# DESIGN AND TECHNOLOGY OF PACKAGING DECORATION FOR THE CONSUMER MARKET



Edited by

**Geoff A. Giles**

# Design and Technology of Packaging Decoration for the Consumer Market

# Sheffield Packaging Technology

***Series Editor:*** Geoff A. Giles, Worldwide Supply Operations, SmithKline Beecham, London

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# Preface

Packaging decoration can have a major impact on the appearance of a finished product and on the decision of a consumer to purchase. Whether we like it or not, at the moment of deciding which product to buy and during our subsequent use of the product, we are all influenced to some extent by packaging decoration—its artwork, its format and its fit to the structural package.

The choice of printing technologies, decoration formats and decoration style, the development of artwork, and the inclusion of legally required and straight marketing information on the package, are complex areas.

This book is designed to guide the reader through the technical and commercial factors to be considered when planning the decoration of a package. It then proceeds to discuss the printing technologies, their relevance to the decoration formats or structural package, the application of the decoration to the structural package, the development of artwork, the use and impact of decoration on a range of consumer products and some of the legal considerations.

The book concludes with a chapter on future decoration systems. Given the rapid pace of change, some developments are within sight and some are just over the horizon. Without doubt, the quest to improve the impact of packaging decoration and its motivational power over the consumer will continue. We shall see efforts to reduce the costs of conventional decoration, while at the same time delivering more sustained quality. The introduction of newer digital processes will offer shorter times from artwork to decorated package, and there will be continued innovation in the visual impact of decoration.

This is the first volume in a new packaging technology series. The chapters have been written by authors well experienced in their fields of business, all of whom are in daily contact with their topics. They are busy people and my personal thanks go to them for giving of their time to write these chapters. Thanks also go to the Publishers for their patience and encouragement.

I also wish to thank my family for their encouragement and understanding during the development of this book, and for carrying out the household chores that I have been able to avoid.

Despite many years in the packaging business, I have found new information in these pages that has proved of real interest to me in my 'day' job. I hope that the reader will find this volume a valuable source of reference, to be consulted frequently.

Geoff Giles

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# 1 Technical and commercial considerations

R. Jesiolowski

## 1.1 Introduction

The development of packaging decoration for the consumer market is a subject which requires consideration of a number of issues: the image and copy to be shown on the container, the processes of converting the design and copy into something which can be reproduced on the container, and the selection of technology to apply the design to the chosen substrate, be it a container or a secondary format which is then attached to a container. There are various technologies and disciplines that apply these 'images' to the package. Selection of the primary packaging form and the market in which it will be placed may significantly influence the graphic design, the decoration format, the application technology, and the final presentation and consumer perception.

The term *decoration* as it relates to consumer packaging (in some parts of the world called fast moving consumer goods [FMCG] packaging) can be grossly misleading. To some it is the visual communication of the product identity, while to others it is the art of applying a decorated label to a package. What is clear is that a structural package and the decoration it carries should not be seen as simply a jacket around the product but as an integral part, the skin of the essence of the product. In many instances, decoration *is* the product! Products are often relaunched with just a new set of graphics, although the product within the package remains the same—such is the importance of that visual impact on the consumer.

This book considers how a package can accept the visual cues inherent in the graphics and translate them into the structural element placed on the container. Selection of the appropriate decoration format, the printing technology for that format and the method of application to the structural package is vital to ensure that consumers are presented with a product embodying all the brand equity envisaged at the outset, despite having undergone packing and filling and the rigours of a supply chain which often crosses borders or even continents.

Structural, visual, decorative and tactile elements of a design should be considered. Poor execution of decoration, even of an excellent design, can have a significant negative impact on a product. On the other hand, exceptional execution of decoration and material specification can present an adequate design beautifully and appropriately in certain circumstances. The challenge is to have both the design and the execution working in harmony. The role of the packaging technologist is to ensure that the creative design is translated into a functional representation which at minimum matches the objectives of the marketing executives and the expectations of the consumer.

## 1.2 The consumer's perspective

Understanding the audience and the environment in which the packaged product will be sold and used is essential. The package product life cycle is shown in Figure 1.1. The package must first attract attention, then be utilised, discarded, and most importantly, be reflected upon favourably and remembered. It is incumbent on the marketer and designer to ensure that both the product and the package meet consumer's expectations and that the experience of the consumer will be positive enough to encourage them to repeat it.

In the visually acute society of today, with limited time to absorb all the information and stimuli in our environment, our sense of sight is depended upon to absorb much more information than in the past. A red sports car, an expensive suit and a fine bottle of wine are all in a sense 'packages' competing for our attention and attempting to convey an impression of character or quality.

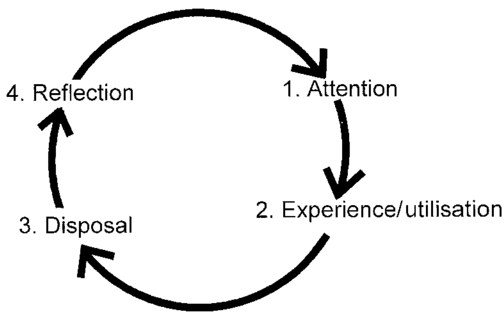


**Figure 1.1** Package product life cycle.

## 1.3 The brand

Most consumer products are associated with a 'brand name' for quick recognition and to give consumers confidence in the products. The 'brand name' needs to be managed carefully and the integrity of the mark must be maintained and delivered consistently throughout any distribution to customers. Any nonconformance to specifications may not only present serious consumer problems and compromise the perceived quality of the product, but it may also jeopardise any legal or copyright protection belonging to the manufacturer or distributor.

Careful selection of the appropriate decoration format and printing technology to match the brand promise is vital.

As an exercise, close your eyes and envision any product that you routinely purchase, one that you depend on or prefer over others. Now place that product in a pure white box with a basic black, standard and poorly printed typeface spelling out the contents. Now what is your impression of the product inside? What value does it communicate? Do you trust the product? Does a reputable company make it? What is the quality of the contents? Did the people who made it care about the product? Do you want to be associated with the product? Does another product command more attention or provide higher expectations? When you see the logo of Mercedes®, Coca-Cola® or the that of McDonalds®, what immediate expectations are projected within your subconscious? How would you feel about those images if they appeared deformed, on a totally different product (i.e. the McDonald® logo appearing on a Mercedes® car) or merely poorly reproduced?

Those who manage the 'decoration' process need to be sensitive to the needs of the internal customer (usually marketing personnel), and the end customer, as well as manufacturing and printing site requirements and their capabilities, materials, logistics and technology. A thorough understanding of the different requirements will ensure maintenance of brand integrity and project objectives, management of costs, and timely delivery of goods to market.

## 1.4 The project brief

A project brief should be prepared to provide a guide to project objectives, the target audience, the competitive environment, pricing, promotion and markets. The brief should also include a full description of the product's personality, budget, supply chain, merchandising and distribution requirements, base copy or selling proposition, expected line extensions and any relevant market research. Although the brief is typically generated by the marketing staff it can and should be refined with suggestions from project team members. This tool can aid structural and graphic design proposals, and should be referred to throughout the phases of design, production and execution.

## 1.5 Decoration considerations

There are countless methods for the decoration of packaging. The choice of even the printing process will depend on the quality of finished product desired, the associated economies of scale, and related resources available. Lithography, rotogravure, flexography, silkscreen, thermimage, letterpress and even laser and digital printing technology have evolved to a point where excellent quality and efficiencies can be obtained. In laser and digital printing, the intermediate step of film and proofing required for traditional methods is eliminated. This saves time and money, especially for lower quantities or for those orders requiring only moderate quality. Even traditional lithography printing is evolving to a 'direct to plate' method, which can eliminate intermediate steps and provide economies and speeds similar to those of digital printing.

## 1.6 Printing methods

Below is a summary of some key benefits and concerns associated with various printing methods. Technology continues to improve these methods and what is currently true will soon alter with continued development. In order to guarantee that the chosen method is appropriate, it is imperative to discuss project requirements directly with the printer, to acquire an idea of costs, and to gain a mutual understanding of quality expectations, specifications, objectives, logistics, quantities required, deliverables and schedules.

Most available printing processes (with the exception of digital) pass through an intermediate stage known as prepress. Prepress distorts the prepared artwork using computerised photographic and digital processes to ensure that the final printed product reflects the image originally approved. Every printing process has unique specifications that are associated with these distortions. Image manipulation, distortion, proofing, and film generation are employed to ensure that when each coloured ink is printed onto the surface, each colour is properly aligned and printed in registration to the others. The film negatives (or positives depending on plate preparation preference) generated from the digitally prepared artwork are used to provide veloxes, chromalins, colour keys or photostats; all forms of proof made by contact and light exposure. The same negatives used to provide proofs are then used to burn or etch into the printing plates for final printing. Typically the plates are photopolymer plates, which are similar to high grade rubber stamps, and used for flexographic printing, or zinc plates for offset plate preparation; these plates are chemically treated and exposed to light to give a plate surface that attracts and holds ink, yet repels water.

Printing in most instances will be performed on cardstock (cartons), paper (labels), metal, glass and plastics. Almost any process can be used to print on cardstock or paper but, with plastics and glass, the choice is more limited. Quality of each application and substrate can vary drastically. When discussing print requirements with suppliers, it is important to discuss substrates thoroughly, to identify the equipment on which these substrates will be printed and packaged, to confirm final packing arrangements and transportation, and to determine how and where the end user will be using the product, and related quality expectations. It is also critical that the printer and associated regulatory personnel ensure identification of any 'leaching' of fumes from the product ingredient through these materials which may affect both the product or its packaging.

### 1.6.1 *Offset lithography*

This is the most common method of printing. It uses the basic principle that ink and water do not mix. A photographic chemically treated metal plate makes contact with a blanket cylinder and the image is captured and transferred by exploiting the repellent properties of ink and water. It is a most economical and versatile form of printing that provides quality and efficiencies especially in medium to large run printing.

### 1.6.2 *Letterpress*

This is the oldest form of printing, useful for short, medium or long runs. The basic principle is that the image or letters, raised on a surface blanket or cylinder, capture ink and transfer it onto the material. There are generally five types of presses in this category: flatbed cylinder, platen, rotary sheet-fed, web rotary and belt. Sheets of paper or rolls can be printed. A distinctive feature of letterpress is that upon very close view, it is possible to see a heavier edge of ink around each letterform from the pressure of the plate although the image itself can appear very crisp.

### 1.6.3 *Flexography*

Flexography is a form of letterpress using flexible rubber or photopolymer plates around smaller cylinders. At one time flexography was considered an inferior printing method, but recent technology has refined the presses, inks and plate material to provide some very good results. In addition, since both press make-ready as well as full production can be achieved for relatively modest costs, it can be a very affordable printing method, especially for lower quantities.

### 1.6.4 *Gravure*

Gravure can provide outstanding quality on a variety of substrates. The basic principle of gravure printing is that a metal cylinder is etched with the image to be printed. The ink is then compressed into the crevices of the etching and the high pressure of the roller and cylinder, in which the substrate travels, virtually squeezes the ink from the crevice onto the paper. Extremely fine detail can be achieved. Gravure inks can dry very quickly, giving the advantage that one ink can be printed directly over another already dried ink instantly, thus eliminating a blend or mix of the colours. Gravure is much used in packaging for specific films, high quality cartons and labels.

### *1.6.5 Rotary screen*

Rotary screen presses have been introduced relatively recently with production speeds that allow more affordable continuous operation than in the past. Screen printing is typically identified by the thick, heavy coverage and finite texture of the screen on the printed image. Screen printing is ideal for unusual or porous surfaces and where extreme opacity is required.

### *1.6.6 Digital*

This is the preferred system for on-demand printing needs and at the time of writing is an economical printing method for low quantities, artwork preparation proofing, or prototypes only. Typically, digital systems exploit electrophotographic ion or electron charge deposition, magnetographic, ink-jet and thermal transfer technology.

Ion and electron charge deposition transfers digital information using an electron cartridge to generate negative charges that transfer a charged image onto a heated dielectric drum. The visible image is then created with a magnetic toner, and transferred to the substrate which is to be printed.

Magnetography is a very similar technique to electron deposition except that a magnetic drum, charges and toners are used to produce the printed page. Ink-jet printing uses droplets of ink driven by digital signals. Thermal transfer involves digital information being transferred to thermal printheads in a machine that melts spots of dry thermo-plastic ink on a ribbon. These inks are then printed onto a substrate.

### *1.6.7 Screen*

Formerly known as silk screen printing, this process uses a screen of silk cloth, nylon or dacron, mounted on a frame. A stencil is produced on the screen and the screen will shield the non-printed areas. Ink is then applied to the screen and squeezed through the porous fibres of the cloth, directly onto the substrate.

## 1.7 Choosing the right printing method

It is difficult to recommend a particular printing method for a particular project for a variety of reasons:

- Every package is different
- Every substrate material may be different
- Every manufacturer and packaging contractor may depend on 'Certified' or 'Qualified' supply base
- Contract or pricing agreements put in place by the purchasing department may be negatively affected

- Printing inks and substrates may contravene local municipal environmental regulations
- Economies of scale will dictate various forms of printing
- Complexity management of specific product components
- Quality requirements
- Design requirements
- Location to manufacturing or packaging site
- Price and related cost of goods

## 1.8 Asking the right questions

As packaging is being designed, it is critical to consider all the environmental influences to be harmonised so that the end result meets expectations. Managing this activity can be quite challenging. The following questions should be asked before recommending a decoration method:

1. How many colours will be required? Are there subtle halftones or photographs, tight registration of colours? Fine or small copy?
2. What material is to be used—plastic, cardstock, paper, corrugated, foil or holograms?
3. Does your business or corporation use an established printer? What technology does that printer have available? Can this technology be used without compromising the proposed design?
4. Are there any bar codes (UPC, Electronic Verification, Interleave 2/5)? Will the printer accept all liability for bar code integrity?
5. What varnishes are available? Will the varnish affect production of the product?
6. Will the ink rub off during shipping?
7. Where does the consumer use the product? (Shower, workplace, car, garage, garden, etc).
8. Who accepts liability for non-compliance of colours or copy?
9. What quality control measures are in place both within the organisation as well as the supply base?
10. Who defines quality and how best can you meet their expectations?
11. What types of documentation are required and to whom will they need to be distributed?
12. If the product is a label or carton, are the adhesives to be used appropriate for the material and the conditions in which it will be stored and used?

It is important that this information is given to the printer so that appropriate inks can be chosen for the environment in which the product will be used, and to ensure product durability and perception through the product's life cycle.

## 1.9 Measurement of colour

Although there are devices which can measure its variance (photospectrometers, densitometers, spectrophotometers), colour is extremely subjective. There are many manufacturers and standards of ink matching systems in the world but most common is the Pantone® Matching System (PMS). Pantone's advantage is that it is globally accepted by the graphic arts industry. Designers, graphic artists, pre-press operators and most printers have reference to PMS and even if an alternative, yet just as reputable, ink matching system has been adopted, Pantone can still be used as a reference.

There are a number of conditions that may affect the colour quality (or fidelity). Substrates, varnishes, climate/humidity during the print or cure cycle, the lighting conditions in which it is viewed or printed and the printing method can all affect the resultant colour. In addition, everyone views colour differently. Although human eyes tend to see colour consistently and agreeably (i.e. blue sky, green grass, and red apple), in reality, the cones and rods within our eyes will perceive light reflected from surfaces slightly differently. This is important to realise when negotiating or discussing colours with internal customers or the supply chain. A complete test and thorough study of colour expectations and fidelity should be evaluated on the intended substrate and all pertinent approvals acquired before printing.

All too often problems arise because the approvals or colour matching were not undertaken under the same lighting conditions as those at the point of purchase. Problems also occur when more than one printing supplier is used; one is used to approve a design and then the other (using different generations of technology) fails to match the approved sample. It is also important to remember that the printing process can vary within the same product. For example, the label can be printed using flexography from printer A on a bright white paper substrate, and the corresponding carton could be printed using lithography at printer B on a slightly heavier and less bright carton material and varnish, thus providing a slightly different effect and colour fidelity.

## 1.10 Subtractive colour (4-colour process)

A process known as 'subtractive colour' is often used for printing photographs or full colour illustrations. The principle of this method is that any colour photograph or illustration can be duplicated by separating and subtracting one of four colours into a collection of colour dots measured by increments of a percentage screen. Typically these four colours are magenta, yellow, cyan, and black although there may be times when one of the colours may need to be substituted because of special effects or printing press limitations.

The separation and re-collection of each of the four-colour dot screens can then provide a corresponding film negative. A plate can then be 'burned' from these negatives and used to transfer ink to the substrate. The size, density and proximity of the dots to each other will provide the variance of colour, tone, and contrast requirements measured by percentage or line of screen. For reference, 100% of a screen is a solid heavy coverage of the ink and 5% is a very fine light tint. When printed in combination, the illustration or photograph will reproduce as a duplicate of the original. The crispness and size of the dot, as well as the quality of the surface on which it is printed, will determine the total quality of print reproduction.

As an experiment, take a colour photograph from a magazine or newspaper and view it carefully under a magnifying glass. It is easy to distinguish the four separate colour dots and to see how their proximity to each other affects colour reproduction. This same dot structure can also be determined on a black and white printed photograph.

## 1.11 Line printing

Another reproduction method for typically less sophisticated two or three colour printing is to print solid colours from ink pigments mixed to match the specified requirements before printing. As stated in Section 1.9, there are a number of ink matching systems world-wide but the one most commonly used is the Pantone® Matching System (PMS). By providing virtually any printer with PMS numbers, the colour palette can be matched to their own ink matching system and a common palette definition can be understood.

The printing, ink, and paper manufacturing industries are extremely complex and this chapter serves only to guide the reader through their decoration requirements. If one is interested in learning more about printing technology, '*Pocket Pal®*' is a basic bible for the graphic and printing industry and is available through most printers or paper suppliers.

## 1.12 Environmental concerns

It is important always to be aware of the impact that your package specifications and materials may have on the environment. Environmental issues and regulations relating to waste, inventory management and production should be reviewed. Types of board or paper stock, inventory control and disposal systems, inks, varnishes and plastics should be considered in terms of their environmental impact. To learn more about environmentally appropriate products, internal expertise, local municipalities, state or federal authorities and trade associations may be consulted.

## 1.13 Bar codes

The bar coding of products developed from an automated checkout system proposed by Wallace Flint in 1932 in the US. A bar code is a series of lines with varying thickness that when scanned with a beam of light or infra-red laser can be used to identify products. Wallace Flint became vice-president of the National Association of Food Chains 40 years later and supported efforts to standardise bar codes, which led to the Uniform Product Code (UPC) in the US. A committee was formed, proposals were submitted for an efficient system to implement such a system, and IBM®'s proposal was accepted as the industry standard. The system has since been adopted for managing inventory and confirming product and pricing by most manufacturers, governments, services and organisations world-wide.

Bar code technology is used in the consumer industry in manufacturing, shipping and distribution, incoming receipt, inventory management, quality control, and reconciliation of packaging components and finished goods. The integrity and quality of the symbol is critical to ensure that the product can be quickly scanned. There are a number of different protocols in use, and it is essential to confirm with customers and manufacturing sites which codes are recommended. EAN, UPC, UCC, ECCC, AMECE, ITF, Code 39, Code 13, pharmacodes, dot matrix, and electronic verification codes are just some of the codes which may need to be generated and imprinted using a variety of printing techniques. This information must be confirmed before creation of any final package artwork. Even the direction or flow of the bar code can have negative consequences if not properly positioned on the package in line with printing press sheet flow. Poor positioning may result in poor code integrity and ultimately to product refusal, customer complaints, damaged components and/or damaged finished stock.

*Bar code colour.* The contrast and colour of the bar code is critical to meeting specifications. Retailers in most countries now accept 'laser' technology to 'scan' the symbol with an infra-red beam of light for ease of product distribution, related accountability, and inventory control. The ink, colour, directional flow, symbol integrity, and positioning of the code must be acceptable to everyone involved from the printers to the cashier at the check-out.

## 1.14 Documentation

In the consumer industry, managing the process and all required information and specifications can be a considerable challenge. Last minute changes from almost any sector within the organisation are inevitable. Proper accountability and quality control systems must be in place to manage and measure expectations, and monitor cost, quality and delivery through detailed documentation. Ensuring that the corporate office, the supply base, the manufacturing sites and any external contractors are all working with the most current and consistent information is critical if deadlines are to be met and quality maintained. Analysis of well documented events can provide a history of performance, identify weak links in the supply chain, ensure quality and consistency, and identify opportunities for performance enhancement.

## 1.15 Quality control

It is important to note that quality can be very subjective. Understanding and managing the expectations of all key stakeholders is critical to ensure that the product meets all specifications and requirements. Quality in the consumer industry must be measured from the perspective of consumers, the retail, wholesale and manufacturing sectors, and bodies concerned with regulatory compliance, as well as that of the marketing team. Each stakeholder will have specific quality control criteria:

*Marketing*: how well does the package communicate its message, meet consumers' needs, maintain brand equity and personality, and maintain projected profitability margins?
*Regulatory compliance*: how well does it communicate, does it comply with regulations, does it meet local agency requirements?
*Environmental*: how environmentally friendly is the total package and its development/manufacturing processes?
*Legal/intellectual properties*: how easy is it to protect the design? Are the product or package claims appropriate?
*Engineering*: how efficiently can the package be filled and run on the manufacturing line? How reliable is the quality of the structure and related integrity of the material?
*Retail customer*: how durable is this package? Is it making the most of available shelf or merchandising real estate? Is the consumer buying?
*Purchasing/finance*: is this package economical? Did it meet projected costs? Is the supply base performing as expected and agreed upon?
*Customer*: is this package right for me? Is it informative, does it meet my values and lifestyle, is it ergonomically friendly, can it be stored appropriately in the place and manner in which I would use it?

The examples above illustrate the broad spectrum of quality control criteria that a package needs to satisfy. One thing is certain: there is hiding within your package a mistake or typographical error within your packaging artwork. Be sure to proof read, then proof read again. Always assume that the package has a typographical error and it is your responsibility to find the error. Nothing can be as costly or embarrassing to a corporation than a typographical error of a mass-produced item or even worse, a product recall because of something as small as a misplaced letter.

## 1.16 Production management

### *1.16.1 Prototypes and mock-ups*

Communicating verbally the subtle aesthetics of design can be extremely difficult and misleading. The author's experience of new product development is that nothing sells an idea like a prototype. Attempting to walk an internal customer through design aspects, and to identify all the critical issues of printing, engineering, colour fidelity and bar code positioning, is virtually impossible without the use of a very detailed drawing or model. In this case a prototype is worth a thousand words and should be built to ensure consistency in communication and interpretation with all key stakeholders. All associated components should be addressed, including labels, cartons, inserts, shippers, bottles, closures, case packs and display units.

## 1.17 Structural packaging

Unique opportunities may arise from adopting a decorative structure for a bottle, closure or box. The current trend is to find a unique characteristic of the product package form to make the product stand out on the shelf in the shop, where consumer impulse buying accounts for over 70% of the reason for purchase.

If the proposed solution is innovative in nature, it can be a more costly alternative. New moulds, stamping, cuts and related product and machinery conformance will need to be researched, tested, and qualified, to ensure that line filling and packing speeds are as expected, and any unexpected variable costs are identified. A review of complexity with plant, engineering, quality control and regulatory compliance personnel can help ensure that line speeds, supply chain quality control and delivery, budgets and costs of goods have been finalised and meet the business projections. If done creatively, a unique differentiation of product can be achieved against the competition, and there may be consumer benefits in storage, usage and ergonomics. It may even be possible to build upon specific visual brand equities and related personality. Specific stability or storage requirements and testing may be necessary to guarantee product integrity, tamper resistance, protection from theft, or freshness over a period of time. Durability during transportation and merchandising also needs to be considered.

For more traditional structural options such as a standard box or label, all specifications related to the manufacture of the structure must be identified and communicated. Traditionally this is commonly known as a dye vinyl and can be prepared in digital, paper or Mylar® form. The dye vinyl is similar to a blueprint and spells out dimensions, the positioning of any unique bar codes required in the packaging process, the positioning of lot numbers and expiration dates for perishables, the direction of the flow of copy and the principle display panel (PDP), printing tolerances for specifications such as ink coverage areas, non-varnish areas, adhesive positioning, cuts and scores. This 'blueprint' must be completed and approved before any finished artwork can be prepared. Any changes in these specifications after submission to the designer for finished art preparation may have a significant impact on package design, line efficiencies, printing costs and schedules.

## 1.18 Substrates and materials

Typically when one thinks about substrates and the surface of packaging substrates, one thinks of cartons and labels. In reality substrates cover a variety of materials from paper, glass and plastics to aluminium, tin, steel or even wood. The range is almost endless and it relates to the personality of the product, related product attributes, expected perception and product positioning, and cost of the product which the package shields. The decoration methods used on each of these surfaces will vary depending on expectations, project parameters and objectives as discussed earlier. In addition, product protection, transportation, the environmental conditions in which the product is used and spoilage will play a major part in the material of choice. As the use of graphics is becoming exhausted in the marketplace, structural packaging will play a more important role in the future.

## 1.19 Global packaging and cultural nuances

The colours, quality, components, substrates, language, dialect, and typography used on packaging can be relevant or approved in one country or culture, yet totally inappropriate or possibly even insulting in another. It is recommended that consumer research be conducted on a global brand to ensure that the product's message is on target and acceptable to the entire distribution channel. Minor variations to the overall design or reproduction process can have a significant impact. Certain printing methods have limitations and improperly or poorly reproduced copy can become unintelligible, especially with some of the character detail of the Eastern languages.

## 1.20 The future of packaging

It is difficult to predict the effect of the next generation of consumers' requirements, values, habits and ever-evolving technology on packaging form, function, or even need. Shopping from home, using the internet, satellite and cable shopping services, continues to challenge traditional merchandising and communication methods. The rising costs of materials, of services and of environmental impact will continue to challenge packaging specifications, materials and usage from the perspective of the consumer, manufacturer and distributor. Packaging technologists, artists, designers, engineers and marketing personnel can help mould that future and ensure the maintenance of quality, communications and product integrity. It is through the success of these relationships and the continuous improvement of products, systems, materials and technological applications that packaging will continue to evolve.

# 2 The printing processes

P. Steele

## 2.1 Introduction

There are five main printing processes currently used for the decoration of packaging in the consumer market, be it direct decoration or decoration via labels and sleeves:

Lithography
Photogravure
Flexography
Silk screen
Letterpress.

In the future, new digital printing processes will be developed aimed specifically at short production runs, enabling marketers to test new product launches without incurring high origination costs, while at the same time producing a quality product with the possibility of introducing variable information for certain markets (see also Chapter 14 on Future Decoration Systems).

## 2.2 The history of printing

Printing began with the invention of paper in China in AD 105. This led to printing from carved wooden blocks throughout the East—particularly in China, Korea and Japan. The oldest known printed book was produced in China in AD 868.

Developments in printing continued with words and pictures being carved together on wooden blocks. However, this necessitated a new set of blocks being cut for each new book. To obviate this, printing presses were developed using type cast from individual pieces of clay so that they could be used repeatedly. These were in common use in China by AD 1041, and by AD 1400 Korean printers were casting type in metal.

Printing in Europe had existed in various forms since the sixth century, but it is Johannes Gutenberg who is credited with the invention of printing in the West and the production of the first book in Europe in 1445. Gutenberg was a goldsmith by trade, living in what is now Germany. At the time all the technologies necessary for the invention of printing were available; it just needed the right mind to put all the pieces together. As a goldsmith, Gutenberg knew how to cast objects in metal, and ink and paper were readily available, together with presses used for wine making which could be adapted for printing. Gutenberg went on to develop the concept of casting individual letters that could be assembled into words, printed, cleaned and reused, a process now known as letterpress printing.

## 2.3 The development of printing

Traditional forms of printing have always required ink to be placed onto a raised surface; for example, metal type letters or an etched printing plate. The inked surface is then pressed against the material to be printed, the ink is transferred and a readable image left on the material. A basic example of this would be a rubber stamp placed onto the inkpad. Ink is transferred onto the raised surface, the pad is pressed against the paper and the ink is transferred to leave the message. This type of printing is very much a 'physical' printing process; ink is transferred direct to the material from the printing plate.

Over the centuries other methods of transferring ink onto paper were developed from Gutenberg's original concept of 'letterpress' printing. The printing processes now in use can be categorised into one of four main types (Figure 2.1): relief, intaglio, planograhic and stencil.

### *2.3.1 Relief printing*

The ink sits on the raised surface of the type or plate, and the printed impression is made when the raised surface is coated with ink and pressed against the paper or other substrate (Figure 2.1a). Typical forms of relief printing are letterpress and flexography.

### *2.3.2 Intaglio printing*

This uses a plate or cylinder, which has been etched or incised with lines, grooves or dots. Ink is applied and the excess is wiped from the surface leaving ink in the grooves. An impression is made when the paper or substrate is pressed against the surface of the plate or cylinder, drawing the ink out from the recesses (Figure 2.1b). A typical form of intaglio printing is gravure.

### *2.3.3 Planographic printing*

This is very much a 'chemical' printing process of which lithography is the only example. The printing process relies on the fact that oil (the ink) and water do not mix. The printing plate is 'chemically' treated and when ink is applied to the flat surface of the plate it sticks only to the 'dry' areas and is subsequently

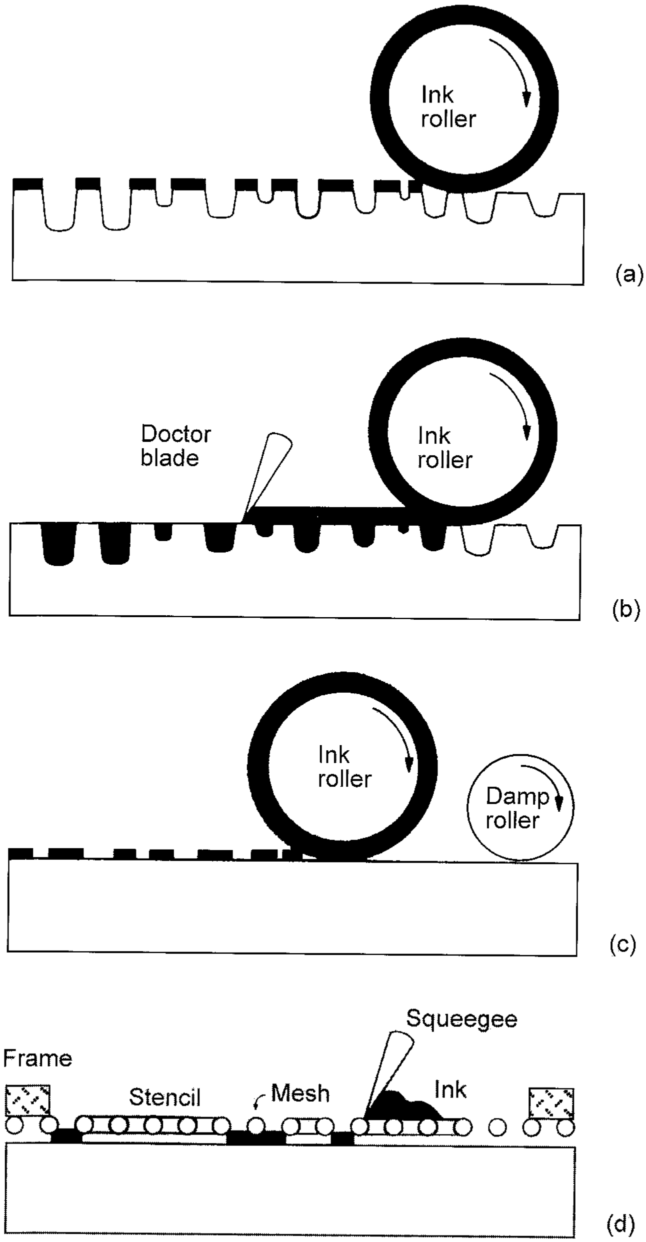


**Figure 2.1** The four main categories of printing process: (a) relief; (b) intaglio; (c) planographic; (d) stencil/screen/silk screen.

transferred to the substrate (Figure 2.1c). This method is used for printing paper labels and printed cans.

### *2.3.4 Stencil printing*

Like relief printing, this is an ancient printing technique where ink is forced through a mask or stencil supported by a mesh (Figure 2.1d). This is now commonly known as screenprinting or silkscreening.

## 2.4 The theory of colour

The use of colour in print has always been important. In the early days, each colour would be hand-drawn and printed, with sometimes as many as 12 separate colours being used. As the demand for colour printing increased, other methods of reproducing colour had to be found.

In theory it is possible to create any colour from a mixture of three primary pigments: red, yellow and blue. A mixture of any two colours will produce the secondary colours. For example, a mix of yellow and blue produces green, a mix of blue and red produces purple. A mix of all three theoretically produces black although in reality the end result is a muddy brown. These combinations apply to *reflected light*.

Pure white light or *transmitted light* contains all the colours of the rainbow and here the three primary colours are red, green and blue-violet; these mixed together give white. Where the primary colours overlap, the secondary colours appear: yellow, magenta and cyan.

These secondary colours form the basis for colour printing, although to produce quality colour printing a separate black is required, this black being referred to as the ‘key colour’. This system of printing in four colours is known as CMYK—Cyan, Magenta, Yellow and the Key black. Other systems of defining colour include RGB (Red, Green and Blue) used for computer displays and the more theoretical HLS (Hue, Luminance and Saturation).

On the basis that any colour can be matched from a mixture of two or more colours the Pantone® Matching System (PMS) was developed. This has now become the printing, publishing and packaging industry standard colour ‘language’, providing an accurate method for the selection, presentation, specification, matching and control of colour with a colour chart of over 1000 colours available for selection. Within the PMS there are nine basic colours:

| | | |
|---|---|---|
| Yellow | Warm Red | Rubine Red |
| Rhodamine Red | Purple | Violet |
| Reflex Blue | Process Blue | Green |

These nine basic colours are supplemented by transparent white and black for colour matching. There are also complementary sets of colours within the Pantone system including a standard range of four colour process inks:

| | |
|---|---|
| Process Yellow | Process Magenta |
| Process Cyan | Process Black |

There are also four supplementary colours:

| | |
|---|---|
| Pantone Yellow 012 | Pantone Orange 021 |
| Pantone Red 032 | Pantone Blue 072 |

There are also metallic inks and specialist selections such as pastel colours that are particularly useful for packaging designers.

The Pantone colour chart shows each colour, together with the formulae for mixing the ink and the printed effect on both coated and uncoated material. For example Pantone 199 C is a mix of 12 parts Pantone Rubine Red (75%) and 4 parts Pantone Yellow (25%) printed on a standard coated paper. PMS 2725 U is a mix of 6 parts Pantone Violet (37.5%), 2 parts Process Blue (12.5%) and 8 parts Pantone Transparent White (50%) printed on a standard uncoated paper.

It should be pointed out that when printing on non-standard papers, where the material may be slightly 'off-white' or 'cream' coloured, then variations to the specified mix will be required.

Recent developments include a new Pantone Hexachrome® system using six colours: brighter (more fluorescent) versions of CMYK plus vivid orange and green. This expands the colour spectrum and is also referred to as *HiFi* colour. When printing using the Hexachrome® system black goes down first, followed by green, cyan, magenta, yellow and finally orange. This system is becoming increasingly used within the packaging industry as it is able to provide brighter and more vibrant colours, which is particularly useful in label production.

### *2.4.1 Screening*

To reproduce continuous tone illustrations or photographs they have to be converted into 'line' by turning them into a pattern of single dots before they can be printed. This process is called screening and can be done either photographically, through a screen, or more commonly nowadays either digitally or by laser.

A conventional halftone contains dots of different sizes, but placed in a regular pattern, according to the type of screen being used. Where there are light tonal areas, within the image, the dots will be small appearing as black dots on white, whilst with dark tonal areas the dots will again appear small but this time as white dots on black. At 50% tonal value the dots form an equal pattern of black and white. (Line illustrations or type copy do not require screening for lithography.)

The halftone produced by the photographic method is achieved by placing a 'screen' between the lens of a process camera and the film being exposed. The screen is usually made of glass with a finely ruled grid pattern. As the light waves pass through the screen they are converted into dots that vary in size, shape and number. When the individual dots of the halftone are printed they appear to melt back into continuous tone.

Halftone screens are measured in lines per inch (or lines per centimetre, in Europe), usually abbreviated to 'lines' or 'lpi'. Using a screen with a higher 'lpi' the number of lines per inch produces a finer dot pattern and hence gives a higher quality of reproduction.

When specifying the halftone screen it should be remembered that the quality of the final halftone dot depends on the material onto which it is being printed. For example, when printing onto newsprint the ink will spread and if the screen is too fine the dots in the darker areas of the image will merge or 'fill in'. Conversely if printing onto high quality art paper using a coarser screen, (that is, one with fewer lines per inch), then the smoother paper will reproduce every dot and the individual dots may be visible to the naked eye rather than *visually* merging to create the desired continuous tone effect. For this reason typical screen specifications may be:

Newsprint: 55 to 65 lines per inch
Smooth uncoated stock: 100 to 125 lines per inch
Coated stock: 125 to 150 lines per inch
Gloss art paper: 175 to 200 lines per inch

Always consult your printer before specifying screen values. Each printing process (and the substrate to be printed) will vary the 'dot size'. This will affect the final printed image.

Conventional screening is referred to as amplitude modulated (AM) screening; that is, the dots are arranged in a regular pattern of rows and columns but each dot varies in size. Other screening techniques now available include Stochastic screening, now referred to as frequency modulated (FM) screening. This type of screening produces dots of the same size but they are randomly scattered; this produces finer vignettes and reduces the possibility of moiré pattern problems. Moiré patterns are irregular wavy lines produced by the superposition at a slight angle of two sets of closely spaced lines (Figure 2.2). These unwanted 'basket weave' effects can occur when screen angles on colour work are not set correctly, when there is regular patterning on an image, or when a halftone has been re-screened.

### *2.4.2 Colour separation*

For CMYK printing any colour drawings, photographs or transparencies need to be separated out into the four process colours—cyan, magenta, yellow and

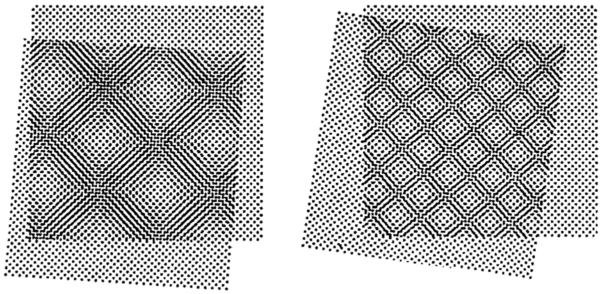

**Figure 2.2** The Moiré effect.

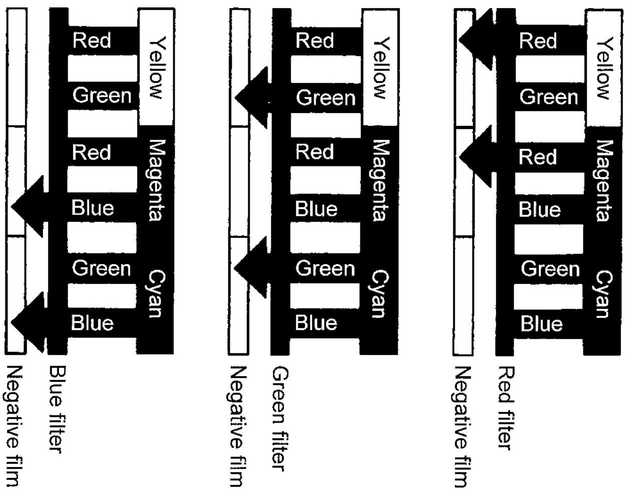


**Figure 2.3** Filter separation.

the key black. This can be done on either a process camera or, more commonly nowadays, scanned in and separated on a flat bed or drum scanner.

*2.4.2.1 Separations by camera*

These are made on continuous tone film using the three colour filters—red, green and blue—for transmitted light. The red filter allows only the blue and green components through, creating cyan. The green filter allows only red and blue, creating magenta, and the blue filter lets through only the red and green, creating yellow. The negatives taken through these filters are known as *colour separations* (Figure 2.3). When colour separating by camera, the screens are laid out at different angles so that the 'dots' are kept separate and in a pattern designed to eliminate moiré effects or 'screen clash'.

For CMYK printing, the screens of the main colours are orientated at 30° to each other. Specific angles are reserved for each colour: the easiest on the eye is 45° so this is reserved for black, the magenta is set at 75°, cyan at 105° with the difficult angle of 90° reserved for yellow, the least obtrusive colour (Figure 2.4).

When preparing colour separations for the Hexachrome® system, green and magenta are prevented from appearing in the same area, as are orange and cyan, so these can share the same screen angles and avoid any moiré pattern.

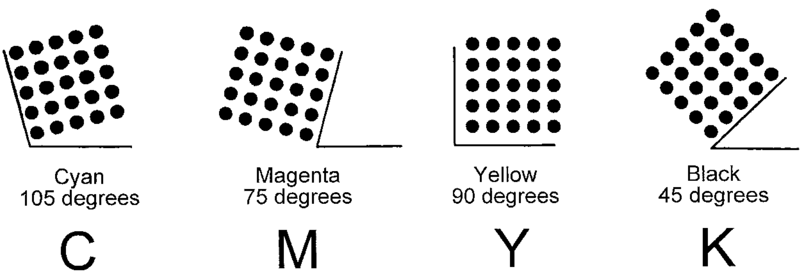


**Figure 2.4** The screen angles used for the main colours in CMYK printing.

*2.4.2.2 Separations by scanner*

The most common method for preparing colour separations is by means of an electronic scanner. Scanners work by reading the artwork as a series of lines or rasters with a beam of light being used to pick up the three colour components. The split beams are digitised and passed into a computer where colour correction can take place if required.

There are various types of scanner on the market and care must be taken to ensure that the finished resolution from the scanner provides the quality of image required. Resolution is a measure of the fineness and quality of the output from a scanner and is usually measured in dots per inch (dpi); that is, the number of dots that can be placed end to end in a line one inch long.

A desk top scanner providing a resolution of 300-dpi will just about be able to produce a halftone at the same size with a screen of 150 lines per inch—the minimum resolution for scanning should be at least twice the screen specification for printing.

They are generally used by design studios to make low resolution scans of colour images which will be replaced later by high resolution scans for printing purposes. Commercial printing generally requires the use of a 'high-end' scanner. These can be of a flatbed type (similar to a desk top scanner) but producing a resolution of 5000-dpi, or the more traditional drum scanner capable of achieving resolutions up to 10 000-dpi. With the image having been scanned and output to a computer, for any colour correction or manipulation, the next stage in the process is to output film for platemaking. This is done by sending the digital information to an image processor, via the raster image processor (RIP). It is also possible to send digital information direct from the computer to plate (CTP).

## 2.5 Summary

Within the decorative packaging market the printing processes used are lithography, photogravure, flexography, silk screen, letterpress and digital. The majority of printed packaging is produced by lithography, photogravure, flexography and silk screen printing methods. These processes are discussed in detail in later chapters.

There are, however, niche market sectors within the packaging industry requiring letterpress and digital printing. These two processes are summarised here.

### *2.5.1 Letterpress*

Letterpress is a relief method of printing in which a raised surface is inked and pressed against the material to be printed. The origins of letterpress go back to 1445, when Johannes Gutenberg developed the concept of casting individual letters that could be assembled into words combined with woodcut blocks for printing illustrations.

Until the 1960s letterpress was the most popular form of printing but it was gradually replaced within the commercial printing field by sheet-fed offset lithography for small to medium runs, and by web offset for the longer runs. The principles of letterpress printing did, however, lay the foundation for the development of flexography, to which it bears many similarities.

Although the process declined in popularity during the 1960s it underwent a revival with the rapid development of reel-fed self-adhesive labelling. The market for self-adhesive labels began to demand high quality colour illustrations as well as line work, and the letterpress printing process has always produced excellent work with superb quality of impression.

To meet the quality requirements of the self-adhesive market, narrow web rotary letterpress printing machines were developed. These use flexible metal or plastic plates and print using traditional oil-based inks modified so that they 'cure' (dry) when exposed to ultraviolet light. These are commonly known as UV inks. The combination of letterpress plates together with oil-based inks compared with the flexo process using solvent-based inks initially provided the higher quality demanded by customers. Rotary letterpress is still often run alongside similar existing flexographic presses but while initially the letterpress plates produced a higher quality, improvements in flexo plate technology have narrowed the gap.

In the self-adhesive label market, combination presses are often seen with letterpress, foil blocking and even silk screen combined on the same press to meet specific design requirements. In the future letterpress will continue to have a place in label printing for the consumer markets but it is more likely to become a specialised process for high quality work, rather than a contender in the more competitive volume end of the market.

### *2.5.2 Digital printing*

The digital printing process is unique in that there are no traditional set-up costs and no film or plates are required to produce the printed image. Printing is possible direct from computer disk or even from artwork and the process is therefore relatively inexpensive for short runs.

The traditional monochrome and colour photocopiers have provided the base for the development of the digital printing process. Full colour work can now be produced on a wide range of substrate stocks. Origination costs are kept to a minimum and initial copies are available, essentially, on demand.

The principle of the process is that the image is directed onto an electrostatically charged drum. This charge leaks away where light from the image falls on the drum, and a resin-based powder (toner) is then attracted to the image areas. The pattern of toner is then transferred to the paper and is 'fixed' when the paper is passed through a set of heated rollers. A full range of CMYK toners is available for the production of colour work and the whole printing process is digital with the production machine operating as a combined laser scanner and laser printer.

These systems generally use reel-fed substrate stock, and the current market is in labels (including self-adhesive) which mass market outlets require to 'attach' quick information such as price offers. A number of consumer markets are also using digitally printed stock for packaging labels and flow wrapped products.

# 3 Linking lithography to packaging decoration formats

P. Steele

## 3.1 Introduction

This is the most common printing process used for the production of paper labels within the consumer packaging market. It is often technically known as offset lithography because the image is not usually transferred directly on to the label material, from the plate, but from an intermediate blanket.

## 3.2 History

Alois Senefelder invented the lithographic printing process in Prague around 1798. At the time he was experimenting with limestone to find cheaper alternatives to engraving images on copper. His experiments with etching in relief were a failure, but he discovered that if a design was drawn on a limestone surface, using a greasy crayon, and the surface was then 'etched' with a solution of gum arabic, water and a few drops of nitric acid, then the area that had been *drawn* became permanently *receptive* to grease. He also found that the *undrawn* area had been desensitised by the gum solution and was permanently *resistant* to grease.

When the stone was dampened and greasy ink applied, from a roller, the ink stuck to the drawn design (being *receptive* to grease) but not to the rest of the surface (being *resistant* to grease). An impression could then be taken giving exact replicas of the original design. This was the beginning of lithography, which literally translated means 'writing on stone'.

The same properties were later discovered in zinc and aluminium plates, much more manageable materials than stone. The original printing process has been further refined, over the years, with the development of colour separation systems, new ink technology and modern printing presses. The printing impression is no longer done directly from the metal plate but via an intermediate blanket. This gives rise to the current term of 'offset lithography' to describe the printing process.

## 3.3 The development of lithography

By the end of the 19th century original line drawings, greetings cards, sheet music, maps and posters were all being mass produced by lithography, and by 1875 offset lithography was being used for printing decorations on to tin plate for packaging applications. The invention of photography in the late 1830s created a demand for reproducing continuous tone images, but it was not until 1852, when the photographer Fox Talbot suggested that tones could be reproduced by means of 'photographic screens', that interest in the development of lithography really gathered pace. Fox Talbot went on to develop gravure for printing continuous tones. Frederick Ives of Philadelphia patented a method in 1881 of converting a photograph into dots. George Meisenbach later refined this idea by producing a single line screen turned through 90° during exposure. The development of the 'halftone screen' had begun.

Illustrations, photographs and type began to be combined by cutting and pasting photographic film. These images could then be transferred directly to a lithographic plate and printed. The invention of the halftone screen also paved the way for full colour printing.

## 3.4 Plate-making

Lithographic plate-making is the process by which the image is transferred on to the plate either by photographing the artwork directly or copying on to the plate, by film imaging, or by sending digital information direct from computer to plate (CTP). Offset lithographic plates have to be thin and flexible enough to wrap around the plate cylinder. They are generally supplied pre-sensitised with a light-sensitive coating and can be made from metal, plastic or paper. The largest proportion of lithographic printing is produced using metal plates that are imaged from film.

Because of their low cost, paper and polyester plates are used for short run work—500 to 5 000 impressions for paper plates and up to 15 000 for polyester plates. They are generally used for text and line illustration work printing small offset single (or non-register) colour work, as they are prone to stretch and distortion on press. They can be exposed under a camera or placed in direct contact with the artwork or film for processing.

Aluminium is the base substrate for most lithographic printing plates. The surface of the plate gives good water carrying (hydrophilic) properties (a vital part of the modern lithographic process) and this characteristic is further enhanced and made more durable by graining and anodising the surface. Aluminium plates are suitable for medium to long runs achieving between 300 000 and 500 000 impressions before the image and grain start to break up, as a result of wear.

Some types of plate can be 'baked' (oven treated) after processing to extend the run life to 750 000 to 1 000 000 impressions.

Tri-metal plates made from steel electroplated with a thin deposit of copper and a hard wearing chrome surface are available for long run work, but these are relatively expensive and with improvements in standard plate technology they are being used less and less.

Most metal plates are supplied surface coated from the manufacturer using a photopolymer (polymeric material sensitive to light) or a diazo compound (this decomposes under ultraviolet light). These have a shelf life of about a year. When exposed to ultraviolet (UV) light the surface coating undergoes a chemical reaction and the solubility of the coating is changed.

Most lithographic plates are produced using a photomechanical process and for the majority of plates the image transfer method is by film contact exposure.

### *3.4.1 Film imaging*

For plate-making the film used by printers is made using a polyester base material that is coated with a high speed and high contrast emulsion on one side leaving the emulsion side of the film slightly duller than the other side. When the printing plates are made, the film is put in contact with the plate with the emulsion touching it (i.e. emulsion side down) in order to obtain maximum sharpness.

Film can be right reading or wrong (reverse) reading and since the film can be viewed from either side it is important to specify 'emulsion up' or 'emulsion down'. The type of film most commonly used in lithographic printing is *right reading emulsion down* (RRED), although conversely this could also be specified as *wrong reading emulsion up* (WREU). For other direct printing processes such as photogravure the film may be specified as wrong reading emulsion down (WRED) or conversely right reading emulsion up (RREU).

### *3.4.2 Positive/negative working*

Plates can be made from either a positive or a negative film dependent on the type of pre-sensitised plate being used. This is known as either 'positive working' or 'negative working'. With negative working plates the coating becomes *insoluble* on exposure to UV light and forms a bond with the plate base. The unexposed (non-image) areas are then removed with a developing solvent. With positive working plates the coating becomes *soluble* on exposure to UV light and is removed during subsequent development. In both cases the coating that remains forms the ink receptive image area.

Other methods of producing plates are available (electrophotographic, chemical transfer and photodirect); the standard process for producing metal plates for lithographic packaging printing is by film imaging, using plates coated with a light-sensitive photopolymer material or a diazo compound, as described earlier.

The developed films are assembled with key lines to check registration for multicolour printing. These are then placed in a contact frame and accurately positioned on the plate using a pin system with the emulsion in contact with the plate surface—emulsion down. A vacuum is then created to ensure there is good contact between film and plate during exposure to the light source.

When a negative working plate is radiated with UV light the exposed photopolymer or diazo resin coating (the image area) undergoes a chemical change. This becomes receptive to ink forming the image on the plate that will print. The rest of the coating, which has not been exposed to the UV light, is then washed off during subsequent processing.

Conversely when a positive working plate is radiated with UV light the exposed photopolymer coating (the non-image area) becomes unstable and is removed during processing. It is the coating that has not been removed during processing that becomes the image area and will print.

After development the plate is rinsed with water to remove any residual developer and coating. The plate is treated with an application of 'gum' leaving a protective film that prevents sensitisation of the non-image areas. The gum also enhances the hydrophilic nature of the aluminium and for this reason is known as a desensitiser. The gum has no beneficial effect on the image areas.

Positive working plates produce less dot grain than plates made from negatives giving consistent quality. However positive working plates can be de-stabilised by light and have a shorter working life than negative working plates.

While the development of plates can be done by hand it is now the more common practice to use an automatic plate processor. A series of rollers transport the plate through the development bath, followed by a water spray, gum application and warm air-drying. The end result gives a surface that is receptive to water (hydrophilic) in the non-image areas and which repels water (hydrophobic) in the image areas. This forms the basis of all lithographic printing.

## 3.5 The printing inks

### *3.5.1 Constituents of inks*

All inks are made from three basic constituents:

- *Pigments and dyes*. Pigments come from a wide range of natural and synthetic sources (organic and inorganic). Dyes are liquid and have to be 'coated' or attached to solid particles before they can be mixed with other ingredients. Black ink is made from carbon black.
- *The vehicle (or binding substance)*. The vehicle is the carrier that binds the dry, powdery pigments together. It can be oil, a natural resin or an

alkyd (a synthetic resin). The type of vehicle to be used is determined by the printing process. Lithographic and letterpress ink is oil-based whilst gravure, flexographic and screenprint ink is resin-based and thinned with a highly volatile solvent.

- *Additives*. Printing inks contain various additives; mainly dryers but also some antioxidants that are added to stop the ink from drying on the printing rollers. Fillers and other agents are also added to give the ink any special properties that may be required, such as slip resistance. Other additives include extenders that increase coverage of the pigment and improve ink transfer from press to paper; distillates which improve the flow characteristics of the ink; and waxes which improve the slip and scuff resistance properties of the ink (a particular requirement when printing packaging materials). Waxes should not be added if the finished product is to be varnished.

### *3.5.2 Other properties*

Lithographic inks must be relatively transparent so that when individual colours are printed over each other they 'mix' to produce the desired colour (i.e. yellow when printed over blue will produce green). They also need to perform well on the press while being constantly contaminated with water from the plate during the printing process.

Water-based inks are also under development owing to environmental pressures although these are currently mainly used for flexographic printing. Conventional lithographic inks cannot be water-based as the lithographic printing process relies on the fact that oil and water do not mix. Lithographic inks must be oil-based and relatively viscous with a high tack (stickiness). They must also have a high concentration of pigment to give the strongest possible colour, as the process demands that the thinnest possible film of ink be applied to the substrate during the printing process.

### *3.5.3 Drying of ink*

Because conventional lithographic inks are oil-based, that is, the pigment and resins used to create the colour are dispersed in oil in order to be applied to the material to be printed, it is necessary to understand how inks dry after being printed.

Initial drying takes place by absorption with part of the liquid vehicle (the oil) being absorbed by the paper or board allowing the ink on the surface to set. In theory this should allow printed sheets to be placed on top of each other in the delivery stack without 'setting off' (i.e. ink being transferred on to the reverse of the sheet above it). With modern presses running at high speeds, further safety factors are built in to avoid the image setting off on to the next sheet in the pile.

Fine particles of powder are sprayed on to the surface of each sheet as it falls on to the pile. This is known as 'anti setoff' spray powder and the layer of fine particles separates each sheet until the drying process is complete.

The next stage of drying is oxidation where the vehicle (the oil) absorbs the oxygen from the air trapped between the printed sheets and the ink gradually changes to a solid state leaving a hard rub proof printed image. During this stage of the drying process the moisture in the paper absorbs any spray powder applied.

With the speed of modern presses continually increasing, set off problems can occur if using conventional inks. A new range of UV (ultraviolet) inks have been developed which 'dry' or more correctly 'cure' by absorbing radiation. Within the packaging industry the use of these UV drying inks is widespread. Because the inks change very quickly from a liquid to a solid state as they pass under UV lamps, more non-absorbent materials such as metallised paper, foil and plastic can be used to produce quality packaging.

## 3.6 The printing process

Lithography is unique among printing processes in that it requires the application of both water and ink to the plate surface in order to differentiate between the image and non-image areas. If ink were applied to a dry plate (i.e. without water), the ink would stick to the complete surface of the plate. The water forms a continuous film on the non-image areas of the plate, which prevents the ink from adhering to the plate surface, but in the image area the water is repelled, allowing the ink to adhere and subsequently print.

To produce a quality print image it is essential that a clear differential between the image and non-image areas is maintained. The surface chemistry of the plate should be consistent throughout the print run, and ink and water should be applied in the correct proportions at all stages; that is, the ink/water balance must be consistently maintained.

### *3.6.1 Ink and water balance*

Early lithographic printing presses had separate roller systems to apply the ink and water but with modern presses the ink and water are now applied together. The ink initially emulsifies with the water, but they must both readily separate when applied to the plate. As a result of the simple chemical fact that oil and water do not mix, all lithographic printing inks are oil-based, so that they each readily separate from the ink/water mix when applied to the printing plate to produce a clear, and well defined, image.

When first starting the print run the application of the ink/water mix will require adjustment to achieve the correct balance. Initial variation across the press can cause 'streaks' in the printing and the lithographic printing process always requires a number of 'waste sheets' to be printed before the correct ink/water balance required can be achieved.

If too little water is applied to the plate the non-image areas can start to accept ink, which will then start to print—a printing fault known as 'scumming' or 'catch-up'. Too little water can also cause tonal values to change, and dark tones can 'fill-in' and print as solids. In both cases increasing the water supply will stop these problems occurring.

If too much water is applied to the plate some may adhere to the image area adversely affecting the ink separating out and reducing the amount of ink transferred. This can result in light tones not printing or solids to become 'mottled'.

### *3.6.2 Fountain solution*

Although the lithographic process can work with water as the only dampening medium, it has been found that the process works more efficiently if certain chemicals are added. The 'water' is fed to the plate from a holding tray via a series of rollers, and because this series of rollers is known as a 'fountain' the dampening medium is generally referred to as the 'fountain solution'. A typical fountain solution consists of:

- *Water.* The main constituent of the fountain solution.
- *Surfactant.* Modern dampening systems generally require the addition of 10% to 15% isopropanol alcohol. This lowers the surface tension of the water and gives improved 'wetting' of the plate and allows thinner films of water to be used without affecting print quality. This is known as 'alcohol dampening'.
- *Desensitiser.* This is a form of cellulose gum used in the plate-making process to protect and enhance the water receptivity of the non-image areas. It is used in the fountain solution to continue to reinforce the desensitisation process.
- *Anti-fungicide.* This prevents the growth of bacteria and fungi that produce 'slimes' that block the circulatory system and which can also rot the roller covers.
- *Acid.* This is generally a phosphoric acid solution, which helps to reinforce the desensitising action of the fountain solution.

It is important that the fountain solution should not be too acid nor too alkaline. This can be monitored by regularly checking the pH value. A typical fountain solution should have a pH value between 5 and 7, but modern fountain solutions generally incorporate a pH buffer system to stabilise the pH while printing.

### *3.6.3 The printing press*

Offset lithographic presses vary from sheet-fed single and multicolour machines to large web offset presses printing in full colour on both sides of a continuous reel of paper in one pass. Whatever the size or type of press the basic principles of the printing process are always the same. A litho machine will always comprise of a plate cylinder on to which the plate is securely clamped, a resilient rubber-coated cylinder called the blanket cylinder, an impression cylinder, a system of inking rollers called the ink pyramid, and a plate damping unit.

A typical single colour offset press will consist of:

Feeding unit
Dampening system and fountain solution
Inking unit
Plate cylinder
Blanket cylinder
Impression cylinder and
Delivery unit.

A single colour sheet-fed lithographic press (Figure 3.1) prints single sheets of material in one colour at a time. Sheets are lifted one by one by vacuum suckers and then passed through the machine by means of feeders, blasts of air and conveyor belts. The plate is first dampened by the fountain and then inked by the ink pyramid. The image is transferred to the rubber blanket cylinder and then 'offset' on to the paper before being finally pressed between the blanket and the impression cylinder. The sheets are then finally stacked in the delivery unit.

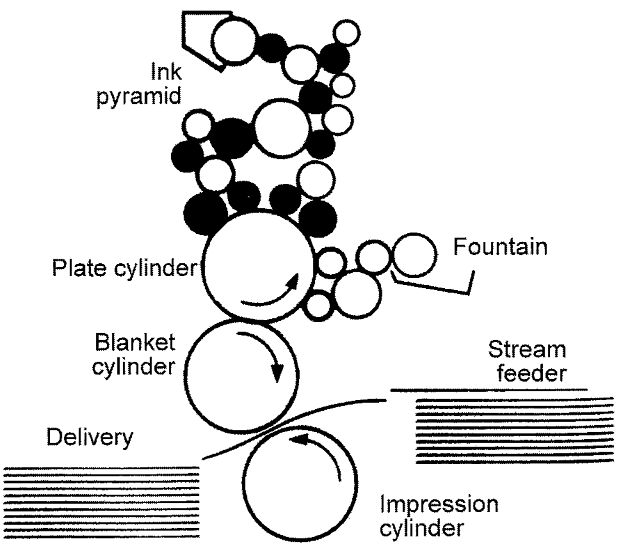


**Figure 3.1** Typical single colour printing press.

#### *3.6.3.1 Feeding unit*

High-speed presses use a stream feeder mechanism; sheets are presented to the rollers overlapping slightly and if a sheet is defective or two sheets are picked up together, 'detectors' cut out the printing unit. There are adjustable stops (front and side lays), which position each sheet as it enters the machine, and sets of metal fingers (grippers) grab each sheet and pull it through the machine. After the sheet has been printed it is released into the delivery unit for stacking.

#### *3.6.3.2 Inking unit*

The ink duct on the machine consists of a steel spring plate (the duct blade) fixed at a tangent to the duct roller, forming a reservoir that holds the ink supply. Ink is fed out of the duct through a narrow gap between the blade and the inking rollers. The thickness of the ink film is controlled by varying this gap in combination with the rotation of the inking rollers. Because the ink is thick and viscous it is fed to the plate through an oscillating roller and a chain of different diameter rubber and metal distributor rollers. This series of rollers breaks down the ink to a thinner and less viscous film before being transferred to the plate.

As ink is consumed it must be replenished, and if there are large solid areas on one part of the sheet being printed, then more ink will be consumed in that area. To allow for this the ink supply must be adjusted across the plate. This is achieved by adjusting a series of keys (thumb screws) that press on the underside of the duct blade. The gap between the duct blade and the duct roller can be adjusted up or down to feed more or less ink to the inking rollers across the sheet, to control the ink requirements of the final printed image. The inking system is often controlled by computer on modern presses and ink settings for each job can be stored for reuse if the job is reprinted. This type of inking system is known as RCI (Remote Controlled Inking).

In many instances the inking and dampening are integrated, with the fountain solution being fed through cloth covered rollers and a fine layer of moisture being deposited on the surface of the plate.

#### *3.6.3.3 Multicolour offset presses*

To print in more than one colour, on a single colour press, the sheets would have to be passed through the machine several times, creating problems of registration between each colour. For multicolour printing, it is usual to print on presses of two, four, six or even eight single colour units linked in-line. Sheets pass from unit to unit maintaining accurate colour registration from the initial feeding mechanism right through to the final delivery unit. This type of press layout is said to be 'in-line'.

For the production of printed packaging, there is often a requirement for gloss lacquers or UV varnish for superior graphic impact or special coatings to provide product resistance. To meet this requirement separate coating and drying units are often included in-line. The coating unit is positioned after the

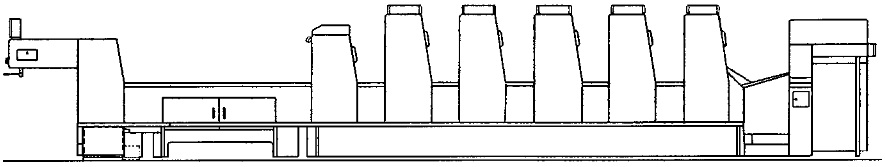

**Figure 3.2** Typical press layout for a multicolour press.

last printing unit and will be specified to apply standard gloss lacquers, UV coatings or water-based varnishes in-line together with the appropriate drying system. The varnish may be overall or to a specific pattern if a relief plate is fitted to the coating unit.

A typical press layout for a multicolour press producing packaging (Figure 3.2) could comprise:

Feeding unit
Printing units 2, 4, 6 colours
Coating unit
Dryer unit
Delivery unit

Multicolour presses can be made more compact by using a system involving the use of common impression cylinders. The paper is supported by one common impression cylinder while being printed from two blankets at the same time. A six-colour press would then comprise of three printing units (two colours per unit) rather than six individual units.

## 3.7 Waterless printing

Conventional lithography uses a mix of water and ink for printing from a 'flat' or 'planographic' plate. Maintaining the ink and water balance to produce consistent quality print throughout the run does, however, require a degree of skill and accuracy.

To overcome these problems 'waterless' printing was developed by the 3M Company—the process being called 'Driography'. This should not be confused with 'dry offset' which is printing from a raised surface plate on to an offset blanket (i.e. offset letterpress printing). Waterless printing still requires a planographic plate but the transfer of ink is only made possible because of the unique plate developed for the process. The non-image areas of a waterless plate have a silicone rubber coating with a very low surface tension, and thus will repel the inks. The image areas are aluminium and accept the inks applied to the dry plate surface just as they would stick to a normal dry lithographic plate.

Conventional printing processes have relied upon the fact that when ink is rolled on to most dry surfaces, the ink film divides or 'splits' with part remaining on the inking roller and part staying on the surface to which it was applied. With waterless printing the ink is applied to the non-image silicone rubber and again makes contact with the plate and splits. Instead of the split taking place within the ink, however, the low surface tension of the silicone rubber allows it to lift cleanly from the plate. At printing speed the ink behaves very much like a cohesive solid, which overcomes the weak contact with the non-image silicone rubber on the plate. In the image area of the plate the ink does split within itself—as in the conventional printing process—because again adhesion is strong to the ink-accepting coating.

Printing without water does have advantages with reduced start up waste, lower dot gain and improved colour saturation. The absence of water does, however, cause other problems. During the run there is a significant increase in temperature within the inking system. Because of the pressure and heat of printing the cohesive strength of the ink would be reduced if regular litho inks were used, and they would smear over the silicone rubber and cause 'scumming' or 'toning'. Waterless printing must therefore use special heat resistant inks and special cooling systems have also been developed, for the ink system and/or the plate, in order to achieve acceptable results. Waterless printing also demands good grades of paper in order to avoid debris accumulating on the blanket. Within the packaging sector the process is now being widely developed for can printing, see Chapter 14.

## 3.8 Advantages and disadvantages of lithography

The advantages of lithography can be summarised thus:

- Extremely flexible and cost effective
- Short set up time
- Wide range of presses available to meet most market requirements
- Plates can be made from positive or negative film
- Prints effectively on a wide range of stock.

The disadvantages of lithography are that:

- The process requires ink and water balance to be consistently monitored to maintain quality
- Inks are translucent and prone to more problems than in other processes.

# 4 Linking rotogravure printing to packaging decoration formats

P. Steele

## 4.1 Introduction and history

Rotogravure printing is an intaglio process (see below) which is used to print everything from the highest quality postage stamps and bank notes, glossy magazines, travel brochures and mail order catalogues, to wall papers and gift wrapping paper.

Owing to the versatility of the gravure printing process, its use in the consumer market is now widespread, producing high quality labels, cartons and reel-fed packaging on to a wide variety of substrates, such as paper, board, plastics and multi-layer laminates.

Although related to earlier intaglio methods of printing, such as etching and copper engraving, gravure is a relatively new process, having being invented in 1852 by the photographer Fox Talbot as a means of reproducing continuous tone. The process is characterised by rich tones and the absence of regularly patterned dots, although a form of screening is used to create 'grains' on the plate or cylinder which, upon etching, are eaten away to create 'cells', the depth of which are in proportion to the tonal values of the original design. This depth variation creates the tonal values with dark areas having the deeper cells, hence holding more ink, and the lighter areas having the shallowest cells. On printing, the darker areas are created with a greater amount of ink being deposited on the paper and the grains are obliterated by the spread of the ink. The process relies on quick-drying spirit-based inks and for this reason early reproductions printed by this process appeared in sepia and green.

## 4.2 The process

Gravure presses are available in both reel and sheet-fed formats but predominantly those used within the packaging industry are high speed rotary presses that print on to a continuous web of material. Because gravure is predominantly a rotary printing process it is often called a 'rotogravure' process.

An engraved cylinder is prepared and this is partially immersed in a bath of thin solvent-based ink. As it revolves the cells in the cylinder pick up ink; the surface of the cylinder is then wiped clean with a flexible steel blade called a 'doctor blade'. This leaves ink only in the cells of the cylinder, so that when a web of paper is pressed against the surface of the engraved cylinder, by means of a rubber covered impression roller, the ink is transferred to the paper (Figure 4.1).

The reel of material may pass through several printing units, each with a different colour of ink, with the final printed material having between six and ten colours applied in-line. This can then be wound on to another jumbo reel at the end of the machine for subsequent conversion into sheets or smaller reels depending on the end user market, or, with specialist finished equipment attached at the end of the line, may be slit, sheeted cut in-line.

The most important feature of gravure is that it prints continuous tones from cells, (containers of ink cut into the surface of the cylinder). Deeper cells or larger diameter cells hold more ink and thus deposit a thicker layer, hence creating a darker image. The final continuous tone image appears to be almost grainless as the ink from neighbouring cells spills out and merges during the printing process. A drawback of gravure printing is that when printing fine letter type this also has to be created from cells which, when examined closely, will appear less fine than that produced by the offset litho process. If in doubt about how a piece of packaging material may have been produced, examine the fine type and if a cell or 'grainy' edge is visible under a magnifying glass, then it has been produced by gravure printing.

In conventional gravure cylinders the cells were of equal size but different depths. This type of cell pattern has several drawbacks in that the cell depth, of the design area, which is just highlighted, may be so minute that any slight wear caused by the action of the doctor blade may be enough to prevent them printing at all. To improve the quality of print on to a wider variety of materials there have been many subsequent developments in cell patterns and shapes. Cells

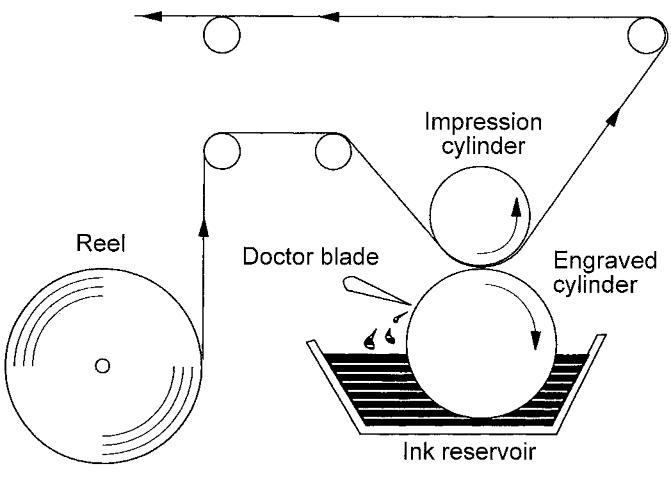


**Figure 4.1** Gravure press. The direction of the arrows indicates the flow of substrate.

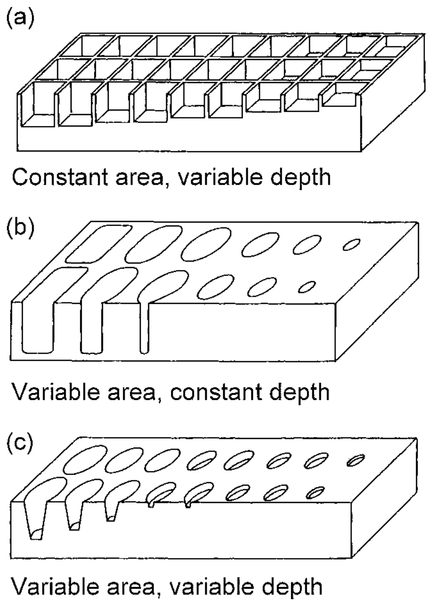


**Figure 4.2** (a) Cells with constant area but variable depth; (b) cells with variable area but constant depth; (c) cells with variable area and variable depth.

may now vary in both depth and area or be made to a constant depth but vary in area (Figure 4.2). The shape of the cell may also vary from the standard circular shape to elliptical or hexagonal if it improves ink flow from the cells on to the substrate.

### *4.2.1 The base cylinder*

A gravure cylinder is essentially a base tube made of iron, steel or aluminium. This must be precisely engineered to ensure that it is true to size, perfectly round and has a smooth surface. If a cylinder is bowed, barrel-shaped or varies in diameter in any way it may vibrate in the machine causing running problems and will be very difficult to wipe properly with the doctor blade, leading to poor print quality and uneven wear. Modern, fast running presses require accurate, dynamically balanced cylinders to ensure that they run freely, minimising the possibility of mechanical damage or wear on press components.

When producing cylinders for use in printing reel-fed packaging products it is most important that the cylinder circumference is carefully checked. If the final printed image repeat is to be 100 mm then five impressions could be placed around a cylinder with a circumference of 500 mm. However, when determining the circumference required in relation to the size of the label, some allowance must also be taken into account for any stretch or shrinkage of the substrate during the printing process. Often part of a customer specification is that the final printed repeat length should not vary by ±0.5 mm over 2000 mm. If the cylinder circumference is incorrect this specification would be impossible to meet.

The machined base cylinder is electroplated with a layer of copper into which the cells are etched. The base copper is usually required to be at least 0.2 mm thick for engraving purposes. The cylinder is placed in a copper sulphate bath with the cylinder acting as the cathode and with the anode bars being copper. In some instances these anode bars are replaced with copper nuggets mounted in titanium trays or baskets.

The composition of the bath and the plating conditions must be controlled very carefully in order to obtain the correct hardness and crystal structure of the copper coating. This is particularly important where cylinders are to be mechanically engraved. Again the cylinder must have a smooth surface as any defects tend to be repeated in the copper deposits. Rough or porous deposits and lack of adhesion can occur if the base cylinder or bath plating conditions are not right.

With modern plating processes the bath is so controlled that the cylinder emerges from it with a bright polished surface, ready to go straight to the developing and etching stages. In older processes the cylinder left the bath with a rather matt surface that needed grinding and polishing operations to produce the required high finish.

After engraving, the cylinder is usually chromium plated for extra durability, when handling, and the improved surface finish helps the lubrication between the doctor blade and the cylinder. This helps to minimise wear and under good conditions the cylinder should then have a life of several million impressions. An additional advantage of chromium plating is that when wear does occur the plating can be removed in an electrolytic bath and then re-plated. This avoids having to remake cylinders: the process can usually be repeated several times providing that the cylinder is removed from the printing press before any wear extends to the copper. If the copper surface is damaged then the cylinder has to be remade.

An alternative method of cylinder preparation produces a thin detachable copper skin between 0.075 mm and 0.125 mm thick compared to the standard 0.2 mm thickness. Here the base cylinder is treated so that the thin layer of copper is only loosely attached to the base. The advantages of this process is that the time needed for deposition, grinding and polishing is reduced and the skin can be rapidly stripped off and the cylinder made ready to receive a new copper deposit without having to go through a regrinding process. Disadvantages are that cylinders are not so robust when handled and are not as easy to repair as 'solid' cylinders. Cylinders can also be coated with a polymer resin that can then be cut directly by laser. Often photopolymer plate systems consist of photopolymer coatings on stainless steel plates that can then be mounted on to magnetic cylinders.

The investment in gravure base cylinders is high in comparison to a litho plate or flexo roller but if handled correctly will produce many millions of impressions, making the process highly suited for the production of quality printed packaging, required in high volumes.

### 4.2.2 *Cylinder processing*

Preparing artwork for gravure is exactly the same procedure as for offset litho except that type and any line drawing is scanned as well as any tone artwork. The screened image may then be produced in film format for chemical etching, leading to the term 'photogravure', or produced as digital information and sent directly to a diamond engraving stylus, leading to the term 'filmless gravure'.

For chemically engraved cylinders, the first stage in the origination process is to prepare a screened film in the format required to provide the specified cell type:

(a) constant area and variable depth—used to produce conventional cylinders,
(b) variable area and constant depth—used to produce direct transfer or invert dot cylinders,
(c) variable area and variable depth—used to produce semi halftone cylinders.

Of the three chemical etching processes noted above, the most common cell pattern within the packaging industry is the variable area and constant depth type, used to produce invert dot or direct transfer cylinders. For this type of chemical etching, a light-sensitive coating is first applied to the surface of the copper coated gravure cylinder. This light-sensitive, high-contrast, photopolymer coating has molecules that are altered by ultraviolet (UV) light during exposure.

A screened film positive is prepared with dots of varying cross sectional area. This is wrapped around the coated cylinder and exposed to UV or laser light. The coating exposed to the light hardens, while the area of the film covered with the screened dot is protected and remains soft. The film is removed and the coating examined for any blemishes. If there are any 'soft' spots in the exposed hardened areas these are painted out with an acid-resistant paint or varnish to protect them during the etching process.

The cylinder is then ready for etching with a base solution of ferric chloride. This eats into the soft unexposed areas of the copper coating, creating the cell. Careful control over the etching process is needed to obtain cells of a consistent depth, but although slight variation in depth does occur the range is usually only between 42–44 microns. Copper hardness affects the etching time, and since this can vary from one batch of cylinders to another the hardness should be checked prior to etching.

This halftone method of producing invert dot cylinders speeds up cylinder production. There is some sacrifice in quality when compared to conventional cylinders, where the cell depth can be varied continuously, producing an infinite graduation of tones as in photography.

Electromechanical engraving of cylinders is now widely available, and is becoming the accepted method for producing the image on the gravure cylinder. The most common version of this type of equipment consists of two cylinders with synchronised rotation. One of these is the gravure cylinder to be engraved, and the other, the scanning cylinder, is the one on which the photographic material to be copied is mounted.

looseness-1 The scanning head contains a light source and an electric eye or photocell. This moves across the copy at a constant speed, and as it does so the light beam scans the copy and light is reflected back to the photocell. The intensity of the reflected light is proportional to the density of the photographic copy. The photocell transforms the varying intensities of light into electrical voltages which are then fed into the computer unit. After certain modifications, these impulses are then changed into electromagnetic impulses which drive the motor. The engraving head moves across the gravure cylinder at a speed related to the scanning head. The engraving is done by a diamond stylus that is shaped so that as it digs into the rotating cylinder it produces cells resembling inverted pyramids. The electromagnetic impulses cause the stylus to vibrate up and down, gouging out the cells. When the stylus is driven deeper into the metal, cells of increasing volume are produced. The stylus is followed by a diamond scraper that removes the burr produced by the gouging action. In this way both area and depth variable cells are able to be produced, as dictated by the scanning head. The normal rate for electromechanical engraving is in the region of 4000 cells/s.

Electromechanical engraving machines are usually multi-headed but slight variations between different heads can occur. The effect on print quality is normally very slight—especially when compared to chemical etching fluctuations—and, when producing catalogues involving different pages or images, the difference between the heads is not noticeable. In packaging, each image is normally repeated many times over the cylinder presenting a different problem since each image must be the same. To eliminate possible variations from a multi-headed machine, packaging cylinders are usually produced on single head engraving machines. Electromechanical methods of cylinder engraving eliminate the variables associated with light-sensitive coatings and chemical etching, and thus bring the process of image transfer under much greater control. The engraved cells have a uniform shape with smooth walls giving better ink transfer which leads to improved print quality.

The latest technique, known as digital engraving, eliminates the need for the scanning cylinder as the intermediate photographic materials are no longer required. The scanned copy is stored electronically and then fed directly to the engraving unit. This method has been particularly successful in packaging, bringing cost benefits by eliminating the need for the intermediate photographic steps.

While not generally used within the packaging industry, mention should be made of the engraving of conventional cylinders producing cells with a constant area but variable depth, with the use of carbon tissue. This is essentially a pigmented gelatine coating on a paper base which first needs to be made sensitive to light by soaking in a solution of potassium dichromate—it may also be purchased in a pre-sensitised form. All operations at this stage should be carried out under yellow lighting—the tissue being insensitive to this colour. The etching process is based on the fact that when part of the sensitised tissue is exposed to light the gelatine will become hardened and insoluble in water, but the unexposed part will remain soft and water-soluble.

The printing image on the cylinder has to be in the form of tiny cells to produce the ink receptacles and to support the doctor blade. This is done by exposing the carbon tissue to a gravure screen—a pattern of opaque squares separated by transparent lines. The carbon tissue is then exposed under the screen in a vacuum frame. The light penetrates through the transparent grid lines, hardening the gelatine coating in these areas. This provides the pattern for the cell walls.

The exposed carbon tissue, with the cell pattern, is then placed in a vacuum frame with a continuous tone film positive of the image to be printed and a second exposure made. No light will be able to penetrate through the dark area of the positive so the carbon tissue coating underneath will remain soft, and therefore soluble. Light will penetrate through the clear area of the positive, hardening the carbon tissue underneath and therefore making it insoluble. In the intermediate areas some light will penetrate, hardening the top layers of the coating. The coating will be hardened to a greater depth beneath the light tones than beneath the dark ones. After exposure the tissue is squeezed into contact with the copper cylinder and the whole cylinder is then partially immersed in hot water. This first softens the paper backing and allows it to be removed followed by the unexposed gelatine. This leaves a gelatine relief image of the original picture superimposed with a hardened gelatine grid which provides the walls between the cells.

Etching is then done with a concentrated solution of ferric chloride. When this is applied to the dry gelatine resist, the gelatine gradually absorbs the acid and swells. The solution then diffuses through the gelatine layer and begins to eat away the copper beneath.

The rate of swelling is rapid at first but gradually decreases as maximum swelling is approached. This means that the maximum is reached quickly in the thin gelatine layer, but takes longer the thicker the gelatine. The etching has to be controlled so that the shadows have the correct depth when the etch just begins to penetrate the resist in the highlights. This produces a gravure cylinder with cells of a constant area but with varying depths. The carbon tissue process is, however, no longer as widely used as a result of to the continuing development of electromechanical engraving.

### *4.2.3 Inks*

Gravure printing uses a wide range of liquid inks. The choice of ink will depend on the substrate being printed and the product, market or environmental requirements. Inks can be formulated to print on a wide variety of absorbent and non-absorbent substrates. By selecting the right resins and solvents they can be tailor-made to key onto virtually any substrate, be it paper, metal foils or plastic materials.

Gravure inks have historically been solvent-based and consist of pigments and possibly a soluble toner (i.e. a dye) dispersed in a resin/solvent vehicle. They bear many similarities to those inks used in flexographic printing, in that they require the evaporation of the solvent during the printing process to leave the solid pigment on the substrate to produce the printed image. Rapid ink drying, by solvent evaporation, allows printing on non-absorbent materials without the danger of wet ink rubbing off on the rollers or 'blocking' (the printed materials sticking together) in the rewound reel or sheet pile at the end of the printing line. Gravure is therefore an ideal process for packaging printing, which uses a wide range of films and foils. Alcohol-based inks are particularly suitable for food packaging as they are free from residual odour.

A wide range of solvents have historically being used, with toluene and xylene being in widespread use in the past. Most major ink manufacturers have phased out the use of these solvents for environmental and health reasons. A range of more environmentally friendly solvents have been developed using alcohols, esters and ketones. Rapid technological developments are also underway in the manufacture and use of water-based inks for gravure printing, although these require carefully controlled drying conditions during printing.[1]

When gravure printing with solvent-based inks, control of the viscosity is essential. The inks are usually stored in tanks and then pumped into the ink ducts on the press via a circulatory pumping system which keeps the ink in constant agitation. This prevents the ink settling out owing to the very low viscosity. It is important to minimise solvent evaporation as this loss decreases the flow of ink; that is, it becomes more viscous. Changes in the ink viscosity alter the amount of ink transferred from the cells to the paper, so altering the appearance of the print or packaging.

Most modern presses are fitted with automatic viscosity controllers. These monitor the viscosity and regulate the addition of further solvent as required.

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[1] **Most gravure solvents are flammable and have low flash points. Safety precautions must to be taken to avoid fires, explosions and eliminate any detrimental health effects.**

In spite of this, routine checks need to be made on the viscosity, throughout the run, for which the operator usually uses a form of efflux cup. The cup is filled by dipping it into the ink and the time taken for it to empty through a hole in the base gives a guide to the viscosity. The size and shape of the cup together with the diameter of the hole affect the ink flow out of the cup. The higher the viscosity the longer the cup will take to drain, but as the ink contains volatile solvents the time that can be allowed for the ink to run through is limited. On the other hand, the quicker the time taken the greater the inaccuracies. With gravure inks being very fluid, a cup is usually selected that will give an efflux time between 15 and 28 s. There are a number of efflux cups in use—Zahn, Shell and Ford being the most common—but all are based on the same principle with the shape of the base of the cup containing the hole determining the accuracy. Obtaining a quality gravure print requires that when the substrate being printed is pressed against the cylinder all the ink from the cells, engraved in the cylinder, is transferred to the substrate. When printing a fibrous material, such as uncoated paper, the material compresses when applied to the surface of the cylinder under pressure, but the paper surface is never perfectly smooth so some cells may fail to transfer the ink. The missing dots cause an uneven print—a fault known as 'dot skip'. Coated papers are smoother than uncoated ones, but because the coating makes the surface harder, it deforms less when pressed against the cylinder and often gives as many 'dot skip' problems as uncoated papers, although the causes are different. Increasing the printing pressure can help reduce 'dot skip' problems but this alone rarely eliminates them. The cells never empty completely when they come into contact with the paper. With etched cells 50% of the ink may be transferred with a much higher percentage transferred from engraved cells. To overcome this problem a technique known as electrostatic assisted ink transfer (ESA) is commonly used.

The ESA process relies on a constant electrostatic force drawing the ink from the cell on to the paper. Under normal circumstances electrostatic electricity is present throughout the printing process from the initial unprinted reel, through a build up of static from friction through the press, to the final rewound reel or cut sheet. The amount of static can vary at any point with a variable static charge from friction on the press which is then offset by points of discharge through steel rollers on the press. There is no set pattern and the polarity can change from negative to positive and back again.

For ESA to work effectively the initial web of material is run over a discharge bar, just prior to the printing unit, to give the material the minimum level of electrostatic charge. The impression roller, used to press the substrate against the printing cylinder, is given an electrostatic charge and as the web comes into contact with the charged roller this charge is then transferred to the substrate material. The web is now charged with a defined quantity of electrostatic electricity, and the electrostatic force draws the ink from the cell on to the material. The strength of charge is such that the ink is drawn into the crevices on the undulating surface of material, thus minimising 'dot skip' problems.

### *4.2.4 Presses*

Gravure presses can be web-fed or sheet-fed but within the packaging sector are predominantly web-fed modular presses; that is, made up of several individual printing units, one for each colour.

Web-fed machines print from a continuous reel of material which is then printed on either one side or both sides and then rewound or converted in-line. The length of the final design, or printed sheet, is determined by the circumference of the *printing cylinder* and *not* the circumference of the *cutting cylinder* as in web-offset.

Within the packaging sector gravure presses usually print from a single reel—the substrate material being very specific to the product being produced. It should be noted, however, that other specialist substrates may be applied in-line for laminated products or for those requiring special barrier properties. This is in contrast to magazine printing where several reels may be printed at the same time through differing print configurations and brought together at the end to produce the final magazine.

Control of the web tension through the press is important. The reel being printed first passes over a dancer roller, which can be used to apply a brake to the reel. When the reel runs out the press is stopped and a new one is manually connected. The reel 'change over' can also be done automatically by means of a 'flying splice' which attaches the end of the old reel to the beginning of the new and then accelerates the new reel up to press speed—all while the printing machine is still running.

Each individual printing unit basically consists of the cylinder, which rotates in the bath of ink; the doctor blade, to remove surface ink; and the impression cylinder, which applies pressure between the substrate material and the cylinder, thereby transferring the ink on to the material. Registration of colours between each unit requires accurate web tension control, although modern presses also incorporate the addition of electronic register control systems that read the gaps between eye marks on the edge of the print. These speed up or retard the printing cylinder to ensure that each colour, throughout the press, is brought into accurate registration with those already printed.

The substrate being printed passes through a dryer hood where a balanced supply of warm air is blown onto the web to remove as much of the solvent as possible. The air is re-circulated with a percentage being extracted and replaced by fresh air. This ensures that the drying efficiency is maintained and that the solvent concentration in the hood does not build up and approach danger levels. Many installations now have solvent recovery or dispersal systems to prevent solvent vapours from being discharged to the atmosphere, to meet both environmental legislation and, if appropriate, to recover the expensive solvent. After passing through all the drying hoods the web is often taken through another final extraction unit, where the final layer of solvent in the printed material is reduced to a minimum. This is particularly important in food packaging where odour retention is unacceptable. The web is then finally rewound for subsequent conversion into sheets or reels, or the material can be converted in-line.

Sheet-fed machines are also available although these run slower and use more viscous, concentrated inks and require a higher pressure to transfer the ink from the cylinder. They are used for specialist work in producing art reproductions and in particular high quality specialist packaging. They can also used for applying special colours, such as gold onto pre-printed litho stock to obtain that 'extra-special' effect required by the packaging market place.

## 4.3 In-line processing

Maximum output from a rotary press is usually obtained by producing reel to reel with no intermediate converting processes. Bulk runs can be printed and then converted as required. When producing long runs of a standard product, such as cartons, in-line processing can be advantageous, allowing a finished product to be produced in a single pass with minimal waste and few changes required to the converting systems. Where production requires the use of a wide variety of substrates (i.e. paper, foil or film), or the products produced may be required to be in sheets, reels or single units, then off-line conversion is usually more economical.

*Advantages*

- Prints on a wide range of substrates and surfaces.
- Presses can accommodate cylinders of varying diameters, enabling different print repeat lengths to be produced on a standard press.
- Capable of producing consistent high quality printing.
- Economical for long runs.
- In-line operations can include lamination and embossing.
- In-line conversion is viable for runs of a standard product.

*Disadvantage*

- High cost of producing cylinders.

# 5 Linking flexographic printing to packaging decoration formats

J. Anderson

## 5.1 Introduction and history

### *5.1.1 History*

Aniline printing emerged as a simple low cost printing process in the early 1900s for printing onto paper bags for the pharmaceutical markets. It used simple hand-cut rubber plates for the very coarse and basic images produced. It was not until the 1960s that it became known as the flexographic printing process, or flexo, after the flexible plates used.

In the 1980s a new plate material, photopolymer, was introduced. This was supported by a stable backing sheet, significantly improving the stability of the print image. This was a key development that enabled flexographic printing to improve the quality and complexity of the image. Throughout the 1990s constant development and improvement made the flexographic printing process the fastest-growing major printing process. By 2000 it had a significantly greater percentage of the print market than had rotogravure printing, and only trailed offset, but by a continuously shrinking margin. Flexographic printing is now the dominant printing medium for flexible packaging. However, flexographic printing is still seen by many as a 'cheap and cheerful' print process, and it is this poor and incorrect image, which is currently one of the greatest weaknesses of the process.

### *5.1.2 The current process*

Flexo is envisaged as one of the simplest of all the major print processes, and in some ways it is. The print quality now possible is comparable to offset and rotogravure printed products, and it is often a more economical process, depending on the product and quantity required. Yet the flexographic process has a wider range of variables to control than rotogravure, with highly interactive process components which are complex to control consistently. Previously this unseen complexity has given flexo an inconsistent nature. However, continuous process developments throughout the 1990s in all of the process components, have improved the modern flexographic printing process to a high standard of consistency, producing very high quality print products.

Modern flexo is a highly productive process capable of short and long production runs, at high levels of quality and consistency. Figure 5.1 illustrates a typical flexographic print unit, stripped to its main components. Ink is delivered from the ink tray to the printing plate via the anilox roll. The anilox roll controls the volume of ink delivered, with any excess ink removed by a doctor blade. The image consists of a raised surface on the plate, with the ink transferred from the plate to the substrate under pressure from the impression cylinder.

Flexo is seen as a simple process owing to the small number of components and rollers in the press. This simplicity is one of flexo's greatest advantages, allowing simple and accurate control of the ink delivery, whilst still allowing very rapid washing down of the press and complete colour changes. However, once on the press there is very little adjustment available for the printer to achieve any significant image changes without affecting the image quality and consistency. Therefore flexo is highly dependent on correct specification of the materials and components used, especially prior to reaching the press.

Because of its simplicity, flexo was one of the cheapest printing processes available, but for lower quality products. In the drive for higher quality, economic differences have shrunk between the major print processes, so process selection now relies on other factors. The selection of the print process to be utilised should depend on the product, its quality, quantity and the materials to be used. Flexo's economic short production runs suit the implementation of the 'just-in-time' technologies now often applied. Also as the desire to reduce waste increases, flexo's ability to produce a finished product, from a reel of substrate, in a single production pass by in-line processing, provides a significant advantage, and adds value to the product. This is especially an advantage over offset and rotogravure printed products, which invariably require multiple production steps.

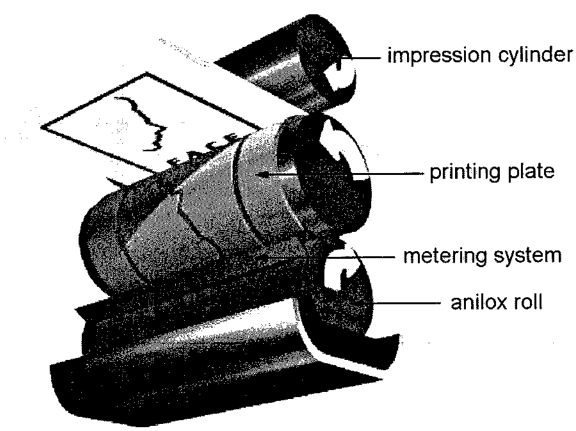


**Figure 5.1** The main components of a flexographic printing press [1].

### 5.1.3 Applications

Flexographic printing is a highly flexible process, printing on a whole range of substrates (Figure 5.2). The flexo industry covers such a wide range of products that it is separated into a range of product sectors. Currently the main industry sectors for flexo are:

*Flexible packaging*—products are printed on plastic or polymer substrates.
*Labels*—self-adhesive labels.
*Pre-print corrugated board*—printing is on a card-based liner prior to the manufacture of the corrugated board. This allows higher quality print to be achieved, but at higher cost for final corrugated board.
*Post-print corrugated board*—printing on the corrugated board after it has been manufactured. Print quality has vastly improved in the late 1990s, with increasing use of finer corrugated fluting, providing a smoother surface for printing.
*Cartons or board*—printing on carton board, mainly for food packaging.
*Paper*—newspapers such as the *Daily Mail* in London are now printed by flexo, along with envelopes, wallpaper and gift wrap, for example.

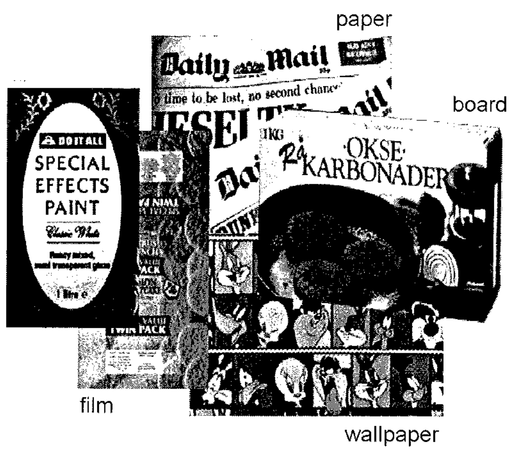


**Figure 5.2** Examples of the range of typical products printing using flexo [1].

### 5.1.4 Market share and changes

Until the 1990s flexo was a low quality printing process for simple images. However since the change from rubber to photopolymer plates, print quality and resolution has increased steadily and flexo now accounts for approximately 25% of all print and it is becoming the dominant process in the flexible packaging, labels and corrugated board sectors.

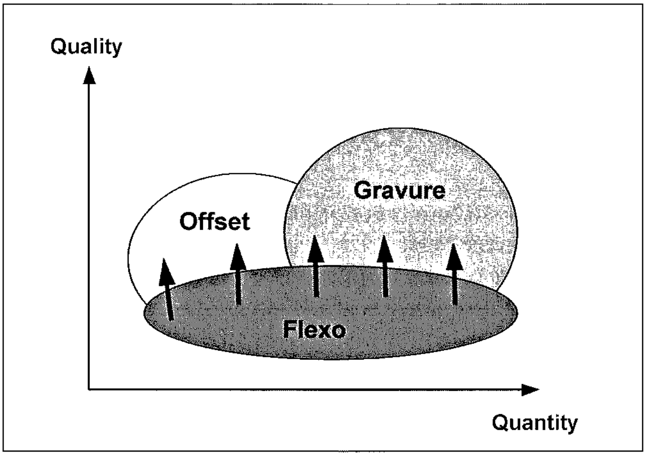


**Figure 5.3** The changes in the print volumes for the flexographic printing process [2].

Flexo is suitable for short production runs, and just-in-time production techniques further increase its potential for the future. Figure 5.3 shows how flexo is increasing its market at the expense of offset and rotogravure printed products; although high quality flexo is no longer a cheaper option, it remains a highly economical and competitive one. Furthermore flexo can go from reel of substrate to finished product in a single manufacturing process, producing the correct number of packages with minimal waste and cost.

### *5.1.5 Advantages*

- Prints on a wide range of substrates and surfaces.
- Economical for short runs, long runs and just-in-time production.
- Capable of very high quality printing.
- Capable of producing a finished product from a reel of substrate in a single production pass, minimising waste production and costs.
- Added value via in-line processing possible (for example, cut, crease, emboss, trim).

### *5.1.6 Disadvantages*

- No longer purely a low-cost production process, especially for high quality print products, but is highly economic for the vast majority of applications.
- Production time from digital design to on-press production is greater than for offset, but less than that for rotogravure printing, at approximately 3 to 4 h.

- Poor public image of the process means it is underused, even when it provides by far the most suitable solution.

## 5.2 Principal components of flexographic printing

Figure 5.1 shows a typical flexo press unit. The actual layout of a flexographic printing press is normally dependent on the substrate onto which it prints. There are four common press configurations. Figure 5.4 illustrates the two most popular. The common impression (CI) format is used for flexible substrates, where the substrate rotates around a central drum. This provides the most accurate prints, and the highest print speeds. The in-line format is used for flexible and non-flexible substrates, depending on the press layout and the substrate path. These presses are used for a wide range of substrates, but are used especially for labels and cartonboard substrates, because they have in-line rotary processing stations, allowing a finished product to be produced in a single production pass. This does, however, often restrict printing speeds. Other press formats are the corrugated press format, for post-print applications where the corrugated board must pass through in a straight path without being bent, and finally the stack press format, where another process, usually polymer extrusion, is carried out first, in-line.

The flexo industry is also divided into sectors by the press width. Wide web presses, over approximately 470 mm wide, are dominant in markets such as flexible packaging, sacks, pre-print and disposables, where long production runs

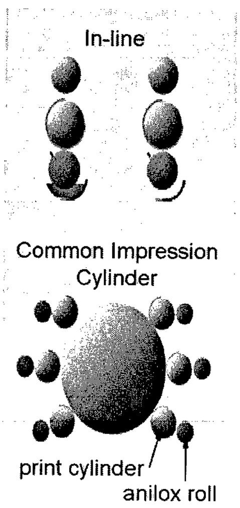


**Figure 5.4** The two most common flexographic printing press layouts [1].

are required. Narrow web presses below 470 mm wide are common for shorter runs and in-line presses, and are often combined with other processes to add value to the product; examples are for labels, cartonboard, and short-run flexible packaging. The flexographic printing presses come in a wide range of sizes and formats, with the trend towards up to 14 colours per press. Flexo presses are smaller, lighter and lower in cost than the presses for processes such as offset and rotogravure. Modern presses are designed for rapid changeover print set up, and minimised waste, with many automated systems to assist, thus further increasing their suitability for rapid change overs, short production runs, and just-in-time production techniques. The following sections will now consider each of the main press components.

### *5.2.1 The printing plate*

These generally consist of photopolymer materials with a raised surface for a relief image supported by a polyester backing sheet (Figure 5.5). Previously rubber plates were dominant, and although these are still in use, they are not dimensionally stable enough for high quality printing. During printing, the plate transfers ink from the anilox roll to the substrate, under pressure from the impression roll.

Conventional plate production is a multi-step process, involving selective exposure of the raw photopolymer to UV light through a negative film to produce the print image required. Any unwanted photopolymer is then removed by the use of special solvents followed by drying to remove the excess solvents. Normal plate production time is often 3–4 h of which over 50% is for plate drying. Printing plates have significantly improved in quality and consistency over the last decade, with the average plate now being much thinner, improving control and reducing production times. With the introduction of digitally imaged

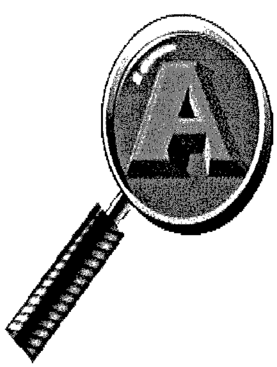

**Figure 5.5** Photopolymer plates illustrating the raised relief print image [1].

plates where the negative image is transferred by laser directly onto the plate surface the image resolution has further increased. However, the need to dry the plate during production to remove excess solvents is still flexo's greatest weakness in pre-press preparation times. Water wash plates are currently up to 50% faster drying than solvent wash plates, but not yet capable of the same image quality.

Conventional plates involve the exposure of the image for the plate to UV through a negative film. This requires a vacuum sheet to be placed over the film to ensure contact to the plate, resulting in defraction of UV light during exposure, resulting in dot gain on the image. Dot gain is where the dot on the plate or the printed image is greater than that on the digital file or film. Dot gain can be adjusted for in the repro to some extent, as long as all the process variables are controlled. Digital plates do not use film to provide the image, but have an extra layer of a black coating on its surface. The coating is exposed to a laser to apply the image directly. The lack of film or vacuum sheet means that the UV exposure is not defracted but produces a cleaner image, capable of very fine dots and higher print image resolution. The digital plates are higher in cost than conventional plates, especially when more than a single set of plates are required.

### *5.2.2 Ink*

Flexo printing uses a wide range of liquid inks, relevant to the substrate and product being printed. The three main types of ink in use are solvent based, water based and ultraviolet cured.

Solvent-based inks require the evaporation of the solvent to leave the solid pigment on the substrate, as the printed image. This was the original flexo ink type, capable of printing on a wide range of substrates, including polymers and metal films, and is still the most often used. However the need to control the release of solvents into the environment has resulted in legislation which adds a significant cost to the use of these inks.

Water-based inks are similar to solvent-based inks, requiring the evaporation of the water to produce the final printed result. Although this requires more energy, via heat, to be applied, the use of water-based inks is actively encouraged as a more environmentally friendly printing method. Water-based inks are becoming dominant in corrugated and paper industry sectors, where the water is absorbed into the substrate, reducing the energy required to dry the ink fully.

UV cured inks are completely different to solvent and water-based ink. UV cured inks are a solid system, with no mass removed from the wet ink to form the dry ink. Instead a chemical bonding is initiated by exposure to set frequencies of UV light. The bonding turns the liquid ink into solid. UV cured inks offer significant benefits in handling, control, and print definition. These inks are a high cost per kg, but with low waste levels, this cost is reduced. Also, these inks require finer, lower volume anilox rolls, where the applied ink volume is reduced. UV inks are very popular for cartonboard and label applications; the high resolution, strong colours and ease of handling make them ideal for narrow web applications.

### *5.2.3 Anilox rolls*

The anilox rolls supply a controlled volume of ink to the printing plate, via a series of cells engraved in the rolls surface (Figure 5.6). The development of finer and more consistent anilox rolls during the 1990s was another key factor in allowing flexo to improve in print quality and consistency. Previously, anilox rolls were mechanically machined into copper which were then chromed. These had limited numbers of cells per cm (up to 120 cells/cm) and tended to wear quickly, resulting in inconsistent ink delivery.

Modern anilox rolls are laser-engraved from a steel roller, precision coated in a fine ceramic. The laser-engraved ceramic rolls last up to 10 years, with cell counts currently up to 500 cells/cm. These provide an even, and consistent ink delivery in a controlled manner. The choice of anilox roll is important for the final printed product required. The anilox roll is the control system for the ink volume supplied to the print plate and substrate, in a similar manner to the ink train in an offset press unit. The anilox roll is much simpler than the alternative system for offset presses, and has little or no flexibility in the volume of ink that can be delivered. The initial selection therefore is vital.

The selection of anilox roll, volume and cell count depends on the ink system, volume and image resolution required. The higher the resolution, the higher the cell count, but the higher the cell count the lower the volume and the smaller the cells. For solvent and water-based inks the cell count is also limited by the effect of ink drying in the cells, reducing the ink volume supplied. For UV inks the cell count is normally much higher, with a low cell volume, because of high

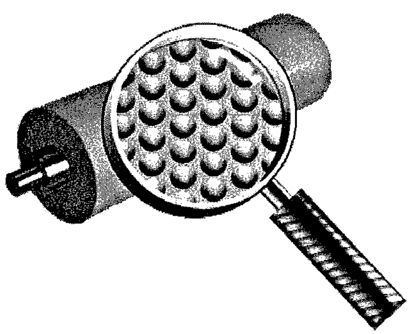

**Figure 5.6** Cell structure on an anilox roll [1].

pigment levels and the 100% solid system. These points briefly illustrate the complexity of anilox selection, and its essential understanding to achieve high quality flexographic printing, consistently.

### *5.2.4 The impression roll*

This is the roller that supplies the contact pressure to generate ink transfer between the printing plate and the substrate being printed. On a CI press it is the large central drum, while for other press formats it is a separate roller for each print unit. The pressure applied by the impression roll is one of the few variables which can be controlled by the printer on a flexographic printing press. The pressure levels applied are critical to achieving ink transfer; with too low a pressure, poor ink transfer occurs, while excess pressure results in plate squash, and a loss of image quality.

### *5.2.5 Reproduction*

The reproduction that transforms the image or concept into a set of photopolymer plates to print an image via flexo is vital to the final image and quality achieved. Up until the mid to late 1990s few repro companies understood the flexographic printing process, and assumed that it should be treated in the same way as offset printing. This resulted in a great deal of acceptable but disappointingly low quality flexo printed products.

Image reproduction via flexo is different, with adjustments to the repro needed to take this into account. All flexo presses must be periodically 'finger printed' to provide data on how the press actually prints, and what adjustments the repro company must make. Once plates are produced to suit the jobs and presses, high quality printing is possible, consistently.

The decision of whether to use one, two, four, or eight colours must be made with respect to the actual print job. Unlike offset printing, changing ink colours is relatively easy in flexo, and so the option of using a single special colour, instead of combining two or three colours, is available with flexo. The use of special colours simplifies the print job, by often reducing the number of colours required, and hence also the cost. Special colour sets, such as Hexachrome™ (six colour standard ink set) are available to flexo, but are normally more suited to offset printing, for which they were designed. The additions of automated ink wash down and colour change systems on press further emphasise this point. A factor resulting from this is the decision to use chromatic or achromatic ink separations for flexo, for the greys. Chromatic is a standard colour separation with greys made up with a fine balance of yellow, cyan, and magenta, where the black provides the detail. In achromatic separations, the black is used for the grey tones, with yellow, cyan and magenta for detail. Achromatic separations are simpler to print, but can look flat, and are not suitable for all print jobs.

### *5.2.6 Substrates*

Flexo prints on a very wide range of substrates. Each substrate is different and, to get the most out of the process, an understanding of the substrate and the flexo process is required. The selection of the actual components and values for items such as the inks, anilox roll, mounting tapes and plates depends on the substrate and image to be printed.

## 5.3 Summary

The flexographic printing process has developed greatly in the 1990s and, further improvements continue to be made. The improvement in the quality and consistency of flexo printed products is set to continue.

The main weakness in the process remains the plate-making time and cost, but with water and dry wash plates expected to achieve the required quality and resolution for most flexo printing, this problem will diminish in time.

The flexographic printing process has advantages in rapid change over and colour change compared to offset, and so is not as restricted as far as the print colours used. Therefore repro for flexo can be made to simplify printing, using special colours instead of delicate balances between two or more colours. The repro house must understand the flexo processes to realise the maximum potential of the process.

In-line processing offers the potential of greater added value to products, with minimal waste and production time. The understanding of the additional processes as well as the flexo process in combination is vital, as problems with one component will stop them all from functioning, so the costs of poor control and understanding can be higher cost products. This will be especially true in the future for in-line processing on larger CI presses, where currently it is the exception.

## 5.4 Guidelines

- Involve the printers as early as possible in the design and planning stages. This should minimise the risk of later print problems and the need for any re-designs or re-prints.
- Understand that flexo is very different to offset and rotogravure printing, and so the repro and plates should be produced by specialists for each process.
- Flexo presses have little adjustment available on press, and so the components and pre-presses supplied to the press are critical to its performance.

- The quality and consistency of the key process components directly affects the quality and consistency of the printed product produced. Therefore savings on consumable costs could only be short-term.
- Selection of the print process should relate to the quantity and quality of the final product required.
- Value adding processes, such as cutting, folding, embossing, etc. can cause a penalty in production speeds when in-line, but offer great potential savings.
- Combinations of different print units in a single press mean that the fastest production speed is only as great as the slowest unit.
- Well-trained employees and operators are needed to run an efficient printing process. Poor training will result in excessive waste and lost production at times of print problems.

## References

1. Flexographic Accredited Computer Education (FACE) Multimedia Training Disk, OVERVIEW, European Flexographic Technical Association, 1998.
2. "The Future of Flexography", European Flexographic Technical Association, Bristol, March 1999.

# 6 Linking screen printing to packaging decoration formats

J. Anderson

## 6.1 Introduction

### *6.1.1 History*

The screen printing process is derived from the oldest printing process, 'silk screen printing', which originated in the Far East. This involved printing through a woven screen made of silk fibres, mounted on a wooden frame. A hand-cut stencil fixed to the screen controlled the image.

The present screen printing process has obvious links with its past, but now uses modern materials and techniques. Automation on the presses has increased the printing speeds and consistency. However, the nature of the process has meant that although it continues to produce a wide range of products, production speeds are very slow relative to the other major printing processes.

### *6.1.2 The current process*

The modern screen printing process is capable of printing almost any fluid or ink, onto almost any substrate, while producing the thickest ink deposit of any print process. Screen printing is used for a wide range of products. This ability to print any fluid onto any substrate in such controlled and heavy deposits provides screen printing with its greatest advantage, achieving products impossible to produce economically by any other printing process, in a single print pass. However, the thick deposit can also be one of its greatest disadvantages, because it requires longer drying times, making screen printing the slowest major print process.

Figure 6.1(a) shows a schematic of the screen printing process. The basic concept is a mesh attached, under tension, to a frame. A stencil is mounted on the mesh, with the print areas having open mesh, and a solid stencil where no print is required. The mesh and stencil in combination are known as the screen. Ink is spread evenly onto the screen with a non-contact doctor blade. A flexible squeegee is then used to push the screen against the substrate and, under this, contact ink is forced to transfer through the screen onto the substrate, while excess ink is removed by the squeegee. The ink left on the substrate is then dried. The processes are then repeated.

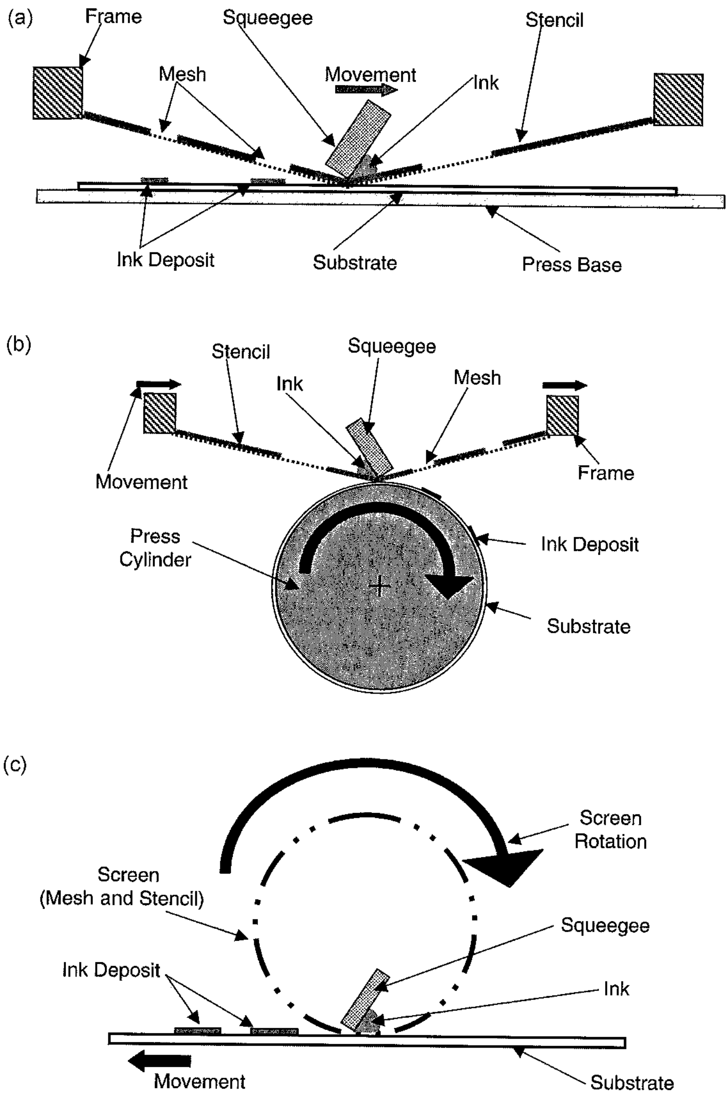


**Figure 6.1** Three screen printing press formats: (a) flat bed press; (b) cylinder press; and (c) rotary press.

The common press formats are shown in Figure 6.1, and consist of flat bed, cylinder, and rotary screen presses. The presses all have different market appliances and production speeds. Flat bed presses are the slowest at up to 1500 copies/h, where the substrate is stationary during the print stroke, and the squeegee moves. The flat bed printing presses are capable of a range of print sizes from $5\,cm^2$ to $2 \times 3\,m^2$. The cylinder presses are capable of higher print speeds, for sheet substrates. The squeegee is stationary whilst the substrate rotates around the cylinder, which is synchronised with the screen movement. Cylinder presses are capable of 4000 copies/h (A3 size), but the substrate sizes are more limited. The final press type is the rotary screen press, which in the main is used for reel to reel printing with individual or continuous images, e.g. posters, wallpaper. Here the screen is made of a special nickel chrome alloy that must support its own cylindrical format and weight. The screen rotates with the squeegee and ink on its inside, forcing ink out through the screen onto the substrate. Because the rotary screen gives a continuous printing action, with no reciprocating nature like the other press formats, it is capable of higher print speeds, up to 90 m/min. However, the print speed is often limited by the need to dry or cure the ink applied, prior to the application of the next ink layer. New techniques allowing wet on wet applications have been developed for wall paper applications, but these can suffer from the increased risk of ink contamination. The rotary screen is limited in image resolution possible, as a result of the limitations of the mesh materials and requirements.

### *6.1.3 Applications*

Screen printing is capable of printing a vast range of products, many of which are not currently capable of being printed in a single production pass by any other process. Screen printing is often used for high value-added products where the slow production speeds are less important, or for lower quality products where quality can be compromised for speed; however these latter applications are dwindling.

### *6.1.4 Market share and changes*

Screen printing has had the smallest market share of the five major printing processes because of its slow production speeds, but it has remained reasonably constant, unlike letterpress, offset, and rotogravure, which have all lost market share to the flexographic printing process. The flexibility and capability of screen printing to print almost anything at any time means that it will never disappear, and with modern screen presses capable of producing a finished product in a single pass the future looks stable for the process. With the increasing inclusion of rotary screen printing in combination presses, a greater range of applications and products are possible with screen printing included. However, screen printing normally concentrates on the shorter production runs, and for markets like the fine graphics sector, digital printing is likely to take large volumes of the current screen printing markets.

### 6.1.5 *Advantages*

As previously stated, screen printing's greatest advantage is its ability to print almost any liquid onto any substrate, in a controlled and consistent manner. Production speeds mean that it is most economical for shorter production runs, for example, less than 50 000 items.

### 6.1.6 *Disadvantages*

Speed of application, cost of screen production and disposal, the high levels of waste produced and the limited number of machines capable of producing a multicolour screen printed product in a single pass mean that, economically, screen printing struggles to compete with many of the other printing processes. With the constant incorporation of digital technology into other processes, and the growth of digital printing in its own right, certain sectors of the screen printing process face a direct threat to their future existence, especially for very short production runs.

## 6.2 Principal components of screen printing

### 6.2.1 *Screen*

The screen is the medium through which the ink is transferred to the substrate, in a controlled manner, to form the required image. The screen is actually made up of two components in combination; the mesh and the stencil. Each of these are major components in their own right, and will be covered in more detail in the following sections.

### 6.2.2 *Mesh*

Polyester, nylon or stainless steel fibres are woven into a fine mesh, at high mesh counts and accuracy levels. The stainless steel is the most stable of the mesh types, but also the most expensive and easily damaged. It is mainly used when high image accuracy and stability is required, such as electronic circuit boards, or biomedical sensors. Polyester fibres are the most common, providing a stable mesh for graphics printing and general screen printing applications. Nylon mesh is the least used in the modern industry, but is suitable when the mesh is required to have significant flexibility, for example, when printing on uneven and curved surfaces where the mesh must mimic the surface profile to form a perfect printing contact.

The normal production process for modern meshes is very time-consuming and expensive, with mesh production speeds quoted in metres per *month*. To use a mesh it must be stretched to apply tension to the fibres, and then fixed to a frame, normally permanently, using a glue. Other non-permanent systems are available; these always add extra weight and cost to the screen, but are adjustable if required. The tensioning of the mesh is critical to break the contact between the screen and the substrate during printing. When a mesh is stretched there is normally an initial tension loss as a result of 'fibre-realignment', causing initial instability; a settling time is required before high quality products can be produced [1].

### *6.2.3 Stencil*

Most commonly this is made from a photopolymer material, sensitive to certain frequencies of UV light. The stencil comes as a liquid or flat sheet, and is either coated or bonded to the pre-tensioned mesh. However, some modern mesh materials come with a pre-coated stencil, removing one step in the pre-press production, and potentially improving consistency. The flat surface of the stencil, on the print side, is essential to the image quality achieved, and should be as smooth and flat as possible. Therefore the sheet stencils are the most accurate, being high precision coatings, but also the most expensive.

Once the stencil is applied to the mesh this becomes the 'screen'. It is exposed to UV light through a negative film. Where UV light strikes the stencil it hardens, but where it does not strike the stencil remains soft. The screen is then washed with water, removing the soft stencil and leaving the hardened stencil material. The open areas of the screen form the image to be printed, with ink passing through these open areas onto the substrate, under pressure from the squeegee.

### *6.2.4 Ink*

As previously stated, screen printing is capable of printing almost any ink onto any substrate, and because of this there are a diverse number of inks available. We will only consider the most common, and their trends over the past ten years.

Prior to the 1990s solvent-based inks were dominant because of their low cost and great flexibility. However, they were not operator or environmentally friendly. Solvent-based inks have steadily decreased in use.

One of the first competitors, and now a major part of the screen printing ink market, are water-based inks. These were promoted as user and environmentally friendly, but have the disadvantage that drying them uses more energy than drying solvent-based ink. Much work has been carried out on dryer efficiency, with modern water-based inks being much more, but not completely, environmentally and operator friendly.

The other main development in screen printing inks was the use of UV cured inks. These are more expensive than solvent or water-based formats, but are much more controlled and consistent because there is no solvent or water to remove to dry the ink. Instead, under UV light of set frequencies, a chemical bonding occurs, creating a 'cured' or solid ink layer. The curing action, instead of drying by evaporation, makes the ink much easier to use on press, eliminating drying problems with the screen (which often affected fine halftone images, causing their loss), and keeping the image open and printing cleanly. UV curing is increasingly being accepted as the direction forward for quality screen printing products, and is almost always used for rotary screen printing in combination presses.

### *6.2.5 Squeegee*

The squeegee is a key process component, and seems very simple. However in reality it relies on a compromise between several tasks, and so is more complex. The squeegee is normally made of a flexible polymer material and has to do three things: force the screen into contact with the substrate; force the ink to transfer through the screen onto the substrate; and remove any excess ink from the screen. The selection of the squeegee depends on the substrate and ink to be printed, along with the compromise between the tasks it must achieve. The squeegee is also used as one of the main on-press operator controls, via the pressure applied to it. Unfortunately, because it is a compromise between three competing tasks, the squeegee can therefore be inconsistent, especially due to speed or pressure changes and poor control.

### *6.2.6 Overview*

Overall, the screen printing process relies on a series of compromises to achieve the final print. Through extensive control of the variables, as for the biomedical sensor printing where consistency is vital, the screen printing process can achieve excellent results. However, until this control is applied, screen printing will continue with its poor and often incorrect image, as an inconsistent and slow printing process.

## 6.3 Industry developments and trends

The basic screen printing process will continue to be used, but in increasingly competitive market places, with the other printing processes threatening several of the main screen printing applications. The use of rotary screen printing will continue to expand within the combination presses, also further expanding the use of UV cured inks.

Alternative screen materials, systems and press formats are under development, getting away from the high cost woven mesh materials, but these are at least three years from the market at present.

The use of screen printing will continue to expand for the high value added products, but in other markets, some loss of market share is expected.

## 6.4 Summary

Although the screen printing process is the oldest print process, it has yet to reach its full potential. A lack of development and control means that the process suffers poor consistency, and a poor process image. Through control and standardisation high quality screen printing, with high levels of consistency are possible.

The screen printing process will never die out because of its ability to print almost any liquid onto any surface, although vast changes are expected in the next ten years. The continued development of UV cured inks and the use of rotary screen printing in combination presses opens up a range of new markets for the screen printing process. These markets are expected to be greater than those which will be lost to digital printing technologies.

The screen printing process seems simple initially, but has a huge range of variables which can affect the final printed product. Only by the standardisation of the processes used will the full potential of the process be achieved.

## 6.5 Guidelines

- Involve the printers as early as possible in the design and planning stages. This should minimise the risk of later print problems and the need for any re-designs or re-prints.
- Understand that screen printing is very different to offset, flexo, and rotogravure printing, and so are the repro and plates, produced by specialists for each process.
- Screen presses have a huge adjustment of variables available on press, but the greater the adjustment from a standard set-up, the greater the risk of process inconsistency.
- The quality and consistency of the key process components directly affects the quality and consistency of the printed product produced; therefore savings on consumable costs could only be short-term savings, often requiring reprinting at a very high cost.
- Selection of the print process should relate to the quantity and quality of the final product required. The screen printing process is slow, and so is only suitable for smaller volumes.

- Well-trained employees and operators are needed to run an efficient printing process. Poor training will result in excessive waste and lost production at times of print problems.

## Reference

1. Anderson, J.T., "An investigation into the physical aspects of the screen printing process", 1997, PhD Thesis, University of Wales Swansea, UK.

# 7 Design and manufacture of labels and sleeves

P. Steele

## 7.1 Introduction

The decoration of packaging within the consumer markets is determined by a complex combination of factors. The first task is to examine the base requirements for the product.

*Product*: This must maintain the brand image and ideally increase market share. Shelf impact and product differentiation is critical to the success of any brand.

*Container*: This may be made of glass, plastic, metal, or fibreboard. Product presentation, processing requirements or market image may determine the container type. A range of products may be produced, using all of the above containers. Brand image requires that the decoration on all types of container match.

*Contents*: These may be liquid, solid, caustic or non-caustic. They may be carbonated causing the primary packaging container to stretch in some way, thereby causing the decoration surface to change shape during the shelf life period. Upon opening the carbonated container will relax and the decoration format, in the case of a label, will need to cope with these changes. The contents may leach through the packaging substrate in some way, thus affecting the decoration surface. This will determine the type of container to be used.

*Economics*: The scale of production may determine the decoration process. The cost per item is usually an issue in the consumer market. Existing filling and packing lines may be used, which may also limit the decoration formats available.

Within the world of consumer packaging, marketing is the main determinant and brand image and market share are vital. Marketers will want to use container decoration to increase shelf impact and to differentiate their product from that of their competitors. Advances in container technology have made many new shapes and sizes available for the product, particularly in glass and plastics. Market demand for these new containers has been made viable only in conjunction with the development of new technologies in substrates, inks, methods of printing and 'label' application methods for container decoration.

The packaging technologist will face a bewildering array of container decoration options. In practice, however, this is narrowed down significantly when all the marketing, technical and commercial considerations have been taken into account. These considerations determine the final choice of the method of container decoration.

The packaging technologist will normally have been involved with the marketing department in the initial product planning stages and will have received advice on suitable packaging options for any proposed new product. Design issues can also be an important influence and should be examined at an early stage of product development. For example, narrow borders at the top and bottom of a wrap-around label can lead to alignment problems on the overlap during labelling. Design factors and their influence on packaging for consumer markets are discussed in detail in Chapter 12.

Mistakes are often made when a method of decoration is chosen for marketing and commercial reasons only. Ignoring critical technical and design issues can make any new product launch costly from both an economic and a brand image point of view.

In the future, environmental issues will be another commercial influence on the choice of container and the method of decoration. Recycling of containers and packaging will increasingly become an issue as landfill sites for packaging waste become less available and their use more costly. Taxes on non-recyclable items of packaging are likely to be more common and if ignored could make many products less attractive to the consumer. All marketing, commercial and technical issues should be remembered when deciding on the design and method of decoration.

## 7.2 Container decoration using labels and stretch sleeves

### *7.2.1 Wet glue labels*

This has been the most popular method of container decoration over the years, but with the development of new technologies for self-adhesive and shrink sleeving options, its market share has diminished and the volume usage is now primarily within the beverage and can labelling markets. It is, however, still a viable option for all other market areas and new developments in ink and paper technology are constantly creating new opportunities, especially when new market trials or promotional offers are being considered. Wet glue labels are supplied in cut, punched and roll-fed formats, depending on market sector requirements.

Cut and punched labels are predominantly printed onto paper by offset lithography, although photogravure may be used for the volume end of the market. Flexography is an option but is not widely used for cut labels. Photogravure and flexography are both used for roll-fed labels. Punched paper labels dominate the beverage markets, although roll-fed plastic is also becoming widely used. Cut wrap-around paper labels dominate the can market. Paper specification is very important for these markets and should be examined closely when preparing any packaging specification.

Packaging specifications for wet glue labels should include the paper, adhesive, use of metal or metallised papers, and decorative finishes.

#### *7.2.1.1 Paper*

The paper used is usually a specified manufacturer's one sided coated label paper. Wet strength or non-wet strength should be specified; this is important for returnable bottles. The weight of the paper is usually between 70 and 85 gsm (gram per square metre). The grain direction is usually east to west (horizontal around the container, not up and down the container). The size of the paper should be specified. Tolerance dimensions are important for efficient high speed labelling production.

All the above should meet the specifications laid down by the manufacturer of the label application machine if the production line is to operate efficiently. Paper specifications are important for several reasons. These are discussed below.

A one-sided coated label paper provides a good surface for printing and can be a standard gloss or cast coated. The uncoated reverse ensures that the applied adhesive bonds effectively with the paper as well as to the container.

Wet strength should be specified in percentage terms and is important within the beverage markets for two reasons. The label is usually applied to a cold, wet bottle and to minimise damage on the packaging line the label should retain its strength when wet. On a returnable bottle the label is washed off the bottle for reuse. The washing-off tanks usually require that the labels remain in one piece for easy removal from the tanks, because if the label disintegrates to a pulp, the tank requires frequent cleaning and is not effective for continuous operation. It is here that the percentage wet strength specification becomes important to ensure the label does not disintegrate. A low level wet strength may overcome line damage in wet conditions, but may not meet requirements for washing off.

The weight of paper, its wet strength properties and the grain direction all affect the rigidity of the label. For an efficient labelling operation the label must not curl within the hopper, so rigidity is useful here. The label is however, often applied to a cylindrical bottle or can, so it must be flexible enough to bend to the contours of the container and allow the adhesive to bond: it must not curl back off the bottle, or the presentation of the label on the container will be adversely affected.

The size of the manufactured label should be as close as possible to that specified by the design. With paper, however, it is not possible to achieve a constant size when cutting and punching so size tolerances must be laid down, usually $\pm 0.25$ mm for high speed labelling machines. It should be pointed out that it is not the size of the label that affects performance but size *variation*; it is perfectly possible to run slightly undersize or oversize provided variation is minimised. A batch of labels can be produced to specification with some at the plus limit and some at the lower limit but that *variation* could cause problems feeding the labels from the hopper.

Other specifications to consider relate to minimising damage to the label appearance on the packing line, and during transit from the manufacturer's warehouse to wholesale warehouse and finally to the retail outlet. During the packing process there can be damage on the line as a result of containers rubbing together, particularly if they spin during travel down the line (Figure 7.1). During the final operation containers are usually packaged in trays or outer cartons in multiple units, 24 or 48 at a time, for warehouse storage. Again, during this

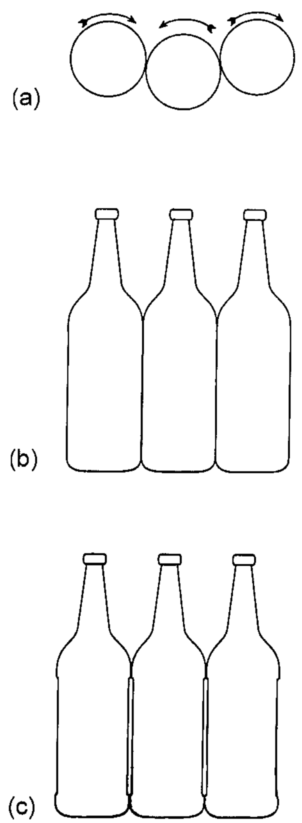


**Figure 7.1** Label spin on the line: (a) containers spin on packaging line; (b) straight-sided containers rub against each other causing label damage; (c) containers with recessed panel for the label minimise label damage.

operation damage may occur as the containers rub against the container sides or carton dividers.

The label should be specified to be printed using rub-resistant gloss or even to have a protective lacquer on the surface. This will help to minimise label damage during the packing process. As part of the label specification, a simulation test for rub is available which rubs the label surface against a specified surface and at a specified pressure/weight; any label damage is assessed after a specified number of rubs. The specification may, therefore, be 25 rubs at $x$ lb. pressure on a PATRA or Sutherland rub tester.

In many instances it may be necessary to specify product resistance. For instance a bottle of hair shampoo, when used in the home, will have some product spillage onto the label. It is essential that the label maintains its appearance and that any instructions on the use of the product are legible throughout its life cycle. To this end inks and lacquers should be specified to be product resistant, whilst on the container, for a specific period of time, say 4 h. Inks may also be specified to have a degree of light fastness, especially if the product is likely to be exposed to strong sunlight.

#### *7.2.1.2 Metallic and metallised papers*

Marketers are always looking at ways to enhance the appearance of the label. Traditionally this could have been done using a metal foil laminated to paper that gives a highly reflective metallic finish, offering excellent design opportunities and an appearance of quality. This is particularly suited to the wines and spirits sectors, where the product commands a premium price and should look and feel expensive. There are, however, problems with this type of production in that, because of the lamination of a thin foil to a paper base, the label is prone to curl when exposed to moisture or when the adhesive is applied to the reverse of the paper base. This can cause major problems on the packing lines, so this type of label may not be suited for use on modern high speed production lines.

The introduction of vacuum metallised paper, where aluminium powder is applied onto the base paper, and improved coating techniques has minimised the curl problem. The cost of a metallised paper is much less than that of foil and could also be said to be more environmentally friendly, using less aluminium which is a non-renewable natural resource. These technical improvements, combined with the reduction in the cost base of the material, have enabled marketers to make a wider use of metallic finishes in both short run and high volume markets.

It should be noted that, when using a metallic foil or metallised material, a key lacquer should be applied to the surface of the material in order to provide a bonding key for the printing inks. This is usually applied by the substrate manufacturer but can be applied by the printer. A white base ink will generally be required as part of the printing process. When using foil or metallised paper care should be taken if the container is a multi-trip returnable item. Washing-off procedures need particular attention as base lacquer and inks reduce moisture penetration making label removal more difficult. Specifications should be drawn up to cover this.

#### *7.2.1.3 Decorative finishes*

A wide range of options is available to enhance shelf appeal and incorporate promotional messages to ensure the product stands out from competitors in the marketplace.

High gloss lacquers can be applied to improve scuff resistance and increase shelf appeal. When applied by offset lithography these can be a standard gloss varnish but, to obtain maximum effect, ultraviolet (UV) lacquers, which are available in both matt and gloss, are usually applied. A combination of these finishes is widely used in commercial print but can also be used very effectively for label decoration. Labels printed by photogravure use a range of solvent and water-based lacquers. In all cases when using varnishes or lacquers care must be taken to ensure that there is no tendency for curl in the final cut/punched label that may cause label application problems.

Embossing is often used for labels in the wine and spirit market sectors where a premium image is required. The emboss feature can be a specific name line within the design or an overall pattern effect. With metallic labels, an overall light emboss finish is often found to aid label application. Crushing of the fibres in the embossing process makes the label less rigid and therefore easier to apply.

Hot-foil blocking can be used to enhance parts of the design using high reflective foils which are also available in a wide range of colours. This process is widely used within the wines, spirits and cosmetic sectors. On paper labels this process is usually carried out as a separate printing process (i.e. not in-line), thus increasing the label cost. Self-adhesive label printing machinery has been developed so that foil blocking can be produced in the same printing pass (i.e. in-line).

New ink technology has given a boost to promotional 'gimmicks' enabling messages to be incorporated in the label using inks that are affected by either heat or light.

*Thermochromatic* inks are a micro-encapsulated liquid crystal with an acrylic resin, water and additives that enable a reversible colour change to occur within predefined temperature ranges. It is possible to have a message such as 'Ready to Drink' appear when a bottle of drink, placed in the refrigerator, reaches the recommended drinking temperature. Equally a chocolate bar could be placed in the refrigerator and 'snow flake' symbols appear when cooled to a pre-determined level (Figure 7.2).

*Photochromatic* inks are very similar to the above but react to light changes as opposed to temperature changes. For instance it is possible to have one or more elements of the design appear, or disappear, once the product has been placed in the dark, inside either a cupboard or refrigerator.

(a)  (b)

**Figure 7.2** (a) Printed emblem appears as temperature reduces; (b) printed emblem invisible at room temperature.

### *7.2.1.4 Benefits of wet glue labelling*

- Wet glue labels offer the lowest cost option of all decoration methods.
- The product is understood by most users of wet glue labels, eliminating the need for a steep learning curve.
- High speed labelling applications are widely available, often with line speeds exceeding 1 000 bottles/min.
- The printing processes used enable high quality reproduction of photographic images, line and tone work, and metallic colours. Special inks to match brand name colours are easily available.
- Origination costs are relatively low for lithographic printing. Photogravure cylinders are expensive but this process is still viable when comparing the origination costs relative to the volumes usually produced.

### *7.2.1.5 Constraints*

- Cannot be applied to highly shaped areas of a container.
- Limited moisture resistance when compared to plastic labels.

## *7.2.2 Self-adhesive labelling*

### *7.2.2.1 The structure of a self-adhesive label*

Self-adhesive labels are printed with each label carrying its own layer of adhesive (Figure 7.3). They are supplied to customers in reel format on a carrier base substrate (silicone release paper). This area of labelling has achieved a phenomenal growth over the past 10 years, as a result of the introduction of new substrates and adhesives specifically developed to meet market requirements.

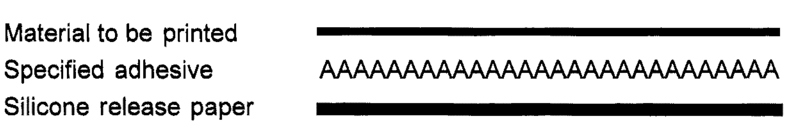


**Figure 7.3** A typical self-adhesive label structure.

Virtually all the printing processes are available for the production of self-adhesive labels: offset lithography, photogravure, rotary letterpress, semi rotary letterpress, flexography, rotary silkscreen, hot-foil blocking, cold-foil blocking.

With such a plethora of print processes available the marketers can create designs to meet almost any market requirements. The success of self-adhesive labelling has meant that machine manufacturers have produced presses that combine various printing processes. Designers can liaise with the label manufacturer to find the ideal combination of printing processes to produce a label that gives their product the most attractive brand image and shelf appeal. The job of the packaging technologist is to ensure that the combination of product, container, printing processes and substrate are complementary and commercially viable. This is not an easy task bearing in mind the wide variety of choices available.

#### *7.2.2.2 Substrates*

The following can only be a sample selection and for more detail the technologist should contact one of the major self-adhesive substrate manufacturers for their catalogue.

*Paper face label material.* There are a variety of papers available.

*White litho.* This is a wood-free general label paper, absorbent for fast drying and ideal for overprinting.

*Vellum.* A smooth finished general purpose matt paper with good printability.

*Thermal transfer.* Surface coated white wood-free paper giving an excellent printing finish. Very suitable for high definition thermal transfer printing.

*Machine coated gloss.* High quality semi-gloss paper with good printability and strength.

*Cast coated.* High gloss paper generally used for prestigious labels.

*Thermal printable.* Non surface-coated heat-sensitive paper for thermal printing requirements.

*Fluorescent.* Wood-free base paper coated with high intensity fluorescing pigment. Used for warning or information labels where immediate impact is required.

*Film face label material.* Some examples of films used for labels are:

*Vinyl.* Calendered (smoothed by roller) plasticised PVC (polyvinyl chloride)—strong, flexible and durable.

*Acetate.* Clear and matt film for general purpose labels—not recommended for outdoor use. Also used as a self-destructive film for tamper evidence in security labels.

*Polypropylene (PP).* Highly durable clear film, ideal for overlaminating.

*Polyester clear.* Strong, clear film, resilient to many chemicals. Suited for overlaminating.

*Polyester metallised.* Vacuum metallised polyester with a print-receptive surface.

*Tyvek.* Synthetic spun bonded polyolefin material. Durable to weather and resistant to most chemicals.

*Prismatic films.* Embossed rigid polyester and polypropylene films are available with light refractive properties

*7.2.2.3 Adhesives*

The following is a representative range of adhesives with recommended usage specifications.

*Permanent.* This adhesive is used for general purpose labelling. Very good tack and can be used on most substrates including applications to curved surfaces. It has good heat resistance with a label application temperature required of over +5°C, and an operating temperature of −10 to +80°C.

*Peelable.* This is a general peelable adhesive with very good tack, but which is removable from a wide range of surfaces. It has good heat resistance with a label application temperature required of over +5°C, and an operating temperature of −10 to +80°C. Special glass peelable adhesives are also available.

*Deep Freeze.* This is used for low temperature applications—flash freezing and adherence to chilled/frozen surfaces. It offers good heat resistance with a label application temperature required of over −20°C and an operating temperature of −10 to +60°C.

*Water removable.* This offers permanent adhesion from dry on smooth surfaces, and is water removable above 10°C. It has good heat resistance with a label application temperature required of over +5°C, and an operating temperature of −10 to +80°C.

*Aggressive permanent.* This adhesive has been specifically designed for use on difficult surfaces such as cardboard and fibrous substrates. It has good heat resistance with a label application temperature required of over +5°C, and an operating temperature of −10 to +80°C.

*High tack peelable.* This is an aggressive peelable for use on rough or difficult surfaces. It has good heat resistance with a label application temperature required of over −5°C, and an operating temperature of −40 to +50°C.

*Blackout.* This is an non-transparent adhesive used for over-labelling to obliterate undersurface information. This might be a promotional message or win message. It offers good heat resistance with a label application temperature required of over +5°C. Operating temperature of −10 to +80°C.

*Pure acrylic permanent.* This is designed for plasticised PVC, transparent films and high temperature applications. It offers excellent clarity and UV resistance making it highly suited for 'glass clear' labelling. Excellent heat resistance with a label application temperature of over +5°C and an operating temperature of −10 to +80°C.

*Water resistant permanent.* This has good adhesion to a wide range of surfaces especially in damp and humid conditions, excellent heat resistance with a label application temperature of over −5°C, and an operating temperature of −20 to +80°C.

This wide range of substrates and adhesives has formed the basis for the growth of self-adhesive labelling within the packaging industry. Whenever a problem or opportunity has occurred in packaging a product or labelling a container, then a new substrate or adhesive has been developed either to overcome the packaging problem or to stimulate product packaging development using new substrates and adhesives.

One of the original constraints in the growth of self-adhesive labelling was the initially slow development of label application machinery. As major manufacturers of self-adhesive labels realised this was a major factor affecting the growth of their industry they set up their own labelling machinery design and manufacturing offshoots.

This combination of substrate and machinery development has enabled them to generate a greater than average increased demand for self-adhesive labels. While application speeds are still comparatively slow, when compared to wet glue labelling, speeds of 300 items/min are achievable, which is often more than adequate for the premium target markets.

The principle for successful self-adhesive labelling is to ensure that once the substrate is printed the label is accurately die cut to shape. Not only must the cutter shape be exact to the design, but the cutting pressure applied must only cut through the substrate and into the adhesive. It should not cut into the backing paper as this can 'weld' the label to the backing causing label application problems. The simplistic principle of label application is to take the printed and die cut carrier web over a roller turning the web at a sharp angle. This causes the label to release itself from the backing paper when it can then be applied to the container or product. To aid the label release from the carrier web a number of backing papers have been developed which, when combined with the release characteristics of the adhesive, can ensure successful application over a wide range of products and variety of production environments.

#### *7.2.2.4 Backing papers*

Typical backing papers are either glassine or Kraft materials that have been 'siliconised' on one side. The 'sandwich' of substrate, adhesive and backing paper is manufactured and printed. The label is then die cut ready for use on the application machinery. The siliconised backing ensures that the adhesive is released from the backing material and that it remains on the reverse of the substrate to affix the label to the container or product. Glassine backing is predominately used for rotary label applications and is usually made in either honey or white—the colours often indicating whether the adhesive in the 'sandwich' is a permanent or semi-permanent adhesive. However, this is not always the case and as such the colour of the backing should only be taken as a guide to adhesive types. Typical glassine weights are around 65 to 85 gsm.

Kraft backing materials are usually specified where a more stable flat, moisture-conditioned release is required. The Kraft backing materials have a greater tensile strength than glassine to give stability in adverse application situations. Typical weights are around 75 to 90 gsm.

#### *7.2.2.5 Benefits of self adhesive labelling*

- Wide range of printing technologies available, including foil blocking in-line.
- The marketer can choose a single printing process or a combination of processes to maximise shelf appeal for the product. Self-adhesive labels generally offer a greater perceived product value, hence the extensive use in the wine and spirits market sectors.
- Wide range of adhesives available to ensure that labels can be applied to almost any product in a wide range of production environments. For example, aggressive adhesives may be used to affix labels to car tyres and deep freeze adhesives for frozen food label applications.
- A new generation of transparent films and 'glass clear' adhesives are now available to stimulate new ideas for product decoration. The transparent parts of the label allow the product/container to show through, giving more opportunities for innovative design.
- Substrates/adhesives can be selected to suit adverse application environments.

#### *7.2.2.6 Constraints*

- Application speeds are slow in comparison to wet glue. To overcome this problem some market sectors pre-label containers to maximise production speeds on filling lines.

- Cutters for self-adhesive rotary printing presses are expensive.
- Large investment in cutters is required to suit the wide range of label sizes needed.
- Self-adhesive labels are significantly more expensive than wet glue paper labels with the additional costs of the carrier substrate and the adhesive.

### *7.2.3 Roll-fed labelling: general*

For certain market sectors there is a demand for labels to be supplied in the form of a continuous printed reel. The sweet confectionery market is a typical example, using paper labels or film laminates as the main method of decorating their product. Labels are printed by either photogravure or flexography onto a standard paper, usually 70 or 80 gsm.

Roll-fed labels have to be applied to a uniform section of either a cylindrical or rectangular container or product, and application rates can be relatively high. Labels are fed from a continuous reel, and are then cut down to single units to be wrapped around the product. The cutting mechanism is triggered by means of a printed eye mark that is usually positioned in the underlap of the label.

The sweet confectionery market is a major user of roll-fed labels and these are usually printed in four to six colours, on the face, with a gloss lacquer to give added shelf impact; this also assists in maintaining line speeds in the final packaging operation by reducing friction on the packing line.

Roll-fed labels can also be used in the form of paper laminates or a range of filmic substrates. These are widely used for 500 ml, 1 l and 2 l PET (polyethylene teraphthalate) bottles within the carbonated drinks and beer markets. The advantage of using a film substrate for this market is that, when these products are filled, the carbonation of the product can expand the diameter of the bottle. With paper labels this container expansion can result in the labels tearing or splitting and falling off the bottle. With film label substrates, such as polypropylene, the label has sufficient elasticity to expand with the bottle with no adverse effect on label integrity.

In order to ensure accurate cutting, the position of the eyemark must be consistent throughout the reel. It is usual to specify that the label image or eyemark should not move more than 1 mm over a printed length of 2000 mm. This can be quite a tight tolerance bearing in mind that the substrate being printed can stretch as it is being driven through the printing press. Routine quality checks on the accuracy of the printed length should be made throughout the printing process.

Label positioning on the container is important so the label manufacturer should ensure that there is accurate positioning of the graphic design, when converting from the jumbo printed reel to single reels for machine application. When applying labels to bottles the wrap around should be checked to ensure labels meet exactly on the overlap.

#### *7.2.3.1 Benefits*

- The production process for manufacturing roll-fed labels is a relatively simple and cost-effective method requiring printing and slitting manufacturing operations only.
- Application systems are well developed and offer commercially viable production speeds.
- With the option of reverse printing on the reel it is feasible to incorporate a competition or promotional message on the back of the label, giving the consumer an incentive to buy the product.

#### *7.2.3.2 Constraints*

- Roll-fed labels can only be applied to a uniform section of a container or package. This can limit the decoration area and place constraints on the label design when using more innovative container shapes.

### *7.2.4 Roll-fed labelling: shrinkable*

Shrinkable roll-fed labelling is based on existing roll-fed labelling technology using a film substrate that is capable of some shrinkage, less than 20%. This makes it ideal for decorating a two piece aluminium can. The label is applied as a wrap-around label in the conventional way, but the decorated container is then passed through a heat tunnel and given a short burst of heat to shrink the label into the curvatures at the base and top of the can.

The two main shrinkable roll films currently available are orientated polypropylene (OPP) and orientated polyvinyl chloride (OPVC). However, film technology in this area is constantly developing as the demand for this form of labelling increases.

#### *7.2.4.1 Benefits*

- Ideal for decorating two piece aluminium cans offering multi-coloured high definition reproduction of designs.
- Gives moisture and product resistance.
- With transparent films, reverse printing of the design offers a high quality gloss finish.
- Reverse printing can offer promotional opportunities.

#### *7.2.4.2 Constraints*

- The limited degree of shrink currently offered by roll-fed films rules out their suitability for tapered, highly shaped or narrow necked containers.
- Pre-labelling of beer cans can cause problems during the pasteurisation process if the hot-melt adhesive is reactivated due to the pasteurisation temperatures.

- There is a lot of can-to-can contact during the filling line operation. Modern cans run at speeds of 2000 cans/min, making the slip characteristics of the can surface critical. OPP and PVC films may slow the filling line unless high slip lacquers are used on the surface of the films to improve their coefficient of friction.

### *7.2.5 Stretch sleeves: polyethylene*

Polyethylene (PE) stretch sleeves are almost exclusively printed by flexography. They offer 360° decoration on the uniform sections of rectangular or cylindrical plastic containers. High density polyethylene (HDPE) containers for milk and PVC and PET containers for soft drinks and mineral waters are the main market sectors using PE stretch sleeves.

The PE film has a degree of elasticity enabling the sleeve to be physically stretched and placed over the container. Once the sleeve has been applied onto the container it reverts back to its original size, forming a relatively tight finish on the container. PE stretch sleeves can be applied to glass containers, but they are not generally recommended for application to glass bottles.

#### *7.2.5.1 Benefits*

- Relatively inexpensive.
- Moisture and product resistant.
- 360° decoration.

#### *7.2.5.2 Constraints*

- Only suitable for plastic containers.
- Flexographic printing is the only technically feasible method of printing.
- Limitation on reproduction of gold, silver and other metallic colours.
- Not suited for tapered, highly shaped or narrow necked bottles. Requires uniformity of shape in the decoration area.

## 7.3 Container decoration using shrink sleeves

### *7.3.1 Background*

Shrink sleeves are now one of the fastest growing and most versatile methods of container decoration. The product was first invented in Japan over 30 years ago with the development of thermo-shrinkable PVC for use as shrink closures for wine bottle caps. The product was then further developed in Japan for the decoration of glass containers but was only introduced into Europe and the UK in the mid 1980s.

In simplistic terms shrink sleeves start life with standard PVC being produced in reels. This is then 'tentered' or 'stretched' in a longitudinal direction and supplied in reels to be reverse printed. The printed material is then converted into sleeves supplied on reels. These are the placed over the container and when heat is applied the material reverts back to its 'unstretched' form, moulding itself to the shape of the container (Figure 7.4).

Initially the use of PVC shrink sleeves in Europe was mainly confined to twin packs and other promotional applications, because the technology for applying sleeves to containers was not sufficiently developed in Europe. As machine application developments took place, the use of shrink sleeves for the decoration of standard glass containers increased.

Further developments in base substrates occurred, bringing other film materials to the marketplace; these had higher shrink characteristics and could be applied at lower temperatures.

As packaging technologists realised the potential of shrink sleeves, the acceptance and popularity of this method of decoration has increased rapidly. New container shapes have been developed in both glass and plastic for decoration

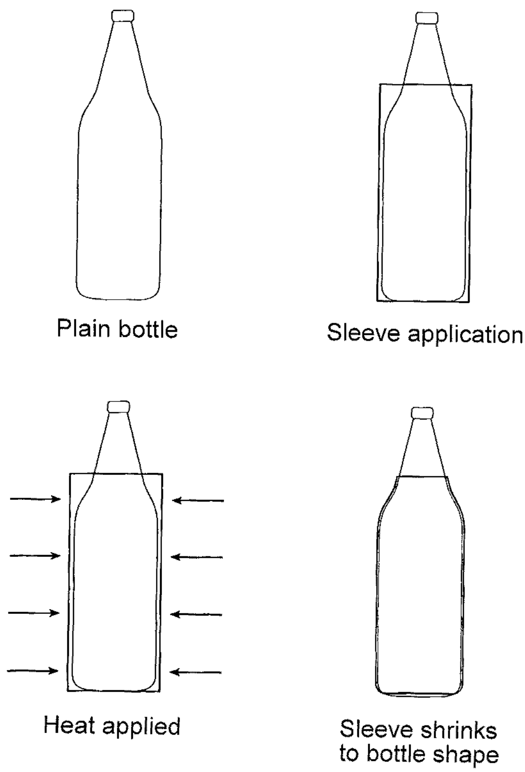


**Figure 7.4** A plastic sleeve is placed over a bottle and shrunk by heat to fit the bottle shape.

with shrink sleeves. Marketers are now able to develop innovative methods of packaging that have greater shelf appeal, improve brand image and increase sales without incurring excessive increases in packaging costs. Shrink sleeves allow the 'labelled' package to become a three-dimensioned decorated package. Graphics come alive; a basic HDPE bottle takes on a whole new dimension of quality, as seen in the flavoured milk sector. The strong branding offered allows one structural container shape be used for more than one brand. This offers very significant advantages where such brands run down one filling line and share the manufacturing processes.

#### *7.3.1.1 The printed product*

Shrink sleeves have traditionally been reverse printed onto clear film in four or six colours plus a backing white. This gives a high gloss finish to the decorated container and ensures that the printed image is protected from damage on the packaging line by being 'sandwiched' between the reverse of the film and the surface of the container.

The printing quality available from photogravure provides first class reproduction for photographic images, with special brand colours and metallic inks available as standard. Flexographic printing is possible, but this is often limited to more simplistic line designs for multi-pack promotions.

The base substrate is printed onto the reverse of the reel of clear material with a number of images across the web. In some cases, opaque or coloured materials can be used which then require surface printing. The printed reel is then slit down into single reels one image wide.

After the slitting operation the printed reel has to be formed into a continuous tube—this is known as the seaming operation. The single reel is taken over a forming device and is then sealed on the overlap, producing a flat tube which is then rewound as single reels. The quality of the seal on the overlap is extremely important: it must not break open when the sleeve is shrunk onto the container. Ultrasonic beams can be used to produce a weld on the seam, but this is a relatively slow process and the resultant seam can be brittle. A more reliable method is to apply a line of solvent to the overlap; the solvent used is usually tetrahydrofuran (THF). This melts the surface of the film which, when folded over, creates an instant and firm bond. The integrity of the seam is then checked under a UV light as the flat tube is being rewound; the solvent line should be continuous to ensure a firm seal.

Finished reels for automatic application are rewound onto cores, the diameter of which should be specified to suit the particular application machinery. Typical core diameters specified are 70 mm, 100 mm and 150 mm. The packaging technologist should ensure that all specifications include the finished core size required for the application machinery being used. This is particularly important where finished reels of the same product are sent to different manufacturing sites for application.

Where shrink sleeves are to be applied manually, the converter will be required to supply the sleeves in single cut format. The continuous reel of sleeves is cut in a similar manner to that used on automatic application machinery: the reels are either printed with an eye mark or more usually with a clear gap between each printed image. An electronic beam reads the eye mark or is activated by the clear gap, and a cutting device comes into operation to form single sleeves. These can be stacked individually for hand application or automatically applied directly to the container.

After application to the container the final stage in the decoration process requires the container to be passed through a heat tunnel to shrink the sleeve onto the container, forming a tight finish.

### *7.3.2 Project management*

Despite the increasing popularity of shrink sleeves, there is often insufficient understanding of the product and its full potential. It is important that the packaging technologist should highlight the elements that need to be addressed if a shrink sleeve project is to have a successful outcome.

#### *7.3.2.1 Design*

This is the first key issue to consider in any shrink sleeve project. The traditional method of container decoration has been to have either a complete wrap-around label or separate front and back labels, with possibly a neck band label. This concept of label design meant that when the first shrink sleeve labels were produced there was a tendency to follow these traditional design concepts not utilising the full benefit of a shrinkable sleeve and three-dimensional decoration.

The all-round full length decorating capability of shrink sleeves on shaped containers was soon appreciated and designers began to explore concepts that were previously unavailable when using other methods of decoration.

In Europe, commercial packaging of beverage containers was one of the first market sectors to use shrink sleeves. This was introduced with certain safety aspects in mind. Concerns had been expressed that if a glass bottle full of carbonated beverage was accidentally dropped, the bottle might explode and scatter broken glass in all directions. It was considered that when a full length sleeve had been applied to the bottle, if any breakage occurred, the sleeve would hold the glass splinters in place thus minimising accidents.

Once the concept had been put into operation, marketers and label designers soon realised they no longer needed to be confined to the traditional label panels: all-round, three-dimensional decoration had become a commercial reality.

Container designers also found that shrink sleeves gave them new-found freedom to design containers that until then had been viewed as impossible to decorate. This freedom to be innovative with label and container designs and at the same time be technically and commercially viable has been the key to the increase in growth and popularity of shrink sleeves.

Producing designs for shrink sleeves requires a different approach to that for other forms of decoration:

- The sleeve is designed to shrink and therefore the label dimensions need to be different to that of the final finished product.
- The label design does not need to be confined to specific label panels, offering greater design opportunities.
- In areas of high shrink, for example, the narrow neck of a beer bottle, the design needs to be pre-distorted to compensate for the eventual shrink.

Most manufacturers of shrink sleeves should be able to provide a layout drawing to enable designers to place key elements of the design correctly in relation to the container. While there may be small differences between layout drawings supplied by different shrink sleeve manufacturers, the following guidelines should prove to be helpful:

- The flat width of a shrink sleeve, half the circumference of the container, should be multiplied by two to give the total label width.
- 1 mm of additional design area needs to be added to each side of the label width (i.e. a total of 2 mm). This additional design area is needed during the seaming operation when the flat printed and slit film is turned into a continuous tube. In the absence of this additional print area, there would be a strong likelihood of a vertical transparent gap appearing in the seam area.
- The sleeve manufacturer will calculate the additional allowances for the width of the design to ensure the sleeve can be applied at optimum production speed on the application line prior to shrink as part of the pre-distortion process. This allowance will vary according to the shape of the container which may affect the ease of application (i.e. narrow or wide-necked, cylindrical or square).
- Every sleeve in the flat form has two folds. The seam position needs to be about halfway between the centre of the design and one fold. By definition this will also determine the position of the second fold. This is a requirement for most automatic application machines as the sleeves are refolded at 90° before the actual application. The distance between the folds must be that of the sleeve flat width.
- The seam position must not be closer than 25 mm from one of the folds.
- The easiest way to produce the design is to have the front panel central in relation to the two folds. It is also essential that the back panel is also central. That is, the distance between the centres of the front and back panel must be the same as the flat width of the sleeve.

- Any bar code used in the design needs to be positioned in an area of minimum possible distortion, with the bar code lines horizontal in relation to the base of the container. It is advisable, though not essential, to ensure that a fold does not go through the bar code.

Most shrink sleeves have 1.5 mm of transparent material at the top and bottom of the sleeve, which is necessary for the following reasons:

- It enables the automatic cutting of the sleeves on the application machine.
- The cutting operation does not have a plus or minus cutting tolerance. Therefore if, for example, the colour of the sleeve at the top is red and at the base of the sleeve black, it is highly likely that a black line may appear at the top of the sleeve or alternatively a red line may appear at the base of the sleeve.
- Continuous designs have the same colour at the top and base of the sleeve, which eliminates the need for transparent areas at the top and the base of the sleeve. However in such cases there may well be the need to print a small eye mark (about 3 mm × 5 mm) on the sleeve to aid cutting. A continuous design will ensure that the maximum possible height of the container is decorated.
- The height of the sleeve needs to be determined by the sleeve manufacturer and/or the sleeve application company. It is often a mistake to work on the theoretical sleeve dimensions as different films have different shrink characteristics and require different sleeve heights.

Designers need to produce the graphic design as they would like it to appear on the container. In areas of maximum distortion, like the neck of a bottle, there will be a need for pre-distortion. It is often best to leave the pre-distortion of the design to the shrink sleeve manufacturer as it does not affect the intrinsic elements of the design. It requires shrink sleeve technology and experience to obtain correct pre-distortion and ensure the final product is as the designer intended.

For rectangular containers all the above points will apply. The only additional point to note is the fact that the container will have four sides giving a clear definition of the front, back and side panels. The ideal place for the two folds would be the centre of the side panels. It is often mistakenly believed that the best position for the fold is on two corners of the container. In practice this can result in distortion and a 'lopsided' finish.

For oval containers it is critical that the front and back panels are central in relation to the two folds. This ensures that during the sleeve application process the sleeve is positioned correctly in relation to the container.

For both rectangular and oval containers, the position of the main elements of the design in relation to the folds is critical, otherwise it will be impossible to position the sleeve correctly in relation to the container.

*7.3.2.2 Glass and plastic containers*

A very high proportion of glass and plastic containers have been designed for wet glue or self-adhesive labelling. In the case of glass bottles, such containers can cause a problem when shrink sleeves are used as a form of pre-labelling. For instance, most beer bottles have a pronounced label panel in order to protect the wet glue paper label during transit. However with full length sleeving of these bottles the label panel results in two contact points where the sleeve can easily be scuffed or damaged. The following steps should be taken to minimise the problem:

(i) Silicone coatings on the sleeved bottles can be applied immediately after the sleeve application, to increase the slip characteristics of the sleeve and offer an additional protection to the film down the filling and packing line.
(ii) New, lightweight glass bottles, with no label panel, reduce the weight exerted on the lower layers of glass on pallets during transit. In addition, bottles with no label panels ensure a larger contact area between bottles, thus reducing the overall pressure at any given contact point.

The ability of shrink sleeves to decorate highly shaped containers has enabled container designers to move away from the traditional bottle shapes and design very original containers that offer increased shelf impact and a greater capability to differentiate the product from that of the competition.

Scuffing and line/transit damage is usually not a problem with plastic containers, but there are other important considerations that need to be taken into account:

(i) Both PVC and PET bottles do shrink when pre-labelled with shrink sleeves and consequently there can be a volume loss of up to 2%. This needs to be taken into account at the container design stage. The volume loss can vary depending upon the container wall thickness, the line speed of the application machinery and the length of time in the heat tunnel.
(ii) Most PVC and PET containers currently used for beverages do have a long area of bottle to bottle contact. The slip characteristic of the shrink sleeves is important in order to ensure maximum filling line efficiencies. The use of high slip lacquers on the surface of the film and/or the use of silicone coatings on the sleeved bottles may be advisable. These coatings can be applied either by the shrink sleeve manufacturer during the printing process, or by spraying the finished container on the sleeving line immediately after application and shrinking on to the bottle.

*7.3.2.3 Choice of substrates*

In the initial development of shrink sleeves, the only thermo-shrinkable material available was polyvinyl chloride (PVC). With the growth of the sleeve market other shrinkable materials are now available, including polyethylene teraphthalate (PET) and polystyrene (PS).

All these substrates are now available for conversion into shrink sleeves, either as seamed sleeves for decoration or seamless extruded tubes for bottle caps and tamper evidence. All these materials can be printed by either photogravure or flexography and can be converted, perforated and cut to singles if required.

Initially all these shrinkable materials were only available to one standard shrink specification; that is, the tentering of the base reel in the manufacturing process produced standard material that shrank or reverted back to its original state when heated. This produced a standard substrate that, when applied to the container and passed through the heat tunnel, gave a known percentage horizontal and vertical shrink at specified temperatures.

As can be seen from Figure 7.5 the standard material gives optimum shrink at certain predetermined temperatures which needs to be replicated in the heat tunnels used after sleeve application.

This standard shrink material is perfectly adequate for rigid containers, with a uniform labelling area, and a fairly standard degree of shrink throughout the depth of the container.

As the concept of using shrink sleeves for product decoration became more widely accepted, it became clear that more highly shaped containers would improve shelf appeal. More highly shaped bottles with narrower necks were developed and used for shrink sleeving but this required substrate manufacturers to develop new high shrink material for sleeves.

The range of high shrink materials gives greater horizontal shrink, enabling the sleeve to be used on more highly shaped containers. There is also a slight increase in the vertical shrink, which needs to be taken into account at the design stage by the sleeve manufacturer, when determining the overall pre-distortion size for the sleeve.

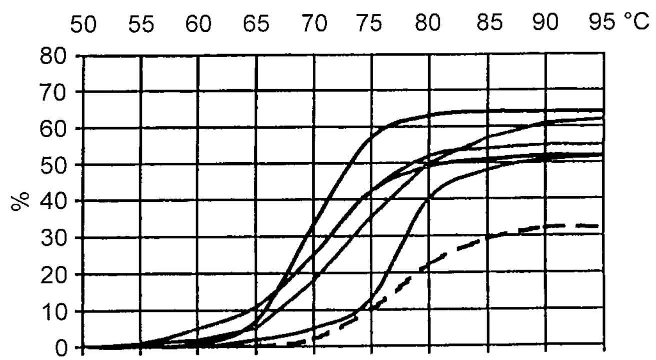


**Figure 7.5** Graph showing shrink and temperature curve for standard PVC.

High shrink substrates have additional benefits when applying sleeves to plastic containers. When a sleeved container is passed through the heat tunnel for shrinking, the actual container will expand as the shrink sleeve contracts to fit the container. On a glass bottle the container expansion is minimal as the actual dwell time in the heat tunnel is low while the containers are passing along the production line. A plastic container, however, will expand with the heat and if too high a temperature is used the container will expand too much. When the container cools down the sleeve is likely to fit the container loosely. Since high shrink materials operate within a lower temperature range in comparison to standard material they are ideal for plastic containers.

At the other end of the scale there is also a need for high temperature substrates particularly where a container is subject to pasteurisation. For instance, when sleeves are used for container decoration within the beer market, the bottles are usually pre-labelled and used on the filling line at a later date. This is done because sleeve application speeds are slow when compared to those of a modern filling line. After filling, beer bottles are usually passed through a pasteurisation process to ensure there are no live bacteria which could have an adverse effect on the product. This requires high temperatures to be applied to the filled container, and it may also be exposed to heat for a much longer period than that required in the sleeving process. A low temperature shrink material would not be suitable in this case and in extreme conditions a standard shrink material may have problems. The higher temperatures used during the pasteurisation process may produce additional shrink on the sleeve, causing it to burst and fall off the container. There can also be steam present in the pasteuriser. This moisture can be absorbed by standard PVC material turning it a milky white colour. In this market sector it is always advisable to undertake trials under actual production conditions to evaluate the substrate suitability under the packaging conditions.

#### *7.3.2.4 Sleeve application*

There are a number of automatic sleeve application systems available, but all operate on the principle of the sleeve cutting from the reel being activated by either a clear gap between the images on the reel or a printed eye mark.

Problems in sleeve application usually occur with variations in the overall width of the sleeve. This is often not an error in manufacturing the sleeve to a specified width but one caused by problems with the shape of the container. Sleeves are easier to apply to a round container—a square container usually requires a slightly larger sleeve to avoid snagging on the corners when being applied.

#### *7.3.2.5 Heat tunnels*

After the sleeve has been applied it must be shrunk on to the container with the application of heat. There are many types of heat tunnel available on the market with the heat source being either hot air, steam or even infra-red. The main criteria when evaluating suitability for shrinking sleeves onto containers is that the applied heat should be directional and as such a system using hot air through directional nozzles is usually most appropriate. To obtain a good fit, different areas of the sleeve may require more applied heat than others to obtain the best result.

In general the heat applied should be kept to a minimum, consistent with the recommended application temperatures for each grade of shrinkable material. To produce good results the temperature within the heat tunnel should be kept consistent and in-line with the appropriate substrate shrink and temperature graphs available from each material manufacturer.

Shrink problems can occur for the following reasons:

- Poor directional heat—check heat nozzles are directed in the area of maximum shrink.
- Temperature variation within tunnel—ensure minimum draughts from open doors.
- Line speed too fast to ensure sufficient time for heat to shrink material.
- Temperature settings not suited to substrate—too high or too low to maximise shrink.
- Containers too close together on the line, not allowing even air circulation.
- Stored containers (especially glass bottles) can be too cold and therefore, when entering the heat tunnel, absorb some of the heat needed to shrink the sleeve. If this proves to be a regular problem a separate pre-heating tunnel should be used.

### *7.3.3 Development work*

Every new sleeving project can present its own challenges and it is therefore essential to carry out sufficient development work rather than expect everything to be trouble free for that crucial product launch into the consumer market.

The following guidelines should be followed in any development project. Whether it is a new or existing container, glass or plastic, a limited application trial using shrink sleeves decorated with a printed graph needs to be carried out to determine the following:

- Ensure that the theoretical sleeve dimensions are correct.
- Highlight areas of maximum distortion with a view to avoiding important areas of design in the high distortion parts of the sleeve, in addition to identifying areas and the extent of any pre-distortion needed.
- Carry out filling line pasteurisation and transit trials if needed.
- For plastic containers, identify possible maximum volume loss.

With recent advances in print technology and the availability of digital printing, it is now possible to reproduce a given design on the correct grade of film and produce an extremely good mock-up. Digital printing is based on four colour process work and is therefore ideal for reproducing photographic images. The printing of gold, silver and other metallic colours is currently not possible. The benefits of digital proofs are:

- No need for the initial expensive origination costs of producing films and engraving cylinders and printing machine proofs.
- Excellent photographic reproduction.
- Ability to see the final design in its three-dimensional form before going to final production.
- The relatively low cost of digital printing enables designers and marketers to make changes to the design which would have been expensive had the photogravure cylinders been produced.
- Ability to produce several hundred samples for market research, pre-sale specimens and samples for photographic work for publicity material.

Digital is the best and most cost-effective method for checking pre-distortion work. Application trials need to be carried out before any application machine is installed to ensure compatibility between the machinery and the sleeve specification.

#### *7.3.3.1 Benefits of shrink sleeves*

- All round decoration on shaped containers.
- Suitable for full length decoration on narrow necked containers.
- High definition photogravure reproduction.
- Excellent metallic colours.
- Combination of matt and gloss finishes.
- Frosty finishes to reproduce an acid etched glass container.
- Pearlised scuff resistant finishes available.
- High opacity finishes for UV protection.
- Pasteurisation capability for pre-labelled bottles.
- Inclusion of UV in parts of the design can be used to highlight a brand name so that it glows in a nightclub environment giving greater sales appeal.
- Translucent finishes.
- Thermochromatic inks.
- Photochromatic inks.

#### *7.3.3.2 Market opportunities*

The use of shrink sleeves for container decoration will continue to grow and more innovative uses will be found to exploit the potential of sleeves within consumer markets. New types of containers will be developed in both glass and plastics for sleeving. New shrinkable substrates will be developed that offer not only decorative possibilities but also product protection. For example, household batteries now use sleeves that not only provide decoration and product information, but also insulate against corrosion and improve the anti-leakage properties of the product.

The packaging technologist can be the catalyst in this growth by exploring the options available and maintaining dialogue with substrate manufacturers, material converters, the producers and decorators of containers.

#### *7.3.3.3 Environmental issues*

The technologist should always be aware of the environmental pressures to reduce waste within the packaging market. When developing new packs, care should be taken to use materials from sustainable sources which at the same time maximise recycling opportunities.

## 7.4 Other methods of container decoration

### *7.4.1 In-mould labelling*

This is the use of paper or plastic labels during the manufacture of containers by blow moulding, injection moulding or thermoforming processes, with the label forming an integral part of the final product, which is then delivered as a pre-decorated item.

The technology was originally developed in North America by Owens of Illinois in conjunction with Proctor & Gamble to supply pre-labelled bottles that could be filled as multiple units in-case. The concept was that this would produce substantial cost savings with the container manufacturer packing the finished empty bottles direct into the transit case that would then be filled on line. There would be no need to label the product on the filling line—thus improving line speeds—and there would be no requirement to take single bottles off the pallet prior to filling.

The initial product development was undertaken on Head & Shoulders Shampoo containers which gave strong marketing benefits. Shampoo is primarily used in the shower and at that time it was found that when the label became wet in the shower it disintegrated or came off the bottle. The in-mould label remained on the bottle for a longer period as the label was an integral part of the bottle and thus maintained the brand image for a longer period.

Established market sectors now cover:

- Household products—liquid detergents, fabric conditioners.
- Toiletries—shampoo and conditioner products.
- Food products—butter, cheese and fromage frais tubs, yoghurt pots and biscuit boxes.
- General—oil containers, video cassette cases.

Much of the growth of in-mould has been at the expense of the pre-decorated container market and has not eroded the traditional markets for paper and self-adhesive labels.

### *7.4.1.1 The principles of in-mould labelling*

The basic principle of in-mould labelling is to take a substrate—paper or plastic—coat it with a heat seal coating, print and convert to a finished label (Figure 7.6).

This label is then used in specific blow moulding, injection moulding or thermoforming operations to produce a container with the label being an integral part of that container. Many methods of inserting the label inside the mould used to form the container have been developed. Often existing machines have been adapted for use.

When the label has been placed inside the mould, the container is moulded with the hot plastic being forced against the heat seal coating, activating the adhesive, forming a strong bond and making the label an integral part of the container (Figure 7.7). The label is flush with the container sides, producing a smoother surface and therefore label damage in filling or in transit is reduced.

Initially in-mould labels were developed as single labels for blow moulding. More recent developments using injection moulding and thermoforming have relied upon reel-fed systems for maximum production and cost-effectiveness.

The original concept involved the label producer coating the reverse of the label with a heat seal coating. Certain substrate manufacturers can now supply substrates with the coating already applied, thus eliminating one of the most difficult barriers for label manufacturers to entering the in-mould market.

It is important, however, to check that any coating applied either in-house or externally has sufficient anti-blocking properties to withstand pressure, since this can be a major cause of waste with the container manufacturer if labels stick together when being inserted into the container mould. This is one reason why reel-fed developments are seen as the major growth area. Similarly any

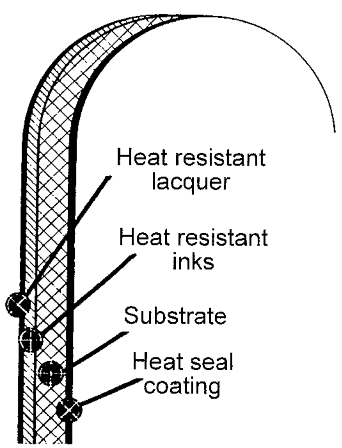


**Figure 7.6** A typical in-mould label structure.

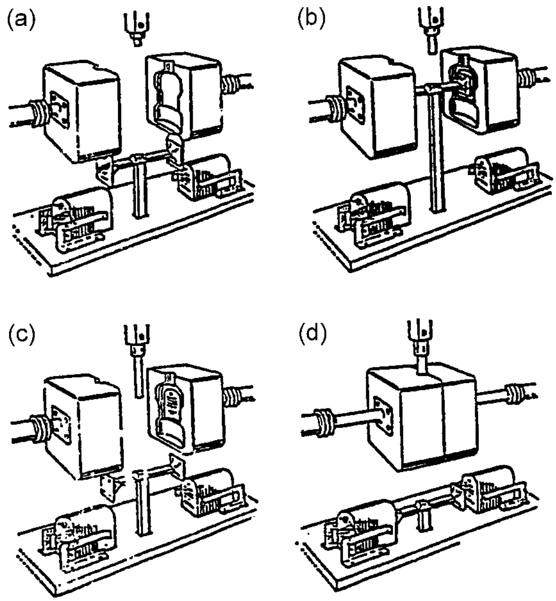


**Figure 7.7** A simplistic diagram of the insertion process: (a) mould open ready to receive the labels; (b) labels placed inside each half of mould; (c) a hot plastic parison is placed in mould; (d) robotic arms collect two more labels as the bottle is blown.

heat-resistant lacquer applied to the surface must have the same anti-blocking properties as well as giving scuff resistance.

With an in-mould label being made up of several layers (see Figure 7.6) it is essential that, when subjected to heat within the moulding process, they react in the same way. Any distortion will cause feeding problems prior to application or will cause wrinkling after application. Both these problems are unacceptable.

The conversion to single labels for blow moulding is exactly the same as ordinary labels apart from any static problems when working with plastic. If single labels are required for injection moulding and thermoforming, the shapes are generally more complex (Figure 7.8). The cutting out can be done in a variety of ways and generally machinery is adapted, making use of that already in place within the suppliers' factory.

### *7.4.1.2 Problem solving*

There are several problem areas relating to the printing of labels within the in-mould label process.

*Avoidance of curl.* It is important that the inks and lacquers are compatible in that when initially printed, and also when subject to heat within the moulding

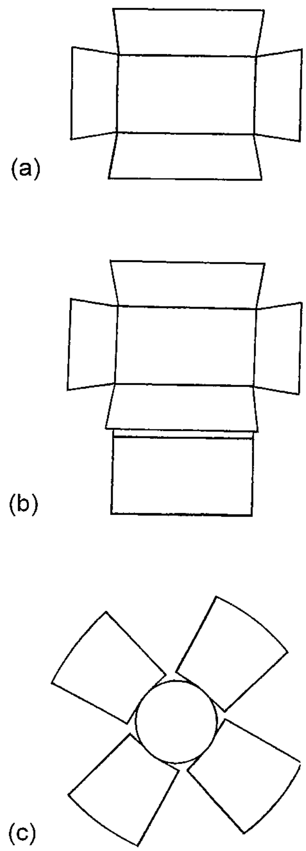


**Figure 7.8** (a) Cutting profile for butter/margarine tub in-mould label—base only; (b) cutting profile for butter/margarine tub in-mould label—base and lid combined; (c) cutting profile for yoghurt pot in-mould label with circular base.

process, they react in a similar manner to that of the substrate. The weight of ink and lacquer applied is vital but can only be confirmed by practical testing with an in-mould label manufacturer. In general, coating weights should be kept to a minimum.

If applying the heat-activated adhesive for the reverse coating, a weight of 5 to 9 gsm may be specified but in practice this is often too high and again practical tests should be undertaken with the actual manufacturer of the in-mould labelled container.

*Avoidance of blocking.* Blocking is the term used when labels stick together or 'block' in the in-feed to the application machine. It is important that labels feed individually and that they do not stick in the hopper or feed double labels into the mould. Labels can cling together if the surface lacquer and/or the reverse coatings are too smooth. They can then cling together and will not easily separate when feeding. When using plastic substrates, static can be a major cause of blocking. It is essential that at all stages of manufacture static is eliminated as much as possible. Manufacturers of static elimination equipment can advise on the most suitable methods.

*Printing plastic substrates.* Heavy film weights should not be applied, as this can make the drying of inks difficult and cause difficulties during the later stages of the container manufacture.

### *7.4.2 Heat transfer printing*

This method is used for the printing of plastic containers via a printed reel rather than directly onto the container. The print methods used are very similar to those used for in-mould labelling.

The decoration process takes place on the production filling line; taking the plain container at the beginning of the line, decoration is transferred from the printed reel, filling is done in-line and the final packaged product comes off the end of the line in bulk cartons ready for dispatch. This integrated production can be taken a stage further with the bottles being placed on the line straight from the moulding process. This method does require a high volume operation, free of mechanical problems. A breakdown occurring at any part of the operation will reduce the production efficiencies dramatically.

The basic principle of heat transfer printing for container decoration is that the transfer label is *reverse* printed by gravure onto a silicone release paper—the first layer printed down appears as the first layer on the container. Thus a lacquer is applied first to give release from the silicone paper and provide rub resistance whilst on the container. The appropriate printed design is then applied—usually in four to six colours—and this is followed by a high intensity backing white—often a double print to lift the printed image from the colour of the container. Finally an adhesive coating is added to stick the printed image to the container (Figure 7.9).

| | |
|---|---|
| SSSSSSSSSSSSSSSSSSSSSSSS | Silicone release paper |
| LLLLLLLLLLLLLLLLLLLLLLLLLLLLL | Release lacquer |
| IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII | Heat resistant inks |
| WWWWWWWWWWWWWWWWWW | Backing white ink |
| AAAAAAAAAAAAAAAAAAAAAAAA | Heat reactive adhesive |

**Figure 7.9** A typical heat transfer label structure.

The production line requires a special label applicator to be placed in-line on the production line. This is generally supplied by the producer of the labels and is specifically engineered to apply their structure of heat transfer label. This can create problems if changing suppliers for label production, with materials not always being interchangeable.

This type of operation was developed in the US where volumes of production made the process economically viable for markets requiring large volumes of decorated standard sized plastic containers, such as the motor oil industry. With the volumes of production being much lower in other parts of the world and with a demand for smaller runs of printed promotional containers in a wider variety of markets, heat transfer printing from the reel has tended to be replaced by direct printing onto containers.

# 8 Application of labels and sleeves

D. Kaye

## 8.1 The aims of package decoration and the impact on application method

### *8.1.1 To help sell the product*

There are three main types of primary package decoration currently in use for consumer products: *labelling*, *sleeving* and *direct printing*, with each of these having its own variants. Irrespective of the type of primary package, and the method chosen to decorate it, however, a prerequisite for optimising the shelf appeal of the product is that the packaging should be in pristine condition at point of sale.

Great care needs to be taken when choosing a decorating medium to make sure that it is compatible with the package to be decorated (i.e. material type, geometry, rigidity). For example, in the case of a 'conventionally-labelled' product, it is essential to ensure that the label is perfectly applied, with total adhesion to the container, a high degree of accuracy of application, and the absence of any adverse visual effect caused by tearing, wrinkling, or staining/discoloration as a result of the adhesives used.

### *8.1.2 To inform the consumer*

Long gone are the days when the decoration of a primary package rarely extended beyond the application of a simple rectangular paper label conveying the name of the product, the manufacturer, and a quantification of the package by weight, volume or number. Today's marketplace demands that decoration conveys far more information to the consumer, some of this information being associated with sales/marketing considerations, while other data are presented in the direct interest of the consumer. For example, information relating to a description of the product and its price may have a bearing on the decision to purchase, whereas an analysis of the product's ingredients may be important for health or dietary considerations. The extent of information to be conveyed to the consumer directly affects the choice of decoration, and hence the method of application.

The design of the decoration must be of adequate physical size to convey all the required information in the optimum position on the container and of optimum size—which will often be determined by legislation. The physical size and the overall geometry of the container will have a significant effect upon the decorating medium and its application. For example, a glass bottle containing high-quality mineral water might carry three separate paper labels, the front body label being the main sales/marketing vehicle, a neck or shoulder label complementing the body label, but often containing details of product price or special promotions, for example, and a back body label to give a detailed analysis of the water's elemental composition. In the case of plastic bottles used for mineral water, the most commonly adopted decoration is a large wrap-around label on the body area of the bottle, which allows ample surface area for all these requirements.

### *8.1.3 To comply with legislation*

For some decades now, the seemingly inexorable flow of national and international legislation has directly affected the nature of container decoration. In most countries, there is a legal requirement to indicate the shelf-life (e.g. 'Best By', 'Sell By' and 'Use By' dates) for foodstuffs, as well as the need for a detailed analysis of ingredients, and detailed instructions for the safe and correct use/consumption of the product.

From the perspective of legislation, it is absolutely essential that the graphics of the packaging should in no way be damaged or deformed by the application process. The decoration must be of adequate size to convey the necessary messages, and preferably located in a cylindrical or truly conical area of the package to avoid distortion by, for example, wrinkling of a paper label, or distortion of graphics printed to a plastic sleeve during the shrinking operation.

### *8.1.4 To protect the integrity of the package*

Container decoration may play an important part in protecting the integrity of the package up to the point of sale. For example, the importance of 'tamper evidence' for many consumer products has been a pre-requisite for many years. For food and drinks products, neck seals (in 'U' or 'L'-shaped configurations), or shrinkable PVC neckbands have been used for this purpose (Figure 8.1). These devices are part of the container decoration and also provide satisfactory tamper-evidence. Similarly, the application of sleeves (made from PVC, PET or polystyrene) can help protect the surface of glass bottles from scratches and scuffing. They also offer a certain degree of protection against fracture, especially in view of the current strong trend towards the use of lightweight glass for reasons of economy.

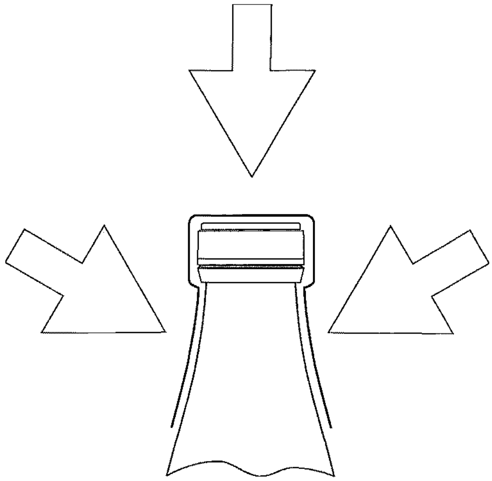

**Figure 8.1** 'U' or 'L' shaped neck strip labels can be used as a means of tamper evidence, as tax/duty-paid indicators for the spirits industry, or simply to complement the overall container decoration.

## 8.2 Principal materials used for primary packaging

### *8.2.1 Glass*

Glass has been used as a packaging material for many centuries. Over the past few decades, its pre-eminence as a material for primary packaging has come under threat from plastics and metal, yet the international glass industry remains very optimistic about its prospects. Increasingly effective lightweighting techniques, coupled with advanced glass coating technology (which increases strength and scuff resistance) have combined to ensure that glass containers maintain their cost competitiveness in an increasingly fiercely-contested marketplace. In Western Europe, for example, throughout the 1990s, glass has maintained its position and has, in fact, enjoyed a modest growth of some 2% per annum.

In the perception of the consumer, glass equates to 'quality', and hence many producers continue to opt for packaging in glass containers in a diversity of types.

Glass is used for the manufacture of bottles, jars and vials, which are used for a very broad spectrum of products, including all types of beverages, food products, cosmetics, healthcare and pharmaceuticals. From the point of view of package decoration, glass is an extremely versatile material since it can be labelled, sleeved or printed. However, careful consideration needs to be given to whether the glass is uncoated or coated (and, in the case of the latter, the type of coating used) and whether it is to be used for one-way or non-returnable containers. Returnable glass containers are currently, in volume terms, in steady decline, although it must be appreciated that in many countries, returnable bottles for products such as beer, soft drinks and mineral waters are still very much the norm.

The type of coating applied to glass containers is very important if *labelling* is to be the chosen method of decoration. The type of surface coating/treatment determines the choice of adhesive to be used (to ensure permanent adhesion of the labels under all conditions likely to be encountered) and this, in turn, determines the type of machinery best suited for application.

If a bottle is returnable, then the subsequent washing/sterilising and refilling requirements need careful consideration. While various direct printing technologies are designed to withstand the rigours of multi-trip bottles (including washing/sterilisation in caustic solution) as yet, totally effective water-soluble hot-melt adhesives are not commercially available, and hence should be avoided in the labelling process. Again, this affects the type of labelling machinery utilised.

Although increasingly common in the beverage industry, shrink-sleeves and stretch-sleeves are not suitable for returnable containers because of their incompatibility with the washing/sterilising process. The removal of plastic sleeves from returned containers is unlikely to be economically viable in the foreseeable future.

In recent years the amount of pre-decoration (i.e. decoration carried out by the glass maker immediately after manufacture of the containers, rather than on the filling line itself) has increased quite dramatically, particularly when plastic is the decorating medium, and used for shrink or stretch sleeves, or for 'no-label look' film labels.

### 8.2.2 *Metal*

Metal has been used for the manufacture of primary packages for nearly 200 years. Tin cans were first used in France around 1810 for food packaging, and since the 1930s, steel cans have been used for beverage packaging. As an alternative to steel, aluminium beverage cans were introduced in the 1960s.

In the consumer sector, the use of metal packaging is primarily limited to food and beverage cans and aerosol containers, all of which have very significant constraints with regard to geometry, and hence with regard to the type of decoration. Such packages are essentially basic cylinders, which are subjected to overall surface decoration. For many products (most notably, of course, beverages), this decoration is in the form of litho-printing during the can manufacturing process, although in the food and petfood industries, labelled cans are the norm.

Where container decoration must essentially be limited to the cylindrical portion of a can only (e.g. with three-piece cans), paper labels predominate, while for two-piece beverage cans and aerosols, plastic labelling from the reel is a viable alternative, allowing a nominal amount of shrinking at the upper and lower extremities of the label over the contoured areas of the cans.

For beverages and aerosols, labelling provides an economically viable alternative to litho-printing in cases where many different products or brands are produced. In such cases, the minimum order levels for printed cans, coupled with the high inventory costs of stocking many different pre-printed designs, means that can labelling can be an attractive option. Only plain cans (known as 'white cans') need be stocked, and the cost of stocking reels of different plastic labels is dramatically lower than stocking high volumes of pre-printed and palletised cans.

### *8.2.3 Plastics*

Plastics have, of course, played a very significant role for decades in virtually all elements of the consumer markets. The main types of plastics used for manufacturing primary packaging are:

(i) Polyvinyl chloride (PVC),
(ii) Polyethylene terephthalate (PET),
(iii) Polyethylene naphthalate (PEN),
(iv) Polyethylene (PE),
(v) Polypropylene (PP).

One of the reasons for the widespread use of plastics for container manufacture is the flexibility afforded with regard to size and shape, since plastics do not have the same constraints as glass and metal.

Great care needs to be taken if a plastic container is to be directly printed (e.g. silkscreen printing) or labelled. From this perspective, whilst PVC and PET/PEN offer few problems, the printing or labelling of polyethylene and polypropylene needs to be very carefully considered. Because of the polymers used for such containers, the surface of the containers after blow-moulding has a 'waxy' texture, which inhibits effective permanent 'keying' of both inks and adhesives. This is known as a *non-polar* surface. The polymer structure can be changed (i.e. *polarised*), resulting in the elimination of the smooth waxy texture, by exposing the area to be printed/labelled to a naked flame (under controlled conditions). This procedure significantly changes the surface tension characteristics of the plastic. Although most PE and PP containers are surface-treated in this way immediately after manufacture, the effect of the treatment can wear off with time and, accordingly, in cases where containers may be stored for long periods before filling and packaging, it is advisable to carry out the flame treatment process a second time, immediately prior to printing or labelling. Of course, there are many applications that will not permit the presence of a naked gas flame on the packaging line, notably the filling of flammable chemical products and distilled spirits.

Two other methods are available for the surface treatment of PE and PP, one of which exposes the surface of the containers to a high voltage electrical current (known as 'corona discharge treatment') and the other to halogen gas. However, these two processes are not particularly suited for incorporation into automated high speed packaging lines.

## 8.3 The main types of container decoration used in consumer markets

### *8.3.1 Labelling*

By far the most predominant method of container decoration in consumer markets is labelling in its traditional and historic sense, namely the physical application of a piece (or multiple of pieces) of *paper, plastic or metallic foil* to the surface of the containers.

Although not as universal as once was the case (thanks to the advent of other techniques, including stretch/shrink sleeving and more sophisticated methods of direct container printing), labelling, in its many variants, still dominates because of its numerous advantages, which include flexibility, versatility, efficiency of application at the very highest production requirements, and the overall cost.

Fully automatic labelling machines offer speed ranges from as low as 20/30 cpm up to 1200 cpm—and even beyond, although requirements for such extremely high outputs are few indeed because of other constraints within an automated production line. The flexibility of conventional labelling allows single or multiple labels to be applied to a very wide range of container types and materials, and only rarely does container geometry prevent some form of label application. Application machinery is available that allows various combinations of label materials (i.e. paper, plastic and metal foil) to be handled simultaneously by a single machine (see Figure 8.2). This has marketing advantages, as a result of the possible combinations of texture (and hence appearance), but also plastic and metallic foil labels offer greater flexibility since they can, (with limitations), be applied to areas of compound curvature, unlike paper labels which should be applied *only* to cylindrical or truly conical areas. In many respects, conventional labelling can be considered as a high speed assembly operation during which three (or more, in the case of multiple labelling) components or elements are combined. These three elements are the container, the label/s and a film of adhesive, which bonds the labels to the container.

The choice of the correct adhesive for any particular application is vital to the efficiency of the labelling process. Pre-cut labels are stored on the application machine in a dispenser or magazine. While historically, various systems have been used for removal of the individual labels, including mechanical and vacuum

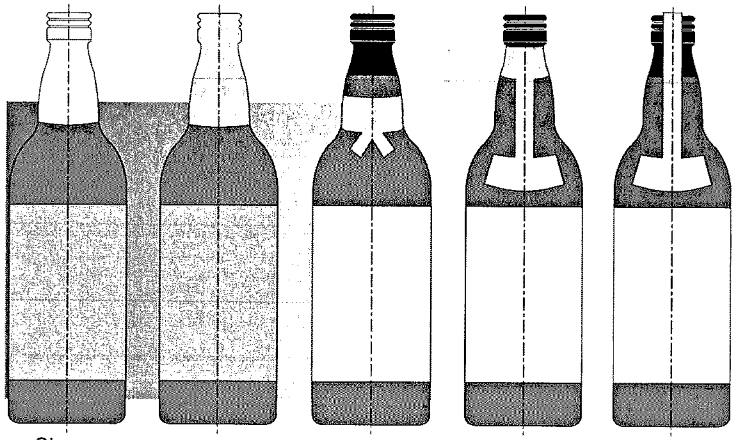


**Figure 8.2** Various types of bottle neck decoration manufactured from plastic, paper and metal (aluminium foil) all of which can be applied individually or in combination on a single rotary labelling machine.

'picking', virtually all modern automatic label application machines use glue as the label removal and transfer device as well as the means of sticking the label to the container.

The adhesive chosen must have the correct physical properties for 'mechanical operation' as part of the labelling process, as well as having the necessary adhesive properties for each individual application. In this respect, a number of key questions have to be addressed, and these are detailed in Section 8.4.

As there are literally hundreds of different grades of adhesives used for labelling, it is beyond the scope of this chapter to review the implications of these in detail. However, for the purpose of automatic label application, it should be appreciated that two main groups of adhesive types are used, and these are commonly referred to as *wet* and *dry*. Wet glues (which can be applied either cold or hot) are mainly fed to the label application point from a container forming an integral part of the label application machine design, or fed by a mechanical pump from a large floor-mounted container. 'Dry glues' are those which are pre-applied to the back of the labels for the process that is commonly known as self-adhesive (or pressure-sensitive) labelling.

#### *8.3.1.1 Wet glue labelling*

Wet glue labelling remains the dominant container decoration method used in some industries, notably for beverages (beer, soft drinks, mineral waters, wines/spirits) and also in the labelling of many types of food products. Wet or liquid adhesives can be used on a diversity of labelling machine designs, which encompass the following:

- Pre-cut labelling.
- Reel-fed labelling.
- Direct-transfer label application.
- Indirect-transfer label application.
- Rotary machine configuration.
- In-line machine configuration.

Furthermore, it should be appreciated that label application can be carried out using either cold glue or hot-melt adhesive exclusively, or by a combination of these two types, dependent upon the application.

#### *8.3.1.2 Pre-cut labelling*

Pre-cut labels are used predominantly where specially-shaped or profiled labels (i.e. as opposed to square or rectangular labels) are required (since these can be produced by the die-cutting process), or in cases where multiple label application is required. An example of multiple labelling is the application of front and back body labels, plus shoulder or neck labels as commonly used in various branches of the beverage industry.

Automatic labelling machines can be used for the application of pre-cut labels using labelling stations (which are often referred to as 'the heart of the labelling machine') of two basic designs, known as indirect-transfer and direct-transfer (see Figures 8.3 and 8.4).

In this context, 'transfer' refers to the travel of a pre-cut label from the stacked condition in the magazine to the point of application to the container being labelled. Indirect-transfer machines incorporate some form of mechanical device interposed between the label magazine and the container. This device, by means of a sequence of operations, removes individual labels from the stack and then transfers them to the point of application, under controlled conditions.

Indirect-transfer machines have been extensively used in, for example, the food and drinks industries for many years, primarily because they offer flexibility, high outputs and high efficiency levels.

The term direct-transfer indicates that labels are transferred directly from the label magazine to the container, without the use of an intermediate transfer mechanism. As with indirect-transfer machines, a stationary magazine containing a stack of pre-cut labels is utilised, but in this case, there is no labelling station. The container to be labelled acts as its own label-removal mechanism, by having the adhesive applied directly to the container surface. The containers are then presented to the label magazine in a controlled manner, and the tack of the adhesive on the container removes the individual labels.

Compared with indirect-transfer machines, direct-transfer machines are very restricted in their versatility, and are used in the main for application of full

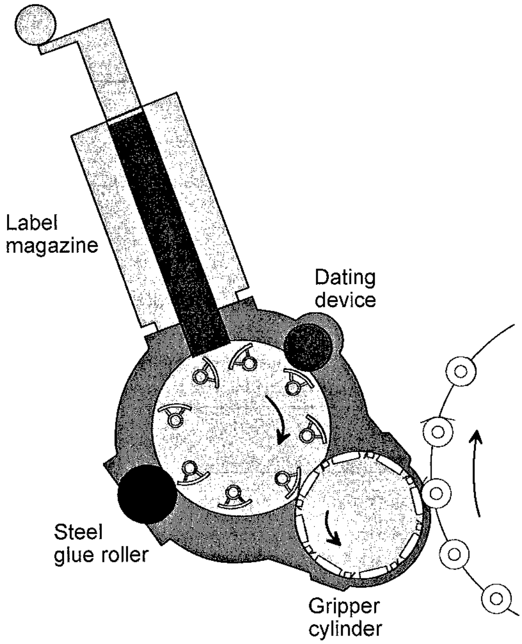


**Figure 8.3** Plan view of a typical high-speed indirect-transfer labelling machine in which there is a 'mechanical transfer system' interposed between the cut labels in the magazine and the containers to be labelled.

wrap-around body labels. They are *not* suitable for multi-label application, for profiled labels or, generally speaking, for application to non-vertical container surfaces.

Because of the designs of the gluing stations (i.e. as opposed to labelling stations), these machines are generally limited to the application of a relatively narrow vertical strip of adhesive to the container surface. This strip is designed to coincide with the overall height and position of the wrap-around label. Containers are rotated (i.e. about their own axes) at a controlled speed, so that the glue strip coincides with the leading edge of the label in the magazine. Owing to the tack of the adhesive, and the continuous rotation of the containers, the label is removed from the magazine, starting with the leading edge, and is progressively wrapped around the container surface. As the label is removed laterally from the magazine, the trailing edge is pulled across a small-diameter driven glue roller, which—during normal continuous operation—is constantly in contact with the label stack, thus applying a second vertical strip of adhesive that subsequently forms the overlap bond.

Unlike the indirect-transfer application, most of the rear surface area of the label remains unglued, and, for most applications, only 5% to 10% of the label

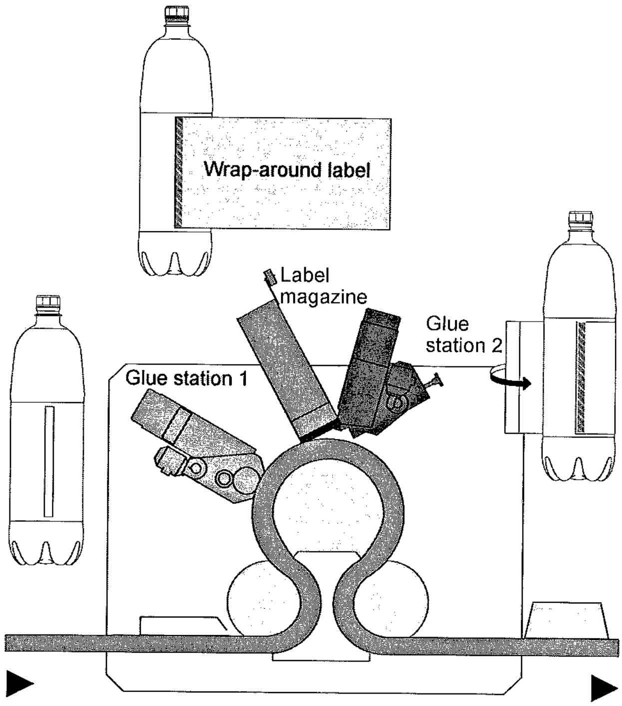


**Figure 8.4** Schematic plan view of a typical direct-transfer rotary labelling machine in which the container acts as its own 'label removal device' as a result of a strip of hot-melt glue applied to the container either by roller or jetting nozzles.

area is covered with adhesive. It should be noted that this labelling concept allows little flexibility with regard to glue patterns. Compared with 'patch' or 'spot' labels (i.e. as commonly applied by indirect-transfer machines), full wrap-around labels have a large surface area, and since the surface area of adhesive (in the form of the narrow vertical strip) is small in comparison, the tack of the adhesive is vitally important, since it must be adequate to overcome the resistance of the label magazine retaining fingers. In practice, this means that (other than for very low output requirements) all types of cold glue are inadequate, since the initial bond strength is insufficient to guarantee efficient label removal. Accordingly, with few exceptions, direct-transfer machines are designed for use with hot-melt adhesives. Hot-melt glues are non-aqueous (i.e. containing no water) and there are many different formulations. The most important property of hot-melts is their ability to achieve a very quick, permanent and strong bond, resulting from the rapid chilling of the adhesive after application.

Compared with indirect-transfer machines, direct-transfer labellers are generally simpler in construction (and hence involve lower capital expenditure).

This advantage must be balanced against the significantly lower versatility and flexibility. As with direct-transfer machines, both in-line and rotary machines are available, but the choice is most likely to be determined by operating speed requirements, rather than by the nature of the labelling application. In-line machines are limited to operating speeds of about 400 cpm (primarily due to bottle stability reasons), whereas rotary machines can operate at 1200 cpm and above, dependent upon application.

*8.3.1.3 Reel-fed labelling*

Over the past twenty years there has been an inexorable increase in the percentage of containers decorated by media supplied in reel format. The three main applications for reel-fed decorating are:

- Self-adhesive labelling (see 8.3.1.7).
- Shrink and stretch sleeving (see 8.3.2).
- Cut and glued labels.

*Advantages.* Cut and glued reel-fed labelling offers a significant number of key advantages, including:

(i) *Reduced production costs*
On a size-for-size and like-for-like basis, initial label production costs are reduced, since the guillotining (for square or rectangular labels) and the die-cutting operations (for profiled labels) are replaced by a simple reel-splitting operation. Label packaging costs (both in terms of labour and materials) are virtually eliminated since label reels are simply placed upon a transportation pallet whereas pre-cut labels (usually supplied in packs of 500 or 1000) can involve the use of paper or film wrapping, paper or elastic bands and polystyrene trays or cardboard cartons.

(ii) *Reduced operator involvement*
Reel-fed labels can be supplied in large-diameter reels (600 to 700 mm diameter) and can contain up to 60 000 labels, dependent upon label size. With a twin-reel system on the labelling machine (equipped with an automatic label web splicing system), reel-fed machines can operate for long periods (in some cases, dependent upon label size and gauge of the material used, up to a full shift), thus eliminating the need for constant operator attendance at the labelling machine.

(iii) *Operational advantages*
Generally, higher production efficiencies can be obtained with reel-fed machines, compared with pre-cut systems, owing to the elimination of some of the common stoppages caused by material problems associated with pre-cut labels. More consistent dimensional tolerances are achieved, and the absence of label magazines eliminates the need for constant running adjustments to accommodate variations in label size. Problems

such as double or multiple label 'picking' (removal from a magazine) resulting from adjacent labels in a stack sticking together because of guillotining or die-cutting 'burrs', inadequately cured inks and lacquers and static, for example, are eliminated. In addition, this prevents loose labels from causing stoppages in the label transfer system.

(iv) *Ability to handle various substrates*
Most reel-fed labelling machines are capable of handling a wide variety of materials, including conventional label paper stock, paper/plastic laminates and plastic films. There are significant difficulties and limitations in handling plastic labels in pre-cut form, and these have contributed greatly to the appeal of reel-fed systems whenever plastic labels are to be applied.

*Disadvantages of reel-fed labelling.* While significant advantages can be gained from a reel-fed application, there are also several disadvantages that should be carefully considered when choosing a new capital plant for container decoration.

(i) *Limited flexibility*
When compared with machines for applying pre-cut labels, reel-fed labellers are relatively inflexible. They are designed mainly for the handling of body labels only, and for application to vertical (i.e. cylindrical) surfaces. Furthermore, most reel-fed machines operate with a knife 'cut-off' system, which means that only square or rectangular labels can be produced. No doubt continued development will result in reel-fed machines being capable of applying labels to non-vertical surfaces (i.e. for neck and shoulder labelling) and for producing profiled labels (i.e. by die-cutting on the machine) but such sophisticated techniques have not yet proved viable and economic at modern packaging line speeds.

(ii) *Cost*
Reel-fed labellers are generally more sophisticated than pre-cut machines, and hence the initial capital cost tends to be higher for any given application. This extra sophistication also has cost implications with regard to the level of maintenance and adjustment, and the required training and skill levels of the operating and maintenance personnel.

(iii) *Output limitations*
The output of a reel-fed labelling machine is mainly determined by the maximum web speed attainable, and this, in turn, governs the maximum labelling speed in relationship to label size. Although reel-fed machines are available for most output requirements, operational speeds cannot yet match those of pre-cut label application machines.

(iv) *Label loading*
Most designs of reel-fed machines can accommodate large diameter label reels in order to minimise the frequency of changeover. Such reels

however (which can be up to 700 mm in diameter) can weigh 20 kg or more and, accordingly, some form of mechanical lifting device will normally be necessary for reel loading on to the machine.

The use of plastic labels, particularly in the beverage industry, increased significantly during the 1990s. The increased usage of plastic film labels has given a great boost to reel-fed labelling generally, since there are very considerable limitations to the handling of plastic labels in pre-cut form. When handling in a conventional label magazine, plastic labels are extremely difficult to control since they do not have the brick-like rigidity of similarly-stacked paper labels, and this results in inconsistencies of glue-film application and subsequent operational efficiencies. In addition, there is the significant problem of static between adjacent labels, which can be extremely difficult to overcome and greatly restricts operational speeds. Some of the key reasons why plastic labels have increased so much in popularity in recent years are:

(i) *Graphics*
Plastic labels appeal to the marketing personnel, because very high quality graphics can be achieved. Plastic film can be printed by flexographic or gravure methods, dependent upon individual requirements, although there is a cost implication. The added brilliance of the colours, and the high-gloss finish achievable with plastic film generally exceed the limits of conventional paper labels. When using plastic labels, it has become very common to leave part of the label area completely unprinted, so that the natural colours of the product are visible through the clear film, thus enhancing the graphics of the label and the overall effect of the product on the shelf.

(ii) *Elasticity*
This is an extremely important advantage, especially when applying full wrap-around labels to PET bottles containing carbonated drinks. Problems have been experienced (especially when beverages are filled at low temperatures) because the pressurised bottles then expand. It is quite common for diameters of large-capacity bottles (e.g. 2.0 l and 3.0 l) to increase by several millimetres. Accordingly, tremendous stresses are induced on the label, and this can result in splitting of paper labels, or failure of the adhesive bond at the overlap position. This particular problem can be overcome by the use of plastic labels (because of the inherent elasticity of the material), coupled with the use of a pressure-sensitive hot-melt adhesive grade, which will allow the plastic label to 'slide' at the overlap point.

(iii) *Strength*
Compared with paper, most types of plastic labels have greater tensile strength, and they are less prone to damage such as tearing or scuffing after initial application.

(iv) *Shrinkability*
Several of the materials used for manufacturing plastic films are heat-shrinkable, and these can be used for labels that extend beyond the cylindrical body portions of the containers to which they are applied. After initial application on the machine, the upper and lower edges of the labels can be carefully shrunk to conform to the curvature of glass bottles or two-piece beverage cans. This has the advantage of increasing the size of label that can be applied, which is often valuable for sales and marketing reasons.

(v) *Impervious to moisture*
Unlike paper labels, plastic labels are totally impervious to moisture, and this eliminates several problems when the product is to be stored under adverse conditions. After absorbing atmospheric moisture, paper labels can bubble or ripple, and are easily susceptible to damage or discoloration, unlike plastic labels.

(vi) *Overlap adhesion*
In the case of full wrap-around labels with overlap, plastic labels can either be bonded using conventional hot-melt glues (as used also for paper labels) or they can be 'welded' by use of a solvent. In many cases, this solvent welding technique will produce an overlap bond, stronger than a glued bond, and often the cost can be lower than when using hot-melt adhesive.

#### *8.3.1.4 The choice of basic machine configuration*

There are various label application machines available. The first choice to be made is often whether to use an in-line or rotary machine configuration, since this will have a significant impact upon key factors such as initial capital investment and the layout of the production line.

The terms 'in-line' and 'rotary' refer to the path of the container through the machine. With in-line machines, the container path is in a straight line, whereas with rotary machines, the containers are fed on to a rotary carousel by means of a starwheel transfer system (see Figures 8.5 and 8.6).

*In-line machines.* The containers are fed in single file to the machine where they are pitch-spaced by means of an infeed worm (feedscrew). They continue to travel in a straight line through the machine. They remain on a slat conveyor, which conveys them past the point of label application, and subsequently through a label-treatment station, the design of which can vary dependent upon the geometry of the containers. Machines handling cylindrical containers usually incorporate an 'after-roll' station, where the containers are subjected to a controlled rotational movement (usually by means of a fixed sponge pad on one side of the conveyor and driven rollers or sponge belts on the other); this results in the label being fully and positively applied to the container surface.

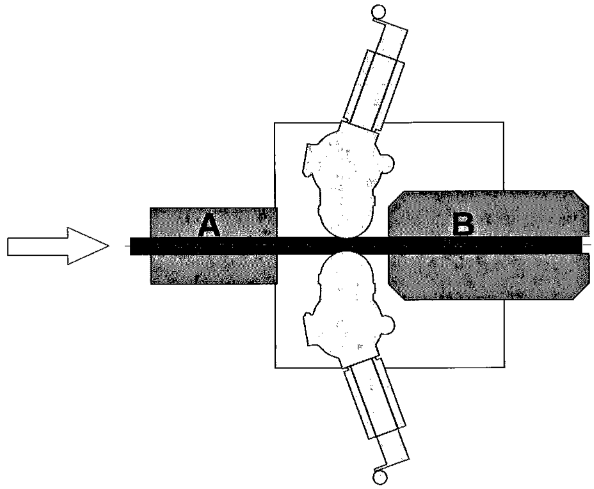


**Figure 8.5** Schematic plan view of a typical in-line labelling machine equipped with two separate labelling stations (one mounted on each side of the central conveyor) capable of simultaneously applying front and back labels. Dependent upon container shape, material and output, in-line machines of this type can be equipped with a variety of infeed systems' ('A') and label 'treatment' devices ('B').

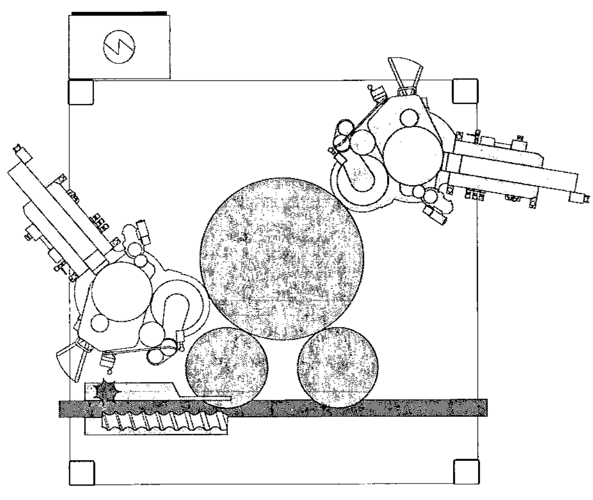

**Figure 8.6** Schematic plan view of a typical indirect-transfer labeller of the rotary type equipped with two separate labelling stations. Such machines can apply a diverse combination of label decorations to all shapes and sizes of containers at outputs up to 1200 cpm, and above.

This rolling action is unsuitable for containers that are not round, and for such applications (quite common in the detergents, toiletries and healthcare industries) the label treatment is achieved either by twin, synchronously-driven sponge belts (suitable for label application surfaces that are flat or very limited in curvature) or, alternatively, cam-operated contoured pressing pads, which are moulded to the same shape as the label application areas of the containers.

There are several disadvantages with this method of container handling, which greatly restrict the use of such machines. Firstly, when handling cylindrical containers, the containers must be free to rotate during their passage through the machine, and thus they cannot be clamped overhead in any way. Operating speeds are therefore restricted because of the need to maintain container stability. Container stability is directly affected by the diameter/height ratio and the linear speed of the container (which relates to line output), and so these factors must be carefully assessed before using an in-line type machine. Because of their relative instability, it is important that the forces applied to the containers during label transfer and final label application are close to the centre of gravity of the container, otherwise adequate control will be impossible. In most cases, this precludes the application of labels to the neck or shoulder areas of the containers.

In principle it is possible to apply front and back body labels simultaneously (by positioning label stations on opposing sides of the central conveyor), but, when handling cylindrical containers, the lack of total control of the containers at the application point means that precise register of the two labels cannot be guaranteed. For this reason, in-line machines are normally only recommended for the application of single body labels onto cylindrical containers.

When handling non-round containers on in-line machines, it is common to have some form of overhead device to clamp the bottles into position against the slat chain on which they are moving. This allows, for example, simultaneous front and back body label application to flask-shaped bottles, as commonly used in the distilling, detergents and toiletries industries.

*Rotary type machines.* These offer many advantages over in-line machines, primarily as a result of the control of the containers throughout the labelling cycle. As with in-line machines, containers are conveyed to the machine in single file, and separated by an infeed worm, but they are then subsequently transferred from the conveyor to a central rotary carousel, via an infeed transfer starwheel. Once on the carousel, the containers are accurately located between a base platform and an overhead centring device, which is mechanically lowered to the containers. As they travel around the carousel, the containers are rotated axially as necessary dependent upon the number, size and position of the labels to be applied. (Historically, this axial rotation has been generated by a fixed annular cam, which forms the lower half of the main container carousel assembly, but on more modern machinery this movement is generated by servo-motors, giving a greater range of cross-sectional shapes of containers which can be handled on a single machine.)

With a rotary type machine, the containers are totally under control at all points throughout the cycle. This system allows precise and efficient labelling to be carried out at the highest production line speeds. Equally important, however, are the flexibility and versatility offered by rotary type machines. Multiple label application can be achieved by using up to four separate labelling stations positioned around the periphery of the container carousel. Most rotary machines can handle combinations of front body, back body, shoulder, medallion, neck-around, deep-cone and aluminium neck foil labels.

Rotary machines have one important limitation. Rarely is it practicable to apply full wrap-around body labels on rotary type machines with indirect-transfer labelling stations. The reason for this is that the size of the developed label (i.e. in its flat form in the magazine) will, in the majority of cases, exceed the maximum label width capability of the machine, owing to the gluing/transfer mechanism design. It is sometimes possible, with small diameter containers, to handle a full wrap-around label, but this will normally greatly reduce the machine's overall flexibility; it is normally more practical and cost-effective to purchase a machine specifically designed for the application of wrap-around body labels.

#### *8.3.1.5 Basic labelling station designs*

*For pre-cut labels.* The labelling station is a very important sub-assembly that is mounted on the machine base plate, incorporating two key operations: the label transfer system and the glue handling system. While individual designs vary, the labelling stations on most modern machines use very similar concepts, which briefly comprise a stationary label magazine holding pre-cut labels in stack form, a vertical glue roller and scraper assembly, a glue segment carousel and a mechanical label transfer device. The design and configuration of the labelling station is vitally important, since the number and pitch spacing of the individual glue segments on the carousel directly determine the maximum and minimum label widths. When selecting a new labelling machine for pre-cut label application, all current and potential future applications should be carefully assessed, to ensure that the labelling station design does not prove to be a restricting factor (see Figure 8.7).

*For reel-fed labelling.* Many parts of automatic high-speed labelling machines are very similar for both pre-cut and reel-fed labelling (e.g. the basic machine, main drive system, machine head assembly and container handling system), but the hearts of the machines—the label application stations—are very different indeed.

As with other related high-speed web handling decorating systems (e.g. self-adhesive labelling and sleeving), the introduction of servo-motor technology

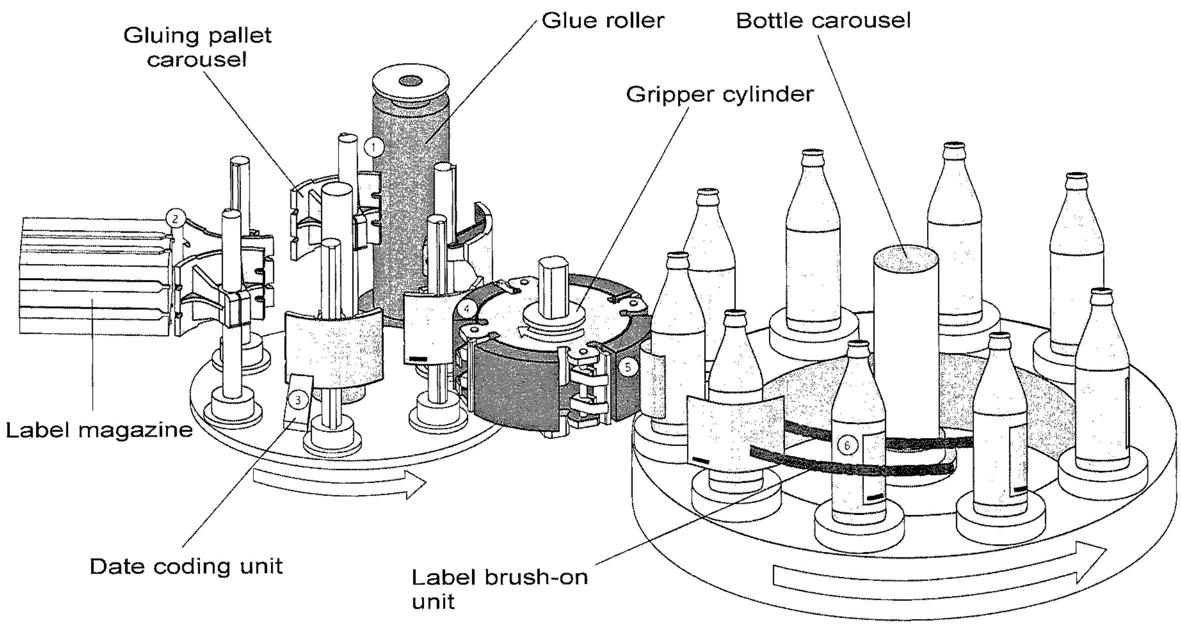


**Figure 8.7** Schematic arrangement of a typical rotary indirect-transfer labelling machine, showing the relationship of the labelling station and the main container carousel. (1) Pallet picks up glue from glue roller; (2) pallet picks up label; (3) label is coded; (4) gripper cylinder picks up from pallet; (5) gripper sponge presses label on to container; (6) label is brushed on smoothly.

has had a great impact upon the design of the application stations, and the levels of control and accuracy achieved. Servo-motor drives for the label web feed are now commonly in use and with them label cut-off length accuracies of ±0.2 mm can be achieved. This level of accuracy matches that of pre-cut labels produced either by guillotine or die-cutting.

Figure 8.8 shows the schematic plan view layout of a high-speed rotary reel-fed labelling machine equipped with two separate, but identical, labelling stations which, by labelling alternate containers in the continuous flow, combine to produce outputs of 800 cpm, and beyond, depending on the length of labels applied. Speeds of 400–500 cpm are possible with single station versions of the same basic machine.

Figure 8.9 shows the schematic arrangement of a modern high-speed reel-fed labelling station equipped with two label supply reels and a fully-automatic web splicing device to ensure continuity of production at all times.

Each label supply reel is unwound in turn as a result of the ‘nip’ rollers, one of these being a knurled metal drive roller and the other being a rubber-coated idler. The knurled roller is driven by the servo motor which varies its speed according to continuous signals received from an optical sensor which ‘reads’ either register marks printed on the label web, or detects the gaps in the graphics of adjacent labels printed on the web. The servo motor makes

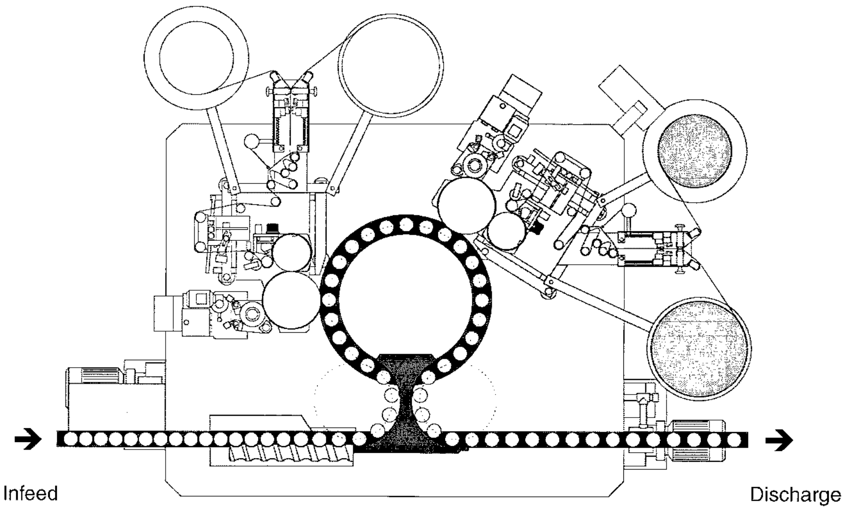


**Figure 8.8** A schematic plan view drawing of a high-speed rotary labelling machine equipped with two separate reel-fed labelling stations, each of which applies full wrap-around paper or plastic body labels to alternate containers in the continuous flow. Note that each labelling station is equipped with two separate label reels feeding a fully-automatic web splicing device that allows non-stop production.

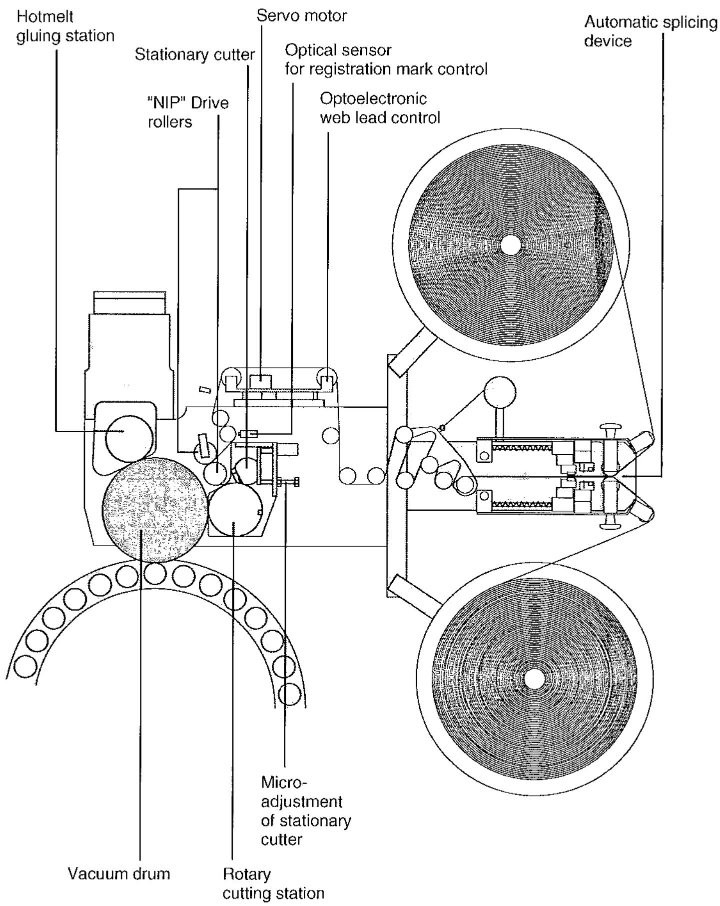


**Figure 8.9** Schematic plan view of a high-speed reel-fed labelling station, which can be used for paper, plastic, or paper/plastic laminated labels. Depending on application, the overlap of the body labels can be achieved by hot-melt adhesive or by the so-called 'solvent-welding' technique.

micro-adjustments to the label web speed to ensure that all labels are precisely cut to the same dimensional tolerances by the rotary cutting mechanism, whose speed is mechanically fixed relative to the machine main drive. A most important element in a high-speed reel-fed labelling station is the control of the web tension (since web breakages must be kept to an absolute minimum), and this is achieved as a result of the label reels being mounted on a base support disc, the rotation of which is controlled by an eddy-current drive motor which provides the basic tensioning. Additionally, a simple mechanical roller tensioning-device located between the reel and the feed rollers compensates for any slight tensioning or slackening of the web.

The nip feed rollers transfer the web to a rotary cutting drum, which can be equipped with either one or two rotary cutting blades dependent upon the machine speed and label lengths to be handled. This cutting drum incorporates vacuum ports for maintaining label tension and control, and rotates against a fixed (micro-adjustable) stationary cutter blade. This cutter blade and the rotary blade/s on the drum accurately shear the label to the required length.

The individual cut labels are then transferred to a large diameter transfer drum which, by a combination of mechanical gripper fingers on the leading edge and vacuum ports on both the leading and trailing edges, transfers the labels across a hot-melt gluing roller. Because the leading and trailing edges of the label are resting on raised 'anvils' the reverse side of the labels receives only vertical strips of hot-melt glue (approximately 10–12 mm wide) for the purpose of initial pick-up on the container and for the adhesion of the overlap. As the individual labels are transferred to the containers on the main rotary carousel, the vacuum to the transfer drum is turned off, and final wrap-around application of the labels to the containers is achieved by bonding of the two hot-melt strips at the extremities of the labels. This basic labelling concept, and this type of labelling station, are equally suited for handling paper, paper/plastic laminates or pure plastic labels.

Particularly in the beverage industries, plastic labels have become extremely popular in recent years, the most commonly used material being OPP (orientated polypropylene) with a gauge thickness of approximately 40 microns.

#### *8.3.1.6 Self-adhesive labelling*

Self-adhesive labels were first produced in 1935, since which time their penetration of the packaging market has inexorably increased. However, growth in the use of self-adhesive labels has accelerated considerably over the past 30 years, and since the mid-1980s this growth can be considered exponential. Most surveys, reports and statistics agree that self-adhesive labels now account for between 60 and 70% of the entire container labelling market. There are many reasons for this very strong and continuing trend; primarily these are marketing, economic and environmental considerations, which include:

- High operational efficiencies
- No requirement for label handling change parts
- Very quick changeover times
- Very high levels of labelling accuracy
- The ability to handle very small labels
- Extremely versatile with regard to label material (i.e. paper, paper/plastic laminates and pure plastic substrates)
- Ease and simplicity of operation and maintenance
- Very clean operation when compared with wet-glue labelling (reduced down-time, etc)

Furthermore, an increasing number of labelling applications cannot be met by wet-glue systems, and this has further enhanced the growth of the self-adhesive sector. Here are just three examples:

Firstly, the use of a clear plastic substrate to create the so-called 'no label look' (i.e. simulating directly-printed containers) has proliferated, particularly during the 1990s, and one of the reasons for this has been the resistance of plastic labels to damage, discoloration, etc. by water, steam, oily and greasy products, etc. It is impossible to simulate the 'no label look' with paper labels, but it is quite remarkable what can be achieved with glass-clear polypropylene labels coated with a film of equally clear adhesive, to enable pressure-sensitive labelling to be carried out.

Secondly, for environmental reasons, there is an increasing trend towards the reduction or elimination of secondary packaging, and one sector of the consumer market which is particularly proactive in this area is that of healthcare and pharmaceutical products. Increasingly, so-called 'multi-fold' labels are being used, since these booklet or 'concertina' type labels can convey a great deal of information (even when applied to a physically small container), and in many cases such labels are replacing the individual cartons previously used for such products. It is not possible to apply these multi-fold labels in individual format in a dispenser or magazine, and accordingly, it is essential to supply them by means of a reel-fed self-adhesive system.

Thirdly, self-adhesive labelling allows very small labels to be applied, which cannot be done efficiently by conventional wet-glue labelling. Examples of this are small medallion labels (15 mm or less) used in the spirits industry, and small circular price stickers, often applied to the container closures.

*Self-adhesive label applicators.* The design of label applicators for self-adhesive label handling can vary almost as much as the products requiring labelling. Hand-held, semi-automatic and high-speed fully automatic units can be designed virtually around any type of product or container requiring labelling.

Over the past 15 years or so, there have been dramatic developments and improvements in the design of self-adhesive label applicators with the consequent increase in the web speeds that can be handled. It will be appreciated that when configuring a self-adhesive labelling machine, it is important not just to consider the container per minute rating of the production line (which, of course, determines the physical size and basic configuration of the labelling machine), but also the width of the labels to be handled, which, together, translate to the required web feed speed. Basic machine configuration and design/capability of the label applicator must be totally compatible (see Figures 8.10 and 8.11).

The evolution of drive technology for self-adhesive applicators (which has progressed through fixed mechanical drives, clutch/brake units and stepper motors through to today's high-tech servo-drives) has allowed web speeds to increase to 100 m/min and above. Indeed, in recent times, an ultra-high

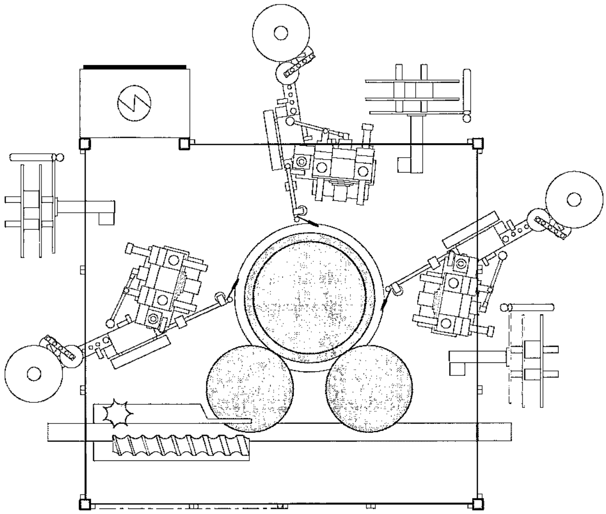

**Figure 8.10** A schematic plan view of a rotary self-adhesive labelling machine, equipped with three separate label applicators, each capable of applying a single label to the same container. A typical application for a machine of this type would be the application of the so-called 'no-label look' achieved by the use of polypropylene labels. Beverage bottles carrying front body, back body and neck or shoulder labels of this type have become extremely popular.

speed self-adhesive label applicator has been introduced, which is claimed to be capable of web speeds of 200 m/min and 2 000 labels/min. However, given the other restrictions on the output of a fully automatic packaging line, the requirements for such ultra-high application speeds are indeed few and far between.

There is still, however, a sizeable market for self-adhesive labelling machines with the label web driven mechanically (i.e. synchronously linked to the main machine drive) at a fixed constant speed. Such machines are ideal for low to medium output ranges, where only one combination of container and self-adhesive label is to be applied. Such machines are not recommended in cases where extreme accuracy of label placement is essential (usually the case where two or more labels are to be applied in accurate register with each other, or with non-round containers where positional accuracy is far more important than on a round container).

For optimum control of the label web feed/drive mechanism (and hence for optimum label placement accuracy) a geared servo-drive unit is deemed essential, especially in applications where several package sizes/types have to be labelled, and where the labelling machine itself is to have a modulating main drive assembly, which will adjust the operating speed to suit the prevailing container flow conditions on the production line. The use of a servo-drive enables the web speed to be synchronised very precisely with the operational speed of

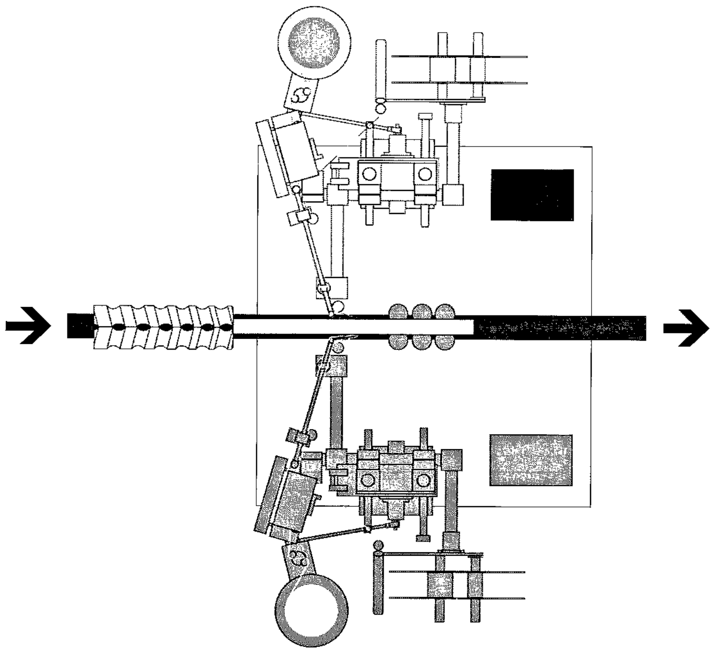

**Figure 8.11** A schematic plan view of an in-line self-adhesive labelling station, with identical applicators positioned on each side of the central conveyor, for applying front and back body labels to plastic personal care products containers.

the container, and to ensure the necessary label register irrespective of machine operating speed. Although the label applicator designs offered by the various manufacturers differ in detail, the basic design concepts are similar to the system shown in Figure 8.12. The web, or backing strip, carrying the self-adhesive labels is unwound from the reel as a result of the web being gripped and pulled by two 'pinch rollers' (typically one being hard rubber and the other knurled metal), which are servo-driven and thus capable of 'pulsing' at high speed to feed the labels at the required output. The operation of the servo-drive is triggered by a photocell, which is positioned in close proximity to the web, and which detects the gap between adjacent labels (typically 2 mm), thus triggering the next pulse of the servo-drive.

The pinch rollers feed the web to the application point or beak as it is commonly known, at which point the web travels around a very sharp radius, which results in a separation of the label from the web in a 'peeling' effect. For most applications, the container to be labelled is then brought into contact with the exposed adhesive rear surface of the label, and the transfer takes place. (It should be noted, however, that in some cases, particularly where extremely small labels have to be handled, or where labels have to be extremely accurately

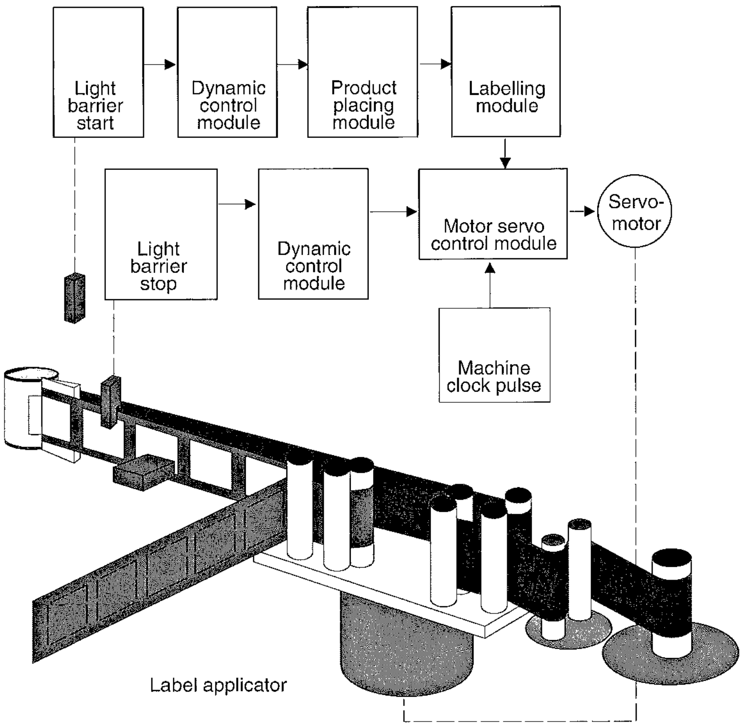


**Figure 8.12** Schematic arrangement of a typical high-speed self-adhesive label applicator utilising a servo-motor, coupled with a sophisticated control system to ensure very precise levels of label placement accuracy.

positioned in 'cartouches' within the bottle design, it is sometimes necessary to incorporate a mechanical label transfer device at this point. Usually, these transfer devices take the form of a cylinder which incorporates vacuum pads that can pick up the labels as they are released from the web and then transfer them through 90° or 180° onto the container, dependent upon the configuration of the machine.)

After travelling around the beak, the label web (now literally stripped of its labels) travels to a re-wind reel, which is driven by an eddy-current drive that ensures a constant tensioning of the web throughout the re-wind process. To enable this to operate effectively, for machines having a modulating speed, it is necessary to incorporate a compensating/tensioning arm (or series of rollers) linked to the eddy-current drive arrangement to ensure that the web is constantly and automatically tensioned uniformly, irrespective of machine operating speed.

Traditionally, the material used for the label carrier web is silicone-coated paper but, in recent times, the use of clear plastic film (either PET or PP) has become increasingly popular. There are three basic reasons for this. Primarily, increasing popularity of the 'no label look' demands the ultimate in adhesive film clarity, and this is enhanced when using a plastic web as the surface is significantly smoother than the surface of silicone-coated paper. However, as application speeds have increased (and with this the increasing risk of web breakages) the stronger plastic web gives greater overall production efficiency. Thirdly, unlike silicone-coated paper, the plastic web is recyclable.

It should be noted that when using clear plastic web material, problems can occur with the use of photocells to detect the gaps between consecutive labels on the web, and in some cases, it has proved necessary to use ultra-sonic detection devices as an alternative to photo-electric sensors.

### *8.3.2 Shrink and stretch sleeving*

Once occupying only a niche sector, the growth of sleeving has been particularly dramatic during the past decade. Sleeving was previously used mainly for cosmetics, toiletries and personal care products applications, but currently sleeving is increasingly wide-spread in all branches of the drinks industry, and is also used for many food packaging applications.

There are two basic types of plastic sleeves: stretch sleeves and shrink sleeves. Stretch sleeve labels are usually manufactured from low density polyethylene, polypropylene and PVC although, of course, the use of PVC is not encouraged in some markets (indeed it is banned as a packaging medium in certain countries) because of environmental considerations. Stretch labels are manufactured in a tube format and then 'flattened' and rolled onto a cardboard core, the diameter of which suits the design of the sleeve application machinery. Similarly, the outside diameters of the sleeve reels are determined by the capacity of the application machinery.

Dependent upon the type of application machine used, the sleeve manufacturer may need to incorporate perforations between adjacent sleeves, which 'break' in order to form the individual sleeves, immediately prior to application to the containers. This separating action is caused as a result of differential speeds within the sleeve transfer station.

These sleeve application stations incorporate specially-designed stretching mandrels, which open up the sleeves before they are transferred down onto the container. Once the mandrel is removed, the stretch sleeves relax and conform to the contours of the containers to which they have been applied. One slight disadvantage of the perforating method of separation is the fact that the upper and lower edges of the sleeves are not perfectly clean and if this is considered undesirable from a marketing perspective, then application machinery is available which incorporates cut-off knives as an alternative to the perforations.

A typical film thickness for stretch sleeves is 55–70 microns and application speeds up to 800 containers/min are possible, dependent upon machine type.

Stretch sleeves are particularly well-suited for application to a diverse range of plastic container types since, unlike shrink sleeves, no heat is used at all in the application process. Accordingly, the technique is particularly well-suited to chilled products such as fruit juices where the container is likely to change shape during filling, or subsequent storage.

In the main, stretch sleeves are used on round containers, where the graphics do not require any form of orientation with regard to the geometry of the containers. However, it is possible to orientate the print with certain machine types, as is necessary for square or other non-round plastic containers. The method of manufacture, reel feed, and application for shrink sleeves are very similar in many respects to those for stretch sleeves. The main difference is, of course, the fact that heat is necessary in order to create the required degree of shrink to ensure that the sleeve conforms totally to the profile of the containers being labelled, without any evidence of wrinkling or distortion of the graphics. Thus, it is manifestly clear that for shrink sleeve applications, the initial physical application of the sleeves to the containers is only one half of the story, since equal, if, indeed, not more, attention needs to be given to the shrinking technology. Here, there needs to be full liaison and cooperation between the manufacturer of the shrink tunnel and the manufacturer of the sleeves since, of course, the plastic film needs to be shrunk by varying degrees in different areas of the container profile, and the original design of the graphics need to fully take into account the subsequent shrinking operation. Dependent upon the application, the heating medium for the shrink tunnels can be electrically heated elements or steam.

One of the biggest advantages of shrink sleeve labels is their ability to provide 360° graphics around very unusual pack shapes. In addition, shrink-sleeves can serve a dual role, firstly being the product's label, and secondly providing a tamper evident device. In such cases, the sleeves are designed to encompass all or most of the body area of the containers, and, in addition, to partially encapsulate the closure areas also.

The most common material for shrink sleeves is PVC but, in cases where the aforementioned environmental considerations have to be taken into account, OPP, PET and orientated polystyrene sleeves can also be used.

Shrink film specifications vary considerably in order to encompass a wide variety of applications, with high-shrink ratios being necessary for the overall body sleeving of narrow-necked bottles as predominantly used in the beverage industries. Low temperature shrink film is used for many types of plastic containers in order to ensure that deformation of the container itself does not take place when the containers pass through the shrinking tunnel. Bi-axially orientated films result in the shrinking action applying in both directions and, of course, the shrink ratios can be different in each direction. In short, shrink films can, these days, be tailor-made to suit individual applications.

In many respects, the application machines used for plastic shrink or stretch sleeves incorporate application stations which have similar web-control features to those outlined earlier in this chapter for reel-fed systems, whether they be for cut and glued individual labels or self-adhesive labels.

The key difference between labelling machinery and sleevers is, of course, the fact that the flattened tubes need to be opened up (usually by a combination of vacuum and mechanical formers/mandrels) to enable application to the containers to take place.

Again, as with many other types of decoration application machinery, both in-line and rotary type machines are available on the market, with respective maximum speeds (always dependent upon application) of 350 cpm and 800 cpm.

Some sleeving applications, of course, involve only the use of shrink bands/ sleeves around the closure areas of containers in order to provide a tamper evident device, although the graphics on such sleeves can be used for special promotional/marketing/pricing purposes (see Figure 8.13).

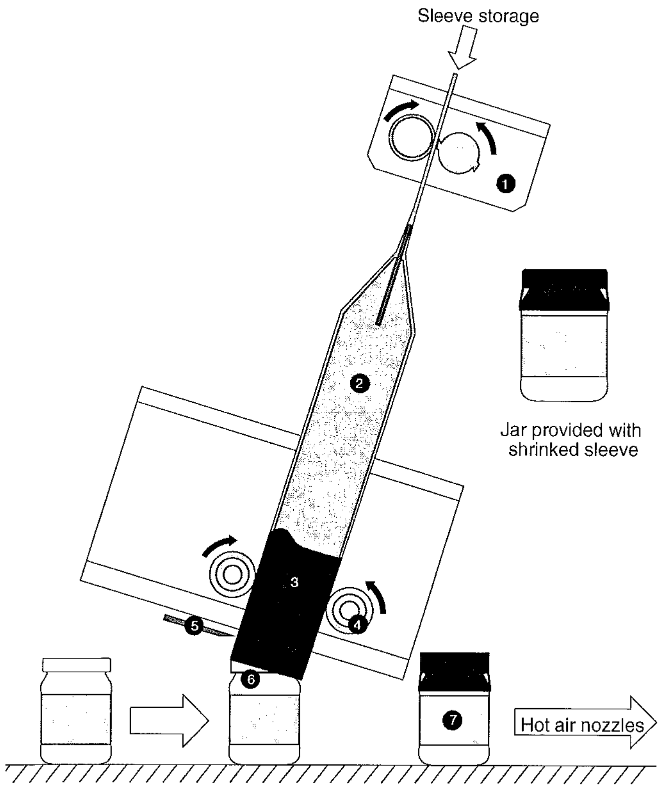


**Figure 8.13** A schematic diagram of a reel-fed machine for the application of shrinkable tamper-evident neck bands to baby food jars. (1) Horizontal perforation device (optional); (2) expanding mandrel; (3) sleeve; (4) sleeve feed roller including vertical perforation device (optional); (5) rotating knife; (6) sleeve transfer; (7) jar is conveyed to hot air nozzles.

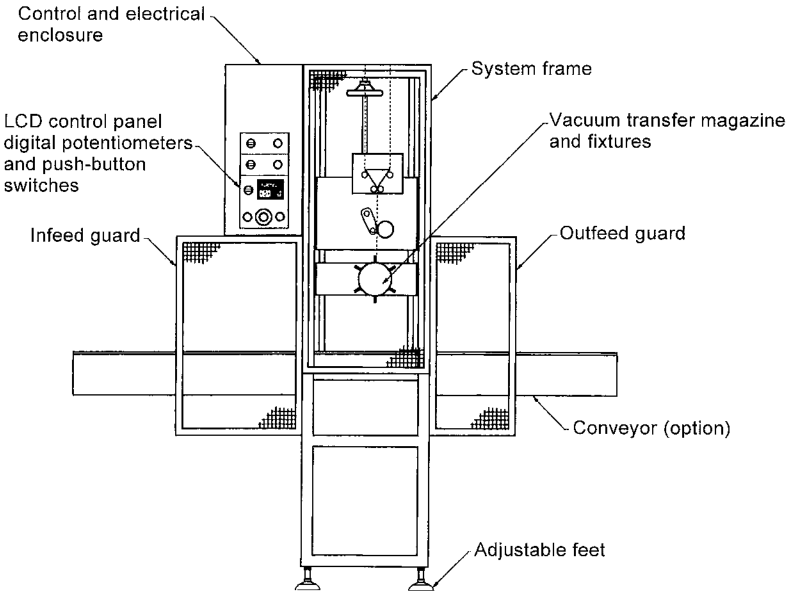


**Figure 8.14** The overall configuration and construction of a typical in-line sleeving machine.

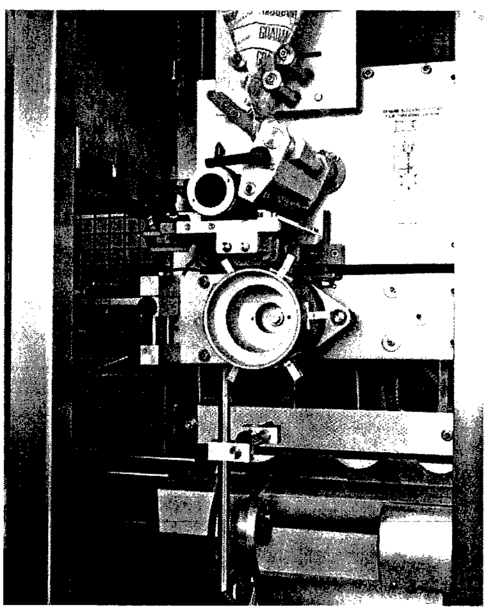

**Figure 8.15** The sleeve/band feed, cut and delivery system for an in-line sleeving machine.

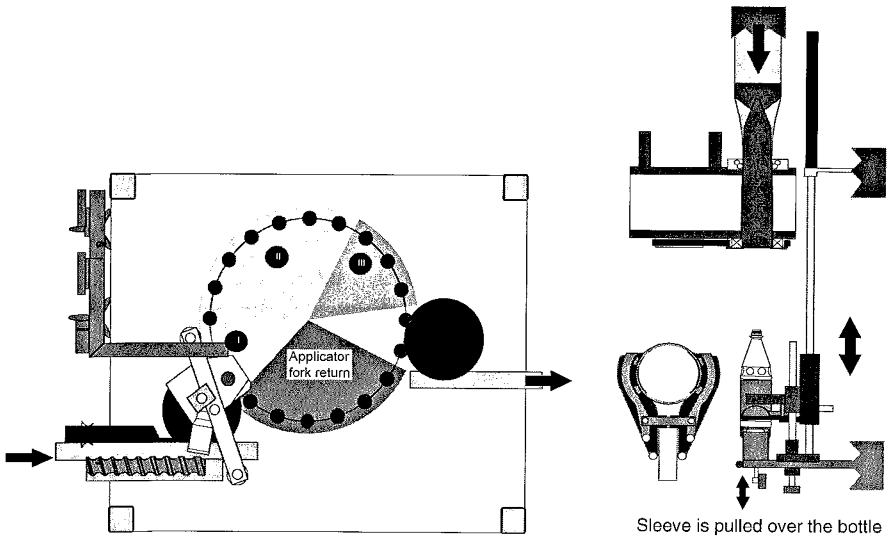


**Figure 8.16** Schematic plan and elevation views of a state-of-the-art rotary machine capable of applying either shrink sleeves or stretch-sleeves. The schematic shows a single sleeving station, but such rotary machines can incorporate two separate sleeving stations (each sleeving alternate containers in the continuous flow) to achieve outputs up to 800 cpm.

### *8.3.3 Direct printing*

With direct printing, the containers receive *directly* the required graphics (usually in the form of specially formulated inks) thus completely eliminating the use of a substrate affixed to the containers either by adhesion (i.e. gluing) or mechanically (i.e. by shrinking or stretching).

It is estimated that, at the end of the 1990s, approximately 7% of all containers used in the packaging industry were directly printed. There are several reasons for this relatively low figure, namely the limited graphical possibilities (compared with other decorating systems) and the economics of the process.

Direct printing, of containers, is referred to in earlier chapters of this book, however, as this chapter deals with the application of decoration formats, there is a system whereby the image is first reverse printed onto a 'carrier label', then this 'label' is bonded to the container for the image to be transferred to the surface of the container and then the 'label' removed. The advantage of this system is that it is possible to have photographic quality decoration (normally produced by high volume gravure) with the flexibility of labelling.

#### *8.3.3.1 Thermal ink transfer labelling*

Container decoration by means of thermal inks transferred from a 'carrier' substrate has been practised since the 1970s, when the Metal Box Company Ltd.

introduced its 'Reprotherm' labels, primarily for can labelling. 'Reprotherm' labels were produced in pre-cut format and applied using a specially modified can labeller to apply the individual pieces of substrate (carrying the thermal inks) to the containers using a special grade of hot-melt glue. Following application of the substrate, the cans were passed through a curing oven, during which time the thermal inks transferred and bonded to the surface of the cans. The substrate then was removed mechanically/pneumatically from the cans, a somewhat complex process, which significantly inhibited the application speeds attainable. Another critical factor in the application of Reprotherm labels was the need to ensure 100% removal of the hot-melt glue used initially to tack the substrate to the cans. A special grade of hot-melt adhesive was employed, which crystallised during the curing process and was thus easily removed, together with the substrate. This process was relatively slow and expensive, and has now been largely discontinued.

Around 1970, the American company, Dennison, (now Avery-Dennison) introduced the 'Therimage' labelling process, this being another heat transfer system whereby reel-fed label images are transferred, as a result of heat and pressure, to the containers. However, whilst this process is still in use today its applications are limited, as a result of several factors. Firstly, the chemistry of the thermal transfer inks is suitable only for application to plastic containers and, in addition, the process involves the use of a heavy wax content which manifests itself on the finished label. Furthermore, the process is very slow (no more than approximately 60 cpm) and hence not very economic.

After years of research, and heavy investment, thermal transfer labelling took a very significant step forward in the mid-1990s when Avery-Dennison introduced a second generation of Therimage labels known as 'CLEAR ADvantage'. This is a direct print 'no label look' technology for plastic, glass or metal containers. A graphic image is reverse-printed on a gravure press in reel format, using a proprietary release liner. The image is subsequently transferred to the containers by a specially-designed machine, which uses a combination of heat and pressure to ensure a permanent and durable bond of the thermal inks to the container surface. The resulting decorated container is one that looks as though the graphic image was printed directly on to it. The advantage of this technology includes:

- 'No-label' look
- High-quality graphics
- Photographic imaging
- Up to seven colours possible
- Line, 4-colour and half-tone printing
- Bright printing metallics
- Gravure printing technology
- Suitable for returnable containers (up to 20 trips)
- Ability to withstand pasteurisation

- Permanent decoration
- Up to 360° decoration capability
- Suitable for both glass and plastic containers
- High speed application (up to 500 containers/min, dependent upon application)

*The application principle.* In considering the application of the latest technology of thermal transfer labelling, it is important to appreciate that a *system*, rather than simply a single independent application machine, is necessary, since the containers to be labelled, whether they be of glass, metal or plastic, require both pre- and post-labelling treatment. This is absolutely essential to ensure effective transfer of the thermo-active inks and a permanent bond to the containers (see Figure 8.17).

In addition, glass containers require two different spray coatings to be applied before the label application, and a final spray to ensure complete curing of the label. The treatment processes for the three basic materials used are summarised as follows:

*Glass*

(i) 'Stearate' spray coat
(ii) Primer spray coat
(iii) Pre-heat containers to 190°C
(iv) Label application
(v) Post-labelling cure for 12 minutes at 200°C
(vi) Final Polyethylene (PE) spray

**Figure 8.17** Labelling machine applying Avery-Dennison's patented '*CLEAR ADvantage*' thermal transfer labels. On the left can be seen the continuous web carrying the label graphics in the form of specially-formulated inks, which are transferred to the glass bottles as the result of a combination of heat and pressure.

*Plastic*
(i) Pre-flame (for polyethylene and polypropylene containers only)
(ii) Label application
(iii) Post-flame (for all types of plastics)

*Metal*
(i) Pre-heat to 175°C
(ii) Label application
(iii) Post-cure for 1–2 minutes at 190°C

The application machines used for heat transfer labels are very similar in general basic design and concept to the previously described rotary machines used for pre-cut or reel-fed labelling, the only difference being in the very special design of the labelling station, one of which is required for each individual label to be applied.

These labelling stations use very similar drive and web-feed technology (servo-driven) as used on other reel-fed labellers for both glued and self-adhesive labels, but it is at the label application point where the machine for heat transfer labelling differs very considerably.

As well as the containers to be labelled being pre-heated, the thermal transfer inks on the web are passed over heated metal platens as they travel to the application point. The key to effective transfer of these labels is a combination of heat and pressure, and for this purpose a specially designed transfer cylinder is utilised. This cylinder incorporates a number of stations (variable dependent upon the label lengths being applied) with each station comprising a curved, heated metal pad and two freely-rotating rollers which are also heated electrically. As the containers travel around the main carousel of the machine, they are constantly rotated at a uniform speed via the base support platforms on which they sit, and the direction of rotation corresponds with the direction of the label web travel around the surface cylinder at the point of application. The position of the label application station with regard to the container being labelled is adjusted so that the necessary 'interference pressure' is obtained, and this pressure results in a rotation of the free-spinning rollers, which transfer the label image to the container surface via a 'rolling-on' action.

## 8.4 Material specifications and their importance in the application process

Without doubt, the entire space allocated for this chapter could be devoted to a consideration of specifications of the packaging materials used in container decoration. This is a vitally important aspect of the effective, efficient and economic performance of a production line, and the effect that the packaging material specifications can have on line performance cannot be over-emphasised.

Only a brief summary of the most important aspects can be included here; other chapters will deal with the material specifications from various perspectives and also emphasise their importance.

Most application machinery manufacturers have a reasonably good working knowledge of the specifications of containers, labels, foils, shrink/stretch sleeves, closures (and will be most willing to give basic guidance and recommendations), but they are not normally able to offer the same level of professional expertise as the manufacturers of these materials. The relevant material suppliers should be consulted before embarking upon the design/introduction of a new package to the marketplace. All reputable suppliers of containers and packaging materials issue detailed specifications for their products, and these should always be referred to the relevant application machine manufacturer for endorsement. Additionally, material suppliers often make recommendations for correct usage of their products, and supply documentation incorporating 'trouble-shooting' procedures. Many materials suppliers also employ technical officers who give advice and guidance to the packaging companies, and liaise with the machinery manufacturers.

Many questions need to be addressed when choosing the type of package decoration for any specific application, and, having made that choice, to ensure successful implementation of the decorating process on the production line. Some of the key questions to be considered are:

- What is the container geometry?
- What is the container material?
- What is the rigidity level of the container?
- Does the container need to be orientated with respect to the decoration to be applied?
- What is/are the decoration material/s to be used?
- What are the surface characteristics of the container?
- What is the condition of the container (e.g. hot, cold, wet, dry) at the point of labelling?
- What is the shelf-life of the product being packaged?
- What are the storage/climatic conditions in the destination market/s?
- Is the container one-way or returnable?
- Does the chosen decoration need to be resistant to immersion in ice-buckets (e.g. champagne, wines)?
- What is the cap/closure material, if relevant (e.g. for any elements of the container decoration that need to adhere to, or encompass, the closure)?
- Does any aspect of the container decoration act as a form of tamper evidence?

The answers to these questions can significantly affect the initial basic choice of decorating process to be used and, once this decision has been taken, the specification of such items as label papers, adhesives and plastic film used

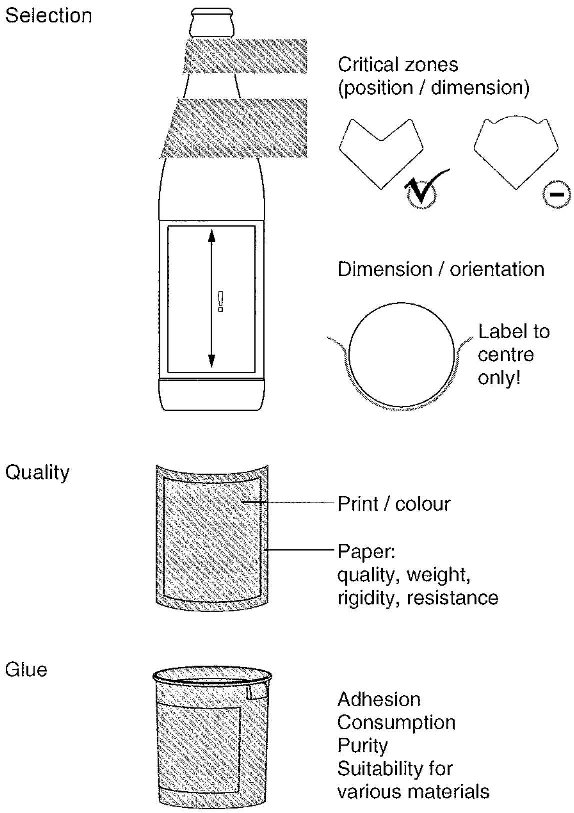


**Figure 8.18** In the case of conventional wet-glue labelling, the relationship between container geometry, label specification and adhesive is extremely important. The 'golden rule' when applying paper labels is that these should be applied *only* on to cylindrical or truly conical areas of containers, otherwise wrinkling will inevitably result.

for self-adhesive labels and/or shrink and stretch sleeves (see Figures 8.18 and 8.19).

## 8.5 The importance of plant layout

After selecting the most appropriate machine, it should be installed in a plant layout that is totally compatible with the machine operating concept in order to achieve the best production efficiency from the unit. In many cases, it is advisable to consider the decorating operation as a *system*, rather than a self-contained machine for carrying out a specific finite mechanical operation. This is particularly true for, for example, shrink sleeving and thermal transfer labelling.

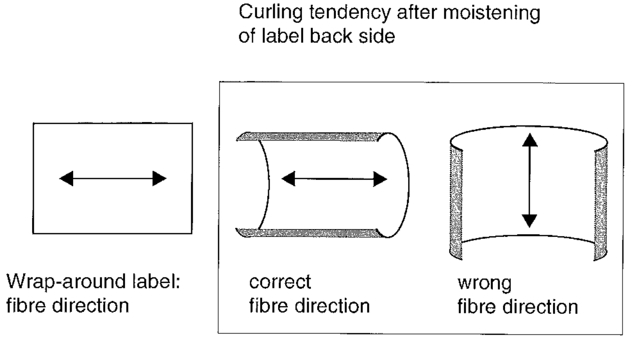


**Figure 8.19** For high-speed decoration using conventional paper labels, the specification of the label paper is extremely important. Factors to consider are paper weight, porosity/density, water absorption capacity, wet opacity, wet strength and grain direction. The importance of grain (fibre) direction is highlighted.

In both these cases, while choice of the application machine is very important, equal consideration must also be given to elements of the system up-stream and down-stream of the application point. When sleeving glass containers, for example, it may be desirable to pre-heat or temper the containers prior to the application of the sleeve, and the production line layout will have to be arranged accordingly. Similarly, very careful consideration must be given to the size and type of shrinking tunnel to be used down-stream of the sleeving machine.

Thermal transfer labelling is a more complex technology. Pre-heating of the containers is essential, as is a substantial period of curing of the labels on the containers after application. In addition to these two areas of container heat treatment, it is also necessary to spray the surface of the containers before and after labelling and, accordingly, all these factors combine to emphasise the need for careful consideration of the layout of the complete system (see Figure 8.20).

When planning the layout, the potential need for drying the containers before labelling must be taken into account. This might involve the installation of a package warmer or of so-called 'air knives' ahead of the labeller. The need for surface treatment of polyethylene and polypropylene containers must also be considered.

With regard to conventional wet-glue labelling, despite the tremendous improvement in the quality of packaging materials over the years (i.e. labels, aluminium foils, adhesives, etc.), the 'golden rule' that labelling machines should run *as consistently* as possible (with a minimum of stoppages) still applies. Careful design of the production line layout can contribute significantly towards this objective.

Most modern labelling machines are equipped with some form of speed modulation, which automatically adjusts the machine's speed, dependent upon the prevailing production line conditions (i.e. the volume of containers on

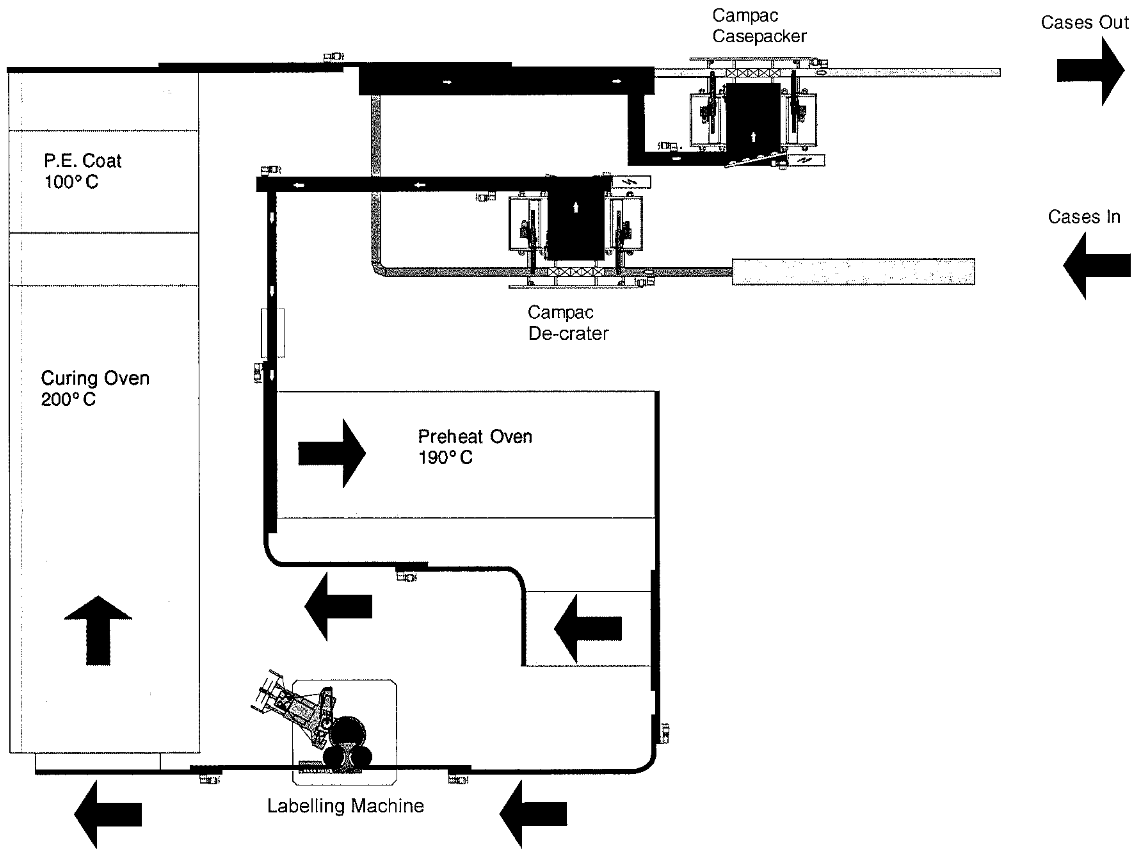


**Figure 8.20** The layout of a 'total system' needed for the application of Avery Dennison's CLEAR ADvantage thermal transfer labelling process to glass containers, from which it can be clearly seen that the label application machine is complemented by upstream and downstream treatments of the containers to ensure effective transfer and permanent adhesion of the thermal ink labels.

the line before and after the labelling machine itself). If the machine is to be free-standing (i.e. not forming part of a larger monobloc unit), adequate accumulating conveyors must be incorporated both up-stream and down-stream of the labeller to ensure a smooth, efficient and continuous flow of containers under all conditions, and these conveyor areas should also provide location points for the line switches/sensors that control the machine's speed modulation. If container flow at the labeller infeed ceases for any reason (e.g. a filler stoppage), the layout and machine control should permit *controlled idling* conditions. In other words, the machine should be allowed to continue to operate at a low speed (without containers passing through, and without label application) in order to keep the adhesive under optimum control, and to ensure that containers can immediately be fed to the machine infeed, without any problems, on the resumption of container flow from the filler. At all points in the line, containers should be handled smoothly, gently and with the minimum of pressure, but this is particularly important in the area between the labeller discharge and the infeed of the end of line packaging machinery. Here everything possible must be done to avoid damage to newly-applied labels, or, indeed, shrink or stretch sleeves.

Direct contact with newly-applied labels (particularly important for cold glue applications) should be eliminated, and this means that all conveyor guide rails should be carefully positioned above and below the labelled areas of the containers. Similarly, the infeed systems of the packaging machinery used should be designed to avoid label contact.

In the case of cold glue applications, the layout should allow adequate drying time in the area between the labeller discharge and the packer infeed. The drying time will be determined by the length of accumulation conveyors although, conversely, it follows that the longer these conveyors, the more risk there is of label damage owing to container-to-container contact after labelling. The amount of drying time can vary enormously depending on many factors, including output, label specification, container material, adhesive specification and ambient conditions.

# 9 Direct printing/decoration on metal

T.A. Turner

## 9.1 Introduction

The decoration of and provision of information on metal packaging can be achieved in a number of ways, including direct printing, special coatings, labels of various types (and cost) and a number of heat transfer processes. Each has advantages and disadvantages in terms of cost, appearance, durability and scope.

This chapter is concerned principally with those processes where the end result can be regarded as being integral with the package itself, which basically excludes adhesive labels, such as wrap-around labels made from paper or laminates, self-adhesive (patch) labels and plastic shrink labels. However, reference will be made to these methods when relevant. Also covered will be the functional properties of decorative systems on metal packaging, but not the internal metal protection.

In order to appreciate the scope and limitations of decoration, of which it must be stressed the actual printing process is only one part, albeit a very important one, it is first necessary to understand something about the metal substrate and the various processes used in metal decoration. Basically there are two metals used in metal packaging: steel in a variety of formats, principally tinplate and tin-free steel, and aluminium, either rigid or foil. The suitability of these metals as a substrate for decoration is quite different as is frequently the visual appearance resulting from printing and decoration.

The metal packaging market consists of a number of segments including the following:

- Food and beverage (beer, carbonated soft-drinks and wine),
- Processed drinks—notably in the Japanese market,
- Aerosols,
- General-line including fancy boxes (biscuits, chocolates, promotional gifts); paint/wood finishing products, oil, agrochemicals,
- Aluminium foil products.

Most food cans are made from tinplate, although there are very significant numbers of shallow drawn aluminium containers used for products such as petfood, fish and meat/pâté. Two-piece cans for beer and carbonated soft drinks are made either from aluminium or steel. Similarly aerosol containers can be made from either tinplate or aluminium, although the manufacturing processes are quite different and this has a significant bearing on the style and quality of the decoration that can be achieved. Finally, most general-line containers are made from tinplate.

The surface and hence optical properties of aluminium, tinplate and tin-free steel (TFS) are very different in that aluminium appears 'white' and the two steel-based products, tinplate and TFS, appear blue. This is accounted for by the differences in types and levels of reflection of light, and hence differences in the colours of the metal surfaces. These need to be taken into account in any decorative process. The main practical implications of the differences are that:

- While the appearance of both metals can be 'normalised' by the application of, for example, a white base coating, thicker films are required on steel than on aluminium to achieve the same levels of opacity.
- Transparent colours, which in practice includes most colours, appear dirty/less saturated on steel in comparison with aluminium and this effect is particularly noticeable with TFS.

There are two fundamental approaches to metal decoration, including printing, and these are:

- Decoration of flat sheets or coils from which containers, components and closures are subsequently made.
- Post-decoration of manufactured containers (or closures) referred to in this text as made-up containers.

While the materials used in each case are fundamentally similar, the processes used are different and so are the results in each case. It can be said that, in quality terms, there are virtually no limitations within the fundamental constraints of the individual printing processes, as to what can be achieved on flat sheets, but there are very real limitations to what can be done on made-up containers. These limitations have been one of the main reasons for the development of alternative decorative processes such as heat transfer and high quality shrink labels.

## 9.2 Materials and processes used in metal decoration

### *9.2.1 Conventional systems*

A conventional decorative system on metal, in most cases, will be made up of coatings of various types and of printing inks.

#### *9.2.1.1 Coatings*

Various types of coatings exist, which serve different purposes and these include size coats, base coats and over-print varnishes.

*Size coats.* These are formulated to promote adhesion to the metal substrate and to facilitate subsequent manufacturing processes. Sizes are applied in very thin films and are tending to be phased-out as better base coats are produced and because their use involves additional costs in terms of materials and application.

*Base coats.* These are commonly white and are applied in thick films (typically 10–15 μm) when they provide a highly reflective base for subsequent printing processes. They may, however, be coloured or, in some cases, even unpigmented.

*Over-print varnishes.* These are clear coatings, which are applied over previously applied coatings and ink films in thicknesses of approximately 3–5 μm and provide gloss and protection from abrasion and/or corrosion. Varnishes can also be formulated to impart special physical or visual/novelty effects such as matt appearance, non-slip feel, surface crazing ('antique effect') or water droplets to give the appearance of coldness. The latter are dealt with briefly in Section 9.9.2.

Most commonly the above materials are low viscosity fluids, which are applied by the process of roller coating in various forms depending on whether sheets or made-up containers are being processed. However, more recently, powder coatings have found increasing use and these require fundamentally different application equipment but, being essentially 100% solids, are one approach to reducing solvent emissions to the atmosphere.

#### *9.2.1.2 Liquid coatings*

These are basically solutions of one or more resins in a solvent into which are introduced various additives such as waxes to impart lubricity and facilitate fabrication, flow-promoters and catalysts to assist cure. Some typical examples of resins used include alkyds, vinyls, and polyesters and epoxy esters dependent on the functional properties required. The detailed chemical formulation of coatings is, however, outside the scope of this text but the reader may find the following useful in understanding some of the terminology used in the industry.

The solvents used in the formulation of liquid coatings may be either totally organic (so-called solvent-based) or a mixture of water and organic co-solvent particularly in a typical ratio of 4:1 (so-called water-based or water-borne). The amount of dry material, mainly cross-linked resin and pigment, left after the drying or curing process—always necessary on metal—is referred to as the solids content and, dependent on type, will be up to, for example, 50%. Some formulations have a particularly high solids content and are referred to as such.

Heat, usually applied in gas-fired convection ovens, is the most common means of drying coatings and inks on metal but an important alternative is ultra violet light, which requires a fundamentally different approach to formulation and is reviewed in Section 9.2.2.

The most common method for applying coatings is roller coating and the design of a typical sheet roller-coater is shown in Figure 9.1. This equipment

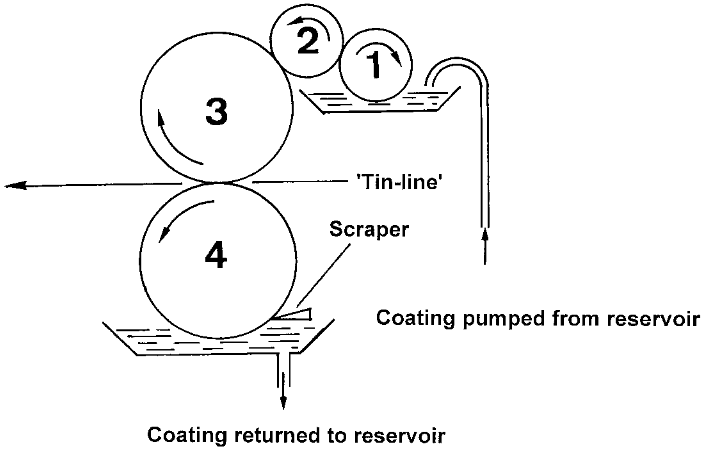


**Figure 9.1** Basic roller coater design: (1) fountain roller; (2) transfer roller; (3) applicator roller; (4) (counter)-pressure roller.

would be capable of coating sheets up to 1 m wide at speeds of up to 7500 sheets/h although speeds in the range of 4–6000 sheets/h are more usual. In such machines the thickness of the coating applied is largely determined by the gaps between the rollers although refinements can be introduced, such as differential speeds between roller 1 and 2 (see Figure 9.1) to improve film thickness control.

Another variant is the offset-gravure coater (see Figure 9.2) where the coating thickness is controlled by the depth of the cells on the gravure cylinder. The latter development certainly offers benefits in terms of process capability and hence film-thickness control.

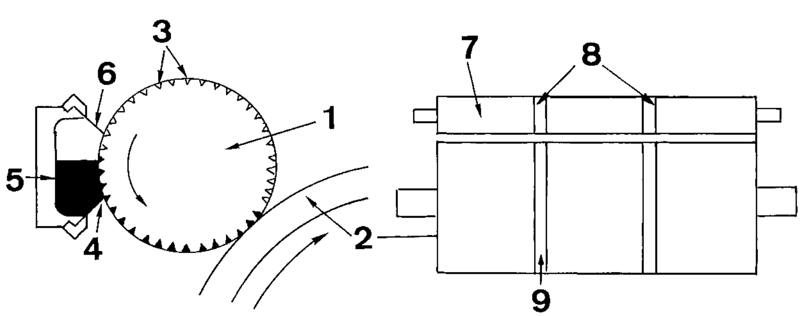


**Figure 9.2** Offset-gravure coater with anilox coating system showing the opportunity for producing stencils: (1) anilox roller; (2) rubber applicator roller; (3) cells; (4) steel doctor blade; (5) coating reservoir; (6) plastic blade; (7) engraved area; (8) non-engraved area/clear margin; (9) clear margin.

The same basic design principles apply to coaters for made-up containers and for coil coating. In the case of two-piece (DWI—drawn and wall ironed) beverage cans the speed would be expressed, for example, as 1200 to over 2000 cans/min and on coil-lines a roller configuration variant referred to as reverse roller coating would normally be used to ensure smoother coatings.

#### *9.2.1.3 Printing and printing inks*

A number of printing processes are available for printing on metal substrates. The most commonly used processes are as follows:

- offset lithography
- dry offset or more correctly (but rarely used) offset letterpress
- water-less planographic processes e.g. Toray (see 9.3.1)

For some special cases silk screen, tampoprint and ink-jet printing are used. The basics of the processes are described in Chapters 3, 4, 5 and 6. Only issues specific to printing on metal will be dealt with here. The principal difference between printing on metal as opposed to paper is that the substrate is non-absorbent and this affects the process in two ways. Firstly, it is arguably more difficult to maintain ink and water balance when printing by lithography although the printer does not have to contend with dimensional instability as in the case of paper. Secondly (and also related to absorbency), during wet-on-wet multicolour printing, film weight control and tack grading is more critical.

Aluminium foil presents a special case since it can be readily handled in coil form either on its own or as a laminate with paper or polymer and so liquid ink processes, such as gravure or flexography are also applicable.

The inks used in the principal printing processes (lithography, dry offset [often called dry-litho, especially in the US]) and waterless planographic processes, are referred to as paste inks. They are highly viscous and rheologically structured dispersions of one or more pigments in a resinous vehicle, with a plastic viscosity typically in the range of 100–500 poises compared to a coating with a viscosity of a few poises or less. The pigments used are not only selected to meet the requirements of the printing process but also to resist colour change during subsequent thermal (stoving) processes and prolonged exposure to light and other special requirements, such as chemical resistance and steam sterilisation. Those used include organic pigments, which are frequently very expensive, titanium oxide for white inks and coatings and carbon black. It is worth noting at this point that few pigments are FDA (Food and Drugs Administration) approvable and most are not intended to come into direct contact with food.

### *9.2.2 Ultraviolet curable systems*

The use of exposure to ultraviolet light (UV) to cure inks, and subsequently coatings, is not new and was in fact prompted by the US. Rule 66{1966} anti-pollution legislation and subsequently by the world oil crisis during the early

1970s. While the environmental benefits persist, it is fair to say that currently the operational benefits provide at least an equal motivation. This will become abundantly clear when further comparisons between printing on flat-sheets and on made-up containers are made in Section 9.3.

## 9.3 Printing on flat sheets and made-up containers

There is a fundamental difference between printing machines for flat-sheets and those for made-up containers. In the former, multiple colours can be applied sequentially with the opportunity for drying between colours, whereas on those for made-up containers all the colours are applied in a single application, which severely limits multicolour superimposition and the opportunities for complex halftone designs. This difference is shown schematically in Figure 9.3.

### *9.3.1 Sheet printing by offset processes*

The two most common processes used for printing sheets are lithography and dry-offset although the use of planographic (i.e. where both image and non-image areas are in the same plane) 'dry' (driographic) processes, such as Toray, is becoming more common. Basically the same machines, with minor modification, can be used for all three processes (e.g. water-cooling is recommended for Toray and, because of printing-plate thickness, some changes in plate cylinder diameter may be introduced for dry-offset).

Print quality is significantly better with lithography and driographic processes than with dry-offset, mainly because of the poorer tonal gradation and the minimum printable dot-size using the latter process. In the case of driographic processes, good press disciplines are essential to minimise any risk of damage to the printing plates, although it must be said that more durable plates and

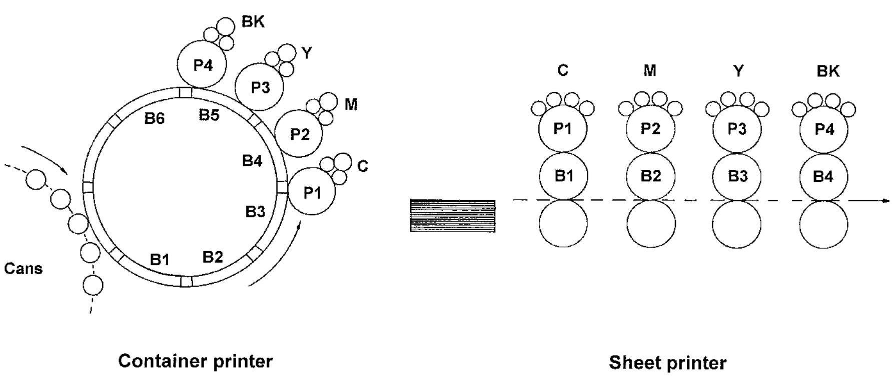


**Figure 9.3** Comparison of the printing of 4-colours on sheets and on containers. P = printing plate; B = blanket; C, Y, M, BK = cyan, yellow, magenta, black, respectively.

increasingly shorter run lengths have benefited these processes. Machines for printing sheets, typically up to 1 m wide by 0.75 m long, are made up of individual units (printing decks), an example of which is shown in Figure 9.4. The number of decks coupled together is limited by the practicalities of multicolour superimposition and the printer's order book. In the simplest terms, provided that the combination of ink film thicknesses and ink rheology is optimised, two colours can be printed, one partially or totally superimposed on the other, with little difficulty. This has meant that single and two-colour machines/printlines have predominated until quite recently. A design comprising four colours required two passes through the line; that is, print two colours, stove to dryness and then print the second two colours. Once again this is not problematical because the mechanical design of the printing-line allows register of the sheets, ensuring all print impressions are in the right place. Nevertheless there are some customers' designs that do not permit two-colour superimposition, for example, the use of two thick opaque colours, and so line utilisation would be reduced. Utilisation of two and three colour printing lines might typically reduce to an average of 1.7 and 2.5 prints per pass respectively, with the obvious adverse economic impact. However, if enough machine passes are employed there are virtually no limitations to the quality of print that can be achieved even with the line utilisation limitation. The advent of UV curable printing inks, which allow each colour to be printed and dried in a fraction of a second by introducing compact UV drying units between decks (referred to as inter-deck curing), has produced dramatic improvements in-line utilisation. On two and three colour

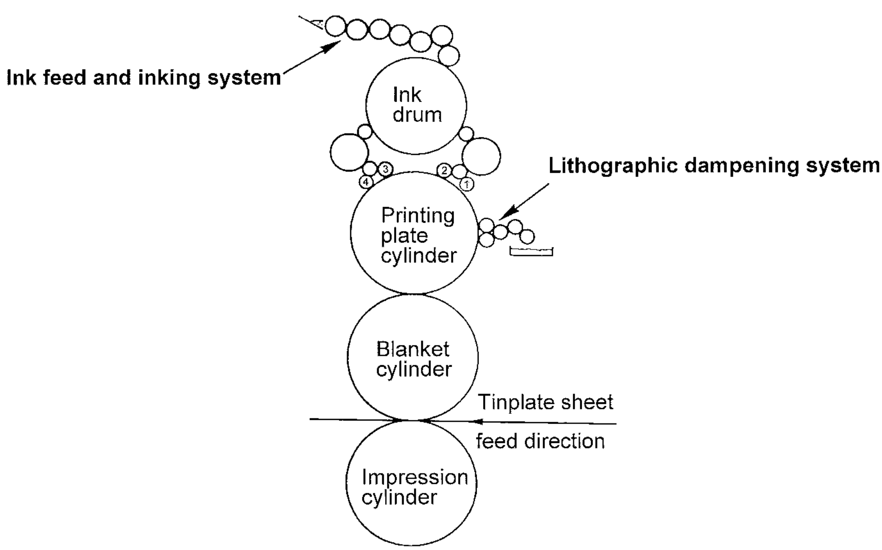


**Figure 9.4** A unit-type lithographic printing press.

lines the theoretical prints per line pass can be achieved and, more importantly, lines with four to six printing decks can be constructed and are becoming increasingly available. A six colour machine, with interdeck UV drying and with a UV curable overprint varnish, would be the basis currently for a state-of-the-art installation, because this would provide the additional opportunity for the use of the Hexachrome™ system in the printing process.

The operational and cost benefits resulting from the use of UV curing, which include reduction in the number of stoving ovens, increased printing capacity, lower energy utilisation, less space, have to be balanced by increased materials' costs. However, the balance is a favourable one and the use of UV curable systems is increasing.

### *9.3.2 Container printing by offset processes*

Lithography is not considered an option for high-speed made-up container printing and hence dry-offset has predominated until the more recent availability of driographic processes. However, the limitations on printing containers are associated more with the commonly used machine/process formats than the basic printing process.

On sheet-fed printing machines each colour is initially applied to its own unique offset blanket although, as each subsequent colour is applied, inks already printed will transfer back from the metal substrate to subsequent blankets unless interdeck drying is installed. In marked contrast, on dry-offset machines for made up containers, all colours are transferred to one or more common blankets prior to being transferred in a single step to the container. This makes the printing of two colours in superimposition difficult but not impossible, although frequent machine wash-ups may be necessary. Truly multicolour halftone designs are virtually impossible, although with the latest machines, utilising planographic dry plates and careful colour separation techniques, there have been significant improvements. However, it is important to note that all colours have to be printed in a single application and there is no opportunity for a second pass through the machine. Despite these fairly basic limitations, machines made by Rutherford Machinery (Sequa Corporation) and Ragsdale (ALCOA), are now available with up to eight colours, and admirably fulfil the market need. Such machines are remarkable feats of engineering enabling lightweight containers to be handled on and off the machines and printed at speeds in excess of 2000 cans/min. The basic design of one such machine in shown in Figure 9.5.

The consequence of the above is that designs printed on made-up containers tend to be simple and the two-piece beverage can market affords a good example. Overlapping of solid colours is kept to a minimum and close register of colours is avoided. Halftone designs are commonly restricted to just two colours with the result being that it is only possible to print a recognisable representation rather than a realistic image. However, recent developments in planographic printing

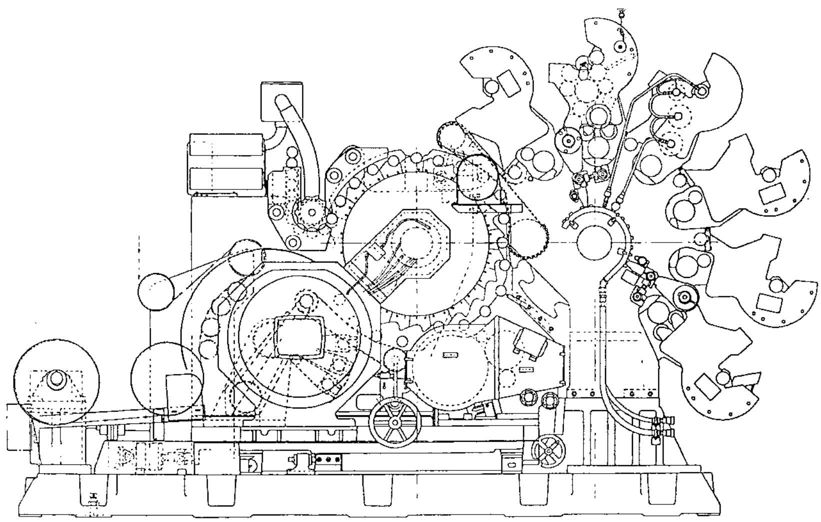

**Figure 9.5** Basic design of a Rutherford Decorator (courtesy of Sequa Corporation).

plates may extend the capability of these machines. Not all made-up containers are printed on such high-speed machines. Aerosols and deep-drawn aluminium 'roll-on' closures, as used on spirit bottles for example, are usually printed on slower machines but the process is still based on the common blanket principle.

### *9.3.3 Aerosol containers*

The differences in the design capabilities of sheet-fed and made-up container printers are further exemplified in the aerosol market. Aerosols are mainly produced by two methods: welding, in the case of steel, and impact extrusion, in the case of aluminium. In the former, the metal is decorated in sheet form, cut up into blanks, which are welded into cylinders, while in the latter, all decoration must be carried out on the formed extruded body. This has resulted in two quite different types of products in the marketplace. Steel aerosols are usually either highly decorative, exploiting the scope of flat-sheet printing, or paper labelled. Aluminium extruded aerosols usually offer simpler designs complemented by mechanically produced surface effects, such wire-brushing or polishing, to exploit the properties of the underlying metal, plus the absence of a welded side-seam.

## 9.4 Limitations of traditional printing processes

Traditional printing methods are made up of a number of process steps now at various stages of development or replacement, as modern computer-based techniques become available and increasingly user-friendly. These steps are necessary to convert the customers' designs to a printed product. Ignoring differences in print quality available from sheet or made-up container printers, traditional processes have a number of disadvantages:

- protracted time to press,
- unit cost to run-length sensitivity,
- lack of flexibility.

Figure 9.6 shows some of the essential process steps in a traditional printing process although many of these, particularly those associated with manual intervention and camera stages, have been eliminated by up-to-date graphic studio techniques utilising modern scanners and image setters. Nevertheless, the rate at which these technologies can be introduced on a global basis can be expected to take some time. However, where they have been introduced, significant reductions in pre-press activity and associated costs have been achieved.

An analysis of the principal limitations of traditional printing systems, listed above, will provide a basis not only for understanding the present and recent past, but also the direction for future development of the industry.

### *9.4.1 Time to press*

It takes a long time to move from customers' concepts to delivering an acceptable product. The process steps, shown in Figure 9.6, can be further simplified to a series of activities as follows:

1. Pre-press activity between origination, acceptance of proofs by the customer and presenting the printer/operative, on the print line, with production printing-plates.
2. Assuming a production run has just been completed, the press needs to be washed-up, new plates fixed on to the machine; frequently, new inks introduced into the ink ducts and a representative sample print produced.

Stage 1 may take a number of weeks and stage 2 a number of hours—it will be appreciated that both time frames are significant for different reasons.

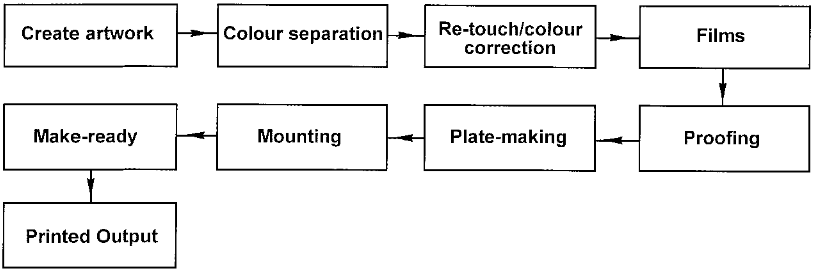


**Figure 9.6** Process steps in a conventional/traditional printing operation.

### *9.4.2 Unit cost to run length sensitivity*

As is the case with most manufacturing processes, the cost of printing is made up of fixed and variable costs. Figure 9.7 shows the characteristic relationship between the unit cost per print and the run-length to be printed with the curve shown becoming asymptotic to the $x$-axis (runlength) as the fixed costs are spread over a greater number of sheets. In simple terms these are the costs associated with everything that occurs before a single sheet can be printed and they can be broken down into the following categories:

- origination
- plate-making
- make-ready/change-over time
- ‘getting ready to run’ scrap

These are the areas which need to addressed if the cost of printing is to be reduced and its efficiency improved and indeed these are, in fact, being addressed within the design of new machines, by increased use of computerisation and automation.

Rather less can be done with variable costs such as materials (inks, varnishes), press maintenance and other consumables.

### *9.4.3 Lack of flexibility*

The above analysis applies, in general terms, to the printing of both sheets and made-up containers. However, in the specific case of the manufacture of

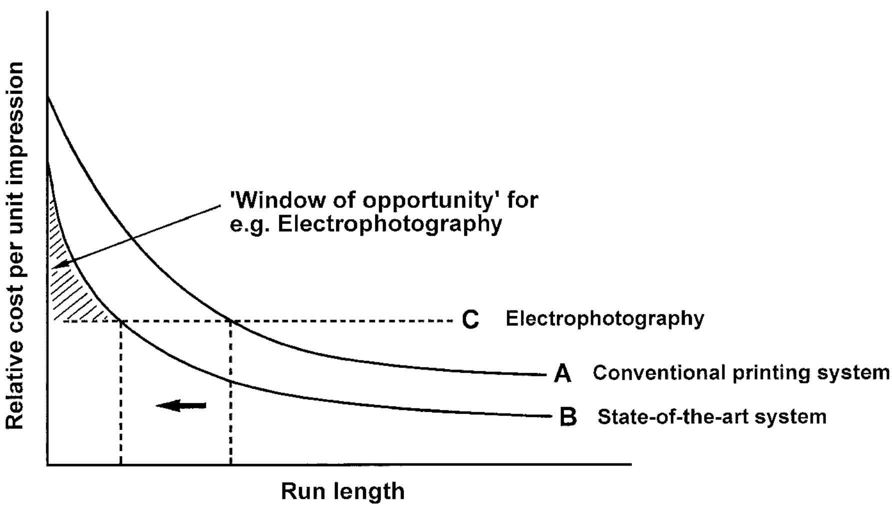


**Figure 9.7** Relationship between cost and run length for alternative printing processes.

two-piece (DWI) beverage cans, the situation is complicated by the fact the decoration process is totally integrated with the rest of the can-making process. In most markets, print run lengths on DWI beverage lines tend to be longer than with sheet-fed operations, but nevertheless design changes have a very adverse impact on overall line efficiency and therefore on economic viability. The trend in the industry is for both can making and decorator (i.e. printing machine) speeds to increase and the number of colour stations per machine also to increase. The impact of these changes is two-fold:

1. While run lengths are getting shorter in some markets, running times per design are certainly getting shorter as a result of increased speed. Capital investment costs are relatively higher and so the impact of any line stoppages are greater.
2. The availability of more printing stations does not necessarily mean more colours. However there is an important increase in flexibility and hence scope for more complex designs, which results in the ability to separate, onto separate plates, solids and halftone areas for any one colour. The latter can significantly improve print quality by, for example, facilitating ink film thickness control to suit different areas of the design being printed.

Some machine and operational procedural changes can help reduce the adverse impact of design changeovers and include the following:

- Interchangeable/spare decorators or inker-units, which be quickly moved in to place during changeovers (so-called roll-on/roll-off units).
- Quick-change plates and blankets.
- Some palletisation of bright (undecorated) can stock so that the early manufacturing stages of the can-making process can continue while the printing operation is being changed over.

## 9.5 State-of-the-art sheet-metal printing operation

Much innovation has occurred since around 1990 in the printing industry, pioneered mainly in the paper printing and publication sectors, directed at all stages of the process, including pre-press and press automation. In some sectors, for example mail order catalogues, digital printing engines have successfully been introduced as well as the more commonplace digital design and plate-making studios. The extent to which digital printing will penetrate the metal printing market remains to be seen but is discussed in Chapter 14.

A number of printing machine manufacturers such as KBA, Mitsubishi, Komori and Crabtree are introducing machines that run faster (about 7500 sheets per h), are more accurate in terms of register and machine pressure settings, and include high levels of automation. A state-of-the-art printing machine (press) has the following fully automatic features:

- Ink wash-up including inker system, plates and offset blankets,
- Printing plate change,
- Computerised colour management system,
- Colour to colour registration monitoring.

These important features, used in conjunction with a modern digital design studio, would be supported by a clear press/process fingerprint (see Section 9.5.1) and a computerised colour-matching system incorporating a colour and design library, and would permit a complete changeover of a six-colour press in 30 min. The introduction of this type of technology can produce very significant reductions in fixed costs (up to around 10% dependent on run length). Plant utilisation can also be dramatically increased bearing in mind that run lengths are often a few thousand sheets or even less, which can mean conventional lines typically spend more time in changeover mode than printing sheets. Included in Figure 9.7 is the cost-to-run length curve for a state-of-the-art printing line and also an estimate of the cost of more futuristic digital processes such as electrophotography (see Chapter 14).

### *9.5.1 Press fingerprint*

This is a term used to describe the process capability of the printing press/machine which may involve a number of features, including accuracy of register, maintenance of halftone dot size and minimum dot size that can be reliably/acceptably printed, and ink transfer characteristics. This information is a crucial calibration feature to allow the use of modern colour and print quality monitoring and control equipment. The fingerprint can be expected to be different between makes/marks of machines and even between nominally identical machines. The establishment of this fingerprint is an essential prerequisite of the modern printing process.

### *9.5.2 How many colours?*

When constructing a printing line the number of printing decks determines the number of colours printable in a single pass through the line. This decision may be based upon a number of factors including:

- An analysis of the current or expected customers' designs portfolio, which may indicate that the maximum number of colours on any design is five but the majority have four colours.
- Related to the above, the amount of flexibility required in the operation—is it better to have two 2-colour lines than a single 4-colour one?
- Should the line configuration and level of sophistication be the optimum for taking maximum advantage of the latest technology and future technology trends?

If the latter is the case and bearing in mind that automation and rapid changeover time (less than 30 min for, say, all six colours) can quickly compensate for any anticipated loss of flexibility, then the following is viewed by this author as optimum:

- 6-colour, in-line machine, with interdeck UV curing units with fully automatic changeover facilities, as described above with the addition of UV curable follow-on varnish system (see Figure 9.8).
- The above supported by a modern digital studio and on-line colour management system, registration etc.

The benefit of the 6-colour format is that it facilitates the use of Hexachromy (see Section 9.5.3) instead of relying solely on a combination of trichromatic printing plus the use of special or 'house' colours.

### *9.5.3 The benefits of the Hexachrome™ system*

Multicolour halftone printing technology was built on the basis of trichromatic printing (i.e. the three colours cyan, magenta and yellow, plus black), which has been highly successful despite some significant shortcomings. The Hexachrome™ system, introduced by Pantone in 1995 utilises a slightly modified trichromatic series, black plus two additional colours, a bright green and a bright orange. This combination of six coloured inks can reproduce approximately 90% of the theoretical colours possible and this increased capability is compared to trichromatic printing in Figure 9.9. The use of six colours requires additional work at the colour separation and plate-making stages and of course, with so many screen overlaps and limited screen angles available, the inevitable moiré/interference patterns can occur. This problem can be overcome by the

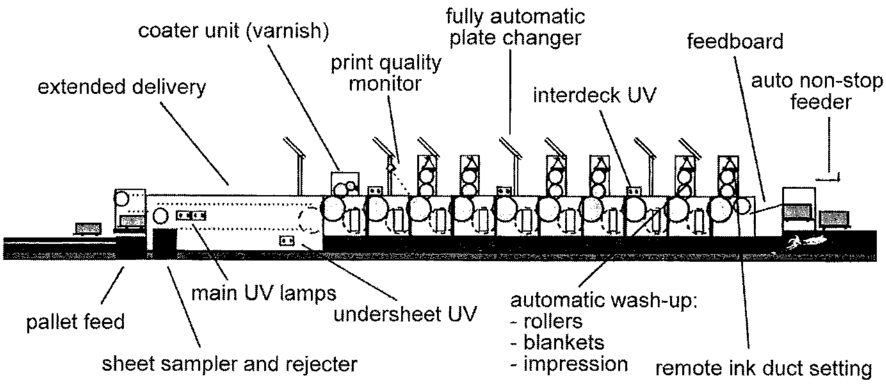


**Figure 9.8** Schematic of a state-of-the-art metal printing line.

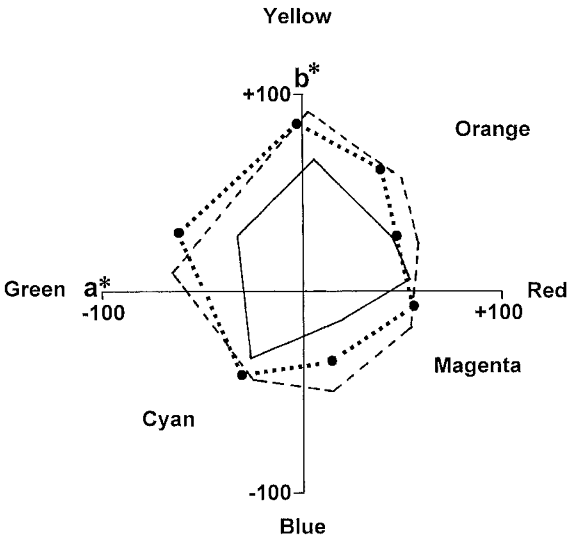


**Figure 9.9** CIE 1976 L*a*b* colour gamuts. Key: •···• Hexachrome™ 6-colour; ——typical 4-colour CMYK process colours; ----extended colour range 12–14 inks.

use of a stochastic (frequency modulated) dots technique instead of the more standard (size modulated) dot system. The additional operational benefits of Hexachrome™ printing (with stochastic screening) include:

- potentially no need to wash up the printing line in between jobs
- There is the potential to group print runs together and so print sheets containing a predetermined range of different designs, which effectively increase run lengths.

## 9.6 Special applications and printing methods

### *9.6.1 Distortion printing*

The metal for many shallow-drawn containers, such as those used for the packaging of fish, seafood, ham and pâté, is printed in the flat and the containers are then formed subsequently. This necessitates the use of an important specialisation termed *distortion printing*. This technology is required to compensate for the distortion in the printed image resulting from the metal forming operation where different areas of the metal sheet are stretched or compressed to varying degrees. This distortion has to be allowed for in the origination and simply speaking a distorted image is printed on the sheet, which corrects itself as the final shape is produced. Most competent can makers have this capability in-house or have access to external trade-houses. Much of the technology is proprietary since the target market is highly competitive, and quality and overall capability determine who gets the business. Consequently, the technology can only be dealt with in outline here.

There are four basic ingredients for successful distortion printing, which are:

1. The right metal specification must be used and this will have low and predictable earing (anisotropic) characteristics and good elongation properties. It is essential to have good, even and reproducible metal distortion characteristics to provide a consistent quality image. As a general rule, however, aluminium is much easier to use than steel although of course steel is stronger and gauge for gauge is usually cheaper.
2. Accurate and hard tooling should be used—it is not appropriate to continually regrind soft tooling.
3. Surface coatings and inks with good flexibility and gloss-retention after forming must be specified.
4. A modern and comprehensive graphics package must be available.

It is also important that both customer and supplier understand the scope of the technology and work together on the design to be distortion printed. Certain design features are best avoided such as horizontal circumferential lines toward the top/open end of the container because these can quickly become slightly wavy. Halftone areas must be approached with care since distortion may change screen angles sufficiently for moiré patterns to appear. Stochastic screening (see Chapter 2) is a potential solution to this problem and should extend the capabilities of the distortion printing process.

The principal stages in developing origination for distortion printing are:

1. A regular grid pattern is printed on to a flat sheet of the metal to be used for the final job, which is then formed into the required shape.
2. The total printed and now distorted grid pattern is then systematically analysed to assess the degree and directionality of the distortion of every square in the pattern.
3. The above information is then used to create a second but now predistorted grid pattern, which, when reprinted should give a regular pattern on the formed shape. If satisfactory, this information can be used to create 'distorted artwork' using the design to be printed on the package.

With a new shape of container several iterations may be required before a satisfactory result is obtained but with modern scanning techniques and software packages the results are increasingly reliable. Information acquired should be stored for re-use for other designs on the same shaped package and for establishing a database to assist with alternative shapes or minor changes in metal properties.

### *9.6.2 Printing of ends and closures*

The decoration of metal packaging components such as vacuum closures and ends, for example, sanitary or easy-open ends for food can be achieved in a number ways. Firstly, the can end is made (stamped-out) from large pre-coated and printed (for example by lithography or dry-offset) sheets. Secondly, they can be printed as single items using usually one of two methods—dry-offset or tampoprint.

Vacuum closures are more commonly printed following the sheet approach with special care being taken to ensure very precise register to the sheet layout to match the press-tooling layout. This is perhaps particularly important when only the top centre panel of the closure is printed, where any misplacement looks very unsightly.

Ends of all types can also be decorated by tampoprinting, where the image is transferred from one of a number of compressible rubber pads, which can be pressed into any recesses on the metal surface. Print quality is not of a particularly high standard. However, the better alternative is to use specially designed dry-offset machines, such as those made by Polytype America Corporation [1]. In these machines the ends are transported in pockets supported by a moving belt and can be printed with up to six colours. A schematic of such a machine is shown in Figure 9.10. Closures such as deep-drawn (aluminium), roll-on

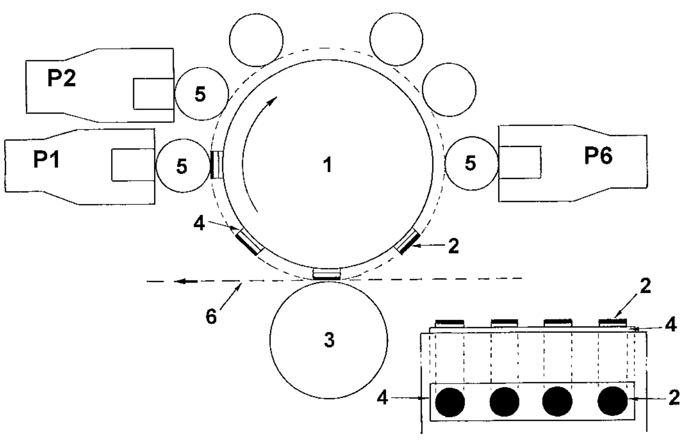


**Figure 9.10** Dry offset printing of ends: (1) blanket cylinder; (2) blanket; (3) counter-pressure cylinder; (4) raised blanket segment; (5) printing plates; (6) pocket transport system for ends; (P1-P6) printing units.

pilfer-proof as used on spirit bottles, are normally printed on dry-offset machines of the type used for straight-sided containers.

### *9.6.3 Heat transfer printing*

A number of attempts have been made to enhance the print quality on made-up containers including a number of varieties of heat transfer technologies. Among the most significant are the Dennison process [2] and the Metal Box Reprotherm process [3]. As far as the author is aware, only the latter has been used commercially to any extent for beverage cans. The process involves the printing of a paper carrier with specially formulated inks where the colorants are sublimable dyes. The carrier/label is held in intimate contact with a pre-coated and varnished can, which is then heated to around 200°C, at which temperature the dyes sublime and migrate into the coating to produce a permanent and very high quality image. The paper carrier is then removed and discarded (which is an inherent cost in the process). Given the ability, through digital printing technology, a varied range of designs could be printed on one reel of paper carrier to give a commercial opportunity of having a random range of decorated cans.

### *9.6.4 Ink-jet printing*

Ink-jet printing warrants only brief mention in this text since its principal application is for coding of packaging (e.g. manufacturing/filling location or 'best-before' dates), using equipment marketed by companies such as Domino, Image, Elmjet and Video-jet . It has been suggested that the intrinsic advantage of non-contact printing, where surface topography can perhaps be ignored, may be more widely exploitable but this is unlikely to occur to any significant extent in the short term.

### *9.6.5 Silk screen printing*

Silk-screen printing has been used in at least two locations (South Africa and the UK) for metal decoration. In the UK it was used for the production of coloured lids for emulsion paint cans, which has since been abandoned. This is worth remembering since the process allows thick uniform ink films to be printed and with the advent of UV curable inks the process could be extended via the use of finer mesh screens.

## 9.7 Direct print or labels

An analysis of the metal packaging market will show that while large segments, such as beverage cans, use directly printed containers' others, such as heat processed food cans, are predominantly paper-labelled. There are of course some very good reasons for this situation. Print run lengths for carbonated beverage cans are commonly very long (several million to several hundred million in the case of a brand-leader in soft drinks) and perhaps the economics of DWI can manufacture, being a more recent technology, are better understood. In the case of food cans, the markets are more fragmented and importantly more seasonal and less predictable in terms of crop size, for example. In this market, paper labels, although more prone to damage or loss, offer more flexibility and significantly lower inventory costs. Additionally, as cans have become thinner they have become beaded and the beads do not always complement a direct printed design. Paper labels are cheaper—the cost of full direct printed decoration on a can may be two to three times greater. However, the use of the latest metal printing technology will have a significant impact on this cost, making direct printing more competitive with paper labels. An alternative to paper labels is the use of plastic shrink sleeve labels (see Chapter 7) which can be applied to both beverage and food cans, provided care is taken to ensure the cans are suitably protected (with suitable external varnish) and completely dry before the sleeves are applied.

## 9.8 Environmental and toxicological issues

There are a number of issues, concerning the toxicological status of materials used primarily in the decoration of metal packaging, of which both the manufacturer and customer need to be aware.

### *9.8.1 Food contact issues*

Regulations controlling the use of materials, which are permitted to come into contact with food, exist in most countries. The US FDA regulations are perhaps the best known and have certainly been the reference standard in the industry for many years. External decoration does not strictly have to comply with this type of legislation but in fact most manufacturers of surface coatings use 'approvable' materials wherever possible in order to avoid, for example, inadvertent cross contamination when sheets are stacked. Inks, by and large, are not suitable for direct food contact because very few pigments are permitted, the notable exceptions being titanium white and certain grades of carbon black. This needs to be taken in to account when printing promotional offers on the inside of food packaging.

### *9.8.2 Heavy metals*

Heavy metal pigments, such as those based on lead and cadmium, have been widely excluded from packaging for over 25 years. A good guide to suitability is legislation relating to the decoration of childrens' toys.

### 9.8.3 *Potentially toxic materials*

There has been much recent concern about the possible toxicological effects of compounds entering the food chain and about food contaminants potentially derived from materials used in the internal protection and external decoration of food and beverage cans. Amongst the highest profile have been bisphenol A and BADGE (bisphenol A diglycidyl ether), phthalate plasticisers and alkyl/alkoxy phenols, all which occur or have occurred in metal packaging coatings of various sorts. The following can be regarded as useful guidelines:

1. Contamination of internal coatings can result from external decoration, for example, during the oven stoving processes.
2. The worse extraction scenario is likely to be in the case of heat processed foods. Packaged dry products, such as powders, are unlikely to be a problem from an extraction standpoint, but odour pick-up may be an issue in some cases.

### 9.8.4 *Atmospheric pollution*

On a global scale metal packaging would not be regarded as a major polluter in comparison with many other industries. Nevertheless world-wide there is pressure to reduce, for example, solvent emissions to atmosphere and discharge of other waste products. Manufacturers of metal packaging must establish clear strategies for compliance to existing and emerging legislation, and should seek the opportunity to review these with customers, especially where changes in the materials that can be used become necessary. Low and non-polluting (both compliance and abatement) technologies exist and continue to be developed. These will ensure continuity of supply to the metal packaging markets, but are unlikely to be introduced without some cost penalties.

## 9.9 Shaped containers and special effects

### 9.9.1 *Container shaping*

It has long been possible to complement direct printing on metal with embossed designs although this process has been restricted to the general-line/fancy-box market; for example, tins for biscuits, cakes and promotional packs for bottled spirits. The embossing is achieved by forcing the metal into a shaped die and stretching the metal as the design is formed by the shape of the die. The technique has more recently been extended into the processed food and other markets, again using metal stretching but this time utilising expanding mandrels inside a welded (or earlier a soldered) cylinder to which ends are subsequently fixed. Such containers have been relatively common in French and German markets, particularly for syrups. The most recent developments have been again in the food and (two-piece) beverage markets where both metal stretching (shapes) and folding (flutes or embossed patterns) techniques have been employed. Currently, DWI beverage cans can be stretched by around 10% into symmetrical or non-symmetrical shapes at high speeds (over 1000 cpm) using either pneumatic or hydraulic pressure. These technologies are an interesting approach to achieving product differentiation, but the marketing strategies that will ensure extensive exploitation have yet to be established.

### *9.9.2 Special effects*

A number of techniques can be employed to impart both functional properties and novelty effects to decorated metal packaging. The more obvious, functionally, are gloss (including slippiness) and durability. These are relatively easily achieved by the application of highly lubricated varnishes where, for example, waxes/silicones migrate to the surface when the varnish is stoved. Conversely matting agents can be included that give low gloss or non-slip properties for products such as place-mats, coasters and waiter-trays.

More complex single and double coat varnish systems can be used to produce novelty effects. One example is the use of overprint varnishes, which 'craze' or wrinkle on stoving to give the effect of age on, for example, a reproduction of an 'old master' oil painting. This type of effect can be achieved by using formulations where various components dry at different rates or where a degree of incompatibility can be introduced. Another interesting effect occurs when de-wetting is intentionally introduced so that raised droplets appear on the dry surface of the decoration giving, for example, the appearance of condensation on a cold surface. Unfortunately, a disadvantage of this type of surface effect may be a reduction of can mobility on high-speed filling lines.

The metal itself can be used to complement printed decoration and some examples include the mechanical brushing of aluminium impact-extruded aerosols prior to decoration and the use of especially finished tinplate (e.g. stone-finish).

## References

1. Polytype America Corporation, Union City, New Jersey, USA.
2. Avery Dennison Co., Cumbernauld, Scotland, UK.
3. Reprotherm, Patents GB 2,2101,530; GB 2,147,265; GB 2,145,971; GB 2,145,972.

# 10 Direct printing on glass

A. Hartley

## 10.1 Introduction

### *10.1.1 Technical*

The intrinsic properties of glass have made it the preferred packaging material for food and drinks since it was discovered over 4000 years ago by the Egyptians. These properties are still as relevant as ever to today's health conscious consumer. Glass is totally inert and preserves food and drink without taint, over long periods. Glass packaging protects the contents fully from ingress of oxygen, and is resealable for consumer convenience. Glass can be sterilised, pasteurised, retorted, hot filled, aseptically filled and even used in the microwave! More importantly, glass can be moulded and decorated to create brand icons which span generations and continents. It is this combination which has maintained the appeal of glass over such a long period.

### *10.1.2 Consumer perception*

Our research continues to highlight the emotional connection that consumers make with glass. They actively enjoy the look and the feel of glass. A product packaged in glass is perceived as high quality, a luxury and worth the payment of a premium. Glass is clearly understood to be natural, pure and untainted, while other packaging materials carry connotations of chemicals and interaction between product and packaging.

In social situations, consumers want to be seen with a glass bottle on the table or drinking from a glass container. The container reflects positively on the consumer in an emotional but powerful way.

### *10.1.3 Environment*

There are environmental benefits in choosing glass packaging. Glass is 100% recyclable, without any loss in quality, no matter how many times it is recycled. The glass container manufacturing industry recover used glass containers through the bottle bank system. The glass is crushed and cleaned, then used as an alternative raw material to create new glass packaging. After remelting and forming, the container is as pure and clean as a container made from virgin raw materials. The temperatures inside a glass furnace are so high that any decoration materials are vaporised and do not affect the quality of glass produced.

Putting recycled glass in the furnace reduces the amount of energy used to melt the glass. It also reduces quarrying, pollution and landfill. These benefits have led the glass container industry to recycle as much glass as possible long before environmental issues were considered, as a matter of good business practice. Glass is a long-term, sustainable choice for packaging.

### *10.1.4 Design*

The basic glass container manufacturing process has remained basically unchanged since the late 1700s. The process has been refined and developed to an amazing level. It is now possible to create a glass container in virtually any shape from the standard beer bottle produced in 100s of millions to a soldier (complete with moustache), a car, a spinning top or a peacock. The basic process, its potential and its limitations remain the same, the last being one's imagination and the depth of one's pockets!

There is an array of decoration techniques available. These can be split into direct, screen printing, colour coating and indirect, labelling or sleeving. However, by the end of this chapter we will see that this distinction is now being blurred by processes such as pressure sensitive labelling and thermal transfer. The direct decoration processes are so called because the graphic design is applied directly to the glass surface and becomes a part of the surface. Direct decoration becomes intrinsic to the container and more importantly, intrinsic to the brand which communicates its values and personality through its packaging.

## 10.2 Properties of glass relevant to direct decoration

### *10.2.1 Positive properties*

Glass is inert and stable; it reacts with neither acids or akalines. If pigments are fired into its surface they become integral to the material and cannot be removed. The surface of glass containers is smooth and non-absorbent. Glass containers are rigid, strong and hold their form throughout all types of mechanical handling, product processing and decoration without any need for support.

The variable degrees of transparency of glass, its opacity, colour and shiny surface are ideal for decoration. The interplay of reflection and refraction allow for complex and elegant designs which are highly prized by marketers.

### *10.2.2 Negative properties*

If high impact forces are applied then the glass containers will break in the decorating machine or in later processing. In early decoration machines the wastage was a significant element of the cost base of decorated containers.

Glass containers are produced in all manner of shapes and sizes which has created many problems for the makers of decorating machinery. Glass containers are also subject to surprisingly large tolerances on key handling dimensions such as the body diameters. On a standard 330 ml beer bottle with a body diameter of 60 mm the standard tolerance is $\pm 1.1$ mm. Any decorating machine trying to print separate colours in registration will have to cope with bottles occasionally as large as 61.1 mm and as small as 58.9 mm.

There is also likely to be a degree of ovality on the body that is most often caused by the bottle 'sinking' back at the mould seams after being taken out of the blow mould. At this point in the manufacturing process the bottle is still glowing hot and malleable.

The bottle or jar will also have mould marks from the blow mould. These are two vertical lines on the glass surface at 180° to each other. Normally these are visual marks only, but as with any blow moulded container, they can be slightly raised, enough to break up any applied decoration. All direct decorating techniques have been developed to exploit the positive attributes of glass and to cope with the negative aspects.

### *10.2.3 Glass colour*

Currently in the UK glass containers are produced in three standard colours: flint (clear), amber (brown) and green. Decoration is applied to all three colours using the same methods. Special furnace colours are produced in 'campaigns', a limited period of around two to four weeks in which different colours are produced. Typically these campaign colours would be dark amber used for cream liqueurs, light amber used for beers or lagers such as Holsten Pils, dark or 'Antique' green and light green or 'Autumn leaf' used typically for wine. The most talked-about campaign colour is blue; light and dark blues are created by adding cobalt to the glass mix. Typically used for mineral water, it was famously used in the UK to resurrect the Harvey's Bristol Cream Sherry brand.

These colours have a higher cost associated with them because of the period of transition into and out of the colour required. These transition periods can typically take two to three days as the correct colour feeds through the 300 or 400 tonnes of glass produced by the furnace each day. During this time the glass colour is unpredictable and usually cannot be used. A single furnace may have up to four glass container-making machine lines running off it. All of these machines will be producing containers from the same glass and therefore during transition all of them will be out of production. Hence it is relatively more expensive and creates less flexible production by pigmenting glass within the furnace.

A more flexible option has been developed to cope with these difficulties, which is to add colouring chemicals to the glass in the forehearth. This is a narrow, shallow channel which feeds glass from the furnace to above the bottle-making machine. The forehearth must be specially adapted for this process which is generically called 'Colourama'. The colouring chemicals or 'frit' can be used to create a wide range of colours such as blue, red and yellow. This process affects only one bottle-making machine at any one time and so is more cost effective. The basic colouring materials are unfortunately expensive and required in quite large amounts.

Specially coloured glass has no effect on the recycling properties of glass. Coloured containers should be recycled in the green section of the bottle bank along with other containers. Glass colour has a profound effect on the success of any decorated brand, and it is important to consider the base colour of the glass at the start of the graphic design process.

## 10.3 Direct decoration on glass

### *10.3.1 Colour coating*

Colour coating techniques involve spraying pigments onto a container and 'firing' (heating) the container to ensure the pigment becomes integral to the surface. There are a wide range of dramatic decoration options offered by this process. However, there is a high cost associated with this method: the cost of the colour coating is approximately equal to the cost of the glass bottle itself.

### *10.3.2 Ceramic spray*

Ceramic pigments are sprayed onto the containers using a solvent-based carrier. Usually the container should not have been cold end coated (a normal coating process for plain glass containers), or have had their cold end coating removed. This is a common source of problems and should be checked out at the start of any new product development featuring a sprayed container. The bottles are usually held upside-down in a 'puck' which covers the neck 'finish' or the threaded portion of the bottle where the cap is fitted. The bottle is rotated and sprayed from the side. The base is not usually coated although this can be achieved by some systems. The colour range available is not as wide as that of organic coatings, but covers most common requirements. The level of transparency can be varied from complete opacity to a coloured tint. The surface texture can also be varied to create effects similar to acid etching called 'spray etch', or can be as smooth and shiny as the original glass surface. The bottles are first dried, then fired at 600 to 650°C. The pigments fuse into the glass surface and develop some resistance to scuffing on filling lines and in transit. They are also resistant to all heat processes after application (Figure 10.1).

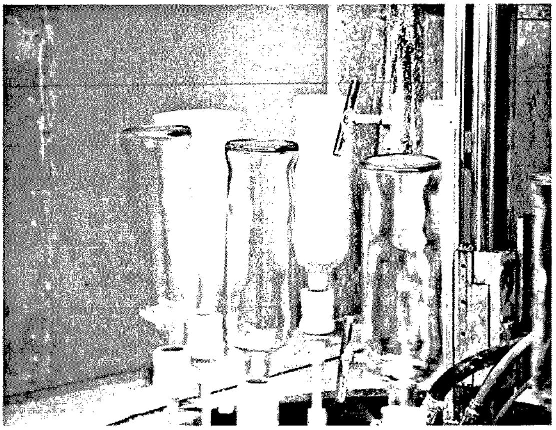

**Figure 10.1** Archers Peach Schnapps bottles being coated.

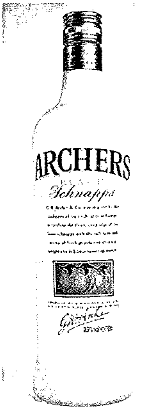


**Figure 10.2** Archers Peach Schnapps after printing.

Particularly dramatic effects can be achieved by combinations of coatings and screen printing. In brands like Archers Peach Schnapps the decorative effect has become synonymous with the brand and the category (Figure 10.2). For other brands to launch into this market requires the use of a similar effect, for example, Newton's Apple Schnapps.

If screen printing is applied over a coated container the resulting colours will be less vibrant than those applied to bare glass. This particularly applies to metallic inks which will appear matt on a coated bottle. This can be alleviated by printing a clear glass layer under the metallic ink, to produce a smooth surface for the metallic ink. This, however, takes up a colour station on the screen printing machine.

### *10.3.3 Organic spray*

Organic sprays use water-based pigments and are available in a vast range of colours, textures and levels of opacity. They use the same application processes and are fired to cure the coating. The firing temperature is 150°C and so less energy is consumed than when firing a ceramic coating; however, the cost of the pigments themselves is high. The resistance to scuffing in transit and on filling lines is less than that of ceramic coatings as the pigments lie on the glass surface like a layer of paint rather than being fused into it. Typically used for high quality spirits, premium beers and ciders, it is often possible to see containers with 'polished' rings on the bottle-to-bottle contact areas. With textured or matt finishes this effect stands out and detracts from the intended brand image. Shiny coatings tend to suffer less from this problem. Coated bottles can arrive on shelf without any scuffing or damage if they are handled carefully during filling and are transported in divisioned cartons or bulk trays with dividers during transit. This extra protection adds cost to the packaging because of the extra materials and labour required.

Organic coatings are now also being developed for packaging applications which offer metallic effects in all colours. These have flakes of metal within the coating to provide the slightly sparkling effect. The material used is basically the same as that used in metallic car paints. These coatings are being developed by companies like Merck Pigments who provide colourants to the automotive, plastics and printing industries as well as the packaging industry. Also now available are two tone colour switching effects: as the bottle is turned in the hand the tone or colour changes. Similar pigments can also be used to create pearlescent effects.

Pigment development is also now being extended into thermographic inks which change colour depending on temperature. Colour choices need to be researched with the supplier as they can be limited, but it is possible to specify the desired colour change, over the desired temperature range. This effect has had some limited use in indicating when products are correctly chilled, but as yet has not been used as a significant part of any well-known brands. The coatings are sensitive enough to leave a clear hand print on a bottle after taking a single drink.

These 'special' effects can be applied to glass containers only in organic inks. Such effects should be considered as developments, and detailed research will be required with the packaging manufacturers to ensure the effect produced is right for the brand.

Enhanced inks are now used in a wide range of printing technologies. These inks are highly reflective to light and appear to be brighter than normal inks.

They can be used to create subtle effects or dramatic images which attract the consumers' attention. These inks have been used to create bottles and graphics which glow under fluorescent lights. They have an increased cost but can create dramatic effects in locations such as night clubs where image and visual impact are essential for any brand to be successful.

Combinations of organic coating and screen printing are again capable of creating very powerful brand images. With organic coatings, organic screen printing inks must be used. The firing temperatures required for ceramic inks would adversely affect the organic coating. Organic screen printing inks have been developed which complement the range of organic coatings available.

### *10.3.4 Metallic coatings*

Truly metallic coatings are also possible—effectively, a mirror finish can be achieved. This is produced by first coating the container with particles of aluminium to build up a base silver layer. The aluminium particles are attracted to the container by applying a positive electrostatic charge. Once the silver layer is created, a second varnish coating is applied to give the metallic coating a colour if gold, bronze or any other colour is required. These special coatings are more expensive because the materials required to produce the effects are themselves expensive (Figure 10.3).

### *10.3.5 Acid etching*

True acid etch is a technique produced by a small number of decorators in the UK, such as Stolzle Flaconage, largely because of stringent health and safety


**Figure 10.3** Coated bottles.

regulations. Across Europe it is more widespread because of the more extensive cosmetics and brandy industries. The effect is created by dipping the container in hydrofluoric acid. The resulting container surface has a soft, luxurious feel which is impossible for the consumer to ignore once the container has been picked up off the shelf.

### *10.3.6 Polymer coatings*

Driven by the need to strengthen glass containers to reduce breakage and allow further reduction of container weight, the glass industry has been active in developing strengthening coatings for bottles. These coatings have developed along two main routes: 'polymer coating', which uses an ultra-thin plastic coating, and 'case gobbing', which uses two separate glass layers to achieve the strengthening effect. These coatings also provide the option of adding colour to the container, and have had some limited commercial use in America and Germany. They are seen as the way forward for glass containers for high volume brands.

As these coating technologies become established it is possible that lightweight coloured containers will be available without the limiting factor of high costs. These lightweight containers would allow the use of existing decoration options and have no impact on the recyclability of the containers.

### *10.3.7 Screen printing*

The basic screen printing process as it relates to glass containers is very similar in its principles to all traditional screen printing. A piece of fabric or metal (the 'screen'), incorporating the design, is stretched around a frame. Pigment is forced through the design by a 'squeegee' and so is applied to the surface below. This process is repeated for screen printing on containers, the difference being that the movement of the squeegee or screen is coordinated with the bottle, held at both ends, being rotated under the screen. Traditionally the screens were made of wood which gave a degree of flexibility to accommodate slight differences in the bottle size and positioning.

Screen printing is restricted to container surfaces which are flat in at least one direction. The slight flexibility of the screens does allow the printing of very slight compound curves, but this flexibility should be used with great discretion as print problems are often caused by too great a degree of compound curvature.

The earliest screen printing machines still used for decorating packaging are simple semi-automatic machines which require the manual loading of a bottle into a 'jig' on a rotating spindle. This spindle holds the bottle with a base chuck and counter point and is then rotated round underneath the printing screen and squeegee until the bottle is printed. The rotation is synchronised with the surface of the screen moving over the bottle surface. The operator removes the bottle and places it into the decorating lehr. The lehr is a long covered tunnel through which passes a slow-moving metal chain link conveyor which carries the bottles. Inside the tunnel are gas jets which heat the container up to the firing temperature of the inks used and then slowly reduce the temperature again (Figure 10.4).

These machines are still extensively used today under the generic name of 'Dubuit' semi-automatics, mainly in the cosmetics industry where high quality, accurate print is required for small volumes of exclusive, high value brands. These simple machines can decorate shaped bottles as well as round ones. The base chuck has a double dimple location device which orientates the container to present the appropriate face to the screen for printing. With round containers the double dimple will still be used to locate the decoration away from the witness marks of the mould split lines on the container side wall. However, these machines can print only one colour at a time. Using traditional ceramic inks which are applied wet ('cold' in printer terminology), most designs are limited to single colours. If wet inks are used, each ink requires firing before another ink can be applied. If the ink is not fired, then attempting to print another colour over or next to it smears the first colour. Firing each colour separately is obviously extremely costly and time-consuming. This provided a great incentive for the development of a viable method of printing more than one colour at a time.

The solution was found in the use thermoplastic inks, now widely available and commonly used where multicoloured designs are required. Thermoplastic

**Figure 10.4** Dubuit machine in use.

inks are dry and solid at room temperatures, but when heated they become thick liquids, ideal for the screen printing process. The thermoplastic inks are heated on a stove until they become liquid and then placed on the screen as normal, and a electric current is passed through the stainless steel screen. This continues to heat the inks to keep them liquid and allows the squeegee to push them through the perforations of the screen on to the rotating bottle. The glass bottle is relatively cold so the inks chill on contact and become solid again. This allows the bottle to be manually passed to another machine (in the case of semi-automatic machines) and another colour ink applied alongside or over the first without smudging. The inks are not yet part of the bottle's surface; only after heating to 600–650°C do the glass particles within the pigments fuse to the surface of the bottle and become tough and scuff-resistant.

If true metallic colours are required in the design the inks used must contain real precious metal and are obviously expensive as a result. These inks have firing temperatures of around 450 to 470°C and so must be applied after other colours and fired separately, further adding to the cost.

The printing registration between each colour is typically 0.5 mm to 1.0 mm in these semi-automatic machines and is dependent on the base chuck picking up the two small recesses or dimples in the bottle's base. This method of physical location results in the bottle being presented slightly differently in each machine which gives the low registration. Because of this technical limitation screen printing designs have traditionally been simple, bold designs using limited colours.

The first automatic screen printing machines were produced by 'Strutz' and would typically allow four colours to be printed with six colour machines also being produced. To print different colours the screen printing process is repeated on separate stations, each with an individual screen and colour. The bottle is transferred to subsequent stations by a chain-driven mechanism which repeats the action of rotating the bottle under the moving squeegee as before. The print registration remains high with this type of machine as the bottle is mechanically orientated at each station, as it is passed from station to station, colour to colour, which allows slight movement in the positioning of the bottles. The individual colour stations of the machine are configured in a linear set-up. The machines are often limited to round containers though shaped ware can be decorated by some machines. This needs to be established by the pack designer at an early stage.

If designs are required to be printed on the front and back of the body as well as on the neck, then each colour on each separate part of the bottle requires a separate station on the printing machine. For example, a standard beer bottle, requiring a front and back label print and a neck label print could typically have a two colour front label and a single colour back and neck label. On a four colour machine this would be the limit of the machine.

Designs that are printed by this type of machine are usually simple, bold, and rely on strong design rather than complexity or high numbers of colours. Print registration is around $\pm 0.5$ mm.

Typical brands which are produced using this type of process are Sol or Carib in the beer sector, and Fanta and Coca-Cola in the soft drinks market. After firing, the pigments become bright, bold graphics which are tough, scratch-resistant and capable of withstanding all heat treatments such as pasteurisation and retorting. They have a slight texture and an inescapable quality which remains true today even though other alternative techniques have been developed.

This process produces decoration tough enough to be used on returnable containers. This style is still extensively used in Africa, South America and the Far East for returnable soft drinks bottles like Coca-Cola, Pepsi Cola and Fanta. In returnable systems, the disadvantages of high cost and limited production capacity suffered by screen printing are offset by a container which can be used many times.

Even in Europe, which has a wide range of more sophisticated screen printing options, these machines are still used to decorate some of our most famous brands. The big advantage of these machines over the semi-automatic option is increased output, though this is often governed by the reliability of the machines, the extended set up times and the throughput of the lehr.

The traditional ceramic inks are mixtures of low melting point glass, colouring agents and solvent to hold the pigment together. These inks require firing at around 550 to 600°C which uses large amounts of energy. Originally these ceramic pigments contained heavy metals to obtain the depth and vibrancy of colour required. All colours contained lead but in particular red and yellow pigments would contain cadmium and lead. With the advent of restrictions on the use of heavy metals in packaging, alternatives have had to be found. Red and yellow colours are still available but do not have the resounding vibrancy of the traditional pigments. This should not stop designers using these colours if traditional ceramic inks are to be used, but it should be understood that the colour will not have the depth of the traditional pigments.

Creating a bright white design can also be difficult if the white design or text is to be printed over another colour. In this case it is often better to print an area of white as the first colour. This is then overprinted with the coloured design which has the white design or text masked out on the screen. In this way the white design or text is still created but is not overlying the colour print which would diminish the purity of the colour (Figure 10.5).

It is also important for the packaging designer to consider the graphics and glass bottle as a whole. The distorting effect of the glass and its contents on the rear label can often destroy the intended effect of the screen printed front labels when viewed from the front. This is a common design mistake; rear labels should be smaller than front labels and bar codes should be positioned on the side of the container if possible.

The solvents used to carry the pigments are now also subject to greater restrictions and controls from improved health and safety standards, which has the effect of increasing the cost of the decoration.


**Figure 10.5** White lettering created by over printing the darker colour.

As a result the cost base of this type of decorating machine would be high. The glass industry uses a 'rule of thumb' that the cost of screen printing will add a further 80% to 100% to the cost of the glass container itself (Figure 10.6). This high cost relates to the labour intensive nature of the process, the high levels of machine down time and the extended set up periods required to get these machines operating at the required quality levels.

The pigment materials themselves are relatively expensive and require high 'firing' temperatures, which necessitates high energy consumption. These machines have a high level of wastage which results in a low overall efficiency.


**Figure 10.6** Screen printed bottles.

The output rates of these machines remain a limiting factor when compared with the volume of containers required by mainstream brands. This requires storage of containers before and after decoration.

The screen printing process in this form has remained the province of premium, niche or high value products like cosmetics and spirits. Virtually all glass manufacturers have this facility but machines are not always fully utilised which further added to the costs associated with the process. Around 15 to 20 years ago screen printing of this type was a common alternative to paper labels for bottle decoration. With the increase in alternative packaging materials the competition within the packaging sector has increased resulting in greater demands on decoration to differentiate brands at lower costs than previously possible.

Screen printing machines have developed rapidly over the last ten years. Around six years ago fully automatic machines providing up to six screen printed colours became available, these machines can also be combined with additional stations utilising different printing techniques, such as hot foil blocking.

Recent developments have taken this further with eight colour machines now available. The drive for decreased unit cost has resulted in a 'double gob' system being developed to increase the output. Two bottles are loaded, printed and unloaded simultaneously, resulting in output rates of 120 bottles/min. The engineering of the machines has been improved to increase the length of production runs possible between maintenance, to increase efficiency, and repeatability of production. If fewer colours are used in each design the output rate can be increased.

Increased accuracy of print registration has been achieved by developing mechanisms which hold each bottle throughout the print process for all colour stations. These machines are now usually based on a rotary machine with printing frames arranged around the outside with the bottles held continuously underneath. This allows intricate designs to be printed in exact tolerance and equates to full halftone images being printed (Figure 10.7).

These high tolerance machines can be set up to print in between the mould seams on a glass bottle. This requires one of the colour stations to be used to orientate the bottle mechanically. It is then held continuously in this position throughout the rest of the printing cycle. Automatic machines are also often capable of printing the neck and body of the container simultaneously, which means neck or back labels do not necessarily have to use fewer colours than the front.

These machines have, in some cases, been adapted to print shaped containers, usually by employing a 'puck' system which holds the container in the required orientation while the puck and container are transferred between the various colour print stations. Such machines are generally designed for decoration of smaller cosmetic type containers.

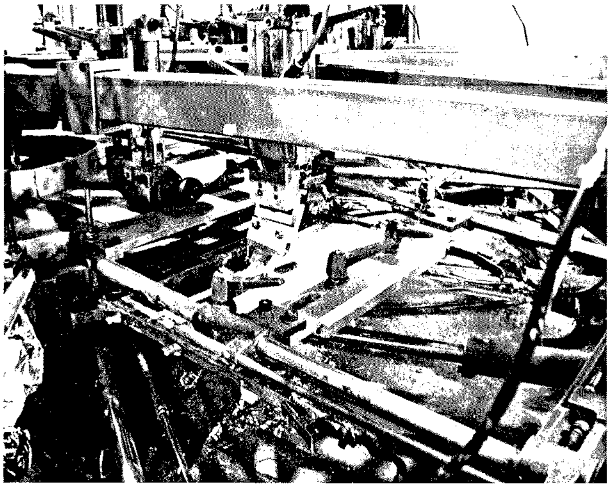

**Figure 10.7** Automatic rotary screen printing machine.

The number of decoration processes available to packaging designers working with glass has also increased. Sleeving, pressure sensitive labelling (PSL) and advances in paper label technology have provided further competition for screen printing.

### *10.3.8 Transfer decoration*

As a further consequence of the limitations of the screen printing process, the technology of transfers has been preserved. Here the decorative design is printed on a backing material which will release the inks when soaked in

**Figure 10.8** Transfer decorated container.

water or heated. Because the image is printed flat, in the normal way, highly intricate designs are possible which use real metallic inks and multiple colours. The transfers are positioned by hand and then fired as in the other decoration processes (Figure 10.8). The cost of this process is high and the output capacity is limited, but the quality of print and resulting image is the ultimate in premium packaging. This process is limited in its applications to luxury spirits and cosmetics.

## 10.4 Ink developments

Two major areas have been the subject of a great deal of innovation by manufacturers:

### *10.4.1 Organic inks*

The development of organic inks has increased the range of colours available to designers. These inks have no heavy metal content and are water-based, reducing the volume of solvents used. These inks are not suitable for use with multi-trip containers which are subject to caustic washes. The organic inks allow finer printing meshes to be used allowing more intricate, finer designs. The lower firing temperatures of 140 to 150°C require less energy but produce a decoration effect which is less resilient to scuffing.

### *10.4.2 Ultraviolet inks*

Within the specialist area of inks and pigments most significant has been the development of UV (ultraviolet) curable inks. Developed by RevTech, USA, part of the Revlon group, one of the world's biggest users of screen printing decoration on glass containers, these inks are environmentally friendly and do not require 'firing' in a decorating lehr. The use of UV lamps at each print station mean that the inks are cured before each subsequent colour is applied, opening up a whole range of printing possibilities. Print quality is improved by good registration, overlapping colour application is now possible and energy consumed by the process is further reduced. The technology is being used commercially on Revlon cosmetics and licensed to other manufacturers under the ENVIROGLUV trade name.

High performance versions of these inks are available which are suitable for returnable applications. Hot stamping with brilliant golds and silvers is also possible using the same ink material. Unfortunately the inks themselves are currently very expensive and this offsets the benefits. As competition increases between packaging materials and decoration techniques these costs are likely to be driven down.


**Figure 10.9** PSL decorated containers.

## 10.5 Pressure-sensitive labelling (PSL)

The drivers of unit cost, print quality and output rates have resulted in the development of alternatives to screen printing for major brands which want the distinctive and premium image of individual bottle shapes and decoration.

PSL bonds a label to the container which is printed on a clear plastic substrate. To remove air from under the label a squeegee is used to force the label down and bottles are preheated to ensure the adhesive produces a uniform bond between label and bottle. The print can be high quality gravure, with screen printing and hot-foil blocking added. The unit cost of PSL is reduced by reel-fed application speeds of up to 500 bottles/min. The premium appearance produced has allowed PSL to capture many brands which would previously have been screen printed, and the lower unit cost appeals to many brands seeking to improve their image over and above that of their paper labelled competitors. PSL however, does not have the same feel as screen printing and the edge of the plastic label can disrupt the visual effect (Figure. 10.9).

## 10.6 Thermal transfer

The disadvantages of PSL have led to attempts to develop a process which can apply a pre-printed gravure or full halftone image to a container and then remove the substrate material all together. A technology which combines the benefits of screen printing, transfers and PSL is being sought by packaging designers, brand managers and packaging manufacturers.

**Figure 10.10** Thermal transfer decorated containers.

Avery Dennison have developed a thermal transfer decoration technology with machine manufacturer Krones. This technology is a fusion of the best elements of the other decoration systems. Thermal transfer technology, trade name 'Clear ADvantage', is a continuous web-fed rotary system similar to PSL. The image is full-colour process printed, including metallic colours, and then transferred by heat and pressure to the container. The backing web material is removed by the transfer roller, leaving no edge around the image. The inks used are organic but have a lacquer coating create a tougher surface than organic screen printing (Figure 10.10). The bottles printed require preheating to around 240°C and must be cured after application for 12 min at 280°C. Application speeds of up to 500 bottles/min are predicted with cost levels below the PSL option. So far this technology is unproven technically and commercially, and there are currently no thermal transfer machines in the UK.

# 11 Selecting suitable decoration formats

A. Emblem and C. Griffin

## 11.1 Introduction

The primary purpose of the packaging used for any consumer product is two-fold: to deliver the product in sound condition, and to communicate certain values and information about the product.

Delivery in sound condition is achieved principally by the pack structure; that is its format and the specification of the packaging materials selected. To deliver a product safely, the pack structure must provide total product protection from the end of the packaging line to final use by the consumer; it must offer a convenient way of using and, if necessary, dispensing the product; and it must meet these requirements at an acceptable total cost and environmental burden.

Communication of values and information is achieved principally by the decoration and shape of the pack. The requirements here are to sell the product and to provide factual and regulatory information about the product.

A successful product sale is achieved by a combination of pack structure and graphics, both contributing to the achievement of an in-store/on-shelf image that is:

- Visible—so that consumers notice the product;
- Recognisable—so that consumers identify the product as relevant;
- Appealing—to complete the purchase decision.

The total presentation of the pack structure and decoration combine to create a personality that is either a *brand* personality when the product is sold in many different outlets or a *product* personality when the product is produced for and sold by a single retailer.

The personality of a brand requires the pack decoration and structure to:

- differentiate it from competition,
- communicate product variants within a range,
- reinforce the brand name/image and sub-brand names/images,
- support the price required for the product,
- be relevant to the product,

and thus appeal to the would-be purchaser.

It is reasonable to assume that most packs on the market are aiming to perform against the above criteria and this chapter examines how a comprehensive range of consumer products addresses these requirements. It assesses the selection of packaging decoration and pack structures currently used in the UK and in selected overseas markets and the potential issues which arise. The space available naturally means some selectivity has been exercised in the products reviewed, although the authors have tried to cover all key product areas and as many different packs as possible.

The consumer market has been divided into product sectors: food (ambient, chilled and frozen), drink, cosmetics/toiletries/personal and healthcare, household and DIY products. Each sector is broken down into product groups, the examples given embracing premium products at one end of the scale and those with a mass-market or commodity image at the other end.

As the examples will show, this differentiation of product positioning and image is achieved via both the choice of packaging format and material, and the graphics, decoration techniques and colours used. While they are not inviolable, there are some generally accepted conventions which should be mentioned here for consideration by the reader. For example, glass used for bottles of mineral waters imparts a higher quality image than the plastic equivalents, while confectionery packed in rigid cartons/boxes places the products towards the premium end of the market, when compared with flexible bags. Also, printed metal tins have an established place in the speciality biscuit market, ahead of the carton, even though the latter may be printed with the same graphics, and a high-gloss lacquer to simulate the appearance of metal.

Colour has a very strong influence on how a product is perceived, as it is the first property the human being sees and registers, and there are some strong colour-mood associations within the human psyche. Rich, dark colours tend to convey a feeling of luxury and indulgence, or perhaps a level of sophistication to which the buyer longs to aspire, and hence are frequently used on premium products such as expensive chocolates, desserts or perfumes. In contrast, soft pastel colours denote care and concern; hence their wide use on the packaging of toiletries and personal care items. Light-reflecting effects achieved by using aluminium foil, metallising or foil blocking can also be instrumental in conveying a premium image, as well as textural effects such as embossing and frosting.

The role of colour in product positioning and in motivating a purchasing decision emphasises the importance both of selecting the optimum colours for a pack design, and of making sure those colours are faithfully maintained and consistent across a range of products and throughout the life of the product. Selecting the right colour requires a thorough understanding of the market, especially any differences in colour association between different ethnic groups: for example, white is traditionally associated with weddings in the Western world, whereas in some Asian countries white is associated with death. Maintaining good colour consistency is a function of control of manufacturing and printing processes and agreement on colour standards between supplier and customer, which is an essential part of the packaging development process.

## 11.2 Food

### *11.2.1 Ambient foods*

The following section describes in detail the various product types, pack formats and specific decoration considerations for the ambient foods sector.

#### *11.2.1.1 Baby foods*

*Glass jar/metal cap.* This pack format is very traditional and uses small, clear glass jars, usually with full wrap-around paper labels. The glass allows some product visibility, but the main graphic presentation is a full colour printed label, offering a reassuring image denoting goodness, purity and care, properties which are highly valued by the consumer in this sector. The tamper-evident metal cap contributes to the presentation of this image. Colour-coding is used in the graphics to differentiate products suitable for certain age groups, allowing the consumer to select the right product quickly.

*Tin.* This is another highly traditional pack format for this sector, and the graphic presentation is very similar to the above, with the obvious difference of no product visibility. The cans are now almost all coated inside and outside with a white lacquer, thus adding to the 'pure and caring' image and making a distinct point of difference between baby foods and other canned products. Full-aperture ring-pull ends are now common, adding to consumer convenience.

*Lined carton.* This format is used for dry products. The printed carton allows good graphic illustrations and stable and attractive presentation on-shelf. Again, colours and graphics are chosen to reflect the accepted image.

#### *11.2.1.2 Biscuits*

*Roll-wrap.* This format is confined to regular-shaped biscuits of a texture which can withstand the rigours of the automatic packing and handling processes without breaking. Commodity lines use clear or white film wraps, with minimal print, while others use highly decorative graphics. The film is printed in reel form by the gravure process (if the run length is sufficient to justify the high cost of printing cylinders) or flexography. However, as the printed film wraps are invariably not smooth, highly intricate graphic designs are not shown to best advantage and printed copy can be difficult to read. Until recently, this pack format has been notoriously difficult to open, but now the use of a clearly-visible tear-tape has improved consumer convenience. It is important, however, that the design does not obscure the tear-tape, which must remain obvious to the consumer.

*Flow-wrap.* This format is ideal for non-circular and/or uneven shapes and textures, which may also require a tray for product protection. The tray helps to regularise the pack shape and gives a reasonably flat decoration surface, compared with roll-wraps. Metallised films are often used to good graphic advantage and give a luxury image, as well as improving moisture, light and oxygen barrier and thus extending product shelf life.

*Carton.* Printed cartons offer greater possibilities than either of the above formats, both for graphic design, and presentation on-shelf, and convey a more luxurious image than film-based packs. Cartons stack well and offer good protection against physical damage. However, they do not generally provide protection against moisture ingress, and a film bag is required inside the carton for this purpose, thus increasing the overall packaging cost.

Figure 11.1 shows a variety of different packaging options for biscuits.

*11.2.1.3 Bread and baked goods*

*Bag.* Film is the main material used for bagged goods. It is usually transparent, but white opaque film is also used for brand differentiation, and also metallised film is being promoted for its quality of extending product shelf life. Good product display in this sector is a challenge, because the bags are often presented 'end on'. Also, consumers tend to handle several loaves before selecting one, so a display soon becomes untidy and unsightly. The closure is often a re-closable plastic tag, crudely overprinted with sell-by information, which contributes to the poor presentation for most brands. There is some use now of re-closable adhesive labels, instead of these tags. Where high gloss films are used, the uneven surface of the bag picks up reflections that distract from the brand communication.

Products packed warm, such as the important in-store bakery sector, need a breathable film to prevent the build-up of condensation (which could encourage mould growth, as well as obscure product visibility) and perforated films are commonly used for this purpose. In contrast to the commercial bakery products described above, the in-store sector tends to rely much more on the attractive appearance (not to mention aroma) of the product as a means of attracting the buyer's attention and any other form of decoration is unnecessary. Simple overprinted labels are used for legally required information, rather than strong branding.

*Flow wrap bag and label.* This is usually a clear bag, giving good product visibility, and a label to give limited branding and product information. Branding often suffers from poorly-presented digital print information on the same label.

*11.2.1.4 Breakfast cereals*

*Carton with inner bag.* This packaging format offers a large presentation area that is grudgingly accepted by the consumer as being greater than the product it contains. The quality of presentation is constantly rising in this competitive market, using good quality offset litho printing and high gloss varnishing, while maintaining the basic carton construction which has not changed much for decades. However, consumer convenience remains low, with opening, resealing, storing and associated instructions being generally poor. With regard to communication, the brand message is often confused by other promotions and distractions on the billboard format. Pack construction and consumer interface remains an opportunity for brand differentiation in this sector.

*Bag.* The bagged format does not carry branding well although an overall impression created by the printed bag can be effective, especially if a block-bottom construction is used, allowing the bag to stand up and be displayed to best advantage. Pillow packs are particularly poor for communicating brand information, as they are often displayed lying flat. For both formats, the uneven surface and reflections from high gloss films or lacquers can cause communication problems. Film selection is important, as the packs can be difficult to open, and once a tear is started, may split. Re-closure is generally not catered for which means the product is likely to be decanted into another container in the home, thus losing its branding altogether during consumer use.

### *11.2.1.5 Cakes and pastries*

*Film wrap (and cartonboard tray).* This packaging format is suitable only for firm, regular-shaped cakes, which can be stacked without being crushed. The decoration is usually confined to the tray where one is used, leaving the film clear for good product visibility. A 'home-made' image is likely to be important in this sector and graphics and warm colours are chosen to reflect this.

*Carton.* The carton protects the product but totally eliminates visibility, unless a window is used. Where this is the case, the product must be secured such that any decoration such as icing does not smear the window, as this can look unsightly and defeat the objective of offering product visibility. The printed carton offers good, all-round decoration potential, for eye-catching graphics, although stacking in store usually limits the visible display area to the carton sides. Variety identification is usually by well-accepted colour perceptions, such as yellow for lemon flavour or brown for chocolate.

Figure 11.2 shows a variety of packaging types for cakes and pastries.

### *11.2.1.6 Canned foods*

The can is the most traditional of the post-industrialisation pack formats and apart from endless lightweighting and constructional development it has not changed its overall presentation for decades, particularly in the consumer's perception. The one breakthrough in presentation and use has obviously been the full aperture ring pull end, which has a cost disadvantage and a real convenience advantage. This format will surely develop for all canned products, as it is much safer to use than the traditional can and can opener.

Some brands have tried exterior surface coatings with over-labelling although only interior coating of the can appears to have been retained in significant volume. Paper-based wrap-around labels are the primary format used, which has a number of issues for the brand. The cylindrical can needs to face forwards on the shelf and some stores will reposition products regularly. Some brands have tried designs that use two or three 'fronts' although this can restrict space for other information. The cans have ribbing in the body section, which gives the pack the required strength in the autoclaving process, but the ribs cause creasing which shows through the label, giving the design a shabby look. A few products have built the ribbing into the graphic design to disguise this problem.

As full aperture cans develop it is likely that squarer section cans will also be developed which will work better for on-shelf presentation.

*11.2.1.7 Coffee*

*Glass jar/plastic cap.* Glass continues to survive as the major packaging material in the instant coffee sector, because of its excellent oxygen and moisture protection and above all its high quality perception. (Of course, its barrier properties are only as good as the effectiveness of the selected closure.) Coffee is a very lightweight and expensive product so the weight of the glass has associated the product with good quality. A lightweight plastic pack does not currently convince the consumer of the quality of the product, or support the price positioning. Glass' real disadvantage of breakage is currently unsolved although sleeved products do offer some reassurance and there are some potentially useful developments in surface coatings. Expanded polystyrene sleeves have been tried but have not yet met quality or cost expectations. The closure is often a disappointment in quality terms and it has not developed much for many years.

Branding potential is offered via unique, custom-made jar shapes, coupled with labels, or by labels alone, using standard jars which are usually variations of a cylindrical shape. Labels can be full wrap-around, individual patch style, or shrink sleeve. Differentiation of coffee variants (strong, mild, decaffeinated etc) works best if strong, bold colours are used in the labelling and this can be maintained across other coffee products such as filter or percolator coffee.

*Vacuum brick-pack.* This format is used for fresh coffee and is enjoying good growth across Europe, as it presents the product neatly and protects well against moisture and oxygen ingress and flavour loss. It is also a cost-effective pack through the whole distribution system as it means little or no wasted space in outer packs. The decorative techniques are governed by the materials which can be handled by the automatic filling and packing process, and these are two or three-ply structures printed in reel form by the flexographic or gravure processes.

The visual appearance of aluminium foil or metallised film constructions is often used to great effect in the design, portraying the quality of the product from commodity to premium. The packs are very strong and stack well on shelf, with a good, flat presentation area for branding. One problem area with respect to communication is the rippling and wrinkling which can be evident on the surface of the film, owing to the vacuum, and this must be taken into account when determining type size and graphic detail, to avoid a confused and/or illegible presentation. Packs which use an overwrap (often paper-based) around a vacuum packed inner pack do not suffer from this problem, although overall economics must be considered here. Pack opening can also present difficulties, as the release of vacuum invariably allows a small amount of product to escape at the same time. Self-adhesive labels have been successfully introduced on many brands for resealing.

Figure 11.3 shows several packaging formats for coffee.

*11.2.1.8 Confectionery*

*Boxed.* In general, boxed confectionery is aimed at the luxury end of the market, the box giving an image of indulgence in its presentation. The use of rigid boxes is rare now, and most 'boxes' are really flat cartons erected on the filling line. The use of film overwrap is common, imparting tamper evidence and moisture and flavour/odour barrier, as well as contributing to the luxury image. However, wrinkling of high gloss films can detract from the graphics on the box, especially on display. Films which shrink on to the pack are better in this regard.

Printed boxes offer good potential for branding using colour and graphics, and display well on shelf. There is strong use of dark colours and foil blocking and embossing.

*Flow wrap.* Aiming at a different market and occasion, single-serving confectionery bars are commonly packaged using this format, often in metallised or pearlised polypropylene film. Chocolate is sensitive to light and hence product visibility can be detrimental to quality, so packs tend to be printed all over.

*Foil and band.* Chocolate bars used to be routinely packed in this format, using a folded, unsupported foil, secured in place by means of a printed paper band. Few UK brands have retained this pack, most having moved to the flow wrap style mentioned above. Where the foil and band is retained, the brand image is strongly presented with colour and typeface, and the paper band offers a crisp, flat surface for decoration.

*Film bags.* Printed film bags made on vertical form-fill-seal machines are routinely used for standard weight packs of confectionery. The films are often full-colour printed, obscuring product visibility and relying instead on graphic representation of the product for the required image.

The use of the Euroslot allows good store display, although where this is not used, display can be poor.

Figure 11.4 shows a selection of confectionery packs.

### *11.2.1.9 Cooking oil*

*Bottle and cap.* PVC and PET are the common materials used here, in conjunction with an adhesive label or shrink sleeve. Glass bottles are used for the more expensive and speciality products. The brand personality is often created predominantly by the structure of the pack or surface detailing, in combination with the appeal of the product visibility and a simple strong logo and imagery printed on the label(s).

Choice of closure is important: it must be reasonably easy to open and reclose; and it should dispense the product in an even, controlled and drip-free manner, avoiding unsightly stains down the sides of the bottle and build-up of congealed product around the neck.

*Metal can and cap.* The standard format in many countries is the rectangular built-up construction metal can with welded side walls seamed to a flat base and top. The side walls are printed in flat sheet form by offset litho and the process permits opportunities for good presentation and branding, often utilising the metallic finish to good effect. Embossing and over labelling can also be used to further enhance branding. This format can provide a range of product positionings from premium quality to basic commodity just through the design and the quality of the printing.

The cap can also be metal or plastic and should incorporate anti-'glug' and anti-drip features for consumer convenience. The cans present well on shelf, with a good, wide printed facing and stability in stacking. The rectangular shape tends to make them easy to handle in use.

### *11.2.1.10 Crisps*

*Bag.* The bagged format for snack foods such as crisps now mainly utilises metallised films, often combined with nitrogen flushing, to achieve maximum product life. The metallising cuts down the transmission of UV light (which catalyses rancidity, producing oxidation in fats); the nitrogen also reduces oxidation, and at the same time provides physical protection by way of a cushion around the fragile product. The metallic effect can be used to advantage in the design. The product is obviously no longer visible and inferior design, photography or reproduction can deliver poor product representation and branding. The bag shape means that all surfaces of the pack are uneven and fine type or long words can be illegible; this can be exacerbated in metallic designs. The bags are seldom displayed well and branding can be confused, with the consumer presentation being limited to the bottom third of the pack. The bags can be difficult for consumers to open, especially if there are no obvious starting points to tear the bag (such as a small nick in the sealing area) or if the chosen film supports tear propagation too well, resulting in the bag splitting and the contents being spilled out.

*Board tube.* In contrast to the film bag, the recent introduction of board-based cylindrical tubes has created a rigid pack format for consistent presentation and communication on shelf. The decoration can be foil or paper-based and the pack offers excellent re-closure although the lid has not yet been exploited as a part of the brand communication. The consumer has the convenience of easy opening via a plastic lid and peelable diaphragm, and easy access to the product through the tube aperture. At the same time the pack offers excellent product protection against physical damage and the tube and diaphragm seal specifications can be tailored to provide the required shelf life.

Figure 11.5 shows a selection of crisps and snackfoods.

#### *11.2.1.11 Eggs*

*Carton.* Almost all eggs are now packed in moulded pulp, fold-over lidded cartons. Surface decoration is limited to one or two colours, in simple line work, as a result of the absorbent and relatively rough surface of the packaging material. Printed labels provide greater branding potential and the moulded pulp can be coloured to enhance the overall image, although the natural grey colour can be exploited for its simplicity.

#### *11.2.1.12 Flour*

*Bag.* The most common format for flour is the block-bottomed paper bag that has left its product deposits on supermarket shelves, customers' clothes and kitchen floors and cupboards for many years. The excess flour is more likely to have come from a pierced bag, damaged in the distribution chain, than from poor forming of the bag. The material used is inexpensive and punctures easily. It has a basic, no-nonsense feel to it, which, from the branding viewpoint, is probably appropriate to a product that is seen as a commodity and in annual decline as fewer consumers bake. The pack is accepted by the consumer due to history and does not offer any help in dispensing the product or in re-closing and storage. The decoration is usually achieved via simple flexographic line designs, printed on the reeled paper, and is confined to bold branding and basic information. Presentation on-shelf is difficult, as the paper becomes creased in transit and the bags loose their shape.

*Lidded carton.* The Cekacan from Akerlund and Rausing offers a modern alternative to the commodity paper bag. This stand-up, rigid format is more expensive than paper bags, but consumer convenience, thanks to an easy-open and re-close feature, is far superior especially as flour is likely to be in the cupboard for many weeks. Also, the container can be refilled. The pack displays well with a wide frontage and offers good branding potential via the printed board wall section, and colour-coded lids to differentiate product variants.

*11.2.1.13 Fruit and vegetables*

*Bulk presentation trays (wood or board) for self-serve selection.* This presentation has great potential for improvement. Currently, branding is on the outer tray but is often obscured by the shelf fittings; tray print quality can also be generally poor. Depending upon the fragility of the product, the tray may have a protective paper or plastic insert designed to separate the products. These inserts can also be coloured to form part of a brand communication.

*Label.* Labels are applied to single fruits such as apples and tomatoes in open trays. This offers branding potential, as well as ease of recognition by staff at the point of sale, for correct pricing. However, they may also contribute to consumer annoyance if they are difficult to remove without damaging the fruit, or if adhesive residues are visible.

*Pre-packed goods in moulded pulp or expanded plastics tray, with clear film overwrap.* These offer convenience and protection, and effectively prevent the consumer from handling (and potentially damaging) individual items. Visibility is limited to a top view of the product. Communication is via the product itself and labels, which offer some branding potential, although this is usually recessive and inconsistent because of the variation in label placement from pack to pack. In particular, overprinted information can be crude and detract from the overall presentation.

*Pre-packed loose in printed bag.* Uneven product shape gives limited opportunity for decoration of the bag and communication is primarily via the product itself. Sometimes a header label in board or plastic is stapled to the bag and is used to carry brand and product information.

*11.2.1.14 Jams and preserves*

*Jar and cap.* The general requirement for these products is a stable shape with a wide aperture for easy access with a spoon. Both glass and PET are used, transparency and clarity being important requirements to allow good product visibility as part of the on-shelf presentation. Decoration of the jar via printed labels is common, although the visual effect on shelf is limited by the jar shape. The use of shrink sleeves gives all-round decoration and provides tamper evidence, although only if the sleeves are applied post-filling and capping, which may limit line speed. Jar shapes are best kept simple, as internal angles prevent the product from being removed, causing customer dissatisfaction. Where metal caps are used, these can be decorated by litho printing, allowing good definition and print quality. Saddle labels are often applied over the cap, coming down onto the jar, providing a 'seal of quality' as well as some measure of tamper-evidence, in addition to the 'pop-up' button now familiar on tinplate caps.

*11.2.1.15 Meat and fish spreads*

*Glass jar and metal cap.* The pack format bears a high level of resemblance to the baby food sector, although obviously the graphic presentation promotes a totally different image. Spreads or 'pastes' are associated with wartime rations in the minds of the older consumer and the manufacturers have tried to revamp the graphics to dispel this association. Design possibilities are limited because the packs and jars, and hence the labels, are small. The jars are frequently shrink-wrapped in multi-packs, using printed films to convey branding, although these can reinforce the commodity image.

*11.2.1.16 Pasta (dried)*

*Film bag.* Much dried pasta is visibly attractive and thus clear film bags are a good packaging medium. These can be of the flow-wrap style, sealed longitudinally and at both ends, or pre-made bags with plastic/metal ties. Uneven shapes preclude the use of highly-detailed graphics, which are best confined to simple designs, leaving the product itself to present the required image.

*11.2.1.17 Rice*

*Film bag.* Film bags vary from the simple pillowpack to block-bottom, stand-up formats, which offer some control over how the product is presented on shelf. Pillowpacks offer poor decoration potential, as only the sides are seen on display and this format presents a basic commodity image. Pack openability remains a problem in this sector.

*Carton.* Printed cartons are used for the more premium lines and offer good surface graphics and pack stability on display. Some also have easy-open and easy-pour features built in to the carton, for added customer convenience.

*11.2.1.18 Salt*

*Drum.* Tube-shaped composite containers with a printed outer layer allow all-round decoration, with designs being kept simple, in-line with the product's commodity status. Pull-up or turn-top plastic dispensing closures provide ease of opening and re-closing, although once opened the moisture barrier of the pack is significantly reduced and the product can cake during storage in the home. Injection-moulded plastic drums are also used; these can be labelled, or surface printed, usually by dry offset letterpress.

*11.2.1.19 Soups, sauces and stocks*

*Sachet (and carton).* Dry products are packed in single sachets, highly decorated, often with full-colour illustrations printed by gravure or high quality flexographic processes. Most specifications use paper as the outer layer and while this offers an excellent printing surface, especially if clay-coated, it also means that the packs withstand only moderate handling before becoming creased, which in turn interferes with the design visibility and shelf presentation. Excessive handling could even impair product protection by destroying the barrier properties of the laminate.

Multi-packs of sachets tend to be printed using simple one or two colour line designs in flexo, and rely on the printed carton for presentation and display. These packs are more robust than single sachets and thus less likely to become damaged by customer handling on shelf.

*Wrapper and carton.* Single-serving stock cubes are individually wrapped, usually in a foil-based material for barrier to spoilage and moisture ingress. Any design on the foil must be very simple because of the pack size and legibility. For this reason designs are usually limited to one colour, for flavour recognition. The wrapped cubes are collated in printed cartons, which offer more potential for decoration and branding.

*Drum.* Spirally-wound tubes are used for 'bulk' stock granules, offering easy opening via a plastic push-in lid and good access to the product. The cylindrical format limits control over graphic design presentation on-shelf, although this is generally overcome by using strong colour-coding for identifying flavour variants, and keeping the message simple.

*Bottle and cap.* Liquid sauces are predominantly packed in the bottle and cap format. Originally glass was the only material used, because of its inertness to what are often aggressive ingredients, especially in savoury products. Polymer developments have changed that and now many brands are packed in multi-layer co-extruded plastic bottles, which, while they may lack the clarity and sparkle of glass, offer consumer convenience in terms of 'squeezability'.

Overall image is thus a combination of product colour and graphic design on the labels, along with bottle shape. Caps on plastic bottles are usually flip-top and incorporate a tamper-resistant induction sealed foil diaphragm. Glass has been retained by the major brands, as an alternative to plastic and relies of its shape and traditional graphics for presentation.

Figure 11.6 shows a selection of soups and sauces in various packaging formats.

#### *11.2.1.20 Sugar*

*Bag.* White granulated sugar is a high-volume commodity product, packed in block-bottom paper bags which are flexo printed in simple line designs in reel form. The machines for making and filling the bags tend to be confined to one structural format, hence differentiation and promotional designs are limited to graphics changes. Plain paper provides sufficient product protection for UK and most European domestic markets, but a polyethylene layer is required as a moisture barrier for tropical climates.

Speciality icing and brown sugars command higher prices and thus are positioned differently, either in printed film bags, or cartons with an inner bag. Brown sugars in particular are visually attractive and clear film bags with simple designs make good use of this. However, presentation on-shelf can be poor due to loose packs and wrinkling of the film. Cartons offer better on-shelf presentation, but with the loss of product visibility.

*Lidded carton.* Like flour, sugar is now presented in Cekacan format, offering good all-round graphics, colour coding via the plastic lid, and stability on shelf. The walls of the Cekacan can be specified to include a moisture barrier for brown sugars, which will harden if exposed to varying conditions of humidity. This is an excellent format for a product which is declining in volume, offering easy access and a good storage solution.

Figure 11.7 shows a variety of sugar packs.

#### *11.2.1.21 Tea*

*Carton.* Both loose tea and teabags are now most commonly presented in printed cartons, offering good, all-round decoration potential and stability on display and in use. The use of film over-wraps provides tamper evidence, moisture barrier and flavour retention, while at the same time enhancing visual appearance by giving a gloss effect to the print. Foil blocking is common on the more expensive brands, possibly aimed at simulating the appearance of the traditional metal tea caddy.

*Tins.* Tins are confined to speciality teas and gift packs. Highly decorative effects are possible with litho printing and embossing and designs generally evoke 'old-fashioned' values or exotic origins.

### *11.2.2 Chilled foods*

The following section describes the various product types, pack formats and specific decoration considerations in the chilled food sector.

#### *11.2.2.1 Bacon*

*Thermoformed film pack.* This pack format relies on product visibility, as consumers want to inspect the product for its leanness and the number and regularity of the rashers. This need is irrespective of any information on the pack, most consumers forming their opinion about the product on sight, rather than on reading a label. Graphics are therefore kept simple, with little or no illustration. There is some use of the 'greaseproof paper' look to denote a traditional image (see comments on cheese packaging, below).

Developments in peelable easy-open and resealable formats are now becoming more commonly available and are helping to remove consumer frustration with this pack format.

### *11.2.2.2 Butter*

*Paper/foil wrapper.* Paper and foil-based block wraps are still the norm for butter packaging although this format will decline in popularity as the use of dairy spreads increases. The wrapped block is a very economical pack and able to present a range of product positionings from commodity to premium, with printed paper being used for the former and printed foil/paper laminates for the latter. The shape means that the display in store is effective, contrasting strongly with the experience in the home, where the pack, once opened, offers very poor convenience in either storage or use. The consumer currently accepts this format only because there is no real alternative in mass market European brands. The wrap was certainly a very convenient pack for cutting the block into measured portions when butter was used more in cooking.

Figure 11.8 shows a selection of butter and dairy spreads.

### *11.2.2.3 Cheese*

*Thermoformed film pack.* Hard cheeses are almost universally packed in thermoformed film packs. Branding and decoration is limited to printing on the 'lid', or via an added label, leaving as much product visibility as possible. A relatively recent move has been the use of semi-opaque 'paper lookalike' films, used to create an old-fashioned paper wrap image, reminiscent of when cheese was cut to the individual customer's order and hand-wrapped. Opening packs is still difficult, although more brands are moving to peelable systems, which offer convenience and safe opening. Some brands also offer a re-close facility.

### *11.2.2.4 Cream*

*Pot/tub and lid.* Slightly tapered pots with printed foil or laminate lids are the normal packaging format in this sector. Decoration potential on the pots is limited to relatively simple designs using the dry offset letterpress process. Graphics on the peelable lid are best kept simple, especially if the foil is embossed (for stiffness). Single colour designs are common, with industry accepted strong colours to denote variants across the different brands.

*Aerosol can.* Uses of this pack format in the food and drink sector are uncommon, but should be mentioned. In this application, the aerosol offers a high level of consumer convenience by making whipped cream available 'on tap' without the messy, time-consuming and unreliable process of whisking it. The printed metal cans tend to have strong branding, and swirled plastic overcaps contribute to the overall image. Cleanliness of the dispensing nozzle is a potential problem.

*11.2.2.5 Dairy spreads*

*Tub and snap-on lid.* Thermoformed tubs with snap-on lids are the common format for dairy spreads. The tubs are decorated using dry offset letterpress, which imposes limitations on print detail and size of type, and precludes photographic quality illustrations. Improved decoration is possible using injection moulded tubs and in-mould labels, although cost and economic order quantity is higher than for thermoformed components. (Large size tubs, e.g. 2 kg and above really require injection moulding for dimensional and shape stability).

Tubs and lids are usually self-coloured in yellows, creams and whites, which seem to be the accepted colours in this sector. Some brands use a printed foil lid, with a clear lid, thus using the foil design as part of the overall presentation. The foil lid is sealed to the top of the container, thus giving good protection against product spoilage, as well as tamper evidence. There is also some usage of a printed paper or foil sheet across the top of the product surface, which offers more branding and information, albeit only seen after the product has been taken home.

*11.2.2.6 Desserts*

*Pot/tub and lid.* Single-serving products such as yoghurts are offered in formats similar to that already described for cream and the same comments apply here, although there is some use of printed film sleeves which allows improved decoration possibilities on the pots. Pots are also collated into groups of four, via the foil lid structure and fours or eights via printed board sleeves, which offer more potential for branding, as well as stacking on display.

Multi-serving chilled desserts vary from the medium-priced family product to the luxury range aimed at the dinner party market, and are offered in a variety of formats. Most rely on product visibility to some extent, which is an important consideration for printing, as this is usually confined to simple text. Products such as trifles are presented in thermoformed packs, moulded to give the required shape and presentation to the product. Products intended to be turned-out onto a serving dish offer a packaging challenge as, unless the product is released intact, the whole effect is ruined and customer dissatisfaction is likely to be high.

Figure 11.9 shows a selection of yoghurts, creams and desserts.

*11.2.2.7 Meat—raw*

*Thermoformed film pack.* This pack format has similar demands to those already reviewed for bacon, with product visibility being all-important to the consumer. The large usage of modified atmosphere packaging (MAP) in this sector means that packs are produced in regular shapes, irrespective of the product shape, which helps display in store. However, the large amount of free space in some packs can invoke a negative reaction from consumers, who perceive this as over-packaging. Easy-open features are currently rare and as the products are usually designed for a single usage, re-closing is not appropriate.

*11.2.2.8 Milk*

*Plastic bottle and cap.* The plastic bottle for in-store and home delivery offers family-sized packs that last a week. The presentation of these bottles is currently standard as all producers are trying to remove as much material as possible from the bottle to reduce the packaging cost. Any pack over 0.5 l has a handle feature that dictates a small label panel. The bottle walls are obviously thin and the pack will change shape as it is filled giving it a rounder section that exposes the label to scuffing as scuff protection features are exceeded.

Labels applied in the dairy in a moist environment present a challenge in achieving good label adhesion. The label design is currently fairly basic as it tends to be retailer-owned and there are few branded products. Milk is also currently presented as a commodity item so label design is minimal, colours are few and never include features such as embossing. In the UK there is now an agreement on variety identification via colour, making it easy for the consumer to select the required product quickly. This is important for such a commodity item.

The packs are generally packed in roll cages filled at the dairy and wheeled into place in the store. The narrow face of the bottle is presented to the consumer, allowing easy access to the handle to select the product.

The label also has to accommodate a large digital image applied at the point of filling giving a best-before-date; this compromises the space available for other imagery and cheapens the total image.

*Carton.* The milk carton is a very good presentation vehicle although it does not have any ability to use shape to differentiate brands. Print quality can be very good although embossing is not economical on the faster production systems. The closure devices now incorporated (screw caps, flip-up tabs) have removed this milk packaging format from being the ultimate in frustrating consumer packs.

*Glass bottle.* The glass bottle despite its obvious problems of breakage is still liked by many consumers and a recent innovation has finally given it a grip feature to help the consumer picking up and pouring from the pack. The 1 pint size limit and retailer home deliveries will ultimately result in its downfall. The bottle has never been used as a serious branding vehicle and decoration has included silk screen printed adverts that survived one trip and was washed off during the bottle cleaning process in the dairy. The crimped foil lid is printed to indicate the milk type and may carry some company imagery, or seasonal messages.

Figure 11.10 shows a selection of milk packs.

*11.2.2.9 Ready meals*

*Tray and board sleeve or carton.* This continues to be a growing area, appealing to the reluctant cook, who wants to produce a meal instantly, without the preparation or the clearing away of cooking pans afterwards. The meal is placed in a formed tray (often CPET) and sealed with a film lid, which itself can be difficult and frustrating to remove, especially when hot.

Most cooked foods are visually unattractive and thus benefit from being enclosed in a printed sleeve or carton, both of which offer good opportunities for photographic illustration. However, stacking on shelf in store can mean that only the side of the pack is seen, while most have the illustration on the top. The base of the sleeve or carton is almost entirely devoted to legal copy such as the ingredients list and cooking instructions. The latter can be quite extensive, especially as the pack format can lend itself to microwave and conventional cooking, from chilled or frozen state, and manufacturers try to allow for all eventualities.

#### *11.2.2.10 Sausages*

*Film overwrap.* Packaging of sausages remains very traditional, using parcel-style film wrapping printed with brand identity and product information, although this may be added via a printed label. Speciality variants and more expensive brands also use a printed cartonboard band or tray, which provides greater potential for graphic illustration. Product visibility is possibly less important than for bacon and meat, and opaque or translucent materials are used extensively.

#### *11.2.2.11 Sliced meats*

*Thermoformed film packs.* This sector uses more graphic illustration than bacon and raw meats, the lid of the pack often being labelled with highly decorated full-colour graphics demonstrating serving suggestions. Product visibility through the pack base is important however, and consumers are frequently seen turning packs over to inspect the product for leanness. Store display tends to be front-on, often using trays to shingle the packs for good visibility of the printed labels.

### *11.2.3 Frozen foods*

The following section describes the various product types, pack formats and specific decoration considerations in the frozen food sector.

#### *11.2.3.1 Ice cream*

*Pot/tub and lid.* Decoration is via both the pot/tub and the lid, although presentation in store in the freezer cabinet may mean that the product is displayed with either the sides or the lid prominent (as in the case of a chest freezer). This must be allowed for in the selection of graphic design.

*Printed carton.* This format offers good opportunities for graphic display and information, as well as good stackability in store. However, consumer use is not as convenient as the above format and cartons tend to be confined to hard ice creams which are served by cutting rather than scooping.

*Printed wrapper.* This format is widely used for single-portion ice creams and for collations of single products (which are presented in a printed carton). The flow wraps are usually heavily branded, although intricate designs and small type sizes are not recommended due to the irregular surface of the pack.

#### *11.2.3.2 Cooked desserts*

*Printed carton.* This format offers good opportunities for branding and product presentation, although geometry of pack on display needs to be considered for maximum impact.

#### *11.2.3.3 Raw meat and fish*

*Vacuum pack.* These products are often of uneven shape with limited flat area for a label, and are also visually unattractive. However, consumers may want to inspect before purchase and thus the label is usually small, mainly fulfilling the information function, with limited branding opportunities. This requirement for inspection also means that the films selected must be robust enough to withstand the physical handling; the products' rigidity tends to denote toughness in the consumer's mind and packs tend to be treated somewhat roughly.

*Loose pack in printed film bag (e.g. chicken pieces).* This format is also subject to rough handling. The uneven product shape provides limited opportunity for attractive graphic design, hence the overall image tends to be poor.

*Thermoformed pack.* The use of a thermoformed tray helps to regularise the product shape and the sealed lid provides a flat area for direct print or the use of a self-adhesive label, which provides a branding opportunity. Graphics tend to be simple.

#### *11.2.3.4 Vegetables*

*Film bags.* Resistance to flexing and rough handling on display is important in this sector. Visual image is impaired by the uneven shape/surface of the product and thus, again, the graphics are best kept simple.

#### *11.2.3.5 General requirements of decoration for all frozen foods*

- Print adhesion withstands blast freezing down to −40°C and holding at −20°C.
- Print adhesion withstands handling while loading into freezers for display, and during customer selection.

- Print legible in top-loading and front-loading freezers.
- Need to obscure product, because of its unattractive appearance (e.g. meat, fish, some ready meals) or the build up of ice crystals in the pack, caused by temperature fluctuations during storage (e.g. vegetables). Therefore use of opaque packaging, which also protects against oxidation by UV light.

## 11.3 Drinks

### *11.3.1 Product types, pack formats and specific decoration considerations*

#### *11.3.1.1 Beer*

*Can.* The ring pull beer can created the take-home beer market. Its strength is its convenience and ability to accept any brand; its weakness for a brand can be its generic appearance as all brands are in this format. Some differentiation has been achieved through shaping of the can in combination with the graphic design. Shaping has been achieved on two piece and three piece cans, with Sapporro in Japan as an early example of three piece and Carling in Europe as a more recent example.

The can suffers from the problem of facing forwards on shelf although most brands are sold in collators that hold the cans in an oriented way.

The use of the can metal to show through in a design is very common in this market as nearly all brands print directly (by dry offset letterpress) onto the formed body of the two piece can prior to filling. A very small number of products are decorated using shrink sleeves, but cost and rate of production confine this to the low-volume, high-priced speciality end of the market.

#### *11.3.1.2 Soft drinks*

*Carbonated—can and bottle.* This category uses the widest range of packaging formats and nearly all packaging materials and processes. There are two main formats: the aluminium can and the glass bottle. The formats are chosen for their ability to withstand internal carbonation pressures. The can is a generic format that is printed and relies upon the graphics for all its differentiation and communication. The glass bottle is much more flexible vehicle for branding in that it offers many permutations of bottle shape, surface finish, bottle colour, closure style, decoration style including direct print, labelling, sleeving and neck labelling.

As with most carbonated products the format is cylindrical to withstand the pressure of the product, so the implications for branding and shelf presentation must be considered.

*Non carbonated—can, bottle, sachet, carton.* This category uses foil sachets, plastic bottles, glass bottles, liquid tight cartons and two and three piece cans. The decision-making for the pack format in this category is driven by a number of factors: the packaging cost that the product can support, the shelf life required and the protection that the product requires from oxygen or UV.

##### *11.3.1.3 Water*

*Bottle.* This is a growing market, where premium products now compete with mass-market supermarket brands. The latter centre on the cheap-as-possible clear PET bottle, with a paper or film wrap-around label.

Premium brands, costing up to four times more than the supermarket own-brand products, generally remain in glass. They use unique shapes and colours for recognition and presentation, plus highly-decorated labels, often using foil, or foil blocking.

Both sectors offer multi-packs, some using printed shrinkwrap to collate three or six bottles, although the graphic illustrations currently offer poor presentation. There is some use of drawn and wall-ironed metal cans in this sector, especially for flavoured waters. Water for the growing sports market is packed in handy-sized PET bottles, designed for good grip and easy opening and closing while 'on the run'.

Figure 11.11 shows a variety of beer, soft drink and mineral water packaging.

## 11.4 Cosmetics/toiletries/personal and healthcare

### *11.4.1 Product types, pack formats and specific decoration considerations*

#### *11.4.1.1 Baby oil*

*Plastic bottle and cap.* This sector relies on soft shapes and colours for branding. Graphics are usually simple and product visibility is important to denote purity, hence the common use of transparent bottles. The bottle shape must be easy and safe to handle with one hand and the product must dispense well, without spilling.

#### *11.4.1.2 Hand cream*

*Plastic tube and cap.* The plastic tube is a very cost-effective pack and offers good decoration potential. Soft, pastel colours tend to be used in this sector, with graphics reflecting the product's formulation and/or end use. Stand-on full-diameter flip-top plastic caps offer easy one-handed use and keep the product at the orifice ready to use. However, the tube format does not lend itself well to full product dispensing and consumer dissatisfaction with product left inside the pack is high. A soft-structured shoulder is now available which helps this problem.

*Plastic tub and cap.* Thick creamy formulations which do not lend themselves to easy dispensing from a tube are packed in wide-mouthed tubs. Tub shape is important as it must be stable in use and allow access to all of the product (i.e. no sharp shoulders to trap product). This format is often selected for products used in the garden/garage and this should be borne in mind when selecting materials, colours and graphics.

*11.4.1.3 Nappies*

*Film wrap/bag.* Disposable nappies are bulky and are used in large quantities, hence the packs are large and can present an imposing image on-shelf. The films usually have a white background, for clean and hygienic image. Branding is very strong in this highly competitive market and brand owners use the pack size to their advantage. Pack stability tends to be good and the larger sizes have carry-handles for consumer convenience, which means they are seldom placed in store bags, leaving the graphics visible after purchase.

*11.4.1.4 Razors*

*Blister pack.* Razors commonly use this format, which presents the product well, provides a backing card for graphics and information, and displays well in store via its hanging slot. Ease of opening can be a problem, but one which can be overcome by using perforations in the backing card.

*Film flow wrap.* At the cheaper end of the market, disposable razors are packed in printed film in flow wrap format. The finished result is usually untidy and has a poor image, because of the uneven pack surface.

*11.4.1.5 Shampoo and shower gel*

*Bottle and cap.* Only a few brands use glass in this sector, the vast majority using plastic for its resistance to breakage. Bottles can be transparent or opaque, surface-printed or labelled, with many unique custom-moulded shapes being used for brand identity. Many brands have several variants within the range, and use different colours and graphics to identify each one. Caps can be flip-top dispensing caps or screw caps which have to be removed, the former offering the convenience of one-handed use. Colour coding is used to identify variants. Some brands of shower gel include a hook feature, again for ease of use.

*11.4.1.6 Soap*

*Wrapper.* Toilet and bath soaps are a declining market, as a result of the widespread use of liquid soaps, offering good dispensing characteristics and clean storage. The sector has polarised into low-cost commodity items, where


**Figure 11.1** Selection of pack formats for biscuits.


**Figure 11.2** Selection of pack formats for ambient cakes.


**Figure 11.3** Selection of pack formats for coffee.


**Figure 11.4** Selection of pack formats for confectionary.


**Figure 11.5** Selection of pack formats for crisps and savoury snacks.


**Figure 11.6** Selection of pack formats for dried soups and sauces.


**Figure 11.7** Selection of pack formats for sugars.


**Figure 11.8** Selection of pack formats for butter and dairy spreads.


**Figure 11.9** Selection of pack formats for creams and desserts.


**Figure 11.10** Selection of pack formats for liquid milk products.


**Figure 11.11** Selection of pack formats for beers, soft drinks and mineral waters.


**Figure 11.12** Selection of pack formats for toiletries and personal care products.


**Figure 11.13** Selection of pack formats for household and DIY products.

low-quality film wraps are used, offering no physical protection to the soap, and the premium sector, where printed film wraps prevail. For this latter sector, physical protection is often provided by a thin card sleeve under the film wrap. This provides a relatively flat surface, which enhances the effect of the film graphics.

*Carton.* Cartons are used mainly for gift soaps, either singly or in sets. The soaps are often individually paper-wrapped to protect against bruising. The cartons offer good decoration potential, the graphics usually reflecting the image of other products in the range, such as perfume and after-shave lotion.

#### *11.4.1.7 Suncare*

*Plastic bottles and tubes.* Suncare products are now available all year round, as a result of the increased amount of foreign travel and winter holidays. Bottles and tubes, with dispensing closures which can be operated with one hand, offer convenience. Containers tend to be branded by colour and graphics, either surface-printed (often silk screen for good ink coverage) or film-labelled. Easy differentiation of sun factors is important.

Figure 11.12 shows a variety of packaging solutions for toiletries and personal care products.

#### *11.4.1.8 Tissues*

*Carton.* Rectangular and square carton shapes are used, with a slit film panel to dispense and separate the tissues. To integrate with consumers' bathroom and bedroom décor, cartons are retailed with branding either in the removable panel or on what becomes the base of the pack when in use. The overall branding can be difficult to achieve, as much of the pack is required to be decorative.

#### *11.4.1.9 Toilet rolls*

*Film or paper wrap.* Toilet rolls are usually offered in multiple packs, from two to 12/15. Paper is commonly used for the two-roll packs and film for all other sizes. All-over printing is used to reflect brand values and differentiate product colour. Like nappies, the larger packs take up much space and have a strong on-shelf presence.

#### *11.4.1.10 Toothpaste*

*Tube in carton.* There is still some use of the collapsible aluminium tube in this sector, but major brands have now changed to laminate constructions, tailor-made to suit the product formulation. This makes for a slightly more robust pack, but still not robust enough to survive the hazards of the distribution chain without a carton. The main decoration is the carton graphics, usually printed to be displayed lying down. Colours and graphics are generally crisp and clean. Unlike hand cream, small caps are used and consumer storage of the tube in use is either lying flat or standing on the sealed end in a holder. There is wide usage of flip-top caps, which must help to avoid misplacing the small cap.

*Dispensing pump.* Plastic dispensing pumps are now widely available in most brands. They are sold without a carton and displayed on the flat base, hence the graphics need to reflect this change from tubes. Decoration is often by shrink sleeve, with good branding potential, while at the same time offering tamper-evidence if the sleeve is extended over the cap.

## 11.5 Household chemicals

### *11.5.1 Product types, pack formats and specific decoration considerations*

#### *11.5.1.1 Bleaches and toilet cleaners*

*Plastic bottle.* HDPE bottles in bright, clean colours and child-resistant plastic caps are the norm in this sector. Premium brands often use unique shapes, which increase their presentation on shelf, as well as providing practical features, such as directional nozzles and easy-grip sides. Printed labels provide additional branding opportunities, although much space is necessarily taken up by legal copy for what are usually irritant chemicals.

#### *11.5.1.2 Washing-up liquid*

*Plastic bottle.* Screen printed polyethylene bottles have been the norm for washing-up products for many years but now more brands are introducing in-mould labelling. The depth and opacity of the screen printing ink enable it to provide a strong image even when printed on a strong background colour. A failing of the screen printing process is the limited print definition preventing the use of multicolour designs and fine detailing. This limitation in decoration quality suggests that the market for in-mould applications therefore has good potential for premium products.

The pack structure is now a vehicle for communicating brand values through the shape, colour and the style of closure. A pull-up closure is available, allowing easy opening, dispensing and closing.

#### *11.5.1.3 Laundry detergents*

*Carton.* Powder products are presented in printed cartons, which have reduced in size considerably over the last few years, as a result of formulation developments. The cartons offer good opportunities for strong branding, present well on shelf, being very stable, and many offer an easy-open tear strip device for added consumer convenience. There are commonly-accepted colours for variety identification.

*Plastic bottle.* Liquid laundry detergents and fabric softeners are packed in plastic bottles. Brands are distinguished by bottle shape and graphics on the labels. Product information in this sector is often extensive, with front and back labels used for this purpose. Most bottles incorporate a device in the orifice to guide product flow, and the caps double up as measures, again offering consumer convenience.

## 11.6 DIY

### *11.6.1 Product types, pack formats and specific decoration considerations*

#### *11.6.1.1 Adhesives*

*Various.* Adhesives are presented in a very wide range of pack formats, usually dictated by the safety issues concerned with the individual product. The ability to provide usage, storage and precautionary information is important, whatever the pack format.

Simple non-toxic, water-based formulations are sold in plastic bottles, often with the convenience feature of a brush incorporated in the screw cap, for ease of application. Decoration is printed on a label on the bottle. Collapsible aluminium tubes are also commonly used, offering good dispensing characteristics, but important information printed on the tube can be lost when the tube is rolled up during use. Large sizes of adhesives are packed in metal or plastic containers, similar to the range used for paint.

#### *11.6.1.2 Batteries*

*Card/blister.* Batteries, either singly or in multi-packs, have long been on the receiving end of loud complaints by the anti-packaging lobby, owing to the widespread use of blister packs which are difficult to open. Some improvements have been made, by using perforations in the backing card, but these can be difficult to locate among the printed copy. Cards offer good decoration potential and the convenience of a slot for hanging display. The reverse of the card offers space for instructions. All-board display packs are now widely used, and offer the advantages of blister packs, without the annoying opening problems.

#### *11.6.1.3 Light bulbs*

*Sleeve or carton.* Single bulbs are packed in corrugated paper sleeves or printed cartons, both of which offer opportunities for only simple graphics, limited to brand and bulb type/wattage.

Multi-packs of bulbs in printed cartons offer a large decoration area for presentation on shelf, although graphics continue to be simple. The key requirement for light bulbs will always be protection against physical damage, and consumers are unlikely to be attracted by pack graphics.

*11.6.1.4 Motor oil*

*Plastic bottles.* The 5 l bottle remains the most common size to date in this sector and it has evolved from the old tinplate can to the plastic blow-moulded bottle. This can be a somewhat unwieldy pack that is difficult to carry, pour controllably and store easily. Improving engine quality will make smaller sizes (1 and 2 l) more common in the future. The decoration is generally printed on high quality self-adhesive labels.

The bottles usually have a complex and uncomfortable closure with an integral pouring device that does not always work. The ability of oil to get onto every surface during distribution requires the label to adhere well and not reveal oil contamination. This can be one of the shortest or longest life cycle products in that it can go from shelf to bin within a couple of minutes or it can sit in the boot of a car or a garage for years. The consumer will not be comfortable with the obvious wastage involved in the short cycle situation in the future. The product does not need much protection from the packaging other than in distribution although the consumer demands a feeling of protection from the product.

*11.6.1.5 Paint*

There are currently two main options for household paints: cylindrical metal body and lid or plastic body and lid which mimics the metal version that it was introduced to replace.

Metal and plastic raw material costs have always been a key factor in the decision on selecting the packaging format. The costs move quite dramatically relative to each other and with such an expensive pack format, the raw material decision can be critical. The packs demand the use of a lot of material as they need to be sufficiently durable to survive the compression forces during stacking on pallets, and the rigours of distribution. Both formats offer a handle feature, unreliable resealing and ease of opening only with the use of an implement. The cylindrical packs require facing on the shelf and need the bulk of the paint range to communicate a strong brand image. The decision between metal and plastic is also dependent upon the product base with water-based paints in either format and solvent-based requiring metal with an appropriate internal coating. The metal containers are all tinplated steel with internal and external lacquers to prevent corrosion. Paint colour communication is generally by adhesive paper labels applied at the point of filling. This keeps the print run at a maximum and the empty packaging stock inventory at a minimum. Some brands have used unprinted metal or plastic containers, decorated using paper or film labels.

The print quality potential on the metal containers is still far superior to the decoration possible on the plastic containers, as the metal containers have the body panel printed in flat form before being welded into the body shape and the base and top ring seamed on.

The European market has seen some 2.5 l packs in clear PET that allow the product to be seen and give the consumer a reassuring feeling about the colour they are buying, even though the paint will be a different shade when dry. These packs are also based on a square cross section which offers better space utilisation throughout distribution and on-shelf display.

Figure 11.13 shows a selection of pack formats for household and DIY products.

# 12 Graphic design and the launch process

S. McGuire

## 12.1 Bridging the gap between designers and printers

### *12.1.1 The gap—historically*

Communication between designers, artwork/reprographic houses and printers has historically, been very poor, perpetuating an atmosphere of mutual distrust among these sectors and providing a platform, in the event of problems, for each one to blame the others. Problems would not normally have arisen if there had been working relationships in place and if information had been shared and discussed. When the creation of artwork is not looked at as three continuous steps—design, artwork and print—but is treated as three separate parts of a project, things become very difficult.

Designers often complain that their creative input has become diluted by the time that artwork has gone into production and packaging has been printed. The effort that they have put into creating a design concept may have been compromised at the artwork and printing stages by the addition of text and the limitations of the printing process, resulting in something barely resembling the original idea. Designs that have been painstakingly initiated may have been developed into artwork and print with no further input from the designers. Coupled with this, the artwork agencies and printers have often viewed any communication from designers, either directly or through the client, as unnecessary interference rather than constructive input into a project.

With the emergence of digital artwork, the problems that can arise if artwork agencies are not involved early in a project have become much worse. Whole ranges of packaging design, including graphics and colours, may have been executed without the artwork agency or printer being consulted, and, because of this, artwork and reprographic agencies may be faced with artwork from the designers that has to be completely rebuilt because of the way that it has been presented. Graphic items may have been supplied in the wrong format, profiles disregarded completely, and measurements and sizes of graphical elements within a range may be inconsistent, all resulting in duplication of effort. Designers, often produce special effects such as multicolour graduations and patterns, easily achieved using the computer platform, without thought of how these will be replicated. Process colours and spot colours are often applied incorrectly, presenting repro problems. Often these things become apparent too late, when everything has been built, and because of this artwork costs escalate and lead times lengthen, making the transition between design and artwork a difficult one. In this situation, artwork agencies are often presented with a design which needs rebuilding and modifying into a product that still presents a problem to the printer.

Printers often complain that the designers and the artwork agency have produced a job that is almost impossible to replicate on press. The need to work to tight print production deadlines makes correction at a late stage difficult. Problems at print stage become exaggerated because of production timings, and in view of cost implications, the printers often feel the need to take control of the artwork and make changes themselves, to guarantee an acceptable result. These changes tend not to be communicated back through the supply chain and in the event of a later revision of the item, the printer's artwork may not have not been updated and so history repeats itself.

### *12.1.2 Bridging the gap*

An artwork project should conform to the brief and hit the required deadlines within budget; this will not happen if everyone does not work together. The project proceeds through three steps (Figure 12.1):

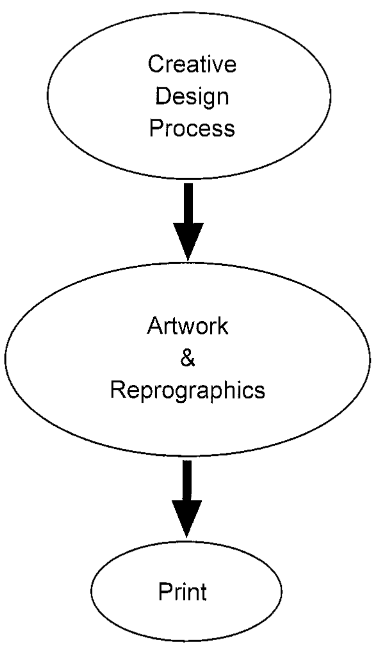


**Figure 12.1** Stages of an artwork project: (1) the creative design process; (2) the construction of artwork and reprographic work; (3) the print production stage.

1. The creative process as provided by the designers;
2. The construction of artwork and reprographic work by the artwork house;
3. The print production stage.

It is very important that it is clear from the very beginning of a project that these three steps are reliant on each other so that a working relationship between these three factors is formed. The artwork agency links both the initial stages with the completion stages which has resulted in it being the natural instigator and facilitator of this communication. As well as being responsible for producing sound artwork the agency is also responsible for providing the link between the designer, printers and customer. Responsibilities such as colour management, ensuring consistency across different printing disciplines, managing expectations and facilitating brand equities on behalf of the client must now be taken by the artwork agencies. Providing clients with sound printing advice, providing assistance with project management, and general administration are also functions which an agency is expected to undertake. When an agency provides the correct level of service, the problem of designers, agencies and printers working in a fragmented and unproductive manner begins to be solved, resulting in a process which is well defined and well executed.

## 12.2 Creating a working platform

### *12.2.1 Understanding client needs*

A successful launch of any packaging product involves the effort and cooperation of many individuals, possessing expertise across many different disciplines. A piece of packaging artwork results from information collated from all these individuals and the creative input of the conceptual design. For this to happen successfully there is a sequence of events that has to take place. Although this sequence differs from industry to industry and company to company depending on working practices the fundamentals remain the same.

Recognising the fundamentals is part of an artwork agency's role. Taking these fundamentals and applying them to an individual company's packaging needs is the next stage. When defining an artwork launch process that is both user-friendly and realistic, there must be a considerable information exchange between both the process owners and its users. To achieve this, good working relationships must exist between the client (the process owners and users) and the supplier (also process users).

For any client/supplier relationship to form, communication and understanding are essential. The supplier needs to develop a good understanding of the clients' specific needs, the limitations with which the client is working, and the expectations that the client has formed. Questions that should be asked are:

- What is the primary objective that the client requires the supplier to meet?
- How, if at all, has that objective been met historically?
- Does this information result in any ideas or lessons that can be learnt?
- What functions must be undertaken by the parties involved within the process?

Once both sides collectively have identified these issues, then goals can be clarified, limitations realised and expectations can then be managed. This will ensure that a rapport will begin to build, creating the foundations of a good working relationship.

### *12.2.2 Defining a process*

To produce a graphic design and launch process, a group which is representative of all of the client's internal departments and all third party suppliers needs to meet. These individuals may play a part in the information gathering for the brief stage of an artwork project, the supply chain or in the artwork approval process. Typically the client will be represented by:

- The project owners, normally marketing or an artwork control department; these people are the project instigators and the ones that create a large part of the brief;
- The department responsible for regulating copy. This department may not have written the text in the first place but it is their responsibility check the text content and approve any claims;
- The department responsible for legal and trademarks;
- The research and design department;
- The technical department, responsible for providing accurate profile measurements and any online or print free areas contained on that profile;
- Representation from the manufacturing factory.

On behalf of the supplier, there should be representation from:

- The designers,
- The artwork agency,
- The printers (throughout all printing disciplines if applicable).

During the initial meetings each department or supplier representative will be required to explain to the group their involvement with artwork, whether it be as part of the conceptual process, the building stage, the administration and planning, or as part of the approval procedures. This group will be brought together to discuss the positive and negative aspects of the existing ways of working, and then a working group will be formed to progress this on to the next stage. All the positive aspects need to be taken and developed, while solutions need to be devised to irradiate the negative. Using the existing model as a base the group then must produce a robust set of working practices with clearly defined actions (Figure 12.2). They must identify the contributors that will perform the actions as identified in each process step (Figure 12.3).

As the artwork process is a byproduct of the main project launch (of which the end result is completed packaging on shelves) it is very important for the group to outline the activities that are not covered by the process. Often individuals from different departments may have many objectives only vaguely related to artwork and outside the core activity. Keeping the process simple and focused on the task, which is to provide a guide to ways of working for the design and launch of artwork, should always be the goal of the group. The eventual process will not be the answer to everyone's problems and there may be a need for secondary groups to be set up to focus on other individual issues.

The group must collectively decide at which stage within a complete product launch project the graphic artwork process begins, and this must be worked through to an agreed ending. Other activities outside the process, on which the packaging artwork has a direct influence, must be considered. Many of these activities rely on the packaging as their foundations, but are not covered by the artwork process. Advertising, point of sale and trade samples, for example, must be considered and provision made to avoid duplication of effort, ensuring that usable files or outputs can be provided and transferred easily in project timeframes.

### *12.2.3 Creating a process*

After establishing beginning and ending points the group will need to work their way through the process in steps. Each new step should follow on logically

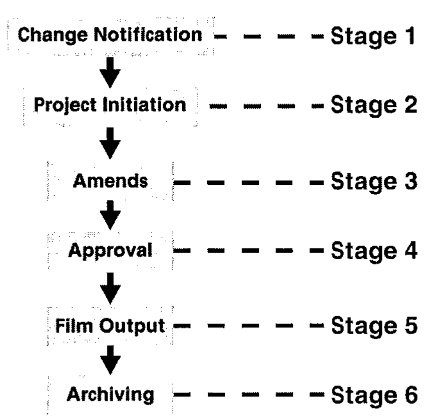


**Figure 12.2** Working practices of the group involved in the packaging artwork launch chain.

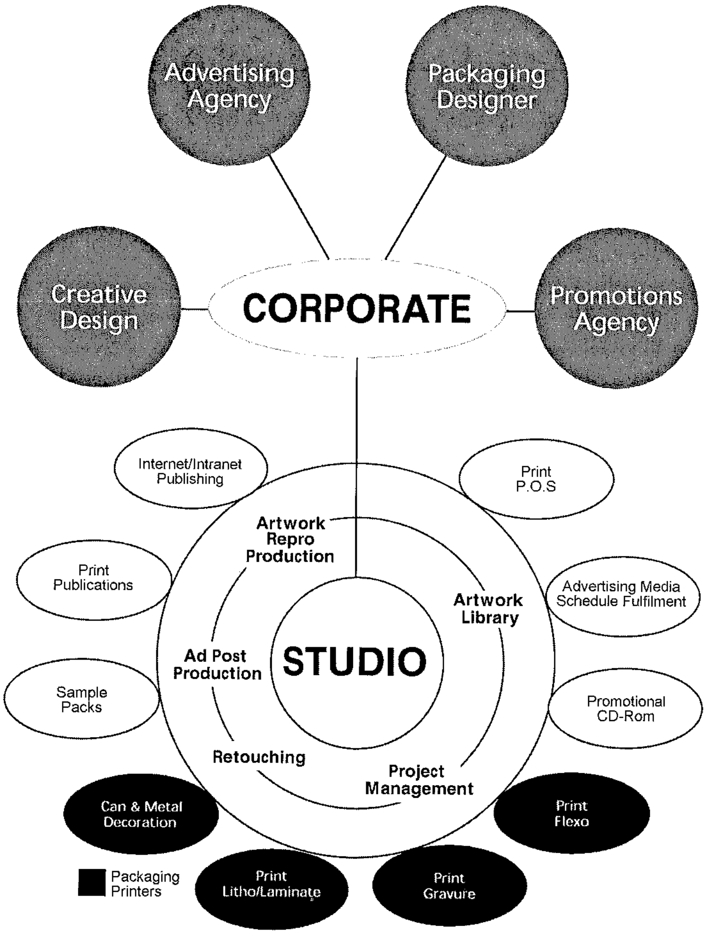


**Figure 12.3** The contributors and the actions they perform at each stage of the artwork process.

from the previous one, from conceptual design to final printed product. It is very important to get the level of detail right at this stage, as missing out pieces of information may prove to be detrimental to the process when it is complete. Every single step needs to be assigned to a contributor or contributors in the process. All actions, even the mundane ones, need to be identified and documented. The aim of the process is not to create extra work for people but to share the responsibilities resulting in a more efficient operation which can be easily maintained.

Viable timeframes will need to be agreed by the group and then coupled with each process step to show the maximum amount of days/weeks that each action or set of actions should take. These timings can be utilised as a guideline for project planning, as well as providing the means to measure the performances of both the client and the suppliers. The end result should eventually be defined so that both client and supplier have a platform from which to work. Once the process has been decided upon this can then be documented accordingly, ensuring that everyone has a clear understanding of roles and responsibilities (Figure 12.4).

Before the process goes 'live', all of the process users need to be told why it was developed, how it was created (i.e. the people involved), what the aims and objectives are, and finally how to use it. The working group must decide the best way of doing this, and in what format the educational materials will take. Normally a process needs to be launched formally by the means of some sort of presentation and for training, and then backed up with the relevant literature. People will also need to know who to go to if they have any problems with the process, or require further training.

After going 'live' with the launch platform the group also needs to make plans to monitor the process' progress and create a forum where further improvements or change can be suggested and implemented. With the education of all process users completed, key contacts identified and provisions made to ensure

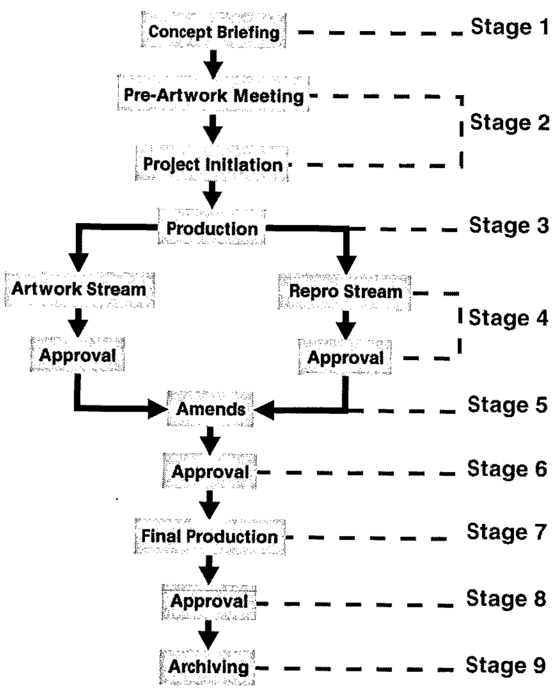


**Figure 12.4** The packaging artwork launch process.

continuous improvements, the packaging artwork launch process is ready to be applied to live projects.

### *12.2.4 Project planning*

Following a decision made to launch a new product, the planning process begins in earnest. Obviously there will be internal procedures and administration that the project leader will have to undertake before the project is approved. The logistics of a project will need to be discussed and debated, volumes decided upon, and estimated costs and timelines produced. Details such as product variants, sizes and markets will also need to be covered.

With new product development, a series of tests may be required to be carried out. Tests of a scientific nature are often required to test safety as part of industry guidelines. Medical tests may have had to be carried out for products of a pharmaceutical nature. All these issues will be part of the overall project plan. On-pack text and claims may need to be submitted to various government bodies for approval. Market research may be needed.

The project also has to be logistically viable. The factories will have to be consulted in order to confirm that both the product and packaging can actually be manufactured. Third party suppliers have to acknowledge that they can meet the specified requirements. Different suppliers may be used to produce different parts of the range, and these may be in different countries, working with different methods, all factors that need to be taken into consideration during the planning stage.

There are many factors which may have ramifications later that could dictate the packaging text and graphical content; therefore, although they are not part of the artwork process, they must have been dealt with before it even begins. The artwork will only be a small part of the overall project, but by having a defined process pattern to follow, it should make this one of the simplest sections to execute. The fact that a set of timings has already been indicated as part of the artwork process plan should also make the allocation of timelines concerning artwork considerably easier and much more accurate. Once the overall planning process is complete the artwork launch process can begin.

### *12.2.5 Communication*

The artwork project will require input from a number of sources, consisting of both internal client departments and external third party suppliers. The project leader will be required to identify the individuals from each department or company who will make up the artwork project team. The artwork project team will consist of the project leader/co-ordinator and representatives from the internal departments required to provide technical or logistical information or part of the approval loop. The team will also include representatives from the designer, the artwork and imaging company, the printers and the manufacturer. A list of the team members should be provided, clearly distinguishing each team member's role within the project.

The next step is for the artwork project team to meet. They should discuss the artwork project plan and each comment on the proposed route and associated timelines. By introducing the team to the project at the very beginning, as opposed to introducing individuals at steps within the process, communication is initiated and the transfer of information will help the project run more smoothly.

## 12.3 The artwork process—initial introductions and information

### *12.3.1 Pre-briefing meeting*

This meeting provides the opportunity for the project leader to explain the project in detail to the group. It is also the forum for the presentation of the preliminary design work that should, by now, have already been created. Although the design process is separate, it is integral to the artwork process. After the overall project team has given the final approval for the project, and while the artwork project team are being assembled and project testing has taken place, the design process should be underway. It is vital however, that the artwork project meeting takes place at the point in time when the design is still in its infancy stage; that is, when there are still a number of design visuals to be discussed, and the final design route has yet to be decided.

The artwork agency and the project leader should chair this meeting. The project up until this point should have been organised by the project leader; however, at this stage, the artwork agency will take over a lot of the project management functions. There may be a need to review the process documentation at this meeting with anyone who may not have been part of the process launch.

The main objective of the meeting is to assess the feasibility of the design proposals and discuss the practicalities of reproducing the designs using various substrates and printing methods. It enables any potential problems to be discussed by those affected. At this stage, everyone will be made aware of any prohibiting factors that require specific solutions, allowing decisions to be made and plans of action to be agreed. The artwork agency and the printers will be expected to provide advice and support to the designer on issues such as colour, the reproduction of illustrations and any special effects such as foil blocking or embossing. If the designs do have any prohibiting factors both parties should be able to suggest various ways to achieve a similar result by using alternative methods. Colour tests may be also be suggested by the artwork agency if there are any concerns with the behaviour of the colours chosen, using the printing methods and substrates available.

The artwork agency will need to check that once the design has been signed off it is presented by the design agency in a format that is compatible with their own systems, including the software package, resolution of images and fonts used. They will also need to ascertain what the printer(s) requires once the artwork and repro is complete and ready to transfer, such as digital files or film formats.

By using the agreed process timings and an estimated brief date, a project plan which includes artwork approval, correction and production proof stages as well as a final film/digital file release date can be calculated by the artwork agency and issued to the group at this point. If there are any timing constraints that require special attention then these will also need to be discussed. This meeting is likely to be the only time that all those involved in this artwork process will be present so it is of vital importance that all attend and that issues are fully discussed. The whole team should be aware of any necessary testing, and any deviations from the original proposal or initial timings. Any changes to the original brief required as a result of this meeting must be highlighted before the production of artwork begins. This negates the need for major changes half way through a project which often have a negative impact on timings and costing.

### *12.3.2 Information gathering*

The next step is to complete the information gathering stage. While the designers are working on any changes requested by the group at the pre-briefing meeting, the artwork project begins to take shape. The rest of the team, armed with the project details, can start to produce the information needed for artwork construction to begin. The project leader will ask team members, already aware of their individual role and responsibilities within the process, to provide certain pieces of information. This will then be collated and forwarded to the artwork agency in the form of an artwork brief, once the final design has been signed off. To produce a correct piece of artwork, satisfying all criteria and built upon the agreed process guidelines, it is essential that all the information is available and agreed upon at the start of the project (Figure 12.5a and 12.5b). Any information relevant to the project, which influences the artwork, will need to be collated. This information may concern graphics, text, legal necessities and constraints, reproduction issues, dimensions and technical details. If all information is readily available at the beginning of the project the process steps can be followed and timelines met. If information is missing at this stage it may lead to corrections or changes to cost and timings throughout the process stages. The artwork process should not continue if the information is not readily available.

### *12.3.3 Briefing meeting*

The 'brief' should document clearly and concisely all items including product variants, sizes and language variants that form the project. It should also indicate

# BRIEF FORM

## marketing

| | | | |
|---|---|---|---|
| PROJECT TITLE | | PROJECT TEAM MEMBERS DEPARTMENT | |
| | | | |
| BRAND MANAGER | | | |
| | | | |
| BRAND VARIANT | | | |
| | | | |
| MARKET | | | |
| | | | |

| NAM REQUIREMENT DATE | QUANTITY | APPROVED/UNAPPROVED A/W | FILM RELEASE DATE | LAUNCH DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

## printer

| | | | | | | PRINT SPEC. CODES | | |
|---|---|---|---|---|---|---|---|---|
| PRINTER | NEW Y/N | CONTACT | TELEPHONE NO. | COMPONENT/SIZE | PRINT PROCESS | PROFILE | GLUE | COMPONENT |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## designer

| | | | | | DESIGN REQUIREMENTS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DESIGNER | NEW | CONTACT | TELEPHONE NO. | COMPONENT/SIZE | DESIGN STYLE GUIDE Y/N | DESIGN TRANSFER METHOD | NUMBER OF COLOURS | FOIL BACKING Y/N | EMBOSSING Y/N (DEPTH) | DEBOSSING Y/N (DEPTH) |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

(a)

(b)

pdd ______________________

| FACTORY/SPU Wrafton/ ____ | | LEGEND CODES | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ARTWORK APPLIED CODES | | | | | LEGEND ONLY CODES | | |
| COMPONENT | SIZE | COPY CODE | EAN CODE | ITF CODE | PHARMA CODE | FACTORY CODE | PACK CODE | DRAWING NUMBERS (PROFILE) | DRAWING REQUIRED Y/N |
| | | | | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

actions ______________________ *** LABEL TO USE A MINI PHARA CODE.**

BF2

**Figure 12.5** Brief forms used in information gathering.

the hand-over date and the required deadline in the form of the film/file release date to the printers. If individual items within the project (such as cartons as opposed to labels or tubes) have different deadlines these will need to be highlighted and treated as separate elements (this should already have been touched on at the project meeting). It should also contain the names of all team members and their contact numbers as a quick reference. The project leader and the artwork agency should collate this information based on the team's input.

Ideally the briefing document should be handed over to the artwork agency's representative or account manager during a 'brief' meeting. Unlike the 'pre-brief' meeting it should not be necessary for the whole team to attend. The members of the team who have compiled the bulk of the brief information such as the project leader, the technical department representative, and the research and design or factory representative should be present. All parties should be presented with a completed copy of the brief as a document to be referred to during the approval procedure. The final artwork can be checked against this document by both the client and the artwork agency. As with the 'pre-brief' meeting this is the opportunity to voice concerns with the brief.

#### *12.3.3.1 Components of the brief*

Certain items should be handed over in addition to the brief's information document. These items often consist of the design(s) and design guidelines, the text, the cutter profile or die drawing and any other additional information such as bar code numbers or on line coding details which may not have been included in the brief.

#### *12.3.3.2 Copy content*

After the text has been through any necessary internal or industry standard approval loops, and once it has been signed off internally, it is ready to be forwarded to the agency as part of the brief. The text should be available in a digital format provided on the preferred transfer medium, again as agreed at the project meeting, with an accompanying hard copy for quality control purposes. The position of the text on the product should also be clearly indicated; for example, if the packaging consists of a carton, the relevant panels should be indicated such as back panel text and front panel text. If there are different items, variants or sizes that have different textual content then this will also need to be indicated clearly. Ideally this text should be presented as individual separate documents headed with the item at the top. If the text is foreign then this must be marked up clearly with headings translated into the agreed common language of the team so that the agency can work out easily where each translation is to go. Multilingual text should be provided in the relevant running order as it needs to be set, within a document which is already compiled and not on individual language documents needing to be broken down and amalgamated with other languages. Hand-written copy should be avoided at all costs as this can lead to content interpretation problems.

*12.3.3.3 The design*

The designer should forward the final approved design and design guidelines, including font and colour references and perhaps brand variations, size and layout variations. This should reach the artwork agency in a format, usually digital, which will have been agreed at the initial project meeting. An accompanying colour run-out should also be provided for quality control purposes in the event of file corruption.

*12.3.3.4 The technical drawing*

The cutter profile is a flat drawing of the packaging which indicates cuts and folds as well as non printable varnish-free areas which allow for any on line coding which may be required (Figure 12.6). The drawing is usually at the same size (100%) and will contain all the measurements of the product. This information should be supplied in a clear format using keys which are easily recognisable by the factory or the technical department providing it and the artwork agency receiving it. This detail should be clearly documented within the process. Although the profiles are generated at the factory, the printers (who supply them to the artwork agency) usually digitise them. Some profiles that belong to larger clients may be utilised across a number of brands; because of this it is always a good idea to use a set of naming conventions for these profiles which is easily recognised by both the supplier and the client. Using the correct naming conventions for profiles will allow future changes to be requested and carried out to existing profiles as well as eradicating duplication of effort when a profile is used for more than one brand.

*12.3.3.5 Coding*

Any pack codes which are required to be applied to the artwork for factory and stock administration purposes also form part of the brief and are required to be supplied by the relevant department.

## 12.4 Preparing to start

Once the final brief has been handed over the artwork agency account manager will need to do a number of things.

*12.4.1 Planning project timings*

Firstly, using the agreed process timelines in conjunction with the film/file release dates, the artwork and reprographic agency will need to create a set of project timings. This will contain all of the key stages in the artwork's life, such as first stage artwork, and first stage artwork approval, as documented in the process, coupled with the projected dates for implementation. Provisions should be made for at least one or two sets of amendments; this usually gives a more realistic representation of the time the project will take. In the event

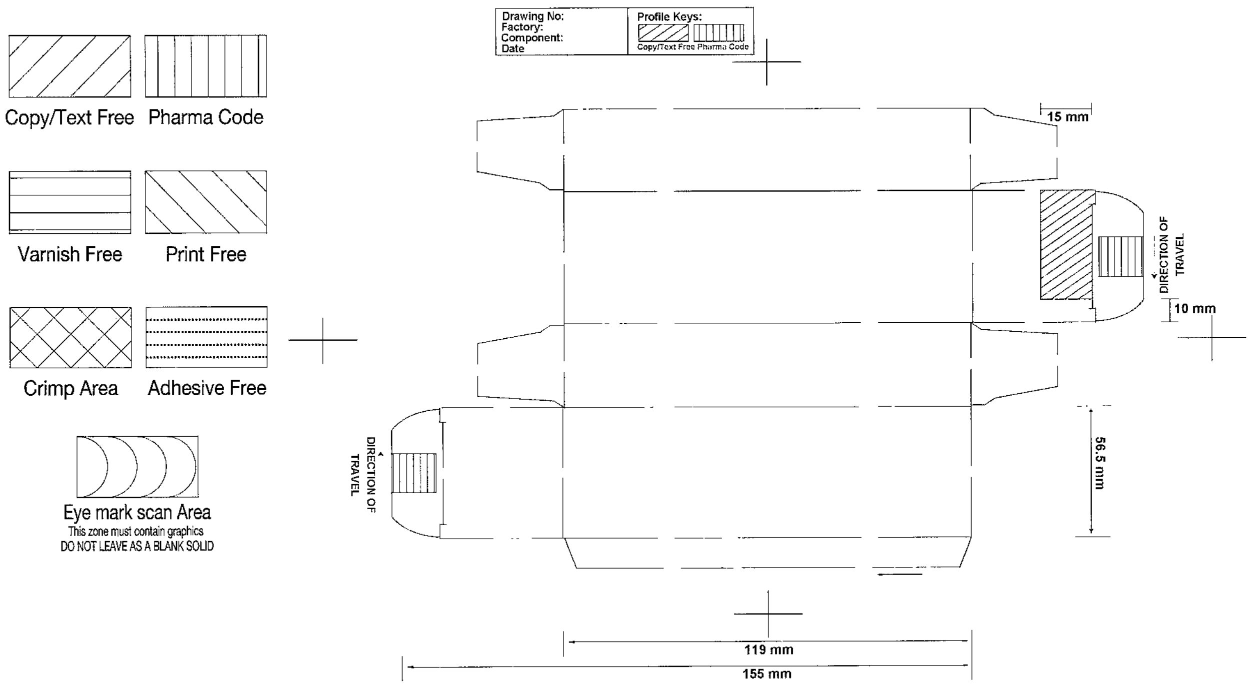



**Figure 12.6** The cutter profile.

that the artwork does not require any amendments it will be completed ahead of schedule whereas unplanned for amendments will delay completion. Once the project timelines have been estimated they will need to be supplied to the project leader for approval. Following approval all members of the team (both on the supplier and client side) will receive a copy and then be expected to work to these agreed timelines.

### *12.4.2 Estimating costs*

An estimation of the cost of the job will also need to be produced at this stage. Depending on the type of work, as a result of the original process discussions, there may already be an agreed price for each variant. However, if the nature of the work varies due to brand or design, then the cost may be generated by the amount of time the job takes, multiplied by an agreed hourly rate and coupled along with material costs. Once the estimated cost for the project has been calculated then this also must be submitted to the project manager for approval. This enables any problems associated with the cost to be discussed and negotiated before any cost has been incurred, allowing the account manager to manage expectations successfully.

### *12.4.3 Transferring the brief into production*

As soon as everything has been agreed with the project manager the account manager will need to transfer a full brief into production. This will usually involve logging the new job into an internal administration system to generate a job number by which all internal departments will identify this particular project. Once this has been done all the components which make up the brief will need to be organised into something which can be easily understood. The completed client brief along with the accompanying elements such as the copy, needs to be compiled. This document, the agreed timelines and cost, and any relevant background information gleaned during the briefing procedure will form the internal job brief.

## 12.5 Initial artwork construction

### *12.5.1 Building artwork*

The aim of any packaging artwork is to convert a creative design into a technically correct format that translates easily into printable material. As with most disciplines to build packaging artwork correctly requires a certain skill base. There are fundamental rules concerning packaging and printing which need to be understood before any individual attempts to build a piece of packaging artwork. Constraints such as minimum point size for type as well as distances from crease and cut areas all must be understood and taken into consideration (Figure 12.7). These issues will not be included in the project brief as any good artwork and reprographic agency, already experienced in these matters, will apply these disciplines automatically.

The artwork operator should digest the brief first of all. If there are areas about which the operator is not completely sure then the account manager should be consulted, and if necessary asked to call the client for further discussion or clarification. Once the brief has been fully understood the building process can begin.

Before the operator can start any elements or items which are specific to this particular client should be gathered together, ready to be applied to all files. The elements may always be applied to the company's artworks, such as boxes containing generic information, legends containing the company logo or version boxes indicating the artwork stage (Figures 12.8 and 12.9). Applying this type of information will mean that artworks can be easily identified, and the content and format of this information should be agreed during the compiling of the process.

The operator will need to check the design files supplied by the designer. If there has been previous communication with the designers during the 'pre-brief' and 'brief' meetings as indicated in the process then the files should be presented

**minimum**
**point size**
**5pt**

**Figure 12.7** Typeface guidelines.

**Version number**
**of artwork file is**
**01**

**Figure 12.8** Box to indicate artwork stage.

**Customer Legend**

| | | |
|---|---|---|
| Colour 1 | Colour 2 | Colour 3 |
| Colour 4 | Colour 5 | Colour 6 |

| | |
|---|---|
| Brand | Pills |
| Variant | Caplets |
| Component | Foil |
| Language | GB |
| Seven Job No. | 990000 |
| Version No. | 01 |
| Drawing No. | F0000000/01 |
| Pharma Code | 000 |
| Factory Code | 000000A |
| Printer | Eurofoils |
| Print Process | Flexo |
| Pack Code | n/a |
| Dimensions | 172 x 66 mm |
| Copycode. | F000000/02 |
| Barcode No. | n/a |
| No.of Colours | 01 |
| Date | 00/00/00 |

**Studio Artwork Department**

**Figure 12.9** Form used to gather information about a company's artworks.

in a way that requires minimum work as opposed to completely rebuilding what has been presented. All elements within this artwork will need to be checked to make sure that they are coloured up correctly. For example, if the artwork had been designed to print in five colours, these being the four process colours cyan, magenta, yellow and black, plus a special purple, then all elements must be made up in these colours so that they are correct for print and not just visually correct. Any standard logos or illustrations, which have appeared on previous artworks and exist as master elements, should be applied to these files to ensure consistency and continuity. The artwork layers will also require some attention to make sure that items which are required to be visually seen on the artwork but are not required on the final printed product can be easily switched off when producing film or postscript separations. Elements which tend to require amendments more often than others should also be situated on separate layers to make changes easier. Size of type and also resolution of the images supplied will need to be checked to make sure they are acceptable for the resulting output once the artwork has been approved.

Once the supplied files have been checked then the correct cutter profiles or die lines can be selected for each variant. All of the relevant technical detail that is contained in each profile will need to be applied to the design file; this may require manipulation of certain elements or even resizing in some cases. If, however, the designers have been provided with the correct profiles, or at least the correct dimensions to work from, during the 'pre-brief' meeting then major changes will not be required.

The correct text will need to be added to the artworks as supplied by the client. This often is the biggest part of the job, as the text contained in the design files is usually incorrect, because it is usually too early during the creative process to supply the correct copy. The text will need to be typeset in the correct font as indicated on the design files as well as in the correct size and colour.

Any illustrations may have been supplied as traditional artwork or as transparencies, and indicated on the designer's files by a rough representation produced in low resolution for position and size only. The illustrations will now need to be scanned to create a digital file and then resized, retouched if necessary, colour adjusted and split into the correct colour channels for print. The colour adjustment and retouching work may take a considerable amount of time and skill so this should to be treated separately at this stage. A high-resolution output of the finished result such as a cromalin or wet proof should be submitted for the project manager's approval. Once approved, the low-resolution version used for positioning can be replaced with the high resolution-version.

All of the building work will be compiled in-line with repro specifications. For instance the artwork operator will ensure that all graduations will be feasible to replicate at final stage and do not cause a problem with tints banding. Problems such as the thickness of keylines or reversed out areas which may cause problems with register will be taken into account. Anything that may require extra deliberation or further testing that has not been picked up at the briefing stage will be considered by the operator during the build. A good artwork and repro house should perform these functions automatically.

Throughout the artwork build if there are any areas not covered by the original design or which require change due to technicalities the account manager should be informed and the designers consulted if necessary. Often there will be a couple of elements which were not considered in the original creative brief but that require some form of creative input. The process should be viewed as a continuous flow instead of three very different parts, this perception should be encouraged in all members of the team throughout the project.

After ensuring with a final check that the project complies with the brief, the operator is in a position to pass the files through to quality control.

### *12.5.2 Colour testing*

High-resolution outputs from scanned illustrations are required in order to obtain early approval during the initial building stage. Colour testing should also be carried out at this stage. The process often answers concerns about the behaviour of colour, whether it is achieving a match to something that has been requested by the designers, or the testing of a vignette. This should be done either by the artwork and repro agency alone or in conjunction with the printer, depending on the materials used, the print process and the ease with which this can be accurately simulated. It is very important to begin the colour work as early on in the process as possible. Indeed if it is a project that is utilising very new technology and substrates it is often prudent to begin this after the pre-brief stage. Colour is very subjective, and it is often a vision within a project manager's or designer's mind that the artwork and repro agency are required to match. Because of this, achieving the perfect colour, or at least creating other options, can be a long drawn-out task. In order to manage all expectations concerning colour and in an effort not to slow down the agreed process (which is usually put in place to make things quicker) it is imperative that colour testing is treated as a very important and urgent matter. It is desirable to deal with this separately at the beginning of the process to save cost and time, instead of trying to solve the issue during the end stages, when the complete artwork has been produced and approved and the final output is produced for final sign off. This will also ensure that once at the print stage the printers will have a very clear target that they will be expected to reach, ensuring a smooth handover.

### *12.5.3 Quality control*

Before a piece of artwork is submitted to the client for approval, it should have passed at least three checking procedures. The operator who has built the artwork is ultimately responsible for the quality of work produced so it is imperative that this operator checks the file before releasing it to the next stage. The artwork should also be checked by someone uninvolved with the project up until this point; a fresh pair of eyes may spot glaringly obvious mistakes that often become invisible to those closely involved in the development. Ideally, a reader or quality control personnel should perform the second check. Quality control should be in possession of all the elements supplied at the brief stage, including the client's briefing document, the hard copy of the text, and the designs, the technical information and profile hard copy and any internal documentation listing details about client specifics. The person undertaking the check should have a good knowledge of the client's specific requirements (i.e. the format and content of the generic information boxes which are required), and a good insight into the internal company standards expected from artwork builds, such as file layout and extra information communication formats.

This second check should include all areas including copy, content, size, appliance and continuity of design among variants, technical specification and most of all conformance to the brief. If there is anything in question at this stage then the operator must be informed and asked to rectify the work. If, however, the artwork appears clean, then the correct documentation is completed as proof that there has been a quality check for auditing purposes and the job will be passed back to the production co-ordinator (Figure 12.10).

The account manager should perform the final artwork check before it is sent around the approval loop. Having been involved in all the pre-brief discussions as well as receiving the brief directly from the customer, the account manager

**Qc reader Checklist** for a/w & Legend

**Submitted by:** Date in: ______ Required by: ______
Time in: ______

**Job description:**

**New Job / Amendment*** highlight the appropriate action

| | | | |
|---|---|---|---|
| Brand: | ☐ | Factory code: | ☐ |
| Variant: | ☐ | Printer: | ☐ |
| Component: | ☐ | Print Process: | ☐ |
| Language: | ☐ | Pack code: | ☐ |
| Seven Job no: | ☐ | Dimensions: | ☐ |
| Version no: | ☐ | Copy Code: | ☐ |
| Drawing no: | ☐ | Barcode: | ☐ |
| Pharma code: | ☐ | No of colours: | ☐ |

- ☐ Read the attached checklist used by the operator.
- ☐ Cross reference the Master Profile with the a/w. *Check all information on profile Legend.*
- ☐ Use the brief sheet/Job ticket to check off the above list.
- ☐ Does the repro work ie: (chokes & spreads or overprinting) effect the appearance of the a/w, and if so have marketing been made aware - or are there any alternatives? *(if so comment in the space below)*
- ☐ Has the a/w been considered to the component?

  So does the a/w: **A** fit the profile and
  **B** fit the component ie: when made up does the front face appear in the right place etc.

**Unapproved by:** DATE:

QC COMMENTS:

**Approved by:** DATE:

**Figure 12.10** Artwork checklist.

should be in a good position to undertake a last check to all that has been built.

## 12.6 The approvals process

### *12.6.1 The approval loop*

Every approval loop will differ between clients but the basics will remain the same. Usually the main contributors to the brief will need to be involved in the initial approval loop to check that their instructions have been carried out correctly and that there are no further alterations needed. There may be individuals in the first approval loop for their own information, but not required to comment unless they feel it necessary. This could be an individual at category director level, for instance. Some departments' approvals can also be related to other departments' approvals and this too should be taken into consideration.

During the process discussions the approval loop(s) should have been ascertained and timelines applied. Once the artwork has been completed the account manager must transfer the artwork in the preferred format around the approval loop, either digitally using PDF (portable document format) files, conventionally using colour outputs, or a combination of both. The movement of the artwork around the loop should be organised directly by the artwork agency or the project manager. It can be distributed simultaneously or consecutively via individual departments in order of preference. All of these procedures will be dictated by the need of departments to see other departments' comments as opposed to all individuals within the loop only being concerned with their own area. Usually the project manager will be the collator of approvals and will have the authority to override any unsuitable requests or make a decision on conflicting suggestions. It may also be deemed necessary to include the designer, printers and the factory in the initial approval loop. However, this is not always a helpful exercise and should be considered carefully.

### *12.6.2 First stage artwork submitted for approval*

The artwork that is being submitted at first stage should be clearly marked as to its exact nature and its purpose. The information boxes that are applied to the artwork should be designed to communicate this necessary information. Areas or forms for adding comments, or requesting amendments or alterations should be agreed so that all communication is in the same format. If projects are submitted in bulk then prioritising items in order of preference can also be of help.

### *12.6.3 The amendments process*

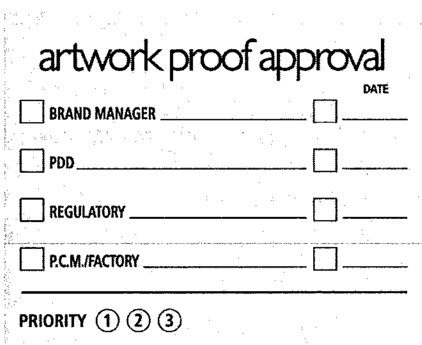
Each contributor to the approval loop will be required to add comments, request amendments or simply sign the artwork off from their perspective within the permitted time allocated. The project manager or the account manager will communicate this time clearly. Comments or amendments must be marked up clearly in an agreed format and returned to the artwork agency via the project manager. It should be clearly stated whether the individual wishes to see the artwork again or is happy for the amendments to be carried out and the process to continue. Once everyone has approved or applied their comments and the project manager has collated and approved these, then the account manager will be notified and receive all documentation back. Before the process can resume the original timelines for the project as generated by the account manager will need to be reviewed, updated and revised if there has been significant deviation.

If the artwork has been approved, then the artwork and repro agency can continue with the wet proofing stage, but if changes are required, these must be made. The account manager must document all change requests/amendments clearly in order to satisfy two criteria: the documented changes will form the new brief for the operator and give quality control something to check against once the artwork has been updated, and secondly, the documented changes will make clear to the customer exactly what they have requested and are being charged for in the final invoice.

The operator will need to understand the amendments brief fully, which may again involve calling the project manager for clarification. Once the changes have been fully digested then they can be applied to the artwork, making sure that the date and the version are updated within the information boxes (Figure 12.11). The updated artwork must then be passed through quality control for checking and then released to the account manager. Following the account manager's final check the artwork is ready to be returned to the client's approval loop.

### *12.6.4 Achieving artwork approval*

The approval loop for this second stage may be shorter certainly if the printers, designer and factory have been included in the first approval; usually there is no need to include them again, especially if the changes are not radical. If certain members of the original approval loop have signed the artwork off at first stage they may not wish to see it again. As with the first submission the account manager must communicate clearly to all in the loop exactly what it is that they are submitting and the timelines in which approval/comments must be returned.


artwork proof approval

DATE

☐ BRAND MANAGER ________ ☐ ____

☐ PDD ________ ☐ ____

☐ REGULATORY ________ ☐ ____

☐ P.C.M./FACTORY ________ ☐ ____

PRIORITY ① ② ③

**Figure 12.11** Artwork approval box.

The client may also wish to check against a copy of their original comments from the first stage submission. The second set of comments/approvals will finally need to filter through to the project manager who can then pass a final artwork approval to the account manager at the artwork and reprographic agency.

After second submission final artwork sign off can usually be achieved, but if this is not so then the process is repeated.

## 12.7 The repro process

### *12.7.1 Applying repro following artwork approval*

Once a final artwork approval has been obtained the project can follow a number of different routes. Artwork once signed off can be passed on to the printers who can apply the repro to their own specifications using an internal department. If the printers do not have the facility on site to apply repro, they may send this business to a local company with whom they have close links. However, the usual course of events dictates that the artwork and reprographic agency will carry on with the repro through to production proof stage. This usually proves advantageous to the client for a number of reasons. Single sourcing ensures continuity with colour, quality and cost. When there is more than one printer involved in a project single sourcing ensures that the standards of repro will be exactly the same throughout, plus the repro files will reside in one place. It also means that the client retains the same control and can use the same process as that for the artwork, keeping things simpler and more streamlined. For these reasons this chapter concentrates on the artwork and reprographic agency route.

Following the artwork approval, the account manager must again move the project into production. If the project consists of many variants produced by different suppliers the repro required may differ among variants. A full specification sheet from each printer involved will be required and should have been obtained during the 'pre-brief' stage. The specification sheet should contain details about their specific printing process. It should document the types of grips that they require and the minimum widths of keylines; it should also contain details about the screen ruling and shape of the dot. Other information should include the thickness of film required and whether it should be positive or negative, right reading emulsion down or right reading emulsion up. If the file is to be transferred digitally then details about the file format and also acceptable ways of presentation and file transfer should be indicated. All of this information will need to be passed from the account manager to the repro department.

The account manager must again update the internal job ticket that has accompanied the job up to this stage. Reference to the date of artwork approval and the version controls applied to this artwork must be clearly stated on this sheet. Colour copies of the approved artwork will need to be supplied for reference within the job bag for the repro operator. All copies of the printers' specifications must be included along with a comprehensive list of which variants are printing in which process. Finally, as with the internal artwork brief between the account handler and the operator at the start of this process, the repro operator should be similarly briefed until completely satisfied that they are in receipt of a complete set of instructions.

Once in possession of a full brief, the repro operator will set about applying the gripping, or chokes and spreads as sometimes called, to the files. Using the printers' specifications as a base, as well as his/her own judgement and expertise for unusual elements, the operator will bleed (spread) or grip back (choke) any overlapping colours in order to make the file easy to print on press. Once all of the areas have been treated the file will be complete and ready to output.

### *12.7.2 Film output*

After the repro has been applied to each of the files the film can be output to the supplied printers' specifications. Each colour from the file will be separated out and plotted to the film processor; it can then be checked against the original artwork laser and the rest of the separations for any mistakes or imperfections. In this case the repro operator will check his/her own work, and quality control will check the films against the artwork laser output for content only. If the film is clean, then it can be signed off internally and passed through for plate-making if wet proofs are required, or alternatively through for cromalin creation. Cromalins may have been decided upon as an option if the colour standards have already been set throughout the project; however, in most cases wet proofs will be required to set the colour standards. Cromalins may also be an option if the print process to be applied cannot be easily replicated by producing wet proofs. Print processes such as letterpress, gravure and screen printing are difficult to replicate using the standard litho wet proof method so it may be decided to opt for a cromalin proof in these instances; this should be discussed at the 'pre-brief' meeting. Cromalins give a good idea of the true colour but are not totally accurate, although they will indicate accurately the content of the film.

### *12.7.3 Plate-making and production proofing*

If wet proofs have been chosen the next step is to plan and plate the images in preparation for proofing. Referring back to the 'pre-brief' meeting and the discussions with the printers, the films may have to be planned in a very specific way, which should have been documented and the information passed on by the account manager. Once the film has been planned successfully it will be made into metal printing plates using a series of chemical processes and ultraviolet light. The dots making up the image on the film protect the chemical layer on the metal plate while the background is burnt away by the ultraviolet light, leaving the image at a raised level on the plate.

Once the plates have been made and checked over they can be then passed on to the proofing operators by production. The aim of the production proof is to provide an accurate representation of the item's content as well as being the colour target that the printers will be aiming for on press. Every effort should be made to replicate the printers' equipment and conditions in the aim of providing a result that they can easily match, and not something that will be nearly impossible for them to achieve. Using the same material and inks as those the printers will be using in production, and emulating the printers' press by fingerprinting techniques will all help to ensure that the wet proofs produced can be easily replicated. The number of wet proofs that are required will be decided by the number of people involved in the process who need signed off proofs for their records. In most cases the following individuals will need to be in receipt of a signed proof following final approval: the printer who needs something to match, the factory so that they have something to check the finished goods against, the project organiser, the regulatory department and the artwork and reprographic agency. These details should be finalised during the 'pre-brief' meeting. Once the relevant number of proofs have been completed and signed off internally at the artwork and reprographic agency, they are then ready to be dispatched around the approval loop pending final sign off.

## 12.8 Final sign off and transfer to printer

### *12.8.1 Final sign off—content and colour*

As with the preliminary artwork stages the wet proofs will need to pass around the client's approval loop. Depending on the relationship with the artwork and reprographic supplier and the amount of trust between them, certain individuals may not wish to be part of this loop as technically there should be no difference in content from the last laser or PDF submission. The wet proof provided at this stage should be for colour sign off. However, depending on the client and the individuals involved there may be a need for the wet proof approval loop to replicate the initial artwork approval and this should be ascertained during the original process discussions.

The wet proofs should also be forwarded at this point to the relevant printers for their final approval. The printers may have seen the first stage submission artwork for the purposes of content approval. At wet proof stage the printers will have the opportunity to see what they will be required to replicate. If the printers have reservations they can use the opportunity to communicate this to the artwork and reprographic agency and get amendments made before the film is released. This step is vital to the smooth running of the whole project. If film or a file reaches the printers along with the wet proof target and there is a problem that will need rectifying this could have devastating effects on the print production lead times. By including the printers in the final approval process such delays can be avoided.

After achieving final sign off, the account manager and project manager have to compile the wet proofs containing the relevant signatures. As an absolute minimum, there should be at least enough signed proofs to provide the artwork and reprographic agency with a signed copy of each variant as well as a signed copy to be sent on with the film or digital file to the printers. Once these have been compiled and forwarded to the artwork and reprographic agency the job is ready to be released.

### *12.8.2 Film/file release*

It is vitally important at this stage that a poor film or digital file exchange does not undo all the hard work. When releasing the file or the film to the printers the format should be exactly as was specified during the 'pre-brief' meeting or during any subsequent communication. The printer should never receive the film or file without a hard copy in the form of a colour laser, cromalin or wet proof. The hard copy proof wherever possible should be signed by the client as proof of approval; if this is not possible, the client should confirm directly with the printers that what they are due to receive is approved and can be moved into production.

The film/file and the signed off proof should also be accompanied by a final sign off form (again, the layout and full contents of this should be devised at the original process meetings). This form should contain a summary of the job's basic details so that it is instantly recognisable by the printers when they receive it. It should also contain an area for the printers to indicate that they have received the job and after performing a basic check of the elements are happy to proceed. The printers should sign to the form and fax this back to the account manager at the artwork and reprographic agency. The artwork and reprographic agency then has a record that the job has been received and is in a viable format. This will also serve as a proof of receipt to forward to the client, and any planning facility that they may have, so that they can continue to monitor the progress of the job during its next stage.

### *12.8.3 Signing off on press*

When the project consists of new pack development or existing pack refresh there may be a necessity once the films/files have all been released to the printers for the client (or someone on their behalf such as the artwork and reprographic agency) to attend the first print run. The attendance of such an individual would be in order to approve the job on press, and this may be required for all of the printers throughout the project, which on a large launch could be a considerable number.

It may be that although the printers have been involved in the process throughout, and might have even carried out a number of print tests concerning colour or materials, this is the first time the job will be run at the speeds and quantities which are required for real production. The wrong results at this stage can prove disastrous not only in monetary terms but also in terms of production timings. Depending on the job itself, the printers' confidence in achieving a close result to the wet proof target supplied and their relationship with the client and understanding of their expectations, the printers may require someone to pass on press. The necessity of this and the logistics of carrying it out should be discussed at the 'pre-brief' meeting so that the relevant planning can be carried out during the project.

Press passes are not always necessary but for large launches they can be deemed an important part of the process. When carried out by a central group or individuals, consistency of approach is assured in commercial acceptable quality and the judgement of reasonable colour tolerance variation.

## 12.9 Completing the job

### *12.9.1 Invoice generation*

Once all items have been released, the printers have confirmed that everything has been received and that the print production stage is continuing, the artwork and reprographic agency should be in a position to submit an invoice for the project to the client. It is advantageous to all parties that any invoicing is done while the job is current so that the client has a chance to rectify their budgets and that any issues are still fresh in everyone's mind.

The invoice should be presented in a clear and precise format. It should contain all the basic details of the job so that it is clear what the invoice is for. A fully detailed cost breakdown by action—artwork build, repro work, film output—and stage should be compiled to achieve an overall project cost. A summary of the initial brief along with a list of dates and details of any subsequent changes or amendments should be documented on a separate sheet to provide a full project cost history. If there have been mistakes made during the project these too should be listed to indicate to the client that this cost has not been passed on to them but absorbed by the artwork and reprographic agency. Finally if a purchase order number has been raised following an initial quote this should be clearly indicated to aid purchasing's role and prompt payment.

### *12.9.2 File archiving*

Following final sign off and invoice submission, all that there remains is to archive the files and any relevant information concerning the project. During the initial process meeting this subject should be discussed. The usual practice is that the artwork and reprographic agency are required to archive the data themselves as part of the contract with the client. If the client wishes to store the digital data then the way in which this is presented to the client at the end of the project should be agreed.

Their internal system platform will determine how an artwork and reprographic agency archives the digital data. It is worth noting that the digital files are the property of the client and the agency are storing this on the client's behalf. If a copy of the files is requested by the client it is vital that the digital data can be easily and speedily retrieved by the agency. The way in which a file or project is stored and the storage of data should be considered to cover all possible requests.

## 12.10 The utilisation of existing and historic imagery

### *12.10.1 Image libraries*

The design and launch process produces a number of artworks once a project has been completed. Clients will need to search through these artworks for a number of reasons, such as reference, presentation materials or artwork change initiation. Previously this has been done in several ways, usually resulting in an individual searching laboriously through boxes of product or folders of files. With the evolution of technology, the creation of digital search engines, from basic image libraries to sophisticated electronic workflow systems linked to master image files, have become standard in the industry.

Image libraries usually consist of some form of low-resolution representation of the artwork file such as an Adobe Acrobat PDF file. Users may search for images using a number of search criteria linked to information details coupled with these files.

With the advent of the image library, ways of working have had to change, adding another step to the design and launch process. At the end of a project files may have to be uploaded to the image library. Image libraries also have an impact on the process itself, as they are often now the starting point where an artwork change or manipulation is required.

# 13 Labelling legislation and bar coding

L. Eve and P. Nutter

## 13.1 Introduction

An important question to ask when looking at the labelling of consumer products must be: what is the function of this labelling information? In answering this question we must look at this from a number of different perspectives.

From the manufacturer's or retailer's perspective, one of the main purposes of the packaging of a product, other than protecting or containing the product itself, is to serve as a vehicle to market the product. This is generally achieved by highlighting the positive attributes of the product and the benefits to the consumer. Therefore, the manufacturer will be looking at how to best use this space to portray his product in the most advantageous way—considerations such as the design, style of text, graphics or pictures to be used will all be of a major importance. However, from the consumer's point of view, the main function of that identical packaging is different. Although the consumer will want to know the benefits of the product, and the design of the packaging will add to the attractiveness of the product, more importantly the consumer will want to know exactly what the product is and what is in it. The consumer will expect the information on the packaging to provide answers to numerous questions such as:

- What ingredients does it contain?
- How do I use the product?
- What is its nutrition content or health implications?
- Are there any reasons not to buy the product (such as allergies or risk factors)?

Hence there may be a potential conflict of interests in the amount and detail of the information that would or should be given on any packaging or labelling. From a regulatory point of view, it is essential that the label contains all the information a consumer may reasonably be expected to need in order to make safe and appropriate use of any product. It is the manufacturer's responsibility to provide this information in an easily accessible manner and in a user-friendly format.

The role of legislation is to bridge the gap between the information a consumer might expect to be given about a product and that which the manufacturer may wish to offer. In order to avoid consumers being misled as to the true qualities of the product, regulations, codes of practice and informal guidance have been issued, which control the type of information that can be presented on packaging of consumer products. However, owing to the vast array of consumer products available on the market, and the introduction of many more new products each year, this is not an easy task for the regulatory team and can prove a minefield for the honest manufacturer or retailer.

The aim of this chapter is to provide a general overview of the legal controls that exist and how these aim to protect the consumer, with a particular focus on food products as the labelling of food and drink products is that which is most widely open to interpretation. The nature of labelling legislation will be reviewed, concentrating on the areas likely to be specifically controlled and areas where it may or has proven difficult to regulate in detail. Unfortunately, because of the seemingly unlimited legislation concerning labelling of consumer products this chapter will not focus on the exact requirements that apply to individual categories of products.

In the absence of harmonised global consumer protection legislation, it is also interesting to contrast the differences in approach that are used throughout the world to protect the consumer.

As the manufacturer or retailer is ultimately responsible for the details that are given on their products packaging, this chapter will highlight the main areas of consideration and provide a useful guide to some of the pitfalls.

## 13.2 General considerations

Whether the product in question is a food, cosmetic, household or any other consumer product, there is likely to be some form of general legislation that will set out broad criteria for its labelling. Take, for example, Directive 79/112/EEC, as amended, which lays down general requirements on the labelling, presentation and advertising of foodstuffs in the European Union (EU) [1]. The Directive stipulates that the labelling and methods used must not mislead the purchaser to a material degree, particularly:

- as to the characteristics of the foodstuff and, in particular, as to its nature, identity, properties, composition, quantity, durability, origin or provenance, method of manufacture or production;
- by attributing to the foodstuff effects or properties that it does not possess; or
- by suggesting that the foodstuff possesses special characteristics when in fact all similar foodstuffs possess such characteristics.

In the absence of specific legislation, these general provisions are intended to serve, essentially, as a safety net to require that any information presented on the label of a food or drink product must be accurate and truthful.

In the UK, one of the EU Member States, these provisions have been implemented by way of the Food Safety Act 1990 [2]. The Act requires that the labelling of foodstuffs must not be false or likely to mislead as to the nature, substance or quality of the food (Section 15). Furthermore, the Trade Descriptions Act of 1968 makes it a criminal offence to apply a false trade description to goods [3]. Although these legal requirements are very general in nature, they do serve as overall protection for the labelling of food products. Manufacturers can, and have been, prosecuted under the general provisions of Section 15 of the Food Safety Act alone.

### *13.2.1 Format and style of labelling information*

Before looking at what legal information must be given on consumer products, it is essential to remember that any such mandatory labelling information must be presented in a manner that is easy to understand and easy to read, otherwise it would be pointless to provide such information in the first place. However, this is not as simple a task as it may seem.

It is relatively easy to set general standards on how to make labelling information easy to read. In general the information must be clearly visible and legible. This means any mandatory details should not be hidden or obscured by other information such as pictures, graphics or marketing details. For example, in the case of a 'use by' date which is to be ink-jet printed on to the lid of a yoghurt pot, consideration must be given to accurately position the printed date. If the printing position is not precisely controlled and the date were to be printed outside the designated area on the label, which could be over a picture that appears elsewhere on the label, the date itself could end up being obscured and even illegible. This may mean that the manufacturer would be liable to prosecution for obscuring the date mark. Therefore, in addition to the final packaging looking attractive to the consumer, the clarity and positioning of any legal information is very important.

### *13.2.2 Positioning of information*

Another example of the importance of positioning of information could be in the case of the name of a product. In many cases, a product is given a main 'marketing' or 'trade' name, or a branded name (e.g. Coca Cola) and this will provide a first impression of the nature of the product to the consumer. However, a trade name may not always provide all the information that is legally required to sell that product, so it may be the case that a more detailed descriptive name is given elsewhere on pack. The positioning of this legal name is very important, particularly when the legal name of a product may be given as a title and a subtitle. The legal name should still be easily and clearly visible to the consumer at time of purchase. In an ideal world this should appear on the front of the pack or a prominent position on the label. However, this may not always be possible, because of the size or shape of the packaging, so many retailers provide the full name on the back of pack; in general, this is likely to be acceptable from a legal point of view, even if it is not user-friendly. If, however, the legal name is given on the back of the pack, it is essential that it is not hidden, in an obscure position or in a small font size. It should still be the most prominent piece of information on that part of the pack.

### *13.2.3 Size and shape of pack*

The size and shape of a pack is also very important when considering the legibility of labelling information. In the case of an individual portion of jam, because the pack size is so small it would be virtually impossible to print all the details that would normally be expected on other food products, without making the text so small as to be impossible to read. In instances like these there is generally room for flexibility in the legislation to allow for only certain information to be given. Certain countries legislation may allow 'small packages' (for example, those where the largest surface area of the packaging is less than $10\,cm^2$), to be labelled with only certain information (e.g. legal name and durability date, if needed).

### *13.2.4 Size of text*

Another consideration when designing packaging is to minimise costs if at all possible. As more and more companies are aiming to sell their products in the global marketplace, if one product is to be sold in more than one country, a manufacturer may aim to produce just one pack which will be suitable for marketing the product in all the destination countries. This is relatively easy to achieve, with the same labelling information being repeated in several different languages on the same pack. However, the space available on most labels for repeating the same information in a reasonable font size is generally limited and hence, it must be ensured that the text remains clear and legible. If too much text is squeezed onto the label in an extremely small font size, although cost may be saved in the short term, in the long run this may cause more trouble than it is worth as a result of the legal challenges from consumers who cannot decipher the information presented.

In general, minimum font sizes for legal information are not prescribed, but this is not always the case. For example, there is EU legislation that specifies minimum type sizes for the indication of net quantity, which depend on the total weight of the product (see Table 13.1).

### *13.2.5 Colour*

There are unlikely to be any legal controls on the exact colours that can be used for text or background of most consumer products packaging, but the

**Table 13.1** EU Legislation on minimum height for figures used in the quantity indication

| Declared quantity | Minimum size (mm) |
|---|---|
| Less than or equal to 200 g or 200 ml | 3 |
| More than 200 g or 200 ml, but less than or equal to 1 kg or 1 l | 4 |
| More than 1 kg or 1 l | 6 |

general controls on legibility of information are again important. There must be a good contrast between the text and background colours (i.e. dark text on a light background is preferable).

## 13.3 Product name

The most important single piece of information that will appear on the label of a product will be its name. This name must clearly identify the product to the consumer quickly and easily. In general terms this means that the product name must be sufficiently precise to inform a purchaser of the true nature of the product and to enable the product to be distinguished from similar products with which it could be confused.

### *13.3.1 Legally required name*

For certain products, there may be legislation that prescribes either an exact name or a description under which the product must be sold. This type of legislation includes recipe-based standards which require a product to meet certain compositional criteria (e.g. minimum/maximum quantity of a particular ingredient), or there may be strict rules on the use of certain active ingredients in medicines or cosmetic products. For example, in the case of chocolate products, many countries have compositional standards for specific types of chocolate, which only allow certain names such as 'milk chocolate', 'plain chocolate' or 'white chocolate' to be used for products meeting the minimum compositional criteria specified (i.e. minimum quantity of cocoa solids, cocoa fat, sugar, milk solids). Generally this type of legislation aims to protect the consumer from being sold what appears to be a 'quality' product under a prescribed name, but which actually contains inferior quality ingredients. Unfortunately, this type of legislation is likely to vary greatly from country to country, which can mean that in order to market the same type of chocolate in a number of different countries the product will require a different name and hence, a different label/packaging for each market (irrespective of language differences).

### *13.3.2 Customary name*

In the absence of a prescribed legal name, a 'customary' name may be used to describe the product. In most countries certain names for products will in time come to be accepted by consumers as the name of the food without any need for further explanation of their composition. For example, in the UK names such as 'Bakewell tart', 'Cottage pie' or 'Fish finger' would be acceptable as the name for certain specific products, as the majority of consumers in the UK know the nature of these products without any further information as to their ingredients. However, if the same products were to be marketed in Japan, it is likely that in order for an average Japanese consumer to understand what they were buying they would need further descriptions to be given on the label. For example, a 'Bakewell tart' may be accompanied by a description such as 'A shortcrust pastry base filled with a layer of raspberry jam and an almond flavoured filling, topped with fondant icing'. Again the use of such names will vary on the country in which a product is to be marketed, and may even vary depending on a particular area or region in a single country.

### *13.3.3 Descriptive name*

In the majority of cases, there will not be either a legally prescribed name or a customary name that could be used as the product name, so a purchaser will rely on the manufacturer providing a full and accurate description of the product, which should indicate its intended function, if appropriate. For example, the description 'chocolate dessert' gives a very general idea of the type of product, but this product could actually be a chocolate mousse, ice cream or cake and hence this description alone would not be acceptable as the legal name of the product. However, the description 'chocolate dessert' followed by the sub-title 'Smooth chocolate mousse topped with a white and dark chocolate sauce and sprinkled with chocolate flakes' describes the nature of the product exactly and would be acceptable as the legal name.

Where specific ingredients are mentioned in the product name they should, in general, be in the same order as in the list of ingredients; for example, 'Tropical fruit juice drink made with a blend of mango, pineapple and passion fruit juices', where mango is the main fruit juice and passion fruit is added in the smallest quantity. However, there may be certain exceptions when a characterising ingredient may be promoted, if in doing so it is unlikely to mislead; for example, 'Tomato Pizza with garlic and onion' where clearly the quantity of onions is likely to exceed the quantity of garlic.

### *13.3.4 Indication of physical condition/treatment*

Certain products will have been subjected to a specific treatment or process (e.g. freezing, drying, irradiation) which could mislead the consumer as to the true nature of the product if this is not indicated in the labelling of the product. It would be false to use the name 'bread' unqualified, if in fact the product being sold is 'part-baked white bread rolls', as the consumer would need to know that the product required baking before it could be consumed. Also, a consumer may not necessarily associate the term 'roast' with a product that has been steam cooked and then subjected to a short period of flash roasting and then followed by the use of a food colouring to simulate a traditional roasting colour. It is generally accepted that the term 'roasted' should only be used for products that have been roasted for a sufficient time at a sufficient temperature to have developed the appearance, colour and texture of a roasted product.

Care must also be taken when choosing the actual words to be used in the description, as certain words may have implications on the acceptable nature of the product. For example, if a product is described as a 'creamy sauce' the expectation of the consumer, and the requirements of the legislation, would be that the sauce should contain actual cream. If the product, however, only contained skimmed milk and vegetable oil, it would be misleading to describe it as 'creamy'. A more suitable adjective, such as 'smooth', should be used instead.

If a product is described as 'traditional', although there may not be any specific regulations restricting its use, again consumer expectations should be taken into consideration. Many manufacturers may set their own standards in this case, or follow industry sector-specific codes of practice, for example, only allowing the term 'traditional' to be used for products made to a documented recipe at least 50 years old. Other criteria may also be drawn up, taking into account consumer expectations of a 'traditional' product, for example:

- the product should only contain naturally derived ingredients, which were available when the recipe was originated;
- consumers would be unlikely to accept the use of food additives, or the presence of pesticides that were not available when the recipe was originated;
- the flavour, texture and appearance should accurately reflect the original product;
- as far as it is practical, the manufacturing method should be as close as possible to the original production method (allowing some flexibility for mass production).

### *13.3.5 Positioning of product name*

For some consumer products, certain pieces of information may be required to be given in a certain position on the label/packaging. For example, in the case of food products in the EU, the legal name, the durability date and the net quantity indication must all appear in the 'same field of vision' on the label. The legislation does not specify exactly where on the label the 'field of vision' must be; that is, it does not have to be the front or main face of the label, but consumers must be able to read the information without having to turn the product back and forth to find it.

In the US, Title 21 of the Code of Federal Regulations [4] prescribes labelling requirements for foods and requires that certain mandatory labelling information, including the legal name of the food, the list of ingredients and nutrition information, be given in the principal display panel (PDP) on the pack. The PDP is defined for the purposes of this legislation as 'The part of the label that is most likely to be displayed, presented, shown or examined under customary conditions of display for retail sale'.

## 13.4 Ingredients list

In general, it is likely that consumers will want to know what ingredients are used in a product and legislation will generally require this information to be provided on the label. The format in which it is presented is likely to differ greatly depending on the type of product. Many different issues arise when looking at how information on a product's ingredients should be presented to the consumer, for example:

- the basis for calculating the order of ingredients in the list
- the names that should be used for each ingredient (e.g. specific, category-based, generic)
- the declaration of multi-component ingredients within a multi-ingredient product
- special rules for the declaration of certain groups of ingredients (e.g. water, additives, processing aids, carry-over additives)
- the declaration of the quantity of certain ingredients
- the format or punctuation to be used

Under European legislation, both foodstuffs and health/beauty products are required to provide a full list of ingredients, although the format for this declaration differs significantly. Therefore, the same ingredient used in both types of products may be declared under different names; for example, 'water' for foodstuffs and 'aqua' for cosmetic products.

In the case of household products such as detergents and air fresheners, there may be no legal requirement to give a full ingredients list. Manufacturers may, however, choose to provide this information voluntarily if space on the label permits. The format for the voluntary declaration of ingredients would therefore not be specified and hence the manufacturer is likely to determine their own policy on ingredients list declarations, which vary from the formats used for other manufacturers products. For example, instead of providing a full breakdown of each ingredient used in the product, a banding system is sometimes used (see Table 13.2).

**Table 13.2** Example of banding system used for declaration of ingredients on household products in the UK

**PRODUCT INFORMATION:**
For your information, the active constituents listed in descending order by weight, together with a description of their function in this product, are given below:

| Constituent | Composition range | Properties |
|---|---|---|
| Sodium Hypochlorite | Less than 5% | Used as a bleaching agent |
| Sodium Hydroxide | Less than 5% | Used to stabilise the formulation and help to remove dirt |
| Anionic Surfactants | Less than 5% | Used as cleaning and thickening agents |
| Perfume | Less than 0.2% | Used to give a pleasant smell |

### *13.4.1 Basis for calculation*

The basis on which the order of the ingredients in the list is calculated can have a considerable impact on the apparent composition of the product in the consumer's eyes, for example in the case of water as an ingredient. If the order for the list was based on the weight/volume of the ingredients present at the time of their use in the preparation of the product (e.g. essentially 'mixing-bowl' stage), and the product contained large quantities of water, this would mean that water would be likely to appear as the first ingredient of the product. If, however, the order for the list of ingredients was based on their weight in the final product, this could have a significant impact if the same 'high-water' product was heat-processed during manufacture. The use of the heat-treatment would result in a substantial loss of water and therefore, water may only appear to be a minor ingredient, or may not need to be declared at all. The basis on which the order for the list of ingredients is calculated can be quite significant in portraying an 'accurate' reflection of the composition of the product.

### *13.4.2 Ingredient names*

It is very important that the correct names are used to declare the ingredients present in the product, otherwise there is potential for misleading the consumer as to the true nature of the product. In most cases, the considerations outlined for the name of the product are likely to apply when considering the names to be used for the ingredients as well. It is generally required that reference should be made to any appropriate treatment or to physical condition of an ingredient, where omission of such information could be misleading to the consumer. For example, it would be misleading to describe a dried milk ingredient that has been reconstituted during the preparation of the product, as just 'milk'; fresh milk has significantly different characteristics to reconstituted milk and would generally be considered to be a superior quality product.

Where a prescribed legal name is laid down for a specific product, such as milk chocolate, then where this is itself used as ingredient in another product (e.g. a milk shake) the same legal name must be used for its declaration in the ingredients list of the compound product.

As an alternative to using the specific name, there may be circumstances when the use of generic or category names may be allowed for ingredient listing purposes, subject to certain conditions. For example, the European Community (EC) general labelling Directive allows for the use of the generic name 'vegetable oil' instead of 'sunflower oil'; where the oil is hydrogenated this must be indicated, 'hydrogenated vegetable oil', for example. In certain cases there are maximum limits on the amount of the ingredient that may be present after which the generic name is not allowed. For example, if the generic term 'herbs' is used for two or more herbs, then the food contains a maximum 2% of herbs.

### *13.4.3 Compound ingredients*

The next type of ingredient that should be considered is the 'compound' or 'multi-component' ingredient, such as a batter used to coat a fish fillet, which is itself made of more than one ingredient (e.g. flour, water, oil, raising agents). There are two ways in which the compound ingredient could be declared in the list of ingredients of the final battered fish product. Either the name of the compound ingredient could be declared, followed immediately by a list of all its constituent ingredients, for example, 'Fish, batter (water, flour, raising agents: . . .), vegetable oil . . .'. Alternatively, the name of compound ingredient need not be declared and its components treated as separate ingredients and given in the appropriate position in the final product ingredients list, for example, Fish, water, flour, vegetable oil, raising agents: . . .,'. In the case of cosmetic products, the second of these methods must be used so that compound ingredients are declared as their individual components at the appropriate position in the list.

However, there are many examples of legislation that provide an exemption from the breakdown of all the components of a compound ingredient. Under Directive 79/112/EEC, where a compound ingredient is present at less than 25% in a foodstuff, it is exempt from the requirement to give a breakdown of all its constituent ingredients. Hence, if the batter on a battered fish fillet constituted 23% of the final product, it could be declared in the list of ingredients as solely as 'batter'. If, however, the batter was present at 34%, all of its constituent ingredients must be declared in one of the two ways specified above. It should be noted that even if such legal standards exist to exempt compound ingredients from a complete breakdown of their component, many manufacturers are choosing either not to make use of this exemption completely (i.e. give a complete breakdown irrespective of the quantity of the compound ingredient present) or to apply their own cut-off level (i.e. give a complete breakdown for any compound ingredient present at over 2% in the final product). In general, the reason for choosing not to make use of this exemption will stem from the concern over the presence of allergenic ingredients in a product and the need to provide the consumer with as much information about the product and its ingredients as possible. It should be noted that, irrespective of the quantity of the compound ingredient present in the final product, if it contains any additives that serve any significant technological function in the final product they must be declared in the list of ingredients, as components of the compound ingredient, for example, 'Batter (contains Colour: Beta-Carotene)'.

### *13.4.4 Additives*

Additives used in products are normally required to be declared in the list of ingredients using specific names, numbers or terms, defined by the appropriate regulations for the particular type of product in question. Although some ingredients, such as sugar, coffee, salt, vinegar and concentrated fruit juices, may serve sweetening, colouring, preserving, flavouring or 'other' additive functions, they would not (generally) be considered as 'additives' and should not be declared as such, but simply as ingredients (as outlined above).

In the case of food products in Europe, food additives must be declared using a prescribed category name (e.g. 'colour', 'preservative', 'flour treatment agent') and followed immediately by either the prescribed specific name or E-number. For example, 'Colour: Sunset Yellow FCF' or 'Colour: E110'. In contrast, the same colour used in a cosmetic product, in Europe, must be declared using its Colour Index number, for example, C.I. 15985. Significant variation will exist between the formats for declaration of exactly the same additive in a food product or cosmetic and also between the countries where the product is to be marketed.

For example, under the South African food labelling regulations, ingredients must be listed in descending order by weight in the finished product, with the exception of spices/seasonings/herbs, vitamins/minerals and food additives, all of which may be listed in any order at the end of the list of ingredients. The format for the declaration of food additives is of particular interest. Food additives must be declared by a category name, unless otherwise specified, such as 'acid', 'emulsifier', 'colour (other than tartrazine)', 'raising agent' and 'flavour enhancer (except monosodium glutamate)'. In the case of tartrazine, this is the only colour that must be listed specifically by its name. The only other types of additives that may not be declared in the list of ingredients using category names alone are 'preservatives' and 'sweeteners'. Preservatives must be declared by their common chemical name, either followed or preceded by the word 'preservative'. Sweeteners must also be declared using their specific name, and if the sweetener is non-nutritive, the words 'non-nutritive sweetener' must be given immediately after the name of the sweetener.

Sweeteners are also a good example of additives that may trigger the use of additional warning statements that must be given in the labelling of the product. Under European food labelling legislation, the name of any food containing an added sweetener must include the term 'with sweetener(s)' or if the food also contains sugar, 'with sugar(s) and sweetener(s)'. If the sweetener happens to be aspartame the statement 'contains a source of phenylalanine' must also be given on the label, although the position of this statement is not specified. If the product contains more than 10% added polyols, the statement 'excessive consumption may produce laxative effects' must be given somewhere on the label (and, even if not a particularly good marketing tool, it must still be clearly visible!).

Under the US regulations on labelling of foods, the label of a food to which any colouring has been added must declare the colouring in the statement of ingredients in the specified format. For certified additives (e.g. Brilliant Blue FCF) they must be declared by the name of the colour additive listed in the regulations, for example, 'FD&C Blue No. 1', although it is not necessary to include the terms 'FD&C' or 'No.', but the term 'Lake' must be declared, if appropriate (i.e. 'Blue 1 Lake').

Colour additives not subject to certification may be declared as 'Artificial Colour', 'Artificial Colour Added', or 'Colour Added' (or by an equally informative term that makes clear that a colour additive has been used in the food). Alternatively, such colour additives may be declared as 'Coloured with —' or '— colour', where the space is filled with the name of the colour additive, as listed in the regulations.

### *13.4.5 Carry-over additives*

The presence of additives in a product may not have been intentional on the part of the final product manufacturer, but may be as a result of 'carry-over' from one of the product's ingredients. For example, sulphur dioxide may be added to concentrated lemon juice when in the form of a bulk ingredient to act as a preservative, but when the lemon juice ingredient is added to a pasta product as an ingredient, its 'carry-over' into the pasta product will not be intentional.

So, do, or should, 'carry-over' additives have to be declared in the labelling of the final compound product? This will depend on the nature of the ingredient that contains the additive and the food in which the ingredient is used, and also the quantities in which the ingredient/additive is used. In the case of the sulphur dioxide used in the lemon juice, the preservative will only be present at very small quantities in the lemon juice and only a small quantity of the lemon juice itself will be used in the pasta; hence, it is likely that the quantity of sulphur dioxide actually present in the final pasta product will be even smaller. Therefore, at such small quantities a preservative such as sulphur dioxide will be unlikely to perform a 'preservative' function in the pasta and it will not need to be declared in the ingredients list of the pasta product. An additive such as a colour is, however, another matter, as the presence of a colour carried over from an ingredient is likely to have some colouring effect in the final product, even if this is very faint; in this case it should be highlighted to the consumer as an ingredient in the product.

### *13.4.6 Processing aids*

Other substances that may be used during the manufacture of a product may be considered as 'processing aids' and hence, in general, will not require declaration in the ingredients list. A 'processing aid' is generally considered to be a substance that is intentionally used during the treatment or processing of raw materials, foods or their ingredients, to fulfil a certain technological purpose, which may result in their unintentional but technologically unavoidable presence of the substance or its residues in the final product, provided that they do not present any risk to health and do not have any technological effect on the finished product. An example of a processing aid would be a mineral hydrocarbon used as a release agent on the moulds for chewing gum, which will aid the manufacture of the product by making it easier to remove from the moulds but will not be an intentional or functioning ingredient in the chewing gum.

### *13.4.7 Indication of quantity of ingredients*

In general it is unlikely that the actual quantity of every ingredient used in a product will be required by legislation to be declared, although there are instances where the quantity of certain individual ingredients in a product must be declared. In the case of foods, it has historically always been the case that the quantity of an ingredient should be declared where particular emphasis is placed on the presence of that ingredient in the product on the label.

Under a relatively new EC Directive, the quantity of the main or characteristic ingredients of all food has to be declared on the label, either as an indication to accompany the name of the product, or to form part of the list of ingredients. This legislation is widely known by the term 'QUID' (Quantitative Ingredients Declaration) and came into force, fully, on 14 February 2000. This was a fundamental change in the labelling of foods and was aimed at providing a consumer with information to enable them to compare the quantity of certain key ingredients in similar products. For example, the quantity of strawberries used to prepare a strawberry yoghurt is required to be declared as a percentage indication, with most manufacturers choosing to give the details in the list of ingredients; 'strawberries (12%)' for example.

### *13.4.8 Punctuation/format for ingredients list*

Specific details such as whether block capital letters, upper and/or lower case text, commas, semi-colons, brackets or any other form of punctuation must be used to present the list of ingredients will not, in general, be prescribed by any legislation. It is more likely that legislation will provide for a general requirement that all mandatory information required to be given in the labelling of a product must be clearly visible and legible, easy to understand and indelible. In most cases, this type of detail will, if at all, be prescribed by the manufacturer of the product as part of any 'house' style or policy relating to the labelling of their products. For example, a manufacturer may set a minimum type size for all mandatory labelling information of 6 points, requiring that the list of ingredients is given in block capitals, separated by commas. However, it is much more important the consumer is provided with accurate and true details on the nature of the ingredients in the product and 'how' this is portrayed to the consumer can be left to the discretion of the manufacturer, provided it can be easily read at the time of purchase and use.

### *13.4.9 Exemptions from declaration*

In certain cases it may not be necessary or helpful to consumers to provide details of the ingredients of a product. For example, raw meat, fresh fruits and vegetables and water are 'basic' primary foodstuffs and to give an ingredients list of such products would meaningless. On other types of consumer products, such as a compact disc (CD) or a dish cloth, which are composed of a number of ingredients, details of the ingredients would be available, but if provided would not influence or aid the choice of the consumer in choosing the product. It would be virtually meaningless to provide details of the materials used to produce a CD, for example, as a consumer would purchase a CD based on the type of music and not the materials from which it is made.

For textile products, although it is unlikely that a full breakdown of the components used to manufacture the product will be required to be given, it is generally the case that such products should be labelled with details of the fibre content. For example, a jumper may contain a ticket stating '55% lambs wool, 20% angora, 15% nylon and 10% silk'.

## 13.5 Date marking

Another essential piece of information that the manufacturer must provide the consumer is details on the shelf-life of the product. For certain products, such as milk and fresh meat, the shelf-life may only be a few days after which it would be unsafe and possibly dangerous to consume the product. For a cosmetic product, the shelf-life may be several years, after which the product may not necessarily be unsafe but, instead, certain active ingredients may no longer be effective. Regulators must therefore ensure that consumers are accurately informed of the amount of time in which a product can safely be consumed or used.

### *13.5.1 Type of durability date*

The format for the indication of this durability date will again vary from product to product and also, from country to country. In the EU, the date mark on foodstuffs either takes the form of a 'use-by' date (for perishable foodstuffs), or a 'best before' date (for longer shelf-life products).

#### *13.5.1.1 Use-by date*

A 'use-by' date must be applied to those foods that are highly perishable, from a microbiological point of view, and which will have a shelf-life after manufacture of a relatively short period, after which their consumption would present a risk of food poisoning. In deciding whether a food product should have a 'use-by' date, it is important to note that *both* criteria have to be satisfied in order for a food to be marked with a use-by date; that is, be highly perishable from a microbiological point of view *and* in consequence likely, after a short period of time, to pose an immediate danger to human health. Generally, such foods requiring a 'use-by' date will have to be stored at low temperatures to maintain their safety, rather than quality. They are likely to be foods either:

- which at ambient or chill temperatures are capable of supporting the growth of pathogenic micro-organisms or formation of their toxins, which could lead to poisoning if not stored correctly, for example; or
- which are intended for consumption either without cooking, or after treatment (such as re-heating) unlikely to be sufficient to destroy any food poisoning organisms that may be present.

Examples of foods required to bear a 'use-by' date include dairy products (such as milk, yoghurts and cheese), fresh/cooked meats and fish, partially cooked convenience meals and pre-packed sandwiches.

Certain foods may fulfil one but not both of the criteria and, hence, should *not* be marked with a 'use-by' date. For example, breads and many other bakery products will become stale in a few days, and hence, their quality would have deteriorated; however, they may still be safe, even if not pleasant, to eat. A product such as butter, which would be required to be stored at low temperatures for quality reasons, would not support the growth of pathogenic micro-organisms and would not require a 'use-by' date.

How should the 'use-by' date be shown? It must consist of the words 'use by' followed by the date, as day, month and year (in that order), and must be followed by any storage instructions that are essential for the consumer to follow in order for to keep the product safely for the specified period. European legislation does provide, that where there is insufficient space on the label to print the actual date, the words 'use-by' must be printed with the legal name and weight indication, but the actual date and storage instructions may be printed elsewhere on the label, provided that their exact location is clearly identified.

So, if a foodstuff does not satisfy the criteria for being labelled with a 'use-by' date, it must be labelled with a 'best before' date, unless specifically exempt. There are not that many foods that are exempt from date marking, but the few that are include fresh fruit and vegetables, wine, vinegar, sugars and salt.

#### *13.5.1.2 Best before date*

A 'best before' date will be the most appropriate for most foodstuffs and will indicate the period for which a food can reasonably be expected to retain its optimum condition (e.g. biscuits will still be crunchy not soft or stale). The date mark should consist of the words 'best before' followed by the date, as day, month and year, in that order. However, alternative forms of the 'best before' date may be used, which depend on the actual shelf-life of the food, as follows:

| | | |
|---|---|---|
| For foods expected to keep for 3 months or less: | — | the date may consist of just the day and month; |
| For foods expected to keep for more than 3 months but less than 18 months: | — | use words 'best before end' and indicate date as month and year; |
| For foods expected to keep for more than 18 months: | — | use words 'best before end' and indicate date as month and year, or year only. |

Furthermore, storage conditions that must be observed so that the unopened food lasts until the date indicated must be given as part of the date mark. For example, these might be 'keep refrigerated' or 'store in a cool, dry place'.

Under many EU countries' legislation, it is an offence to sell any food past its specified 'use-by' date, as, if a food were to be consumed after this date, it would be considered unfit for human consumption. In the UK, many of the prosecutions of food retailers relate to selling foods past their 'use-by' date, so it is essential that manufacturers use a realistic date of durability and only apply a 'use-by' date on those perishable products on which it will be required by law. There may not be equivalent legislation to prosecute a retailer for selling a food past a 'best before' date, as the food may not pose any risk to health, but may just be less crunchy, slightly soggy or less fizzy, but would be perfectly safe to eat.

## 13.6 Name and address

In order that the consumer can contact the company responsible for a product, all consumer products should be marked with a contact name and address. Even with something seemingly as straightforward as this, there will be legal requirements on exactly whose name and address must be indicated. In the case of foodstuffs, either the name or business name and an address or registered office of either or both of: the manufacturer or packer, or a seller established in the EU, must be indicated. Although this means that the name and address given for the manufacturer or packer can be located anywhere in the world (only the seller is restricted to the EU), in order to be customer-friendly, it is generally best to provide contact details of the responsible party in the country marketing the product. The format and amount of detail needed for the address is not specified, but it should generally be either a full postal address, or PO Box number. There is no reason why an e-mail address or customer care telephone number cannot also be given, but this should only be in addition to the postal address.

For products containing hazardous chemical components, such as household bleach, there are regulations which require that the name, address *and telephone number* of the responsible person be given on the label. It is advisable to qualify the telephone number with the words 'NOT FOR EMERGENCY USE'.

## 13.7 Origin marking

Many labels will have indications of the country of origin of the product given in association with the name and address of the manufacturer, e.g. 'Produced in the UK for ABC Company Ltd, London, UK'. However, in general the country of origin of a product will not need to be indicated, unless the labelling or presentation of the product suggests or implies a particular origin to the consumer.

As mentioned under the general considerations, Directive 79/112/EEC, as amended, stipulates that the labelling and methods used must not be such as could mislead the purchaser to a material degree as to the characteristics of the foodstuff and, in particular, as to its nature, identity, properties, composition, quantity, durability, origin or provenance, method of manufacture or production. This prohibition extends to the presentation of a food (in particular its shape, appearance or packaging, the packaging materials used, the way in which it is arranged and the setting in which it is displayed) and to its advertising. Foods are generally deemed to have been manufactured, or produced, in the country in which they last underwent a treatment or process resulting in a substantial change. It is likely that the transformation of pork into bacon, ham or pies would be regarded as a treatment or process resulting in a substantial change, but simple slicing, cutting or packing of the meat would not.

If the label of a product *as a whole* implies that a product comes from, or has been made in a country, other than where it is actually originates from or is produced, the true origin must be indicated on the label. All aspects of the label will be taken into consideration when determining the implied origin of a product, for example, if the name of a country or place is included as part of the name, brand name or fancy name (e.g. 'American-style hot dog sausages'). The use of any other written or pictorial material (such as maps, flags or pictures of famous landmarks) could also trigger the requirement to provide country of origin labelling.

Care should be taken to avoid misleading consumers when indicating the true place of origin of a product, particularly where this, or any other information given on the label or otherwise in the presentation of the food, might lead the consumer to assume incorrectly that the source of the ingredients and the country of final processing are the same. If the place of origin of the food is not the same as the place of origin of its ingredients it may be necessary to provide information on the origin of the ingredients. For example, bacon made in Germany using Danish pork should not be described as 'German bacon' but could be described as 'imported Danish pork cured in Germany'.

## 13.8 Quantity indication

For products such as foods, cosmetics and household products, that are sold as pre-packed products, but which can be sold in a variable quantity (as determined by the manufacturer), it is likely that there will be legislation to require they be marked with an indication of quantity. In the case of such products, strict legislation will set down how this should be indicated. The legislation takes into consideration issues such as how the quantity should be measured (by weight, volume, length), the units to be used (metric, imperial), basis of control of declared quantity (e.g. as an average quantity, minimum quantity) and the size and position of quantity indication. However, in the case of other products such as electrical appliances, crockery or furnishings, which are sold as single functional items, generally irrespective of amount, it would be virtually meaningless to indication their quantity and therefore, such products can simply be sold with an indication of their number, 'a camera', 'two cushions', 'a set of 6 teacups', for example.

For products sold by variable quantity, the simplest will be those allowed to be sold with a indication of quantity by number (e.g. '4 currant buns'), which will generally be exempt from the requirement to bear an indication of quantity by weight or volume. The number of items present in the pack must be clearly stated on the label. Individual countries' legislation should be consulted to determine whether or not a particular product can be sold with a quantity by number, as this provision is likely to vary widely from country to country.

For liquid products the indication of quantity should be given in unit of volume (e.g. millilitres, litres, pint, gallon). For solid products the quantity will be required to be given in units of mass (e.g. grams, kilograms, ounce, pounds). However, a problem may arise for semi-liquid/solid products where it may not be immediately obvious as to whether the quantity should be measured as a mass or volume. Generally this decision will be left to the judgement of the manufacturer, but certain countries' legislation may specify exactly the units used to indicate quantity on specific types of semi-liquid/solid products.

Where a product is marked with an indication of a specific quantity, for example, 100 g, a consumer is likely to expect that the package does actually contain 100 g of the goods they are purchasing. If a packaged product, however, only contained 90 g of goods, the quantity indication would be false and misleading to the consumer. Therefore, manufacturers must ensure that the correct quantity is indicated on their packaging, in order to avoid misleading consumers. There are two methods that can be used by manufacturers in order to ensure a package does contain the indicated quantity.

### *13.8.1 Minimum system*

The easiest method is the 'minimum' system of quantity control. This system assumes that *every pack* will *always* contain a minimum of 100 g of product. In order to achieve this, the manufacturer must set the weighing equipment to 'overfill' each pack to guarantee 100 g is deposited into each package. Unfortunately, using the minimum system of quantity control will increase costs for the manufacturer as a significant number of packages will contain more than 100 g and hence a substantial amount of product will be wasted.

### *13.8.2 Average system*

In order to avoid wastage, legislation has been developed that allows the 'average' system of quantity control and this is the method that is generally used for most consumer products. EC Directives 75/106/EEC and 76/211/EEC make provision for the 'average' system of quantity control [5]. The average system of weight control is based on the average contents of a consignment of goods rather than the contents of an individual pack. Essentially, the average system ensures that the total quantity of goods to be included in the packages, when divided by the total number of packs, must not be less that the 'nominal' or stated quantity. Also the number of non-standard or underweight packages must not exceed accepted limits. This system of weight control therefore allows a certain number of packages to contain a quantity of goods slightly less than that stated on the label, but still within certain specified limits. The average system allows the manufacturer flexibility and economy while ensuring that consumers are not misled into purchasing underweight packages.

### *13.8.3 'e' mark*

A symbol that may be applied to the majority of goods within the European market is the 'e' mark, used to signify that such goods are made up to the EC-based average system of quantity control. Its use is not obligatory but, when used, the 'e' mark is a guarantee recognised throughout the EC that the goods to which it is applied have been packed in accordance with the relevant EC Directives. It must be of a prescribed form and size (see Figure 13.1) and it is only valid when the declared net quantity is within the range 5 g/ml to 10 kg/l. Advantages of the 'e' mark include:

- Use of it allows free passage for packages within the EU for weight and measure purposes;
- Its use allows goods that are not normally packed to the average system (i.e. normally packed to the minimum system) to be brought within the average system.

The 'e' mark does not apply outside of the EU, so will not be required on goods to be sold in the rest of the world.

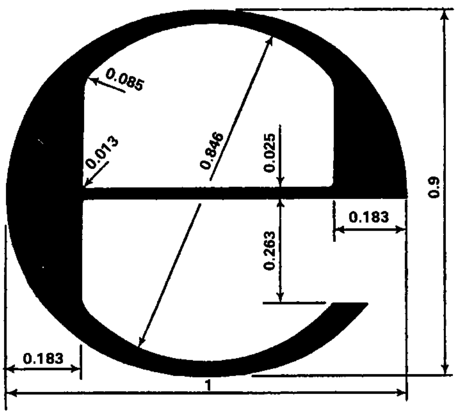



**Figure 13.1** The shape and relative dimensions of the 'e' mark used within the EU.

### *13.8.4 Size/position of quantity indication*

There are also likely to be requirements on the legibility and position of the quantity indication. Again, the quantity indication must be easy to understand, clearly legible and indelible, as well as not being hidden or obscured or interrupted by any other information that may appear on the pack. Certain countries may set minimum heights for the figures used to express the quantity, where the actual height may vary depending on the quantity of goods contained in the package (e.g. minimum 2 mm high for goods not exceeding 50 g, minimum 3 mm for goods of between 50 g and 200 g). Individual countries' legislation should be consulted to determine the appropriate size, as requirements are likely to vary from country to country. Irrespective of the height of the figures used for the quantity mark, the European 'e' mark must always be a minimum 3 mm high.

Regulations in certain countries (in the US and Europe for example) require that the quantity indication must appear on a certain part of the label. In Europe, on foods the net weight or volume must appear in the same 'field of vision' as the product name (legal name) and the durability date. In the case of alcoholic beverages, which require an indication of alcohol content, the '% vol.' indication must also be given in the same field of vision. What constitutes the same field of vision is not defined by the regulations, but is generally understood to mean that, although not necessarily appearing on the same face of the product, these three (or four) indications must appear in a position that enables consumers to read them together without having to keep turning the product back and forth to find them. Also, for household products containing hazardous chemicals, the quantity indication must be given in the warning panel on the label. In the US the indication of quantity must appear in the principal display panel (PDP).

## 13.9 Usage instructions

In order that a consumer can make correct and safe use of a product, it must be labelled with specific instructions for use, such as cooking and storage instructions for foods, application instructions for cosmetic products and dosage information for detergents. These instructions must be clear, user-friendly and sufficiently detailed in order that the average consumer can follow them accurately and make appropriate use of the product.

In the case of food products details of any specific storage temperature for the unopened product should be clearly labelled in a prominent position on the pack—'Keep refrigerated/frozen', 'Store in a cool, dry place'. If the product must be heat-treated before consumption, cooking instructions must be provided, which should include details of the most appropriate methods, times and temperatures of cooking—'For best results cook from frozen in a conventional oven at 180°C for 35 minutes', 'Not suitable for microwave cooking'.

On health and beauty products, directions for use should contain sufficient information to ensure that the product is used safely. For example, the directions for use on a hair conditioner might be 'After using shampoo, apply XX conditioner. Smooth gently through to the ends of the hair. Leave for 2 minutes before rinsing thoroughly'. Where a hazard or risk is likely to arise an appropriate warning should be included with the directions for use. On a shampoo or conditioner, after the directions for use, it may be advisable to include the warning 'Avoid contact with eyes. If this should happen rinse well with clean lukewarm water'.

Symbols may also be used to provide specific usage instructions, such as the washing symbols given on textiles, which indicate the type of wash cycle and temperature that is most appropriate for a specific garment. The specific type of symbol that should be used may vary from country to country.

## 13.10 Warning statements

There may be instances when there may be risks associated with the use/ consumption of a product, or a consumer may want to be informed of other essential information about the nature of the product. This information will be communicated to the consumer by the use of a warning statement. Depending on the severity of the risk, there may be legislation to require the use of a specific warning, or even in the absence of legislation, manufacturers may voluntarily choose to warn consumers about less serious risks/ingredients. Warning statements generally fall into one of two main categories, either relating to safety/risk issues or ingredient-related issues.

### *13.10.1 Safety warnings*

Product-safety regulations, in general, require that only 'safe' products may be placed on the market, and if there are any potential safety risks associated with a product these must be communicated to the purchaser in order that they can make an informed choice. This type of legislation does not specify the types of risk that must be highlighted as these are likely to be specific to each individual type of product. It is the responsibility of the manufacturer of an individual product to determine the specific risks that might be associated with their product and determine whether the product should be labelled to indicate any potential risk. For example, on products, such as carbonated drinks, sold in pressurised containers, it might be appropriate to give a warning such as 'Pressurised container—open with care, covering cap'. On a fish-based product a warning such as 'This product can contain minor bones' would be advisable.

For aerosol products, specific regulations [6] require a specific detailed warning to be given, such as shown in Figure 13.2:

Under EU legislation [7], products containing hazardous chemicals, such as bleach in a household cleaner, must bear on their packaging a label or warning panel containing the following details:

- the name, address and telephone number of the responsible person,
- the name of the product,
- the name of the constituent(s) that results in the product being classified as dangerous for supply,
- the indication(s) of danger and the corresponding symbol, if any,
- the risk phrases applicable to that product, and
- the safety phrases appropriate to that product.

An example of a warning panel is shown in Figure 13.3.

**CAUTION: EXTREMELY FLAMMABLE**

Pressurised container.
Protect from sunlight and do not expose to temperature exceeding 50°C.
Do not pierce or burn even after use.
Do not spray on a naked flame or any incandescent material.
Keep away from sources of ignition.
Do not spray near or place can on polished or painted surfaces.
Do not spray in eyes or face.
Do not use on sore or broken skin.
Avoid deliberate inhalation.

**KEEP OUT OF REACH OF CHILDREN**

**Figure 13.2** Warning for aerosol products.

**KITCHEN CLEANER WITH BLEACH**
Contains Sodium Hypochlorite

**KEEP OUT OF REACH OF CHILDREN**

**IRRITANT**

- Irritating to eyes and skin
- Avoid contact with skin and eyes
- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
- After contact with skin, wash immediately with plenty of water
- If swallowed: seek medical advice immediately and show this container or label

**WARNING! DO NOT USE WITH ANY OTHER PRODUCTS**
**May release dangerous gases (chlorine)**

Produced in the UK for ABC Products Ltd, London, UK.
Tel: 0111 111 1111.

**Figure 13.3** Warning panel for a product containing a hazardous chemical.

Manufacturers may also choose to label products with other warning statements which may not be required by law, but which will provide useful information to consumers. For example, on a shampoo a warning such as 'Avoid contact with eyes' would be appropriate, whereas on deodorants the statement 'Do not use on sore or broken skin' would be relevant.


**Figure 13.4** CE marking.

On toys there are likely to be regulations that require warnings to be given if the toy could be a risk or is unsuitable for certain children. For example, the EC 'Toys' Directive requires toys that might be dangerous for children under 36 months of age to bear a warning, such as 'Not suitable for children under 36 months' *or* 'Not suitable for children under three years' together with a brief indication, which may also appear in the instructions for use, of the specific risks calling for this restriction [8].

Toys that are subject to the specific safety regulations may not be marketed in the EU unless they bear the CE marking (see Figure 13.4) in a visible, easily legible and indelible form. The CE marking is used to indicate that the toy complies with all the required standards and hence should indicate that the toy is safe. The various components of the CE marking must have substantially the same vertical dimension, which may not be less than 5 mm.

### *13.10.2 Ingredient/nutrition warnings*

Although most ingredients of a product will be safe for consumption/use and will not pose any risk to the majority of consumers, certain ingredients may be a potential problem to a small group of people by causing hypersensitive (allergic) reactions. For example, an allergic reaction to milk might cause a mild reaction of a slight rash, while other reactions may be severe and life threatening, such as a reaction to peanuts. As a result of increasing consumer concerns about allergies and intolerance, particularly in relation to food products, manufacturers are choosing to highlight any potential allergenic substances contained in their products, whether or not they are mentioned specifically by name in the list of ingredients.

Under European law, cosmetic products, such as sun screen creams containing benzophenone-3 are required to bear the statement 'Contains Oxybenzone'. However, there is limited legislation on allergen labelling which has resulted in numerous different formats currently being used to provide this information to consumers.

Certain manufacturers choose to use 'flash' statements such as 'Contains nuts', whereas other manufacturers may choose to highlight their presence using the list of ingredients (see Figure 13.5).

| INGREDIENTS |
|---|
| WATER, DOUBLE CREAM (22%), DOLCELATTE FULL FAT SOFT CHEESE (9%), CHEDDAR CHEESE (8%), BECHEMEL SAUCE (WITH SOYA LECITHIN, FLAVOURINGS), FULL FAT SOFT CHEESE (4%), BUTTER, ONION, GARLIC PUREE (WITH PRESERVATIVE: SULPHUR DIOXIDE), CAYENNE PEPPER |
| ***CONTAINS MILK, WHEAT, SULPHITES & SOYA** |

**Figure 13.5** Example of allergens indicated as part of the list of ingredients.

## 13.11 Nutrition information and claims

### *13.11.1 Nutrition labelling*

As an increasing number of consumers become aware of the benefits of a healthy diet, more and more countries now require food products to be labelled with information on the nutritional content of the product. In the US every food product must be labelled with mandatory nutrition information in the prescribed format. In other countries, nutrition labelling information is voluntary and only becomes mandatory when a nutrition claim, such as ‘low fat’, is made on the label of the product. However, in these countries where nutrition labelling is still voluntary, most manufacturers provide the information on all of their products, even when no nutrition claim is made, as consumers have come to expect this information to be present.

Nutrition information can be presented in various formats, with the US and European formats being completely different. A US nutrition panel (See Figure 13.6) gives information on the nutrient content of a serving of the food and specifies the number of servings per pack. The panel must contain information on the calorie content of a serving of the product, as well as the amount of other specified nutrients, such as total fat, cholesterol, sugars and fibre. However, the amount of each nutrient must also be expressed as a percentage (%) of the daily value for that nutrient. For example, based on a 2000 calorie diet, the required daily amount of carbohydrate would be 300 g, so for a product containing 39 g of carbohydrate per serving, the serving would provide 13% of the daily value of carbohydrate required.

In contrast, European nutrition labelling information [9] must be given per 100 g of the food, with details of amounts per serving only given voluntarily as

**Nutrition Facts**

Serving size 1/3 cup (54 g) dry (approx. 1 cup cooked)
Servings About 3

| Amounts per Serving | |
|---|---|
| **Calories** 190 | Calories from Fat 0 |
| | **% Daily Value*** |
| **Total Fat** 0 g | 0% |
| Saturated Fats 0 g | 0% |
| **Cholesterol** 0 mg | 0% |
| **Total Carbohydrate** 39g | 13% |
| Dietary Fiber 1 g | 4% |
| Sugars 3 g | |
| **Protein** 8 g | |
| Vitamin A 2% | Vitamin C 0% |
| Calcium 0 % | Iron 4% |

* Percentage Daily Values are based on a 2,000 calorie diet. Your values may be higher or lower depending on your calorie needs:

| | Calories | 2,000 | 2,500 |
|---|---|---|---|
| Total Fat | Less than | 65 g | 80 g |
| Sat Fat | Less than | 20 g | 25 g |
| Cholest | Less than | 300 mg | 300 mg |
| Sodium | Less than | 2400 mg | 2400 mg |
| Total Carbohydrates | | 300 g | 375 g |
| Dietary Fiber | | 25 g | 30 g |

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

**Figure 13.6** Example of US nutrition panel on a food product.

| NUTRITION | | |
|---|---|---|
| TYPICAL COMPOSITION | A 45 g serving provides | 100 g provide |
| Energy | 670 kJ/159 kcal | 1489 kJ/354 kcal |
| Protein | 3.3 g | 7.4 g |
| Carbohydrate | 25.6 g | 56.9 g |
| of which Sugars | 10.8 g | 23.9 g |
| Fat | 4.8 g | 10.7 g |
| of which saturates | 3.0 g | 6.7 g |
| monounsaturates | 1.0 g | 2.1 g |
| polyunsaturates | 0.6 g | 1.3 g |
| Fibre | 1.1 g | 2.4 g |
| Sodium | 0.2 g | 0.5 g |
| INFORMATION | | |

**Figure 13.7** Example of a European nutrition panel on a food product.

additional information (see Figure 13.7). The amount of each specified nutrient must be given, but this information is not required to be given in the context of the required daily amount of that nutrient. However, there have been developments in this area, where manufacturers are choosing to provided extra information on the guideline daily amounts of calories, fat and sodium, so that consumers are aware that 30 g of fat per serving of a product would be considered as a high fat content and would exceed the amount of fat required in one day as part of a healthy diet.

### *13.11.2 Claims*

In order to highlight the benefits of a product to the consumer, a manufacturer may choose to use flash claims on the label of a product as they have a strong impact on the consumer. Depending on the type of claim, there may or may not be legislation or codes of practice/guidelines controlling their use. Any claims that are used in the labelling of a product must not be false or misleading as to the nature, substance or quality of the product.

In Europe, the legislators have been unable to reach agreement on criteria for nutrition claims for foods, although there have been several proposals issued over a number of years. Therefore, it is currently the responsibility of each individual EU Member State to draw up controls on the use of claims if they feel appropriate. In the UK there are legal controls on claims relating to energy claims, protein and cholesterol claims, and also claims referring to the vitamin or mineral content of a food. In the absence of legislation for any other nutrition claim, the Food Advisory Committee (FAC) of the UK Ministry of Agriculture, Fisheries and Foods (MAFF) issued guidelines on claims concerning fat, sugar, fibre and sodium content of foods. The FAC Guidelines specify the minimum or maximum levels, as appropriate, of a nutrient that could be present in a food before a claim can be made and require nutrition declarations so that the consumer knows how much of the particular nutrient is present. Although these guidelines have no directly legal force, manufacturers are advised to follow their requirements, and in this way they are used as a self-regulatory industry standard.

### *13.11.3 Natural claims*

Other claims that are widely used by manufacturers as marketing tools are those based on the use of the word 'natural' on food labels and in advertisements, such as 'With natural ingredients', 'Completely natural', and corresponding negative claims, such as 'No artificial additives'.

### *13.11.4 Health claims*

Increased recognition of the role of diet in maintaining good health has led to the growth of the market for so-called 'functional' foods and the use of 'health' claims in their labelling. Only Japan and the US have legislation controlling the use of health claims on functional foods, with other countries having difficulties in agreeing acceptable criteria on which health claims should be based. However, the UK, Sweden, the Netherlands, France and several other European countries have taken the route of self-regulatory industry guidelines as a method of preventing the use of false, misleading and prohibited health claims.

'Health' claims are generally defined as direct, indirect or implied claims in food labelling, advertising and promotion that a food carries a specific health benefit. Generally, under the industry guidelines, it is considered acceptable to refer to maintenance of good health in general or of a specific part of the body; 'Food 'x' helps to keep your body (heart) healthy', for example. It is also acceptable to refer to risk factors that may adversely affect good health, for example, 'Food 'x' helps to keep your cholesterol levels healthy, which helps to maintain a healthy heart'; however, any such references must be in the context of a healthy diet and lifestyle with the aim of reducing the risk of disease rather than having a preventive effect.

### *13.11.5 Symbols and logos*

Symbols and logos are often used by manufacturers to highlight a particular quality of a product, such as 'vegetarian', 'not tested on animals', or 'suitable for freezing', as consumers will be able to identify them quickly and easily on a range of products. A conspicuous and easily recognisable logo which is used to identify a desirable quality of a product can be used as a marketing aid, either as an endorsement or as a main selling feature.

## 13.12 Product photography and illustrations

In general, there will be a requirement that the pictures of the product on the packaging must be representative of the product inside the packaging. The use of misleading pictures may result in prosecution under trade description legislation. Common problems with pictorial representations of a product include:

- Overstating the key ingredients (e.g. meat in a pie) by adding more in the product to be photographed than is typically in the pack (Figures 13.8(a)(b)(c)).
- Understating bulk ingredients, which misleadingly suggests a greater quantity of the premium ingredients.
- Depiction of fruit or other ingredients, when only artificial flavours are present; for example, pictures of strawberries on a yoghurt which only contains an artificial strawberry flavouring and no actual fruit.
- Pictorial representations of an ingredient that does not appear in the product, presented in such a way to suggest this it is present.
- Over-emphasising the size of the product, a filling or topping.
- Products that require preparation before consumption or use should be made up following the pack instructions, even if this results in a less attractive product.

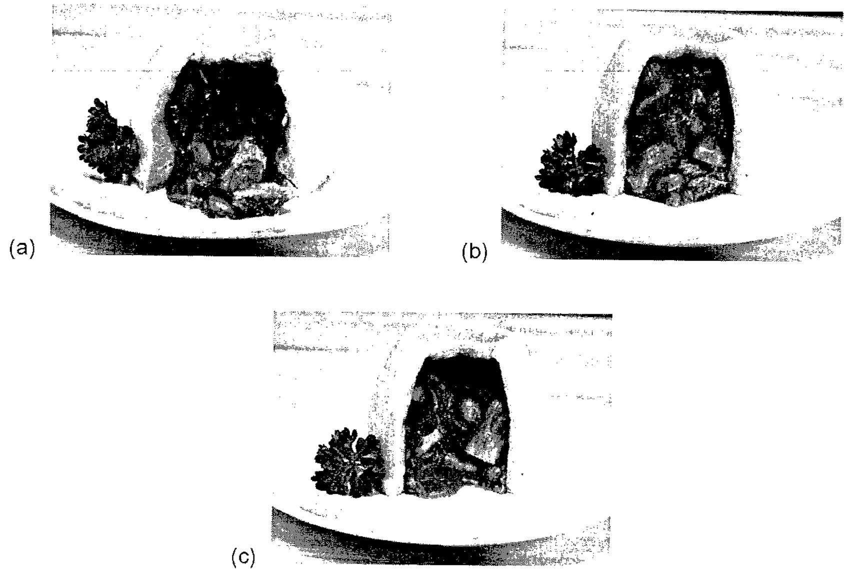


**Figure 13.8** (a) Product prepared as per cooking instructions. (b) Unacceptable product presentation—extra ingredients added. (c) Acceptable product presentation.

- A statement such as 'Serving suggestion' should be used if the picture on pack illustrates the product with any other ingredients that are not contained in the pack (e.g. ready meal shown with parsley as a garnish, or a side serving of bread) where consumers would not reasonably expect such foods to be present themselves.

## 13.13 Bar coding

### *13.13.1 Introduction*

The bar code has become an essential component of the packaging design. Introduced in the US in the early seventies it is now found on almost every consumer item sold throughout the world. The bar code should be regarded as an integral part of any new product specification and is as important as the product description, the ingredients list, or even the legal title.

The success of bar coding has been entirely the result of the early adoption of International bar code standards by the consumer goods sector. This has allowed bar coding to develop across international boundaries and has been at the core of the Universal Code Council (UCC)/International Article Numbering Association (EAN) system's success. Predominantly a system used for consumer goods the UCC/EAN bar code standards are also used extensively in many other industries such as the car industry.

This section will cover the main topics that need to be considered to bar code a consumer unit and a traded unit successfully. With the reliance of many retailers on scanning at the point of sale, for sales information, in re-ordering and in distribution systems, it cannot be taken lightly. Failure to bar code an item correctly is likely not only to frustrate customers at the checkout but may be a considerable barrier to getting the item listed by a retailer in the first place.

All bar codes should scan first time, every time. While this is achievable there are many pitfalls for the unwary designer. This section will guide the reader round the most obvious and commonly experienced problems. However, it is important to remember that trading relationships often lead to specific requirements between trading parties and even bar code standards can vary from one country to another, so not only the bar code standards bodies such as UCC and EAN International should be consulted but also customers to ensure that their requirements are known.

### *13.13.2 The bar code number*

#### *13.13.2.1 Allocation*

Allocation will either be by the brand manufacturer or the retailer for own brand products. This will be from a number bank allocated by the numbering authority in the home country of the manufacturer or retailer. The numbering authority can be contacted in each country by access to the web site of either EAN International or UCC.

#### *13.13.2.2 Structure*

The standard format of coding for a fixed weight item is EAN 13. The EAN 13 digit code is constructed as follows:

1. The first two digits are the country code. This identifies the allocating country and not necessarily the origin of the product.
2. The next five digits are the manufacturer or retailer number allocated by the local numbering authority.
3. The next five digits are available to the manufacturer or retailer to allocate to their products.
4. The last digit is the check digit. This is a modulo 10 algorithm and is calculated from the preceding 12 digits to ensure that they are either keyed or scanned correctly.

EAN 8 digit codes are also allocated by some numbering authorities to small products where space on the label is very tight. Examples would be cosmetics or batteries. Rules on the procedures for allocation EAN 8 codes vary from one country to another so individual numbering authorities should be consulted.

### *13.13.3 Designing the bar code*

#### *13.13.3.1 Size or magnification*

Bar codes are produced to a standard or nominal size that is usually referred to as the magnification percentage. This gives a range of sizes that can be used between 80% and 120% of the nominal size. Best practice is to use 100% magnification wherever possible as this gives sufficient tolerance for most print methods. Reducing the code down to 80% can be dangerous as the tolerances for bars and spaces are reduced by more than half. Reduction to 80% magnification should only be considered when essential to the packaging and high quality printing techniques are being employed.

#### *13.13.3.2 Symbology*

For retail items intended to be sold at the checkout there is a choice between two symbologies of bar code. In the US the standard bar code symbology is called UPC and has two common variants called UPC-A and UPC-E. UPC-A is by far the most common symbology used and is normally expressed as a ten or 12 digit code. In the rest of the world the common symbologies are EAN 13 and EAN 8 (Figure 13.9).

**Figure 13.9** (a) EAN-13; (b) UPC-A; (c) EAN-8 and (d) UPC-E bar code figures. Magnification = 100%.

#### *13.13.3.3 Bar height*

There is a standard bar height for each bar code symbol at each magnification. However designers are often tempted to reduce the nominal height of the bars. When considering bar height it is important to take into account the following factors:

1. If the product is likely to be sold at a checkout then it is likely that it will need to scan in every direction. To achieve this the bar code must have a minimum height of 16 mm.
2. If the product is only likely to be sold in a slow-moving environment then further truncation of the code may be permissible; however it is always wise to avoid truncation wherever possible.
3. The product is physically too small to take the bar code at full height. Always give as much height as possible to achieve the optimum scan rate for the product.

#### *13.13.3.4 Orientation*

Orientation of the bar code is important to ensure that the product will scan first time on cylindrical products. On a flat surface the print direction should be the main factor. It is advisable that on any curved surface that the bar code is oriented so that the bars go round the curve rather than up and down. This gives the scanner the best chance of seeing some or all of the bars when scanned. If this guideline is not followed then often the product will fail to scan as some of the bars are lost round the corner.

#### *13.13.3.5 Location*

When deciding the location on the product for the bar code, it is important to remember the following. Cashiers like bar codes to be in familiar places so that they do not have to look all over the product to find it. Most retailers use 'upright' or hand-held scanners that will read any code presented to them. In addition most consumers will place items the correct way up on the checkout. Thus, the 'rear side' of most packaging is the best location for the bar code on most packaging types. If this is not possible then it should be located in a position that will be easily seen by the cashier. An important safety issue is not to put the bar code on or near the top of a bottle as this would cause the cashier to invert the bottle when scanning it with all the inherent dangers that this would involve.

#### *13.13.3.6 Colour*

A scanner reads a bar code by measuring the reflectance from each space between the light absorbing bars of the bar code. The scanner uses a red laser light to scan so it is important to be aware that red bars on a white background would not scan at all, unless the red contained a significant amount of black.

Black bars on a white background are the best combination to ensure adequate contrast. However dark green and blue should also give adequate contrast. For other colour combinations tests should be carried out on an approved verifier to identify whether adequate contrast exists. Verifiers will be discussed in Section 13.13.4.

*13.13.3.7 Light margins*

The light margin (or quiet zone) is the clear area to the left and right of a bar code. It is an essential component as the scanner will use it to identify the start and end of the bar code. Insufficient space for the light margin caused either by interference from the edge of the label or surrounding artwork are the most common causes of bar codes failing to scan. In some countries, a light margin indicator (usually seen as a 'V' rotated 90° anticlockwise after the last digit) has been introduced to try to protect this area of clear space. It is essential to ensure that the light margins are of the correct dimension by the use of a verifier. Dimensions for light margins can be obtained from either UCC or EAN International or a national EAN numbering authority.

*13.13.3.8 Barcodes for traded units*

A traded unit is referred to by a variety of terms, such as outer case, box, case or store orderable unit. It is common practice for retailers and manufacturers to scan not only the retail code at the checkout but also the traded unit at either Goods-in or at other points in the supply chain. The Traded Unit bar code has become as much of a pre-requisite to the successful launch of a product as the retail bar code.

While the principles of bar coding are much the same for traded units, the symbology of bar code used can be quite different. In addition to the EAN 13 (with a new number to identify the change in count) there is also the option of using ITF 14 and EAN 128.

*13.13.3.9 ITF 14*

ITF stands for 'Interleaved Two of Five' and is the name of the symbology. This has been the common method of bar coding traded units for many years and is still the most frequently used. The ITF code is an easily printable code on outer cases especially when printing on (corrugated) board.

The 13 digit number allocated to the traded unit will need to be prefixed by a leading zero as ITF codes can only be printed with an even number of digits. The bar code should be specified to the printer as follows (Figures 13.10 and 13.11)

*Printing on board.*

*Magnification*: 100%

*Bearer bars*: These protect the bars from uneven ink spread during printing and prevent short scans.

*H. print gauge*: These allow the printer to adjust the print method to ensure correct ink spread.

*Bar height*: Absolute minimum of 25 mm for items likely to be scanned in automated environment but ideally 30 mm minimum.

*Colour*: Bars should always be black when printing on board due to the poor reflectance qualities.

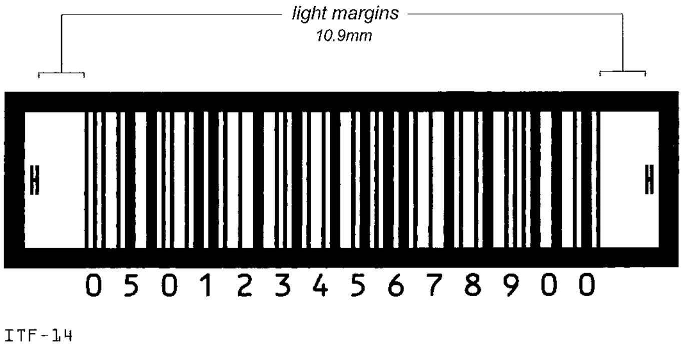



**Figure 13.10** ITF-14. Fibreboard materials. Not actual size.

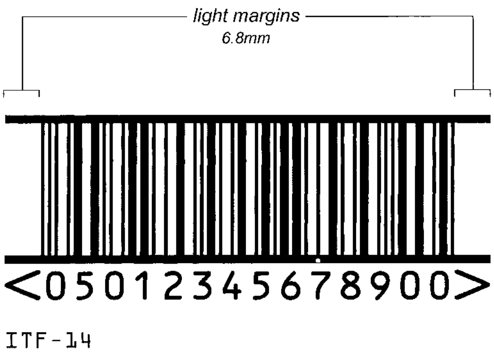



**Figure 13.11** ITF-14. Label printing. Not actual size.

If pre-printing then ideally the bar code should appear on all four sides with a minimum of two adjacent sides.

*Printing on labels.*
*Magnification*: 62.5%
*Bearer bars*: Top and bottom optional.
*H. print gauge*: Not required.
*Bar height*: 25 mm.
*Colour*: Black on white.

Ideally one label per side; however, most scanning systems work perfectly well with one good bar code and so this is the minimum standard which most retailers find acceptable.

light margins
5.0mm

< (01)05012345678900(15)980211 >

EAN-128

**best before date 11 February 1998**

**Figure 13.12** EAN-128. Not actual size.

### *13.13.3.10 EAN 128*

This is the newest symbology of bar code for traded units and is currently most popular on short-life products where variable data is required (Figure 13.12). Its use on ambient and non-food items is growing and should be acceptable for all sectors.

EAN 128 is a special sub set of Code 128 and it is important to specify to the printer that the requirement is for EAN 128 not Code 128. The bar code should be specified as follows.

*Printing on board.* As for ITF 14.

*Printing on labels.* As for ITF 14 except the target magnification that works best in most applications is 50%.

### *13.13.3.11 Additional data in the bar code*

One advantage of EAN 128 is that it allows additional data to be encoded. This is because the data within the code is prefixed by an application identifier that tells the system what the data is. Thus data such as date code and batch number can be concentrated within the same bar code. It is always best to discuss, with trading partners, the requirements for any additional data.

### *13.13.4 Verification and quality control procedures*

There is a standard for bar code quality devised by CEN/ANSI. This standard will grade a bar code that can then be matched against the application that it is likely to be scanned in. A retail or consumer unit code is likely to demand a grade A or 4 level of readability whereas a traded unit code may be acceptable at grade D or 1. Again it is important to discuss, with trading partners, the grade requirement.

To establish the grade of a bar code symbol a bar code verifier is required. Standards have again been set by CEN/ANSI to ensure that all verifiers work to the same standard. It is highly recommended that verification checks are carried out as a minimum at the start, middle and end of all production runs to avoid costly errors.

## References

1. Council Directive 79/112/EEC of 18 December 1978 on the approximation of the laws of the Member States relating to the labelling, presentation and advertising of foodstuffs for sale to the ultimate consumer, *Official Journal of the European Communities*, **22** (L33), 8/2/79, 1-14, as amended.
2. Food Safety Act 1990, HMSO, London.
3. Trade Descriptions Act 1968, HMSO, London.
4. Code of Federal Regulations, Title 21 - Food and Drugs, Department of Health and Human Services, Washington, USA.
5. Council Directive 75/106/EEC of 19 December 1974 on the approximation of the laws of the Member States relating to the making-up by volume of certain prepackaged liquids, *Official Journal of the European Communities*, **18** (L42), 15/2/75, 1-13, as amended; Council Directive 76/211/EEC of 20 January 1976 on the approximation of the laws of the Member States relating to the making-up by weight or by volume of certain prepackaged products, *Official Journal of the European Communities*, **19** (L46), 21/2/76,1-11.
6. Commission Directive 94/1/EC adapting some technicalities of Directive 75/324/EEC on approximation of the laws of the Member States relating to aerosol dispenser, *Official Journal of the European Communities*, (L23), 28/1/94, 28-29.
7. The Chemicals (Hazard Information and Packaging for Safety) Regulations 1994, S.I. 1994 No. 3247, ISBN 0-11-0438-779.
8. Council Directive 88/378/EEC on the approximation of the laws of the Member States concerning the safety of toys, *Official Journal of the European Communities*, (L187), 16/7/88, 1, as amended by Council Directive 93/68/EEC, the "CE marking Directive", *Official Journal of the European Communities*, (L220), 30/8/93, 1.
9. Council Directive 90/496/EEC of 24 September 1990 on nutrition labelling for foodstuffs, *Official Journal of the European Communities*, **33** (L276), 40-44.

# 14 Future decoration systems

G. Giles

## 14.1 Introduction

Continuous progress has been achieved in packaging by companies over the years. Technologies that seemed fully stretched have found new leases of life and new technologies have appeared, often extended and adapted from other industries. This is evidently the case for the decoration of packaging. Pressure will continue to be exerted to reduce the costs of goods, to increase speed to market and to innovate. Feedback from focus groups indicates that consumers are motivated by 'three dimensional' decoration, that is, when a 'labelled' container becomes a complete package. In particular, heat-shrink sleeve decoration has made great inroads into the market. New developments in this area now allow more controlled shrinkage and greater shrinkage ratios, leading to an increased use of shrink sleeves on narrow necked bottles. 'Glossy' extravagant packaging costs more and there is a limit (which differs for different markets) on how far this can progress but, in many examples, the developments in packaging decoration, such as improved print technology and better decoration formats, have enabled marketers to respond to legislation on waste reduction or to market forces on cost reduction: digital printing offers shorter run lengths, with superb quality, while the more conventional flexographic printing has opened up new opportunities for decoration. *Packaging Week*, February 2000, had a report of a new label, printed using specially formulated opaque UV-cured flexo inks. The manufacturing company claimed that the pressure-sensitive 'no-label look' labels 'are indistinguishable from labels produced by more costly rotary screen processes'. In some markets cartonboard outers have been discarded and replaced with decoration formats that can still make the primary pack appealing and yet carry the appropriate messages.

With developing desktop PC computer technology and software, it has become easier to produce reasonably presented work. Such technology must revolutionise the decoration of packaging. It should be possible to complete all the stages, from design to processed artwork and from on-line approval to direct printing electronically in the foreseeable future. The next five to ten years will see changes in the whole environment for printing: in the required skills and in the working environment.

The advent of PET (polyethylene terephthalate) changed the beverage bottle market both in terms of pack sizes (2 and 3 l carbonated) and the blowing of bottles in-house, with managed and stand-alone operations. So why should similar developments not revolutionise the packaging decoration market?

Speed to market, costs of inventory, the impact of electronic data systems (EDS) and feeding demand information back through the supply chain will all call for more electronic intervention in the decoration (and decorating) process.

Given the opportunity for shorter runs or even 'white stock' being printed on-line, the opportunity to promote more frequently or even align a product with a major retailer or to use local languages becomes a benefit, rather than the potential cost builder that it is at present.

## 14.2 Printing

### *14.2.1 Flexographic printing*

The details of flexographic (flexo) printing were covered Chapter 5, detailing the industry developments and trends for the future in flexo printing, which remains one of the most dynamic and fastest developing conventional printing processes. Throughout the 1990s the quality of products produced has increased enormously, yet flexo still has further potential. The target is now not necessarily higher image quality, as flexo can already match offset and rotogravure, but greater consistency and repeatability.

#### *14.2.1.1 Digital plate-making*

Digital plate-making, or 'filmless' plate-making, is where the negative film for the image is produced by direct laser etching of the image into a black coating on the plate, prior to the UV exposure process. This replaces the conventional methods of using film images and scanning the image to make the plate. The plate then goes through a conventional plate-making process. The plates produced by this method are of much higher quality, especially with fine halftone dots and reverse text. However, they do cost more and still use conventional solvent wash out plate-making, with the need to dry the plate to remove any excess solvents. This still results in a three to four hour plate-making process.

Alternative plate-making systems are under development and offer significant potential for improvements in plate-making times, making flexo even more competitive with offset printing. Currently these alternatives cannot reach the same resolution as solvent wash-out plates.

At present there are two potential alternatives to solvent wash plates: water wash and dry wash plates. Water wash plates are already in use in the corrugated and paper printing industries, where they have reduced the comparable plate-making time by minimising the amount of drying. It is expected that the use of water wash plates will continue to increase as higher resolution and image definition is achieved. Dry wash plates are still not a commercial product and are undergoing industrial testing. This is a proprietary chemical process, but does offer the potential to bring the plate-making process down to an hour or less in total. All of the developments in plate systems offer flexo a significant advantage in an increasingly competitive marketplace.

#### *14.2.1.2 Sleeve technologies*

Sleeve technologies involve a plastic or carbon fibre cylinder being placed over a steel roller, like a sleeve. It is unnecessary to take out or insert the heavy roller each time, just the relatively light sleeve, thus allowing rapid job change during production. Sleeves are now used for plates and plate mounting, along with anilox rolls. Sleeves are not a cheap option in the press and press building, but the potential benefits offered in press down-time are highly significant. Sleeve systems often reduce changeover times for six colours to just 20% or less of the time to change steel cylinders, also providing a health and safety benefit as the weights to be handled are reduced.

#### *14.2.1.3 Cold cure UV inks*

One of the problems with the current UV cured inks are that the UV lamps produce heat and ozone gas as a side product. These lamps use a wide range of UV frequencies to cure the ink, and some of these frequencies do not cure the ink but generate heat that causes problems with substrate materials and ink stability. The ozone gas is a health and safety hazard.

Cold cure UV inks and lamps were developed late in the 1990s and are only now being installed on presses. These use a single specific narrow band of UV frequencies to cure the ink, with the lamp frequency matching the ink almost exactly. Thus, curing is achieved fully without the generation of heat and ozone, offering UV cured inks even greater potential.

#### *14.2.1.4 Combination printing*

Up to now flexo printing alone has been reviewed. However, as with all print processes it has advantages and disadvantages. Combination printing is an attempt to maximise the benefits of each of several print processes in one press. Presses often combine flexo, rotary screen, letterpress and offset printing. These combination printing lines often bring significant enhancement to the final print with a minimum cost by being a single production process. However, the combination presses often produce new, unusual problems as a result of interactions between the processes, and these must be considered carefully.

Combination presses are currently almost all narrow web in format, owing to the cost implications of combining large press units. They are mainly used in the label industry where significant value can be added to the product by such combinations. In the future, larger and larger combination presses may be become common.

#### *14.2.1.5 Cassette printing units*

One of the advantages of flexo is the low number of moving components in the print units. This has offered the potential to create a cassette system, which contains the ink supply, anilox roller and printing cylinder in a single self-contained unit. This is set up off-press, then once a print job is finished the old cassette is removed and the new one inserted. This allows the down-time on a press to be minimised and, when combined with presses having individual drivers per roller/cylinder instead of gears, reducing press weight while maximising flexibility.

#### *14.2.1.6 Plate mounting systems*

With the developments in the quality and consistency of flexo plates, the mounting of these onto plate cylinders and sleeves has also had to advance greatly. The plates are basically mounted using a form of double-sided tape to hold them securely in position. Tapes can now be solid, compressible or more often a compromise between the two. Solid tapes provide support and consistency for solid areas of print, while soft or compressible tapes are needed for halftone printing where the tape must compress to stop the dots being squashed and distorted during printing. The development of suitable compromise tapes has permitted the printing of both solid and halftone images on a single flexo plate. As tape technology continues to develop, the printing capabilities and flexibility of the flexo process will increase.

#### *14.2.1.7 In-line processing*

Producing a fully finished product from a reel of substrate, in a single production pass is seen by many as one of flexo's greatest advantages. Exact numbers of a required product can be produced with little or no waste, or storage. To achieve this, rotary tools are included in-line with the press to apply pre or post-print operations. These tools can cut, crease, fold, emboss, and hot or cold-foil block, all within the production process. These add significantly to the value of the flexo process, offering large potential savings compared to carrying out these tasks in additional operations, as in offset printing. Currently, the majority of in-line processing is done on in-line presses used for labels and cartons industry sectors, with corrugated presses also having some processing options. In the future it is planned to add these to common impression (CI) flexible packaging presses, opening up a whole new range of packaging options. The printing speeds are often limited or slowed, however.

### *14.2.2 Digital printing*

Without doubt digital printing will become the standard method of printing, taking over from conventional printing as the current digital print engines speed up and costs reduce. With computer power increasing rapidly (doubling every

18 months!) digital printing should be a major technology in the packaging sector by 2005. Digital technology will also improve the existing technologies, speeding up printing plate production and the artwork transfer process from designer to printer. Flexo printing is making big improvements in print quality and will continue to compete with digital printing.

Packaging is becoming increasingly more sophisticated and so must the decoration technologies. Retail trends are changing with more trade channels opening up as well as pan-continental plants having to supply wider ranges of products. These trends stimulate pack and label decoration changes. Sites will have to deal with an increasing variety of graphics, local language packs and price marked packs as well as the usual promotions. With current decoration technology such variety merely adds to the overall costs. Continuing environmental legislation and consumer group pressures also force changes. Developments are being focused on greater image quality, complexity of product variety (particularly local language packs or legislative information), consistency of quality, product information and instructions and safety and security. These drive the pressure on brand owners to change pack and decoration design.

The need for reduced packaging (to match environmental legislation) and increased on-pack information to give clear ingredients and nutritional information will cause conflicts for the packaging designer. We will see increased opportunities for new labelling systems (see Sections 14.4.2 and 14.4.3).

The key business drivers will be faster speed to market, cost effectiveness, accuracy and control to reproduce quality, and to increase the impact of a printed, decorated, container. The designs also still need to be innovative.

Packaging runs will become shorter and printing will be done to order. In fact this has now become a requirement, with several printed label suppliers working the principle of ECR (Efficient Consumer Response, although in their case Efficient Customer Response). Quicker turn-around of orders must result.

Fundamental marketing changes to direct marketing will drive further segmentation and targeting. This will lead to more product proliferation and a shorter product life cycle. Smaller targets are now in reach. Digital printing has now become a marketing tool. Currently it is used for promotional packaging, point of sale material and special labels. It will speedly take over structural packaging decoration. Short run lengths have traditionally been a challenge in terms of cost effectiveness. Now it is possible to print the exact quantity that is required by the user, and not simply the quantity that is convenient for the producer. Quantities could be in thousands or even just a single item! There will be no stock write-off waste, no over-runs and all the production can be used. With ever faster changing graphics it is very likely the graphic content may change before the next print run. Digital printing will reduce the setting up costs normally associated with conventional printing.

This will even give the user the potential opportunity to order a quantity of labels or heat shrink sleeves that are printed in a sequence or continuous reel in the order of the production run, that is, 1000 labels in English, 500 in French, 750 in German, or divided by product variant, thereby overcoming the need to change the decorating machine!

It will also be possible to print codes on the label or sleeve that will tell the decoration application machine what decoration graphic the label is, enabling faster changeovers as the label becomes 'intelligent packaging', even telling the filler/packer what the product is and the pack size. This will lead to faster changeovers on the filler/packing line or to an operation with the whole line being run from a computer terminal. No inventory of labels needs to be held; the digital files just have to be stored, opened and fed to the digital printer when more labels are required. Each file can then be updated with the very latest information before re-printing. This will make the speed to market faster. Artwork files can be stored centrally by the brand owner and downloaded to a printer anywhere in the world.

The opportunity for shorter run lengths has many applications such as test marketing, producing promotional packs or producing just a few packs for promotional filming. Samples sometimes are required for National Account Managers (NAMS) to take to selected customers to announce a new launch. It is much better to be able to take a real pack, than a hand-made mock-up. When launching new products in certain product categories, regulatory samples are required to register the new product. These need to be the 'real' product and not models. Sometimes there are product shortages from stock made by conventional printing methods and digital printing can be used to plug the gap. This is an issue for multi-component packaging such as a labelled (conventional or sleeved) bottle in a carton. It is difficult to balance the different print run lengths for each of the components and then have the right quantity at the packing/filling line, even allowing for any on-line spoilage of any one component. When a customer orders a 1000 cases of product he should expect 1000 and not 950 because there was a label shortfall. Similarly the packer/filler should not expect to have to carry over runs to allow for any shortfalls. This is where the industry will tighten up on wastage.

For promotional activity digital is very good for printing sequential numbering or different bar coding on the 'fly'. Winners and losers can be coded for on-pack promotional activity.

Further flexibility can be offered by digital in that it can print any quantity of labels, for example, on the actual substrate, and the process allows for complex or multiple substrate label production. Normally, different printing processes may be required, or different suppliers with differing printing processes. This makes colour variation a real challenge. It means that different packaging specifications need to be held for each manufacturer.

Multiple proofs can readily be prepared for approval. This speeds up the actual approval process as all 'approvers' can have a copy simultaneously. Revisions, corrections or adjustments can readily be made and new copies produced. Alternatively, 'on-screen' approval can be given as the printed article will be the same as the screen image.

As the digital printer calls off stored files it is easy to have labels with multiple variants, local language versions and test market quantities in each version. This can include regional contact details (sometimes a regulatory requirement), different languages, constant text layout with image changes, or constant image with text changes. High-fidelity colours are used for excellent shelf impact. The image is consistent run after run or from machine to machine. There is no distortion of the chosen graphic, which occurs in conventional printing.

For those label producers with a range of printing technologies it is possible to use the appropriate technology for the most cost effective result (Figure 14.1).

There are a number of digital print systems on the market. The cross section of one such machine, the Indigo Omnius, is shown in Figure 14.2. This printer works on the offset process in that each colour is 'offset' from the 'blanket' roller onto the web of material passing through the machine. Therefore, this particular process is an intermittent one as each colour is built up.

In summary, digital printing can offer:

- Increased services from the label supplier from design through to finishing
- More creative solutions available to the brand owner
- Differentiated products and brands
- Faster reaction to market conditions

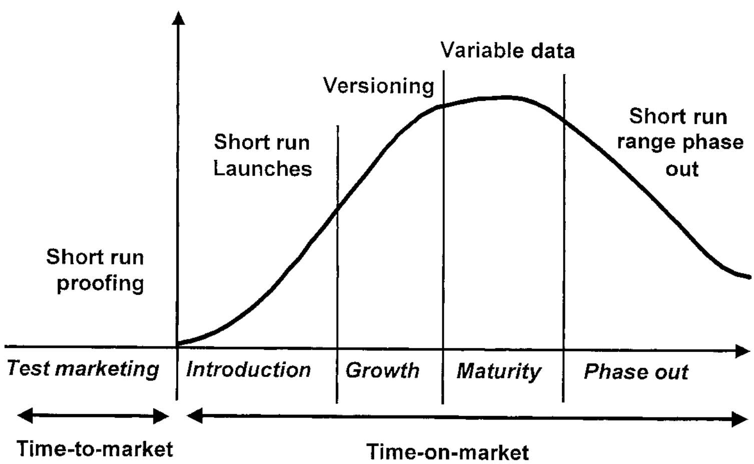



**Figure 14.1** Applications *vs* product life cycle. Digital printing is being used for the shorter run lengths at product proofing, promotional and product phase out stages. During the stages of 'versioning' and 'variable data', when relaunches or updates take place but volume is relatively high, 'combination' printing can take place (see Section 14.2.1.4). Reproduced by courtesy of Label Vision Limited.

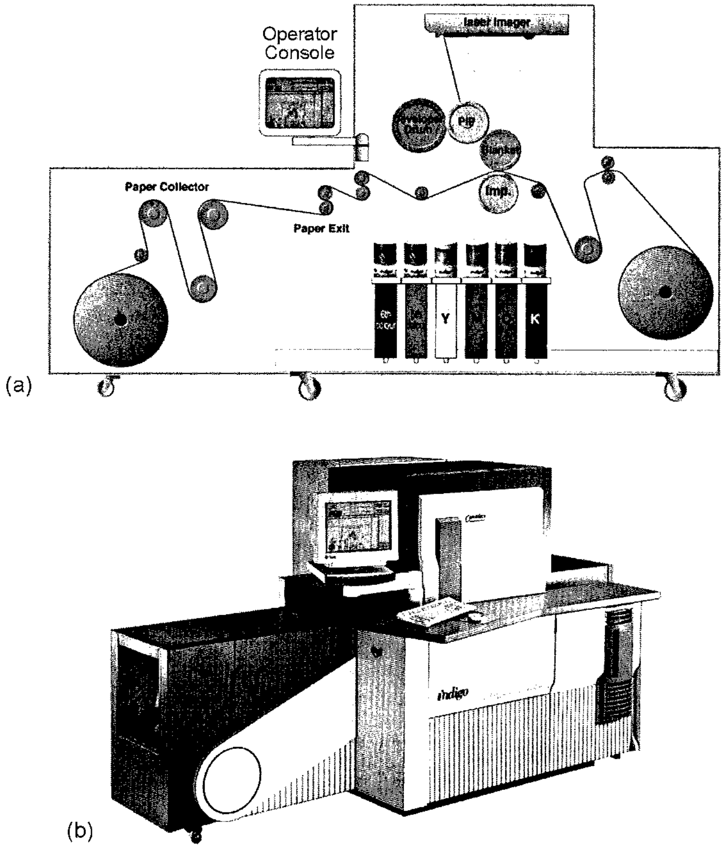



**Figure 14.2** Indigo Omnius digital printer, showing (a) the internal workings and (b) the overall view of the machine. Reproduced by courtesy of Indigo UK.

- Increased effectiveness of direct marketing
- Flexibility to react to legislative changes
- A complementary technology to conventional printing
- Reduced origination and wastage costs of conventional decorating

Direct on-line printing will be perfectly viable once the digital printing technology develops to pace with filler/packer line speeds. If one thinks this is too complex then one should consider the now humble desktop PC. We think nothing of printing off colour copies—just click an icon and out the pages come. We do not have printing technologists sitting by the office printer. The process has become that simple and why should package printing not do the same?

A first step would be for current suppliers of printed materials to supply a service and 'manage' the operation in key customers' plants. As mentioned earlier, the PET (polyethylene terephthalate) bottle market went through a similar evolution in the 1980s when suppliers of blown bottles switched to supplying performs and 'managed' in-plant blowing operations. In the space of 10–15 years this has become quite the norm.

### *14.2.3 Substrates*

Digital printing currently has a limited range of special effect inks available with no metallic, and so more emphasis might be placed on using the substrate as part of the finished decoration. This has the advantages of:

- Better presentation of the product with conventional inks as well as improved barrier properties and, in some cases, metallisation giving premium images
- A more durable product through the distribution chain, offering less scuffing and more rub resistance
- Better aesthetics when balanced with the structural packaging format

### *14.2.4 Effect finishing*

Predicted developments in this area are:

- The continued development of inks and surface finishes to give improved product differentiation
- The extension of surface embossing, normally used on quality short run products, to higher volume, 'commodity' products to re-position new, premium, variants
- The development of hot and cold-foil stamping for more mass market packaging, as will alternative ways to deliver the same effect, by special inks and substrates
- The extension of holographic effects which are seen as eye-catching and 'premium positioning'. These effects will be extended to new package formats. *Packaging Magazine*, 24 February 2000, reported on a 'breakthrough in aluminium beverage can technology' resulting in what is claimed to be the world's first holographic-effect can. The Australian can manufacturer used micro-engraving to press the metallic surface of the aluminium can into a patterned shape, giving a dramatic visual effect when light hits the 'holographic' design.
- The development of other decoration technologies, because holographic effects are relatively expensive to apply to non-metallic packaging, requiring the use of aluminium foil
- The use of gloss 'spots' to highlight important messages. This exists but can be used to a greater effect against a matt background.
- The use of a mixture of clear areas in labels through which to 'glimpse' the interesting product or, when the product is clear (and hence 'pure'),

or where the graphic designer wishes to decorate the reverse of the label and see through to the back of the package, with clear products.

- Anti-static finishing to allow for more cartonless presentations for plastics-based primary packaging
- Anti-slip finishing for improved transportation with less transit packaging
- High slip finishing for smoother handling during filling and packing on higher speed lines

### *14.2.5 Efficiency*

Predicted developments in this area are:

- Increased use of printing inks which require less or no time before applying finishing coatings so the complete decoration and finishing can be done in-line.
- Improvements in the overall efficiency of conventional printing. There are already very significant skills and investments in the conventional printing market. This market will take hold of new technologies, such as digital, to speed up the pre-press work, speed up print changeover times and produce more consistent quality. This will narrow the gap between full digital printing and technologies such as flexo.
- Improvements in the efficiency of the printing equipment and print line to reduce the operating costs to make conventional printing even more competitive.

### *14.2.6 Inks*

#### *14.2.6.1 Photochromatic*

Anything that can add value to the finished product and attract (and retain) consumer interest will be developed. The opportunity of printing with light-sensitive inks that can reveal a message under the correct light levels will be exploited. Consideration will be given to the impact at the point of sale and how to make the decoration call attention to the product on the shelf. This will require inks to perform under normal store lighting conditions. The same applies for the point of consumption or usage, for example, graphics might glow under UV light in night clubs for drinks which are consumed directly from the bottle or can.

#### *14.2.6.2 Thermochromatic*

Thermochromatic graphics already appear on products which need to be served at a temperature (normally chilled). ‘Serve chilled’ could be underwritten with a message ‘Too hot’ if the temperature has not been reduced enough. Holding a chilled package in the hand can give the impression of the hand on the pack during drinking.

#### *14.2.6.3 Chromatic—Metallic*

Metallic finishes are perceived as redolent of quality and premium imagery. Labels printed with gold metallic surrounds are a classic format for premium products. Applying this technique to metal cans opens up more opportunity. The development of pigmented, metallised base coats was an important feature of the 'Steel Life' initiative originated as a partnership between the Association of European Steel Packaging Producers (APEAL), designers, ink specialists and printers (*Soft Drinks International*, December 1999). The use of strong, vibrant colours was also employed against a metallised base coat which, in this instance, had a silver lustre, but which can be designed to give a range of effects—from silver through gold to bronze. Printing was carried out in the conventional manner using a rotary 6 colour dry-offset printer.

#### *14.2.6.4 Special inks*

At the time of writing, further work continues on using inks in areas other than the printing of images. As these remain subject to confidentiality agreements, the trade press and published patents should be studied to glean more information.

## 14.3 Packaging formats

Once in-line decoration becomes commercially viable then attention will turn to the primary or immediate secondary packaging (i.e. the carton on a bottle, tube or bag, in the case of cereals). This is because to print a carton in-line, and to cut and crease it is complicated. Digital print lines are currently reel-fed, so, if this format can be utilised on the packing/filling line then it will offer other benefits.

If the packaging can be of the form-fill-seal type or reel-fed direct to the product or primary package, then additional savings can be made with the packaging and with the operational costs. Also, the Packaging Minimisation and Producer Responsibility legislation in the UK and Europe makes any developments which reduce packaging of interest. For example, aseptic drinks cartons lines have reels of pre-printed laminated board feeding the packer-filler. If the reels were plain white the print could be applied directly on-line and the package could be made up on-line for other products.

This developing concept could even challenge the use of cartons altogether (which come under criticism in some market sectors owing to settlement of the contents). What if the carton could be replaced with a highly decorated flo-wrap or sachet? What if a bottle or tube was to be packed into a flo-wrap, in-line printed to give very fast line changeovers with local language/local promotions or price marked pack, all with a standard inner primary package? Such a variety of printed graphics would be expensive today not only in origination, but in additional down-time on the line, inventory control and wastage, for example.

Where the structural package has a secondary decoration format placed upon it such as a label or sleeve, then the development of in-line digital decoration will remove the need to decorate a substrate and then bond the substrate to the package. One should examine the impact PET (polyethylene terephthalate) bottles have had on the carbonated soft drinks market (and now on the beer bottle market), referred to earlier. One might expect digital printing to have a similar effect on decorated packaging.

### *14.3.1 Metal cans*

The structure of the can will continue to develop to add more brand 'stand-out' and consumer interaction, for example, surface finishes, textures and shaped cans. Improvements continue to appear in two piece cans with shaping and texturing. Embossing on two piece cans has already been adopted but will need locating with the graphic decoration in order to give greater impact. This will give stronger brand 'stand-out' and make the can more tactile. The on-going issue of high production volumes is gradually being reduced as new printing and shaping technology is scaled up and economics improve.

*Soft Drinks International* (February 2000) featured 'Metal cans that excel'. In the Metal Packaging Manufacturers Association's annual Best in Metal awards the gold award went to a distinctive range of steel cans for 'Tango' soft drinks (a carbonated soft drink from Britvic Soft Drinks, a major UK producer), which featured an 'explosion of colour'. The same article featured another major can manufacturer, winning an award for its 'unique' aluminium cans featuring compelling graphics and decoration which glowed under ultraviolet lighting, a superb feature for brands sold, for example, in night clubs.

### *14.3.2 Glass*

There has been a resurgence in premium products packed in glass bottles and containers. The trend for custom shaped designs with embossed features will continue. The combination of premium decoration formats such as shaped labels with gold featured printing will be a strong selling point for glass. New developments in pressure-sensitive labels (PSV) and thermal transfer (such as the Avery-Dennison/Krones 'CLEAR ADvantage') will only help to improve the potential for glass *vs* plastic packaging (see Chapter 8).

New coatings will permit additional lightweighting of glass making it more financially competitive and more robust.

### 14.3.3 Plastics

In recent years plastics packaging has made new in-roads to some conventional areas such as milk packaging with rigid plastic bottles. Flexible laminate pouches have been used for products normally packed in metal cans such as soups and pet food. This is linked to the improved processing conditions that pouches offer over retorting metal cans. With improved decoration and form-fill-seal equipment, pouches could well continue to advance into conventional packaging sectors. Flexible laminate pouch packs readily carry premium decoration, be it through metallised laminates to full multicolour gravure printing, and packaging waste legislation make these formats even more attractive.

Another recent development for laminate pouches is the use of an integral zipper, applied when the pouch is made up on the form-fill-seal line. A recent launch in the UK (*Packaging Magazine*, January 27, 2000) illustrates a flexible laminate pack for a premium cereal product. The pouch has, this time, a pre-applied zipper with an easy open feature which avoids having to decant the product into a sealed container. With a pre-applied zipper the bag is less difficult to fill and offers a weight reduction over conventional, rigid packaging which satisfies the legislation element. This application is on a triple laminate, stand-up, high gloss bag with spot matt lacquer to give 'highlights'. The graphics use metallic greens and reds to give premium colouring. Although metallised, the pack features a see-through window, another development overcoming the problem of fully metallised laminates. The pack was flexo printed using computer-to-plate digital repro and is a good example of conventional technology utilising modern digital technology.

## 14.4 Decoration formats

### 14.4.1 Direct decoration on metal cans

#### 14.4.1.1 Waterless printing

Current print technology for metal cans (see Chapter 9, Section 9.3.1) is standard Rutherford printing with 6 colour facility plus base coat. Quality standards will continue to improve and be more equipment based and less operator based. As cost pressures continue, manufacturers will work hard to reduce levels of wastage and increase printing line output to reduce operational costs.

From 2000 we will see the use of 'waterless' inks (Figure 14.3). Schmalbach-Lubeca of Ratingen, Germany, announced it 'is planning to develop the process further with various customers' and 'Waterless printing involves the use of a much finer screen, resulting in high definition images of near-photographic quality' (*Packaging Magazine*, October 21, 1999).

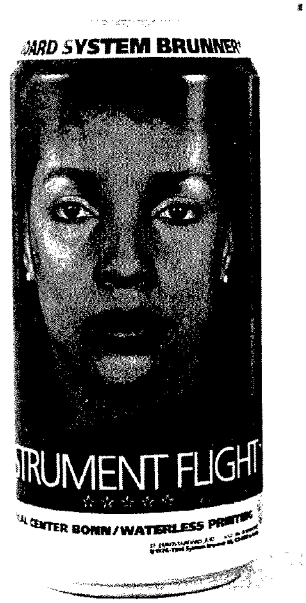



**Figure 14.3** Waterless printed can. Reproduced by courtesy of Schmalbach-Lubeca.

The basic principles of waterless printing are to use conventional printing processes with colours expressed as CMYK (cyan, magenta, yellow and the key black). When mixing these four colours in screen terms they should accommodate all the colours of the spectrum, although it may be necessary to add one or two colours for 'special designs'.

Conventional offset-litho printing of cans uses both ink rollers and water rollers to ensure the ink adheres to the image area of a printing plate and is rejected where the water adheres to the non-image areas. There is no water in the waterless system, as the name implies. To overcome this potential limitation, the printing plate technology is key to allowing the process to print a very fine screen. The standard process can only print to a very coarse screen.

The other critical factor is in the temperature control on the inker station. This area is controlled in all sections of the inker, up to and including the plate cylinder. To accommodate the new process, inks have had to be modified and are of a higher viscosity than conventional inks.

One other difference, which allows waterless to reproduce almost photographic images, is the elimination of separation in the design as the process allows all four colours to be printed on top of each other. Obviously, it will be important to have the correct amount of (combined) colours to be able to create all the various shades of colours required in the image to be reproduced.

#### *14.4.1.2 Digital printing*

Developments in digital printing for cans will give the opportunity for ones which are randomly printed offering promotional product or collectors' cans. The UK once had the 'Lager Lovelies' printed by the Metalbox Reprotherm process which produced a range of photographic quality cans in sets to be collected, once empty! Waterless printing (Section 14.4.1.1) is probably a transitional stage to using digital printing on cans.

#### *14.4.1.3 Pre-coated coil stock*

Pre-coated reel-fed coil used to make two piece cans will allow such cans to have a base colour with the same colour going over the can base. We have already seen coated ends giving a black can end, as in the case of Britvic's Tango (UK carbonated soft drink). This is thought to give the can more visual impact and could probably include even more decorative effects.

#### *14.4.1.4 Tactile inks*

Tactile inks will be used to give the sensation of bubbles on the can or, if presented creatively 'feeling the fruit' in a soft drink if printed locally and registered with the base graphics.

#### *14.4.1.5 Debossing*

Debossing will develop as another way to develop tactile properties in a can. Examples already exist in Budweiser, Grolsch and Speckled Hen (UK beer) cans. Embossing features are considered more complicated as an internal force is needed in the can to deform the metal outwards.

#### *14.4.1.6 Thermochromatic inks*

Thermochromatic inks will be developed to signal the temperature of the can for drinks which are best served cold or chilled.

#### *14.4.1.7 Shaping cans*

Full shaping of cans will have to wait until the shaping technology becomes more cost effective in production. The consumer is interested in the sensation but recognises the product contained and chooses not to pay more. Brand differentiation opportunities will drive this development.

### *14.4.2 Sleeving*

This decorating process can be used to decorate packaging which is normally printed at high speeds and for long run lengths. Two piece 202 cans are one such example, and some markets require shorter run lengths for new products or promotional activity. *Soft Drinks International* (December 1999) reported that Russian beverage processor Osha chose roll-fed shrink sleeve labelling for its short production runs. Indeed Osha became the first processor in the world to apply roll-fed labels commercially to necked-in 202 beverage cans. Polyvinyl chloride (PVC) labelling material was used to meet the 20% shrink requirements of the necked-in 202 can.

*Packaging Magazine* (January 27 2000) featured an article on glass coffee packaging which was sleeved. The sleeve labels were gravure printed up to seven colours on 50 micron PVC with metallic effect inks to echo the chrome of Harley Davidson motorbikes and Cadillacs. Halftones created a three dimensional effect for special features in the graphic design. Photographic quality illustrations were produced from neck to base; high density inks produced 'vibrant' blues with a 'silver stream' image.

These examples demonstrate that developments in decoration quality will appear on more premium products. As the material and heat shrink oven technology develop, it will become easier to decorate narrow neck bottles and containers as well as those susceptible to heat distortion.

Sleeves on glass bottles combine the quality tactile properties of glass with the all-over decoration benefits of sleeve decoration. When sleeves are applied to glass bottles directly from the cold end of the glass bottle-making line, then the sleeve affords some added protection to the freshly-made glass surface. Any small scratches on the surface can reduce the performance of the glass container. New developments in light-weighting glass packaging also apply surface coatings. On fully sleeved bottles, if the bottle breaks the glass fragments are retained in the sleeve and creates less potential for injury. A disadvantage of sleeving glass bottles is that any glass defects are more supported and therefore can travel through the distribution system further before complete failure occurs. This problem will be resolved by the improvement of glass quality as part of the continuous improvement programs operated by manufacturers.

#### *14.4.2.1 Materials*

Sleeve materials have evolved to suit local market applications and the film material technologies. In the UK the usual material is PVC, but in Europe PET (polyethylene teraphthalate), OPP (oriented polypropylene) and OPS (oriented polystyrene) prevail. In Japan, for example, PVC is hardly used and the dominant materials are OPS and PET. The European sleeve thicknesses are in the region of 50 microns. In the Far Eastern markets thinner gauges are being used (i.e. under 30 microns) and it is to be expected that these gauges will be used in Europe as part of the lightweighting and packaging minimisation initiatives.

PET is seen as a major material in the sleeving market. While the gauges in Europe range from 40 to 50 microns, the Japanese markets are down to 27 microns. This is because PET offers the best potential for down gauging. PET is a 'rigid' plastic and can retain its strength in the thinner gauges. While PVC sleeves might be only 80 to 85% of PET sleeves (at 50 micron gauge), PET has greater scope to be more cost effective when down gauged (i.e. to less than 30 microns).

OPP and OPS are weaker and softer, hence making it more difficult to reduce the gauge and not suffer tearing or similar problems both in manufacturing and in the distribution chain, once applied to the package.

*14.4.2.2 Recycling*

Recycling the sleeves in the post-consumer scrap cycle is an issue. In Europe the plastic materials being recycled are separated mainly by water. OPP has a good environmental perception because it has a specific gravity less than one and it floats during separation. This makes it a good choice for use with primary plastic packs with a specific gravity greater than one. However, OPP is not suitable for very well shaped bottles. For this reason the UK market does not recommend using PET sleeves on PET bottles. However, in Japan, they separate the granulated post-consumer waste by vortices of air. This means the lighter particles (i.e. sleeve granulate) are lifted faster than the heavier primary packaging material.

An alternative used in some countries is to have the whole sleeve perforated along its length so that the consumer can remove the sleeve (particularly from a plastic primary package) before segregating the materials. This is only effective in those countries that have well-established recycling channels supported by consumers.

Great efforts are underway to enable the sleeving material to be recycled. Ink formulations are in development which will come off the sleeving material (in the recycling process) to enable it to be used again. This assumes the use of water in the recycling operation. There would need to be a recycling process using air separation technology, perhaps, to split the sleeving from the primary packaging and then a washing process to strip the ink from the sleeving granulate. This should then enable PET sleeves to develop in Europe, with sub 30 micron gauges.

*14.4.2.3 Developments*

There will be further progress in decoration effects with sleeves. Local metallising will help to improve the visual impact of sleeves. Localised stretching of the substrate material will give differential shrinking, when applied to the primary package, to give the effect of crinkled foil. These sleeves could be used on the tops of wine bottles, or other premium product packaging. Used on the sides of packaging, these sleeves could give a new tactility to the package.

Combining tamper evidence with sleeves offers an inherent benefit and this 'free' feature will continue to develop. As sleeve materials develop greater shrinkage ratios with more shrink control so as not to destroy the graphics, then narrower-necked bottles can carry this form of tamper evidence.

There will also be more creative use of sleeves, using the technology for decoration and not just as a replacement for conventional labels. For example, one company has developed the sleeve to decorate a toothbrush handle.

Issues regarding water penetration or uneven distortion during application have been overcome and this product will be on the market in America and Canada.

*14.4.2.4 Printing*

The main process is gravure with some flexographic printing. However, digital printing is expected to gain ground in this market because sleeving it is a reel-fed process and it would be possible for a customer to order a few thousand sleeves in one language, a few more in another language, all in one reel, and these products could be packed on one continuous operation on the filling line.

*14.4.2.5 Heat activated labels*

Some markets use sleeves as a direct replacement for a paper label, which means the sleeve is applied to an even, flat or cylindrical surface. This is a waste of the heat shrink sleeve's potential. Heat activated adhesive plastic labels are being developed that overcome the problem of many plastic 'no-label' labels, which are self-adhering and normally require the use of a backing substrate; this becomes scrap material once the label is applied. Heat activated adhering labels are reel-fed to be complete wrap-around or part segment decoration and have no tack when cold. Being reel-fed they are not suitable for shaped or punch cut labels. This technology has been used in the dry battery cell market for some time and is now moving into more consumer markets.

*14.4.2.6 Tactile inks*

Foaming inks will be developed further, not only for the tactile effect but also for more functional effects, such as providing additional heat insulation properties on microwavable packaging for the ease of removing the heated package from the microwave oven. The ink can be applied in vertical stripes to minimise the amount of ink used on the package and yet still provide good surface coverage to protect the hand.

*14.4.2.7 Tamper evidence/anti-counterfeiting*

Increasing use of sleeves for tamper evidence was referred to above. There will continue to be developments in the current anti-counterfeiting systems (i.e. holographics) and these will become incorporated into the decoration technologies as part of the decoration or graphics.

*14.4.2.8 Manufacturing and application*

As film thicknesses used on sleeves become thinner, benefits will ensue, such as greater ease of application, improved designs of applicators, less heat required to shrink the sleeves, faster application, and more sleeves per reel, thereby reducing the number of reel changeovers. This will also enable sleeves to be added to a wider range of heat-sensitive primary packaging and improve shrink ratios.

*14.4.2.9 Summary*

- Sleeves will become more cost effective as a result of down gauging and more standardisation of film (i.e. greater use of PET, less use of PVC). In the longer term further developments in polypropylene and even polyethylene-based material sleeves are expected.
- Removable inks will become available to improve the recyclability.
- Digital technology will allow shorter run lengths and more rapid changeovers.
- Eventually, full digital printing will enable on-line decoration, which will mean the sleeve manufacturer will need to provide a 'decorating' service and not just a sleeve and applicator.

### *14.4.3 Labelling*

Increasing demand on the amount of decoration and graphics to be carried on a package will continue to be debated. There will be increased demand for more legislative text and nutritional information. More primary packages will stop using cartons in response to cost reductions and packaging waste legislation. It will be a challenge for the commercial teams to balance this with the brand image. We are already seeing increased use of systems such as Fix-a-Form, in this case, from Denny Bros Printing Ltd., of the UK (Figure 14.4). This is a multi-page leaflet label system, available globally, designed to create extra space for product information instructions or promotional messages with the advantage of being supplied on-reel for automatic application by standard labelling equipment. All variations of Fix-a-Form can accommodate fragrances, scratch-off panels, coupons or sample inserts or benefit from added security measures.

For over-the-counter (OTC) medicines or pharmaceutical products, which are packed into a primary package format (bottle or sachet) then packed into a carton with an information leaflet, these labelling systems will be of increasing interest. One only has to imagine the complexity, and on-cost, of having a packing/filling line dealing with a primary pack, secondary pack, folding a leaflet and stuffing it into the carton. The consumer must, inevitably, discard the leaflet without reading it, as probably they do the carton. Systems such as Fix-a-Form can be applied as readily as a label and remain attached to the primary package to which it relates, therefore protecting the consumer (and manufacturer) and helping to reduce misuse of the medicine or product.

There are even on the market small electronic devices in greetings cards that shout a message when the card is opened. These can repeat themselves over and over again with about ten seconds of message. As costs reduce, such devices might appear in packaging and shout out a promotional greeting or a warning every time a medicine package is opened.

(a)

(b)

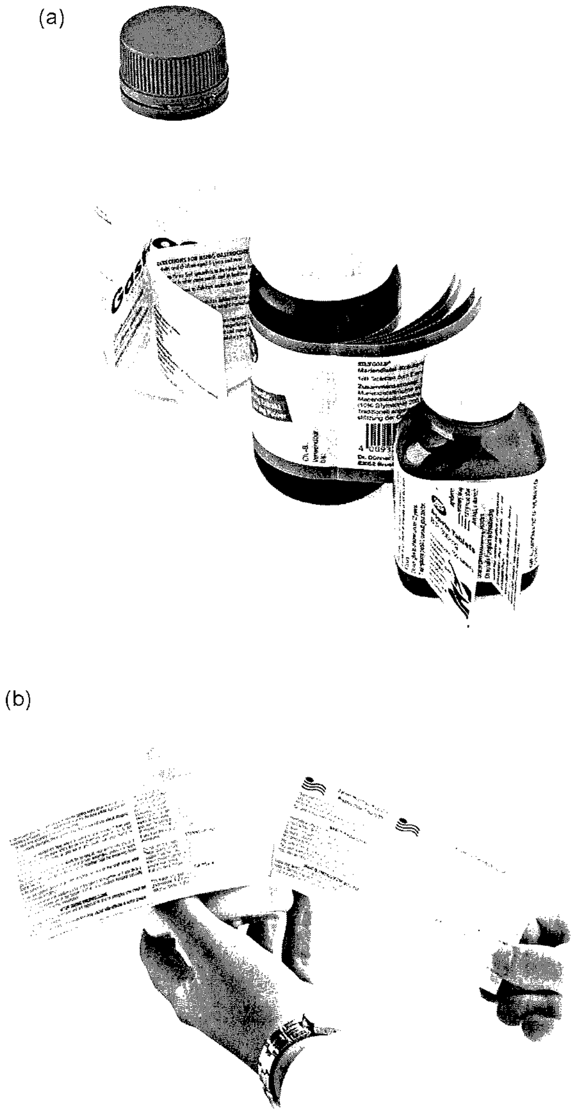


**Figure 14.4** Fix-a-Form multi-page leaflet labels. Reproduced by courtesy of Denny Bros Printing Ltd.

### *14.4.4 The future*

Currently we will pay to have a creative designer develop some compelling graphics, then, through the use of a repro house convert these to a format suitable for printing. In most cases these will have to be tailored to suit the printing press 'footprint'. The printer will then decorate a substrate (such as a paper label, plastic sleeve), store it and then deliver it to the packer/filler for application to the primary package. Where more than one printer is used, more than one artwork specification is likely to be required. Similarly, colour approval will be required from each printer. Colour variation standards will need to be agreed.

Consider the time it takes from designer to filled, printed stock going off to the customer or end user. Pressure will continue to speed up this 'supply' chain and reduce the amount of inventory in the 'supply' chain. Digital printing may develop to the level where it can decorate a rigid, primary pack format, on-line with direct application, without the need for a secondary substrate such as a label or sleeve. Creative artwork can be developed, and approved on screen (even from the other side of the world); colour standards will be fixed and reproducible time and time again. It is possible to download the images to be printed from a global 'warehouse' anywhere in the world, direct to the packing line. The artwork will be up-to-date and can be matched to suit local requirements. Protecting, and controlling, image assets will become increasingly important to global brands.

Early in 2000 we saw the launch of digital projectors in cinemas. This allows images to be sent direct from the film studio to cinema without the need to manufacture reels of film and distribute them globally. How many reels are needed for a feature length film and how long does a reel of film last when showed three times a day? All this will become a thing of the past, and so will the conventional artwork generation, printing and decoration of packaging.

With such flexibility we will see attention turning to the mixing of formulations and the filling and packing. We will need to be able to switch formulations over faster. As the product is taken off the shop shelf then information will be passed down the line for replacements. Once decoration changes occur then there will be additional pressure on packaging formats to follow.

## 14.5 Internet or home shopping

The argument will rage on as to the role of branded packaging and exciting graphics, should internet or home shopping become a significant part of grocery consumer shopping. However, one thing is clear: as the artwork process speeds up and digital printing becomes more commonplace it will be possible to change artwork for legislative or promotional purposes faster than the products coming through the supply chain, or for inventory stocks to be used up. So, what package or product images or claims will the brand owner, or retailer, put on the web page? The consumer will expect that the product seen on the screen and ordered is the same as the product delivered. We are already hearing of consumer complaints arising from the product delivered not being the one ordered. Imagine the complaints when a product is re-launched and the old product is still in the supply chain!

The other argument is as to the role of packaging in this developing opportunity. It is this author's view that the internet consumer will be motivated by the brand image and equity as communicated though advertising and the web page. Therefore, the packaging can be more functional in structural design. This does not mean plain packaging, but packaging that will travel though the supply chain right to the door arriving in usable condition, looking good enough to eat, drink or savour in any other way. This means no scuffed packaging, or broken tamper-evident features. Therefore, iso-modularity will give opportunities for standard outers or RTPs (Returnable Transit Packaging) which will protect the consumer unit package.

Decoration will need to make the more standardised packaging format look more attractive and provide stronger brand stand-out. Digital printing and shrink sleeve decoration will provide this.

## 14.6 Environmental considerations

### *14.6.1 Legislation and Life Cycle Analysis (LCA)*

There will be continued pressure on the environmental impacts in producing printed/decorated articles.

- Any impact from byproducts being pumped into the atmosphere from the printing process or resulting from wastage disposal will have to be reduced year on year.
- The impact of decoration on the complete Life Cycle Analysis (LCA) will have to be taken into account.
- The impact of decoration formats in disposing of, or recycling, packaging. e.g. plastics developments for sleeves, polyvinyl chloride (PVC) sleeves declining rapidly in the global market.
- Inks being developed which separate from the decoration format (plastic) substrate more easily in the recycling process so that the substrate materials can be recycled.
- As packaging from brand owners becomes more pan-continental and even global then greater coordination between legislation in various countries will be necessary. In the meantime exporting companies will have to give more detailed consideration to these issues when selecting their packaging and decoration formats for 'global scale' distribution.

### *14.6.2 Wastage*

Printing technology improvements will reduce the number of printed articles required to produce a given amount of decorated products. Over-runs will be minimised to reduce wastage.

With improved lines of communication and faster creative artworks, approved electronically, passed through to the digital press (perhaps even on-line), finished/filled products could come off the production line the same day approval is given—each in a different language! This will reduce stock write-offs and high inventory levels. Reduced run lengths and lower inventory means more artwork changeovers (to be managed in development). Manufacturers of printed decoration formats will need to rethink their overhead structure to minimise fixed costs.

## 14.7 Summary

As printers change, they must ask themselves: 'How can my business contribute to their business success?' (John Birkenshaw–*Print Week*, 5 March 1999, Pira International). Birkenshaw goes on: 'In other words printers should stop thinking of themselves as people who just print and should start focusing on their "total service offering" from design to despatch'. Pira predicts that by 2004 digital presses will be able to produce 10 000 A4 pages/min in mono colour and 2 500 A4 pages/min in colour at 1200 dpi (dots per inch). Compared to the 15 000 sheets/h of the litho presses of today (2000), the digital presses could do this in just six minutes!

## References

1. Label Vision Ltd, Vision House, Oakham Business Park, Mansfield, Nottinghamshire, NG18 5BU, UK.
2. Indigo UK, Croxley Business Park, Watford, Hertfordshire, WD1 8YJ, UK.
3. Pira International. Randalls Road, Leatherhead, Surrey, KT22 7RU, UK.
4. Denny Bros Printing Ltd., Bury St. Edmunds, Suffolk, IP32 6NU, UK.

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# DESIGN AND TECHNOLOGY OF PACKAGING DECORATION FOR THE CONSUMER MARKET

## Edited by Geoff A. Giles

The decoration of packaging for the 'fast moving consumer goods' market plays a vital role in promoting the product to the customer, as well as in carrying informative and legislative detail. Combining these roles requires commercial awareness, detailed knowledge of the relevant technologies, creative care and consideration of the effects of colours, typefaces and images which must support the brand, position the product and provide the required product 'stand-out' at the point of sale.

This practical handbook, written by a team of experienced industrialists and those involved in relevant, applied research, details and discusses the printing technologies and decoration formats used on the mainstream structural packaging that is found in consumer markets worldwide. The emphasis is on the technology.

The volume is directed at packaging technologists and those involved in the design and development of packaging. It will also be of interest to those responsible for specifying or purchasing the decoration of packaging.

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