FOOD AND BEVERAGE PACKAGING TECHNOLOGY

SECOND EDITION

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Food and Beverage Packaging Technology

Second Edition

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Preface

This book informs the reader about product preservation processes and techniques, product quality and shelf life, and the logistical packaging, packaging materials, machinery and processes, necessary for a wide range of packaging presentations and methods of distribution used for the production and marketing of food and beverage products. The role of packaging in enhancing the sustainability of the food and beverage supply system is also emphasised.

It is essential that those involved in packaging innovation and design have a sound understanding of the fundamental requirements for consumer safety, product protection, preservation, together with a broad appreciation of the multi-dimensional role of packaging. Business objectives may include:

- the launch of new products or the re-launch of existing products
- the provision of added value to existing products or services
- cost reduction in the supply chain
- improved sustainability credentials of a product and its packaging

This book sets out to assist in the attainment of these objectives by informing designers, technologists and others in the packaging chain about key food and beverage packaging technologies and processes. To achieve this, the following five principal subject areas are covered:

(i) Packaging innovation and design (Chapter 1).
(ii) Bio-deterioration and methods of preservation (Chapter 2).
(iii) Packaged product quality and shelf life (Chapter 3).
(iv) Logistical packaging for food marketing systems (Chapter 4).
(v) Packaging materials and processes (Chapters 5–10).

Chapter 1 introduces the subject of food and beverage packaging and its design and development. Strategically, packaging innovation can be an important source of competitive advantage for retailers and product manufacturers seeking to promote and differentiate their brands. Chapter 2 discusses bio-deterioration and methods of product preservation that are fundamental to conserving the integrity of a product and protecting the health of the consumer. Chapter 3 discusses packaged product quality and shelf life issues that are the main concerns for product stability and consumer acceptability. Chapter 4 discusses logistical packaging for food marketing systems – it considers supply chain efficiency, distribution hazards, opportunities for cost reduction and added value, communication, pack protection and performance evaluation. Chapters 5, 6, 7 and 8 consider metal cans, glass, plastics and paper and paperboard, respectively. Chapters 9 and 10 discuss active packaging and modified atmosphere packaging respectively – these techniques are used to extend/optimise the shelf life and/or guarantee quality attributes such as nutritional content, taste and the colour of many types of fresh, processed and prepared food and beverage products. Chapter 11 discusses the relatively new subject of bioplastics, which are being rapidly adopted for a wide range of food and beverage products in predominantly niche markets.

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1 Introduction

Richard Coles

1.1 INTRODUCTION

This chapter, together with Chapters 2 to 4, provides a rationale and a context for considering the numerous types of packaging technology available in today's food and drinks industry. Chapter 1 includes an historical perspective exemplifying packaging developments over the past 200 years and outlines the role of packaging for enhanced sustainability in the food supply system. It highlights the protective, preservation, brand communication, environmental and logistical functions of packaging. Also, it briefly introduces packaging strategy, design and development. Packaging design and technology can be of strategic importance to a company, as it can be a key to competitive advantage in the food and drinks industry. This may be achieved by, for example:

- meeting the needs and wants of the end user better through packaging innovation and design
- enhancing the environmental credentials (or sustainability profile) of a brand and its packaging
- opening up new distribution channels
- providing a superior quality of presentation
- enabling lower costs and/or increasing margins
- enhancing product/brand differentiation
- improving the logistics service to customers

The business drive to reduce costs in the supply chain must be carefully balanced against the fundamental technical requirements for food safety and product integrity as well as meeting the increasing challenge to be environmentally responsible whilst ensuring an efficient logistics service. In addition to protecting the brand, there is a marketing imperative to project brand image through value-added pack design. These often conflicting requirements may, for example, involve design inputs that communicate distinctive, aesthetically pleasing, ergonomic, tamper-evident, convenient, functional and/or environmentally aware attributes. For example, the latter may be illustrated by the rapid growth of compostable bioplastics packaging for use in various niche markets such as organic produce. An overview of bioplastics packaging is presented in Chapter 11.

Thus, there is a continual challenge to provide optimal cost-effective pack performance that satisfies the needs and wants of users across the packaging chain, with health and safety being of paramount importance. At the same time, it is important to minimise the environmental impact

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of products and the services required to deliver them. This challenge is continually stimulated by a number of key drivers – most notably the following:

- the fast-rising number of eco-conscious consumers in advanced economies
- growing legislation and political pressure in response to public concerns over packaging and packaging waste. These concerns are being highlighted by the media and pressure groups
- the impact and financial implications of meeting a raft of wide-ranging environmental legislation and measures such as the EU Directive on Packaging & Packaging Waste (2004/12/EC amending Directive 94/62/EC), the EU Renewable Energy Directive (2009/28/EC) and the EU Landfill Directive (99/31/EC)
- concerns over future availability of resources. For example, the production of oil is likely to peak soon if it has not done so already (Industry Taskforce on Peak Oil & Energy Security – ITPOES, 2010)
- rising expectation by stakeholders for companies to identify sustainability issues, set appropriate targets and demonstrate achievement in accordance with corporate social and environmental responsibility (CSER) policies
- the continued growth of internationally traded products and global brands creating a highly competitive retail environment
- higher energy costs and increasing price volatility of commodities. In response, companies are facing intense pressure to mitigate the cost implications for their manufacturing and distribution operations

In particular, there is a drive to reduce the amount of packaging used and packaging waste to be disposed of. However, this drive to minimise and, in certain cases, eliminate packaging may actually increase the risk of product damage and waste generated, thereby negating the environmental benefits being sought from packaging change. In fact, the environmental impacts due to food and drinks waste are often far greater than those due to the packaging itself when one considers all the resource inputs (including water and fossil fuels) and emissions/waste outputs involved in food and drinks raw materials sourcing, transportation, product manufacture, distribution and use, and final waste disposal. There may be a sound argument to invest in *more* packaging if it reduces food and drinks waste through extending shelf life – for example, by supplying smaller portion packs to meet the needs of single householders who may have irregular consumption patterns due to busy lifestyles. According to research conducted in 2007 by the Waste & Resources Action Programme (WRAP, 2008), approximately one-third of the food purchased by the average UK household is thrown away often with product still in its original packaging, either opened or unopened.

The growing importance of sustainability – interlinking social, economic and environmental considerations – and logistics in the food and drinks supply system means that manufacturing systems, distribution systems and, by implication, packaging systems have become key interfaces of supplier–distributor relationships. Thus, the roles of the market, the supply chain and, not least, society (an integral part of the ‘environment’) have increasing significance in the area of packaging innovation and design. Ideally, product/packaging innovation should be coupled to design from the end user’s perspective whilst adopting a ‘design for the environment’ approach with sustainability being the philosophy underpinning new product development.

A key challenge for the packaged food and drinks industry is how to adopt sustainable principles and goals whilst addressing cost, performance and market pressures. Ideally, packaging design and innovation should be considered by brand owners at the ‘product concept’ stage with sustainability specified as part of the design brief. Arising from the above discussion is the need for those involved in packaging design and development to take account of social, economic, technological, marketing, legal, logistical and environmental requirements that are continually changing. Consequently, it is asserted that designers and developers of packaging need to cultivate an integrated view of the influence on packaging of a wide range of functions, including quality, production, engineering, marketing, food and drinks technology, R&D, purchasing, legal issues, finance, the supply chain and environmental management.

1.2 PACKAGING DEVELOPMENTS – AN HISTORICAL AND FUTURE PERSPECTIVE

The last 200 years have seen the pack evolve from being a container for the product to becoming an important element of total product design – for example, the extension from packing tomato ketchup in glass bottles to squeezable co-extruded multi-layer plastic bottles with oxygen barrier material for long shelf life.

Military requirements have helped to accelerate or precipitate some key packaging developments. These include the invention of food canning in Napoleonic France and the increased use of paper-based containers in marketing various products, including soft cheeses and malted milk, due to the shortage of tinplate for steel cans during the First World War. The quantum growth in demand for pre-packaged foods and food service packaging since the Second World War has dramatically diversified the range of materials and packs used. The great variety of food and drinks available today has been made possible by developments since the nineteenth century in food science and technology, packaging materials and machine technology, transport and storage methods. An overview of some key developments in packaging during the past 200 years is given as follows:

- *1800–1850s*: In 1809 in France, Nicolas Appert produced the means of thermally preserving food in hermetically sealed glass jars. In 1810, Peter Durand designed the soldered tinplate canister and commercialised the use of heat preserved food containers. In England, handmade cans of ‘patent preserved meats’ were produced for the Admiralty (Davis, 1967). In 1852, Francis Wolle of Pennsylvania, USA, developed the paper bag-making machine (Davis, 1967)
- *1870s*: In 1871, Albert L. Jones in the United States patented (no. 122,023) the use of corrugated materials for packaging. In 1874, Oliver Long patented (no. 9,948) the use of lined corrugated materials (Maltenfort, 1988). In 1879, Robert Gair of New York produced the first machine-made folding carton (Davis, 1967)
- *1880s*: In 1884, Quaker® Oats packaged the first cereal in a folding box (Hine, 1995)
- *1890s*: In 1892, William Painter in Baltimore, USA, patented the Crown cap for glass bottles (Opie, 1989). In 1899, Michael J. Owens of Ohio conceived the idea of fully automatic bottle making. By 1903, Owens had commercialised the industrial process for the Owens Bottle Machine Company (Davis, 1967)
- *1900s*: In 1906, paraffin wax coated paper milk containers were being sold by G.W. Maxwell in San Francisco and Los Angeles (Robertson, 2002)
- *1910s*: Waxed paperboard cartons were used as containers for cream. In 1912, regenerated cellulose film was developed. In 1915, John Van Wormer of Toledo, Ohio, commercialised the paper bottle, a folded blank box called Pure-Pak®, which was delivered flat for subsequent

folding, gluing, paraffin wax coating, filling with milk and sealing at the dairy (Robertson, 2002)

- *1920s*: In 1923, Clarence Birdseye founded Birdseye™ Seafoods in New York and commercialised the use of frozen foods in retail packs using cartons with waxed paper wrappers. In 1927, Du Pont perfected the cellulose casting process and introduced their product, Cellophane
- *1930s*: In 1935, a number of American brewers began selling canned beer. In 1939, ethylene was first polymerised commercially by Imperial Chemical Industries (ICI) Ltd. Later, polyethylene (PE) was produced by ICI® in association with DuPont™. PE has been extensively used in packaging since the 1960s
- *1940s*: During the Second World War, aerosol containers were used by the US military to dispense pesticides. Later, the aerosol can was developed, and it became an immediate post-war success for dispensing food products such as pasteurised processed cheese and spray dessert toppings. In 1946, polyvinylidene chloride – originally referred to as Saran – was used as a moisture barrier resin
- *1950s*: The retort pouch for heat-processed foods was developed originally for the US military. Commercially, the pouch has been most used in Japan. Aluminium trays for frozen foods, aluminium cans and squeezable plastic bottles were introduced, e.g. in 1956, the Jif® Lemon squeezable lemon-shaped plastic pack of lemon juice was launched by Reckitt & Colman Ltd. in the United Kingdom. In 1956, Tetra Pak® launched its tetrahedral milk carton that was constructed from low-density polyethylene extrusion coated paperboard
- *1960s*: The two-piece drawn and wall-ironed can was developed in the United States for carbonated drinks and beers; the Soudronic welded side-seam was developed for the tinplate food can; tamper-evident bottleneck shrink-sleeve was developed by Fuji Seal, Japan – this was the precursor to the shrink-sleeve label; aluminium roll-on pilfer-proof cap was used in the spirits market; tin-free steel can was developed. In 1967, the ring-pull opener was developed for canned drinks by the Metal Box Company; Tetra Pak launched its rectangular Tetra Brik® Aseptic (TBA) carton system for long-life ultra-heat treated (UHT) milk. The TBA carton has become one of the world's major pack forms for a wide range of liquid foods and beverages
- *1970s*: The bar code system for retail packaging was introduced in the United States; methods were introduced to make food packaging tamper evident; boil-in-the-bag frozen meals were introduced in the UK; MAP retail packs were introduced to the United States, Scandinavia and Europe; PVC was used for beverage bottles; frozen foods in microwaveable plastic containers, bag-in-box systems and a range of aseptic form, fill and seal (FFS) flexible packaging systems were developed. In 1973, DuPont™ developed the injection stretch blow-moulded polyethylene terephthalate (PET) bottle that was used for colas and other carbonated drinks
- *1980s*: Co-extruded plastics incorporating oxygen barrier plastic materials for squeezable sauce bottles, and retortable plastic containers for ambient foods that could be microwave heated. PET-coated dual-ovenable paperboard for ready meals. The widget for canned draught beers was commercialised – there are now many types of widget available to form a foamy head in canned and glass bottled beers. In 1988, Japan's longest surviving brand of beer, Sapporo, launched the contoured can for its lager beer with a ring-pull that removed the entire lid to transform the pack into a handy drinking vessel
- *1990s*: Digital printing of graphics on carton sleeves and labels for food packaging was introduced in the UK; shrink-sleeve plastic labels for glass bottles were rapidly adopted by the drinks industry; shaped can technology became more widely adopted in the United States and Europe as drinks companies sought ways of better differentiating their brands

- *2000–2010*: In 2006, nanotechnology was used to modify the internal surface properties of a squeezable plastic bottle for a global brand of mayonnaise to enable easier product removal thereby reducing product waste. In 2007, the world's first 100% recycled PET bottle for the UK's 'innocent®' brand of 'Smoothie' fruit drinks. In the United States, manufacture of the world's first commercially compostable maize starch-derived polylactide or polylactic acid (PLA) bottles used for water. In the UK, Walkers™ Crisps became the first company in the world to display a carbon footprint reduction label on a consumer product

Since the advent of the food can in the nineteenth century, protection, hygiene, product quality and convenience have been major drivers of food technology and packaging innovation. In recent years, there has been a rising demand for packaging that offers both ease of use and high quality food to consumers with busy lifestyles. The 1980s, in particular, saw the widespread adoption by the grocery trade of innovations such as gas barrier plastic materials utilised in aseptic FFS plastic containers for desserts, soups and sauces; plastic retail tray packs of premium meat cuts in a modified atmosphere; and retortable plastic containers for ambient storage ready meals that can be microwave heated.

Technological developments often need to converge in order for a packaging innovation to be adopted. These have included developments in transportation, transport infrastructures, post-harvest technology, new retail formats and domestic appliances such as refrigerators, freezers and microwave ovens. For example, the development of the microwave oven precipitated the development of convenience packaging for a wide range of foods. In addition, the sociocultural and demographic trends, consumer lifestyles and economic climate must generate sufficient market demand for an innovation to succeed.

In the future, it is likely that packaging will need to become smarter to more effectively communicate with consumers, improve convenience, augment brand identification/value and enhance sustainability credentials. For example, data matrix barcodes consisting of black and white modules in a two-dimensional square or rectangular pattern and printed electronics can help address rising consumer demand for more product information – such as origin, GM, organic, Fairtrade® mark, food preparation and pack recyclability. The pattern is decoded by camera phone to communicate more detailed information about the brand/product to the consumer. As environmental concerns grow, packaging will play an increasingly important role in the sustainability agenda of the food and drinks industry. Increasingly, consumers are deciding for or against brands on the basis of ecological or social criteria. In order to win and retain their custom, companies will need to develop and effectively implement sustainable development policies that include addressing climate change, resource management, pollution and waste.

1.3 ROLE OF PACKAGING FOR ENHANCED SUSTAINABILITY OF FOOD SUPPLY

Consumer demand for pre-packaged food and drinks, much of which is sourced on a global basis, continues to rise in advanced economies and a growing global population is also increasing the demand. This consumption trend is being reflected in emerging economies and lesser developed countries experiencing rapid urbanisation. In response to changing consumer lifestyles, large retail groups and food service industries have evolved. Their success has involved a highly competitive mix of logistical, trading, marketing and customer service expertise, all of which is dependent on quality packaging. They have partly driven the dramatic expansion in the range of products available, enabled by technological innovations, including those in packaging.

The retailing, food and drinks manufacturing and packaging supply industries are continuing to expand their operations internationally. The sourcing of products from around the world is increasingly assisted by a reduction in trade barriers. The effect has been an increase in competition and a downward pressure on prices. Increased competition has led to a rationalisation in industry structure, often in the form of mergers and takeovers. For packaging, it has meant the adoption of new materials and shapes, increased automation, extension of pack size ranges and a reduction in unit cost. Another effect of mergers among manufacturers and retailing groups on packaging is the reappraisal of brands and their pack designs.

Increasing market segmentation and the development of global food and drinks supply chains have encouraged the adoption of sophisticated logistical packaging systems – Chapter 4 discusses 'Logistical packaging for food marketing systems'. Packaging is an integral part of the logistical system and plays an important role in preventing or reducing the generation of waste in the supply of food. Fig. 1.1 illustrates the distribution flows of food from the farm to the consumer. It should be noted, however, that some parts of the chain permit the use of returnable packages.

Globally, the food and drinks industry makes a significant contribution to climate change and other environmental issues. The industry is a major user of fresh water, non-renewable fossil fuels and other non-renewable natural resources such as metals. Increasingly, however, business leaders are becoming aware of the connections between climate change, energy, fresh water availability and the demands of their stakeholders for corporate accountability. The main

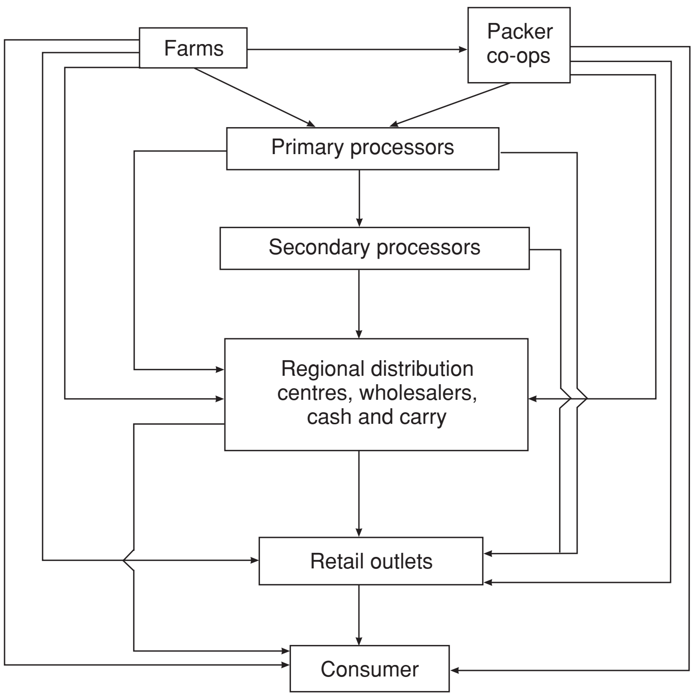

Fig. 1.1 Food distribution systems. (Adapted from Paine & Paine, 1983.)

environmental challenge for society and industry generally is to meet targets for reducing carbon dioxide (CO_2) and other greenhouse gases (GHGs) to address the growing global issue of climate change. Ecological and social impacts linked to climate change include decreasing per capita availability of fresh water, increasing stress on food supply, rapid deforestation, adverse effects on human health, pollution and loss of biodiversity.

The food and drinks industry is aware of rising environmental concerns and, for some years, has launched a range of initiatives to respond to these concerns. Initiatives have focused on, for example:

- the environmental impacts of transportation, particularly with regard to pollutants such as CO_2, oxides of nitrogen and other GHG emissions
- packaging litter and the volume of packaging waste in municipal waste
- pollution associated with methods of disposal, particularly landfill and incineration
- the sustainability of groundwater abstraction and use
- health risks to wildlife from discarded packaging
- sustainable sourcing of packaging materials, e.g. Forest Stewardship Council® (FSC) certified paper and pulp

Over several decades, packaging has attracted much adverse attention and scrutiny by the media and public many of whom perceive packaging to be a waste of resource and believe that used packaging represents a much larger contribution to the solid waste stream than is actually the case. An industry survey involving interviews with European packaging company senior executives reported that the packaging sector was 'a highly visible and growing contributor to the waste stream' (PricewaterhouseCoopers, 2009). The general consensus was that a common definition of 'sustainable packaging' would represent significant progress. In this regard, there is a number of industry initiatives in place to define 'sustainable packaging', e.g. the Consumer Goods Forum's Global Packaging Project (www.theconsumergoodsforum.com), the Sustainable Packaging Coalition® (www.sustainablepackaging.org), the Sustainable Packaging Alliance (www.sustainablepack.org) and the Greener Package Guidelines for Sustainability (www.greenerpackage.com).

Packaging's role in helping to achieve greater sustainability in the food supply system has fast become a strategic issue for both industry and government, which need to take account of the economic consequences of climate change and the serious resource implications of growing global demand for products, including food and drinks. Economic considerations affecting product (and packaging) costs include the price of oil, the economic climate, energy and raw material costs/availability. Numerous case studies on packaging from across the food and drinks industry have demonstrated that a 'greener' business can deliver not only environmental benefits but also economic benefits and enhanced marketing opportunities, e.g. refer WRAP's Envirowise (www.envirowise.wrap.org.uk).

The *total product cost* should take account of the impact of *environmental value* on cost because of the opportunity this value presents to significantly reduce costs. For example, these may include energy, transport, waste disposal and water costs. It may also enable companies to minimise the financial impact of changing legislation and other economic instruments relating to matters such as packaging and packaging waste. A value chain perspective integrating environmental solutions from across the supply chain will serve to improve the environmental profile (including carbon footprint) of a company, thereby enhancing its brand image. Examples include:

- adopting packaging which extends product shelf life and reduces food and drinks waste
- selecting pack designs by brand owners that facilitate recycling or reuse
- action by retailers and brand owners to help develop recycling infrastructure
- obtaining packaging materials from environmentally responsible suppliers and raw materials from sustainable sources
- adopting low carbon and renewable energy technologies for packaging production, product manufacturing, distribution and retail operations e.g. the provision of more energy efficient machinery by packaging manufacturers
- using space-efficient pack designs for more energy efficient distribution and lower emissions per unit load of packaged product
- providing reduced weight/volume containers, wrappings and closures by packaging material suppliers and converters
- reducing the number of components in a pack, e.g. two-piece instead of three-piece closure
- increasing the level of post-consumer recycled (PCR) and recycled industrial scrap content of packaging
- more environmentally responsible print processes
- reducing the weight of labels or increasing the recycled content
- improving energy efficiency and water management in food and drinks packaging operations
- reducing the energy/GHG emissions and thereby reducing the carbon footprint associated with packaging materials manufacture, supply, on the packaging line, in the factory and the warehouse
- adopting packaging that effectively communicates brand values and green credentials to consumers

Environmental policy on packaging should focus on resource efficiency and not just waste and recycling. A full strategic response to the environmental issue would include:

- minimising energy and raw material use
- minimising the impact on the waste stream
- not causing environmental damage

There are many alternative routes to achieve these objectives but the key possibility for a retailer or manufacturer to gain competitive edge is repositioning all products to satisfy a comprehensive audit. The risk and uncertainty involves the relative strength of environmental concerns and other key consumer attributes.

There are management tools to reduce or compare the environmental impacts of industrial systems, and these include life cycle assessment (LCA). LCA is a management tool involving a detailed examination of the environmental impact of a product at every stage of its existence, from extraction of materials through to production, distribution, use, disposal and beyond. The International Organization for Standardization (ISO) has responded to the need for an internationally recognised methodology for LCA (ISO: 14040 and ISO: 14044).

Environmentally compatible packaging that is resource efficient, and/or enables greater resource efficiency in product use and distribution, assists the preservation of the world's resources. It also assists by preventing product spoilage and wastage, and by protecting products until they have performed their function.

A Tetra Pak® motto is that a *'package should save more than it costs'*.

Generally, food and drinks packaging contributes only a relatively small proportion of the total energy consumed and GHG emissions involved in the food supply system, product use and waste disposal. Emissions of GHGs from manufactured foods tend to be dominated by emissions from the production stage, i.e. agriculture. For example, it was estimated using 2007 data (Millstone & Lang, 2008) that packaging contributes around 5% of UK food-related GHG consumption in contrast to impacts from fertiliser production (5%), agriculture (39%), food processing (12%), transport from overseas (6%), retailing (5%), catering (8%), food preparation in the home (11%) and waste disposal (2%).

In conclusion, the value of food packaging to society has never been greater nor, paradoxically, has packaging attracted so much adverse media publicity and political attention. In response, stakeholders in the food and drinks industry need to fully appreciate and actively promote the positive contributions that their packaging makes to society. It is also crucial that they actively innovate and redesign packaging – ideally, through collaborative partnerships in their supply chains – to effectively meet the sustainability challenge and the changing needs/values of their consumers. At the same time, they need to satisfy the mass of laws, regulations, codes of practice and guidelines that govern the industry.

1.4 DEFINITIONS AND FUNCTIONS OF PACKAGING

The principal roles of packaging are to contain, protect/preserve the product and inform the user. Thereby, food and drinks waste may be minimised and the health of the consumer safeguarded. Packaging combined with developments in food science, processing and preservation techniques, has been applied in a variety of ways to ensure the safety of the consumer and integrity of the product. The success of both packaging and food technology in this regard is reflected by the fact that the contents of billions of packs are being safely consumed every day.

There are many ways of defining packaging, reflecting different emphases. For example, packaging can be defined as:

- a means of ensuring safe delivery to the ultimate consumer in sound condition at optimum cost
- a coordinated system of preparing goods for transport, distribution, storage, retailing and end use
- a techno-commercial function aimed at optimising the costs of delivery whilst maximising sales (and hence profits)

  However, the basic functions of packaging are more specifically stated as follows:
  - *containment*: depends on the product's physical form and nature, e.g. a hygroscopic free-flowing powder or a viscous and acidic tomato concentrate
  - *protection*: prevention of mechanical damage due to the hazards of distribution
  - *preservation*: prevention or inhibition of chemical changes, biochemical changes and microbiological spoilage
  - *information about the product*: legal requirements, product ingredients, use, etc
  - *convenience*: for the pack handlers and user(s) throughout the packaging chain
  - *presentation*: material type, shape, size, colour, merchandising display units, etc
  - *brand communication*: for example pack persona by the use of typography, symbols, illustrations, advertising and colour, thereby creating visual impact
  - *promotion (selling)*: free extra product, new product, money off, etc
  - *economy*: for example efficiency in distribution, production and storage
  - *environmental responsibility*: in manufacture, use, reuse or recycling and final disposal

1.5 PACKAGING STRATEGY

Packaging may also be defined as follows: *'A means of safely and cost effectively delivering products to the consumer in accordance with the marketing strategy of the organisation.'* A packaging strategy is a plan that addresses all aspects and all activities involved in delivering the packaged product to the consumer. Packaging strategy should be allied to clearly defined marketing, manufacturing and sustainability strategies that are consistent with the corporate strategy or mission of the business.

Key stakeholders in the strategic development process include management from technical/ quality, manufacturing, procurement, marketing, supply chain, legal, environmental and finance functions.

Packaging is both strategically and tactically important in the exercise of the marketing function. Where brands compete, distinctive or innovative packaging is often a key to the competitive edge companies seek. In the UK, for example, the development of the famous widget for canned draught beers opened up marketing opportunities and new distribution channels for large breweries. The packaging strategy of a food manufacturer should take into consideration the factors listed in Table 1.1.

Table 1.1 Framework for a packaging strategy.

Technical requirements of the product and its packaging to ensure pack functionality and product protection/preservation throughout the pack's shelf life during distribution and storage until its consumption
Customer's valued packaging and product characteristics, e.g. aesthetic, flavour, convenience, functional and environmental performance
Marketing requirements for packaging and product innovation to establish a distinct (product/service) brand proposition; protect brand integrity and satisfy anticipated demand at an acceptable profit in accordance with marketing strategy
Supply chain considerations such as compatibility with existing pack range and/or manufacturing system
Legislation and its operational/financial impacts, e.g. regulations regarding food hygiene, labelling, weights and measures, food contact materials and due diligence
Ethical/environmental requirements or pressures and their impacts, e.g. light-weighting to reduce impact of taxes or levies on amount of packaging used; sustainable sourcing of materials, responsible labour policies of suppliers

1.6 PACKAGING DESIGN AND DEVELOPMENT

Marketing 'pull' is a prerequisite to successful innovation in packaging materials, forms, designs or processes. The most ingenious technological innovation has little chance of success unless there is a market demand. Sometimes, an innovation is ahead of its time but may be later adopted when favoured by a change in market conditions. Specialist technical research, marketing research and consumer research agencies are employed to identify opportunities and minimise the financial costs and risks involved in the development, manufacture and marketing of a new product.

During the 1980s in the UK, for example, the radical redesign of traditional plastic film overwrapped, flat-shaped cartons with flip-open lids for retail packs of tea bags was based on focus group consumer research for a leading branded tea supplier. It was motivated by the rapidly growing competitive threat from packaged instant coffees in the hot drinks market. The result was a rigid upright carton with an integral easy tear-off board strip but without the traditional plastic film overwrap that was difficult to open. Metalized polyester pouches are used to contain 40 tea bags for convenient tea caddy or cupboard storage. Carton designs may contain either a single pouch or multiple pouches. The pouch prevents spillage of tea dust, provides freshness and conveys an image of freshness that is often reinforced by the promotional on-pack message of 'Foil packed for freshness'. The carton shape, label and colour combinations were also redesigned for extra on-shelf impact. This packaging innovation was widely adopted by retailers and other manufacturers for their branded teas. This pack format is still commonplace today on supermarket shelves although a tea packaging innovation called the 'softpack' has been successfully introduced by a leading tea brand in recent years. A new tea packaging innovation adopted by a major tea brand in 2009 is a pouch made using metalized biodegradable cellulosic-based film that is suitable for home composting because of its low aluminium metal content at less than 0.02%.

Generally, more successful new product developments are those that are implemented as a 'total product concept' with packaging forming an integral part of the whole. An example of the application of the 'total product concept' is the distinctive white bottle for the 'Malibu'® brand of rum-based spirit drink that reflects the coconut ingredient. There are many examples such as cartons with susceptors for microwave heating of frozen chips, pizzas and popcorn, and dispensing packs for mints.

Ideally, package design and distribution should be considered at the product concept stage. Insufficient communication may exist between marketing and distribution functions; a new product is manufactured and pack materials, shape and design are formulated to fulfil the market requirements. It is only then that handling and distribution are considered. Product failure in the marketplace due to inadequate protective packaging can be very costly to rectify. Marketing departments should be aware of distribution constraints when designing a total product concept. With high distribution costs, increased profitability from product and pack innovation can be wiped out if new packaging units do not fit in easily with existing distribution systems. It is necessary to consider whether packs are designed more for their marketability or for their physical distribution practicability. This would not necessarily be so important if it were not for the growing significance of distribution costs and environmental performance, in particular those for refrigerated products that require high energy input throughout the cold chain.

The development of packs is frequently a time-consuming and creative endeavour. There may be communication difficulties between business functions and resource issues that impede pack development. The use of multidisciplinary teams may expedite the packaging development process. This has the effect of improving the quality of the final product by minimising problems caused by design consequences that can result from sequential development. Computer assisted design and rapid prototyping facilities for design and physical modelling of packs give packaging development teams the ability to accelerate the initial design process. In packaging development, thorough project planning is essential. In particular, order lead times for packaging components need to be carefully planned with suppliers at an early stage in order to ensure a realistic time plan. For example, the development of a plastic bottle pack for a juice drink may involve typical stages listed in Table 1.2. There may be issues such as a supplier's availability of injection stretch blow-moulding machines due to seasonal demand for drinks containers and consequent lack of spare production capacity.

With reference to the definition *'Packaging in product distribution is aimed at maximising sales (and repeat sales, and so profits), while minimising the total overall cost of distribution from the point of pack filling onwards and, possibly, extending to used packaging reuse, disposal or recovery',* packaging should be regarded as *'a benefit to be optimised rather than merely a cost to be minimised'* (Paine & Paine, 1983).

Table 1.2 Typical stages in the design and development of a new plastic bottle pack.

Define packaging strategy
Prepare packaging brief and search for pack design concepts: functional and graphical
Concept costing, screening and approval by cross-functional packaging team
Pack component supplier selection through liaison with purchasing
Cost tooling: design and engineer new moulds for bottles and caps with suppliers
Test pack prototype: dimensional, drop impact, leak, compression, cap fit, etc.
Commission artwork for labels
Shelf life testing; barrier performance evaluation
Model and sample production: filling system; labelling; casing, etc.
Market test prototype
Design, cost and evaluate transit pack performance for prototype: drop, compression, etc.
Determine case arrangement on pallets and assess influence of factors affecting stacking performance: brick or column stacking, relative humidity, moisture, pallet design, etc.
Define quality standards and packaging specifications
Conduct production and machine trials: efficiency and productivity performance
Plan line changeovers
Develop inspection methods and introduce a quality assurance service
Commission production line for new or changed packaging systems
Fine-tune packaging operations and specifications

'Packaging optimisation' is a main concern of the packaging development function. The aim is to achieve an optimal balance between performance, quality and cost, i.e. value for money. It involves a detailed examination of each cost element in the packaging system and an evaluation of the contribution of each item to the functionality of the system (Melis, 1989).

Packaging should be considered as part of the process of product manufacturing and distribution, and the economics of the supply chain should take into account all those operations – including packaging – involved in the delivery of the product to the final user. Increasingly, the costs involved in reuse or waste collection, sorting, recovery and disposal are being taken into account. For example, a take-away food service may decide to adopt an easily collapsible aseptic fill bag-in-box system for long life or extended shelf life drink to reduce product wastage, minimise waste packaging storage and reduce waste disposal costs. The overall or 'total packaging system' cost stems from a number of different components, including materials utilisation, machinery and production line efficiency, movement in distribution, management and manpower. They may include some of the operations listed in Table 1.3.

Table 1.3 Typical handling operations for an ambient storage retail pack.

Production line container forming, de-palletising or de-nesting
Container transfer on conveyor system and container inspection (cleaning)
Filling, sealing (processing) and labelling
Casing, case sealing and coding
Palletising and stretch-wrapping
Plant storage
Transport to warehouse
Lorry transport to retail regional distribution centre (RDC)
RDC storage
Pallet break-bulk and product order pick for stores at RDC
Mixed product load on pallets or roll cages to RDC dispatch
Loaded pallets or roll cages delivered by lorry to retail stores
Loads moved to back of store storage area for a short period
Load retail cabinet or fill shelf merchandising display