applications where short run flat colour, metallic and special effect inks are printed. This is of course due to the process's ability to print a very wide range of pigments and coatings.



Categories of package

Packaging has several categories, with labels the largest. Specialisations such as embossing and foiling may be required as part of a packaging printing sales offering. Such things as strapping, jiffy bags, pallet and bubble wrap, polythene and mailing bags, plus packing tape are all part of the packaging business. They are not necessarily the whole basis of a printing business, but they support packaging applications. Keep in mind that for every type of package there are many options for materials and therefore for inks, adhesives and coatings.



Labels

Labels made from papers and plastics are used in primary and secondary packaging for all applications including mailing and shipping, industrial and decorative applications in all industry sectors. The range of label options covers price tags, pressure sensitive, heat-shrink and stretch sleeve labels, heat transfer and glued labels, such as those found on tins and bottles. Pressure sensitive labels account for around a third of the global market.

Most labels are printed with flexo technology however many products such as spirits include components printed with various technologies including gravure, offset, flexo and digital printing for bespoke embellishments.



Example of label created with HP Smartstream D4D and printed using HP Indigo digital printing.

These options include etching, metal effects, foil stamping and so on. Where digital printing technology is used for label printing electrophotography dominates with UV inkjet following. The conversion of primary labels to digital printing processes is running apace, due to lower per copy costs for run lengths of less than 100,000 copies and the growing range of substrates available for digital printing devices. Most inkjet label presses are continuous feed single pass engines.

Flexible

Flexible packaging is generally considered the most economic and effective way to package food and drink, plus pharmaceuticals and indeed any product with a potentially long shelf life. The usage of flexible packaging is rising as technology improves and expands the range of production

for which flexible packaging is suitable: wraps, bags, envelopes, pouches. They are easy to store, convenient, offer efficient material usage, weigh less and can be less expensive to produce. Most containers are made of polyethylene terephthalate (PET) which accounts for about one third of production, however bio plastics are increasingly available.

Flexible packaging materials are layered or single thicknesses, with various degrees of elasticity, using different materials including paper, plastics, metal foils, bio

*Flexible packaging examples
courtesy of 3-Print.com*



polymers made from plant materials and various coatings. They are available as sheets, bags, sachets and pouches in various shapes and dimensions including blister packs used for medicines.

Flexible packaging materials can be pre-printed or carry a label and configured in combinations to suit different product categories. Flexible packaging is light and effective so it's often used instead of glass. A flexible package can store in 0.68 kilograms as much liquid as almost 23 kilograms of glass. The last ten years have seen considerable innovations in flexible packaging with reduced weights, handles and zip locking. These innovations reduce transport costs, improve shelf life and protect contents. Food innovations such as preserved soups and casseroles that do not need chilling, have also driven advances in the flexible packaging sector. Capacity for easy modification and diverse configurations has allowed flexible packaging to claim market share from simple commodity films and cardboard packaging.

Corrugated

Corrugated board is used to package 90% of all goods shipped. This composite material is made up of outer and inner layers used together as a single unit. Single faced corrugated rolls comprise a liner layer plus fluting. Double wall corrugated has liners on both sides of the fluting and two or three single faced corrugated layers can be stuck together to form double- or triple-wall corrugated board for additional strength.

FEFCO (fefco.org) are the manufacturers body and they offer a wide range of useful information on their website. Corrugated packaging is made up of 70-80% of recycled fibre and the supply chains for recycling it are widely established and effective.

Corrugated packaging can be either printed directly or preprinted. Direct printing mostly uses flexography or digital printing although the latter accounts for only a tiny proportion of global volumes. The other approach is to preprint a liner that is

then laminated (glued) to the board. There is potential for convergence between this form of packaging and sign and display applications. Corrugated packaging can, for example, be used for printed displays, to hold leaflets, other forms of print, and primary packaged goods. Although it should be noted that for sign and graphic printers to approach the packaging at any scale requires multi-million pound investments. However there are a broad number of UV flatbed presses that bridge the gap well for significantly less capital expenditure.



Examples of colour packaging on corrugated board.

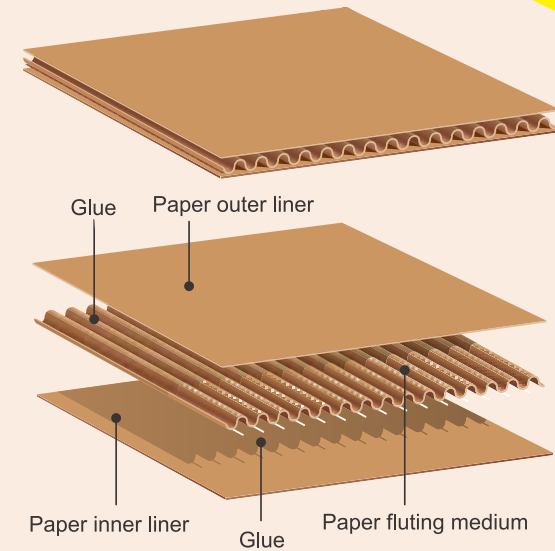


Illustration of corrugated board construction

Single face board	F flute	0.9 to 1.2 mm
	E flute	1.2 to 2.0 mm
	B flute	2.4 to 3.0 mm
	C flute	3.5 to 4.0 mm
Single wall board	F flute	0.9 to 1.2 mm
	E flute	1.2 to 2.0 mm
	B flute	2.4 to 3 mm
	C flute	3.5 to 4.2 mm
Double wall board	F/E flute	2.6 to 2.9 mm
	E/B flute	3.6 to 4.1 mm
	E/C flute	5.0 to 6.5mm
	B/C flute	6.0 to 7.6 mm

This diagram illustrates some commonly used corrugate flute types.

These are some of the inkjet presses available:

MTEX New Solutions Multi+ memjet inkjet printer for fast throughput sheet or finished box blank overprinting.



HP Scitex 17000 UV Flatbed Corrugated press with GreenGuard Gold inks and throughput of up to 1,000 mtr² per hour.



Inca Onset X3 HS UV Flatbed runs at 900mtr² per hour and can benefit from fully automatic loading and off-loading with robotic material handling.



HP C500 Single Pass inkjet press for high speed printing of corrugated board using water-based inks.



EFI Nozomi Single Pass UV inkjet press for high speed printing of corrugated board at 75 linear metres per minute.



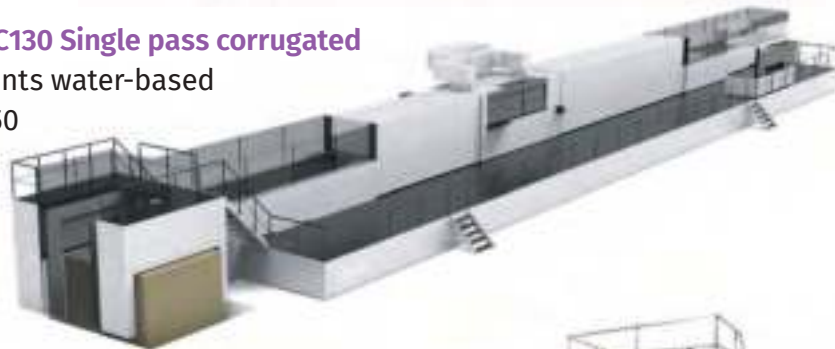
Barberan Jetmaster Single Pass inkjet high speed corrugated press at up to 80 linear metres per minute



Hanway Glory 2504 Single Pass water-based inkjet using Kyocera printheads for corrugated board at a production speed of 100 metre/minute.



Durst Delta SPC130 Single pass corrugated inkjet press prints water-based ink at up to 9350 sqm/hr at 800dpi.



HP T1100 Single pass water-based inkjet press for high speed industrial pre-print production at 183 linear metres per minute.



Cardboard boxes

Cardboard boxes made from board can be made in an endless array of shapes and sizes, including cylinders, if the folding and cutting equipment is available to produce them. Manufacturers of household cleaning products, cosmetics, food and beverages, and healthcare products are the biggest users of these materials.

The folding carton market, the second biggest in the paper and board based packaging sector, is growing in some geographies and facing increased competition from flexible packaging and rigid plastic containers in others. Demand in developing economies for packaged foods, cigarettes and healthcare products, the largest sector for folding cartons, is growing, by some estimates at over 4% CAGR.

Kraft B Flute corrugated boxes.



Rigid containers

Glass, metal and plastics are all used for rigid container packaging, and even paper can be turned into a rigid packaging material. Cans are made from aluminium, which is mostly used for drinks, or tinplate which is used for food. Although the technology for filling rigid containers is designed for industrial applications, smaller and less automated machines are available.

Advances in inkjet printing technology are making possible direct-to- shape (DtS) printing, printing directly onto bottles, cans, sleeves and other containers. This has considerable attraction for variable data applications and because it shortens time to market however



Direct to Shape printing is a relatively new application for digital inkjet printing. It's potential to collapse conventional supply chains is expected to have a major impact on the packaging market.



Direct to shape personalised print courtesy of Xaar.

printing device and printhead, plus inks have to be considered. Inventory and shipping costs are lower per item and variable data means that goods can be targeted for very narrow interests. This technology has huge potential and some big brands are starting to use digital inkjet printing for DtS printing. It's potential to collapse conventional supply chains will have a major impact on the packaging market.

Finishing and fulfilment

Finishing is key for any packaging application, since it turns the print into the end product. For cartons, corrugated and many flexible applications cutting and creasing are required either before or after printing. Die cutting makes multiple, identical shapes, such as for labels, production of which benefits from integrated cutting and plotting for individual labels. Gluing and windowing with cellophane and PVC windows aid packaged product display, but materials must be safe and nonmigrating when used with food. The final product may require varnishing for protection or laminating which adds cost but provides good protection.



Elitron KOMBO TAV-R twin head fully automatic cutter

ESKO CAD cutter commonly used for prototypes and low volume orders

Processes such as embossing and foiling provide enhanced visual and tactile effects, but are expensive and require additional processes which means time, money and process control. Technology is also available for embossing and adding other tactile effects through curing as part of the digital printing workflow.

It is clear that packaging is a very specialised business. For printing companies new to it an easier option is likely to be printing the labels that go onto containers, rather than investing in volume manufacturing, filling and finishing equipment. But cutting and finishing are essential to the packaging workflow. Select a machine that can cut the materials you print and that is flexible so that it can be used for packaging as well as other applications such as sign and display work.



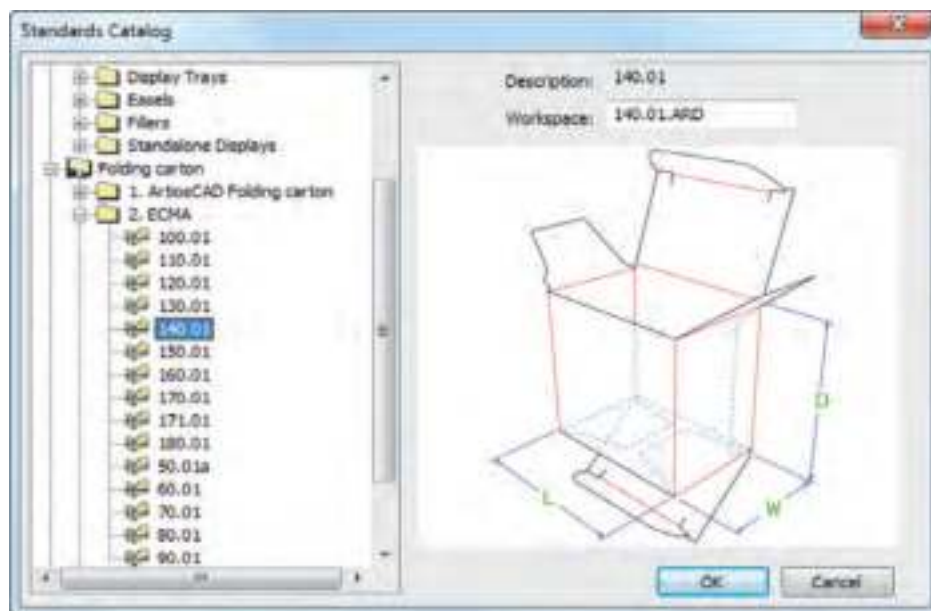
Form, function and design

Packaging, more than any other print application, must consider its distribution and use, which means potential packaging print buyers need to understand their design constraints. This includes such things as calculating box sizes accurately and controlling colour appearance. Design has to take into account structure, marketing potentials, logistics,

shelf life, regulatory and legal requirements, end-use and environmental impact. Quality control is also vital for high value packages, especially for high end brands or for anti-counterfeiting measures.

Performance criteria have to be considered at the start of the packaging project. Design considerations must also take into account content required on the package such as the name of the maker, the brand and associated logos and colours, ingredients, health, nutrition and safety details, directions for use and disposal and barcodes. There may be design regulations to comply with, such as the European Union's requirement that required text is not concealed under folds.

Package design has to consider techniques to reduce waste, theft and forgery as well as enhancing sales and brand profile. In no other graphics application are the requirements so complex, especially for food, beverage and pharmaceutical applications where health and safety cannot be compromised and toxicology and contamination must be considered throughout the supply chain. The BRC accreditation for food safety was first published in 1998. Its latest version, the seventh, helps those involved in food to ensure product safety and quality as well as legal compliance.



The advantage of the professional CAD solutions is that they modify structural elements of any design in relation to scale and materials used.



Make sure you have the right tools for the job. Esko's Studio plug-ins for Adobe Illustrator automate many packaging design tasks.

In any application package designs should be prototyped, and created using specialist software such as Esko's ArtiosCAD suite of studio plug-ins for Adobe Illustrator. Interactive 3-D visualisation saves time in presenting ideas to clients and the need to create mock-ups because they can be done virtually. Specialist tools also save time in checking shrinkage characteristics and distortions as well as fit.

Designers must consider all technical and logistical considerations at an early stage. This includes transportation challenges, as well as the usual concerns of colour management across substrates, workflow management, approvals and quality assurance.

High tech for packaging

There are various applications for electronics in packaging, although environmental impact and sustainability has to be addressed when considering it. Adding Automatic Identification and Data Capture (AIDC) technologies to packages containing food, for instance can help to indicate the condition of the contents. Radio Frequency Identification (RFID) chips can be used as well as bar codes to track and verify goods packages in transit.

Barcodes and RFID tags



The added electronic dimension means that this can happen in real time. Smart labels link the product to a website where more information about the product is available.

Active and intelligent packaging is a new addition to packaging options. It is intended to further cut theft, reduce waste and make products impossible to fake. Smart packaging can alert consumers to foods going off, but fans of this technology see many more applications include Augmented Reality and so called connected packaging. Active packaging materials can include antimicrobial nanomaterials that activate when food starts to spoil, for instance. The combination of printed electronics, communications software and packaging allows brands to collect customer and sales data using the electronics printed onto the packaging. This is cheaper and more convenient than collecting data via barcodes, and allows brands to track who bought what, where and when in real time which they might not appreciate.

Whether consumers will accept this is another matter, but it illustrates the potential new business applications available when print, communications and electronics are combined with



packaging. Technology can increase intimacy and understanding between brands and consumers.

One of the biggest concerns consumers have expressed in recent years relates to the recyclability of packaging and reducing waste. The addition of electronics to packages complicates their recyclability so this may slow deployment of intelligent packaging. A more likely candidate for the future of packaging is edible packaging, such as straws, cutlery (possibly only for small meals), food films and drinks pouches. Edible packaging has the added advantage of being zero-waste.




Environmental impact and sustainability

Packaging uses lots of energy and raw materials, much of which is wasted when the package is discarded. But against the resource use must be weighed the benefits packaging brings in terms of reducing waste, protecting contents and cutting food and pharmaceuticals spoilage.

The role of design is important in this context too because design for the environment ensures that considerations for packaging's end-of-life processes are incorporated in the package from the start. This is not a new idea: in 1924 Henry Ford pointed out that "picking up and reclaiming scrap left over after production is a public service, but planning so that there will be no scrap is a higher public service."

In the 21st century, designing packaging materials to reduce volumes and waste is one of the goals for governments, manufacturers and other players in packaging supply chains. In the UK for instance packaging producers and users handling 50 tonnes of packaging materials annually and having a turnover of over £2 million are classed as 'obligated' packaging producers.





Such companies are legally required to meet specified recovery and recycling obligations, and to have formal certification for compliance. ISO has developed several standards for optimising packaging systems to reduce the use of substances hostile to the environment, including lead, cadmium, mercury and hexavalent chromium, and to reduce the amounts of materials required. Governments also encourage consumers to recycle materials and increasingly recycling symbols are appearing on packaging.

In some countries, such as Sweden and Switzerland, a deposit can be redeemed on glass and metal cans, boosting recycling rates. Recycling symbols also aid sorting and raise awareness of recycling and resource management. Legislation is another powerful incentive and in Europe has helped drive considerable volume. Europeans currently use about 16 tonnes of material per year, with five of those tonnes going to waste. The difficulty for governments is codifying waste and coming up with models that suit local expectations for recycling and waste reduction, and especially circular economies.



Next steps

Building a new business to service the changing packaging market is complicated and takes considerable planning. Understanding the packaging supply chain is a start, but so is an appreciation of opportunities for your company and its customers in this sector. An easy beginning may be to work with trade packaging printers, and selling a limited range of options online. Digitally printed runs of as few as one can have a high per piece value, and this can provide a foundation for specialist high quality packaging applications. Provide an online catalogue from which buyers can select from a range of formats, customisation, size and finishing options. Keep production lean, automate as much as possible, have hands-free workflows and standardised processes. There's money to be made in packaging, if the sums add up.

Published by FESPA Limited
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