

### 3

## The product development process

The PD Process coordinates the specific research activities such as product design, process development, engineering plant design, marketing strategy and design with the aim of producing an integrated approach to the development of new products. The overall aim is to create a product that an individual consumer or a food manufacturing company or a food service organisation will buy. The two parts of product development – the knowledge of the consumer’s needs/wants and the knowledge of modern scientific discoveries and technological developments – are both equally important. The PD Process combines and applies the natural sciences with the social sciences to systematically produce innovation in industry.

The PD Process is a system of research for the individual product development project and the product development programme. It varies in detail from project to project but overall retains the same structure of four main stages, subdivided further into 7–9 stages in some product development models (Cooper, 1996; Earle, 1997). The four stages are product strategy, product design and process development, product commercialisation, product launch and evaluation. Between the four stages, there are critical evaluations and top management decisions on the project and the products, called stage gates (Cooper, 1990) or critical points (Earle, 1971). **Critical points** are an essential part of the PD Process. For the critical decisions to be made, certain knowledge has to be generated in the research – the **outcomes** from the various stages. To build this knowledge, specific research is needed – the **activities** of the various stages. The project teams choose different procedures for these activities – the **techniques** used in the activities. There are important interrelationships in the four main stages between:

Critical decisions +-- Outcomes +-- Activities +-- Techniques

This PD Process can be called the Critical PD Process because it is based around critical decisions, and because there is critical analysis of the activities/ techniques and the outcomes throughout the project.

### 3.1 Product strategy

Stage 1: product strategy, starts with the finalising of the product development strategy and product development programme. Then the aims of the individual product development projects can be set. The project starts with the generation of new product ideas and the outlining of the product design strategy, and ends with the product concept and product design specifications. There is real dichotomy in the decisions and activities; there is on the one hand, the need for freedom to be creative, and on the other, the need to set boundaries in the product design strategy. Before top management can make the critical decision to fund the further stages of the project, or to stop it, or to return it to the team for more knowledge, there are three critical decisions:

1. Is the product concept a unique product satisfying the needs and wants of the target consumer/customer?
2. Will the product concept and the project deliver the financial and other aims set in the business and product development strategies?
3. Does the product concept harmonise with the company's business and environment?

Top management, to make these decisions, needs knowledge on the processing, production, distribution and marketing technologies for the product. Knowledge will be incomplete at this time. The financial predictions (sales revenue, gross profits or margins, the probabilities for success, the returns on investments or break-even times), and future costs and time for the project are very approximate. There will be other specific requirements for each project, such as enhancing health (Ericson, 1997), environmental effects, food regulations and trade barriers. But of course the most important knowledge is the description of the product idea in the product concept and the product design specifications. The project team has to build up this knowledge throughout the stage, and the type of knowledge identified will determine the critical activities that have to be completed in the product development project (Earle and Earle, 1999). The knowledge is built up in substages and decisions are made at the end of each stage usually by product development management, but sometimes by top management if the project is a major innovation and costly.

The substages in Stage 1: product strategy for the individual project are:

- defining the project;
- developing the product concept;
- identification of processes, distribution and marketing;
- development of product design specifications;

- planning of the project;
- predictions of project costs and financial outcomes.

This is total technology research incorporating product, processing and market research with consumer and society studies. At this early stage, the knowledge may be generalised, and the aim is to make it greater in breadth and depth through the later stages of the project. This stage sets the direction for the product development project, and has been identified in much research as most important to the final success of the project.

### 3.1.1 Defining the project

The aim, outcomes and the constraints have been identified in the product development programme and presented to the product development team or manager for the project. But there is usually a need for further desk research by the team to determine the accuracy of the aim, outcomes and constraints and also to ‘flesh them out’ to give a more detailed project definition that can drive and control the project (Rosenau, 2000). This is also the time to select a suitable PD Process for the project and to set out an outline project plan.

There are four aspects of the initial research to define the project by developing more detailed aims: product ideas, consumers, technology and market as shown in Fig. 3.1. The research includes all aspects of the PD Process. At the same time the team is developing new product ideas, and relating them to the market possibility, to the technology possibility and to the product possibility. What are the products? Can they be made? Can they be sold? Who wants them? What do they need? These are the types of questions being discussed by the team and it is an important time for team interaction. This is only ‘desk research’ – using information in the company, outside records, published textbooks and papers, which are easily available. There is a maximum use of tacit knowledge within the group and within the company. Information technology has improved the storage and use of knowledge in product development, in particular the use of product models with a framework of raw materials, ingredients, packaging and production methods (Jonsdottir *et al.*, 1998).

#### **Think break**

In a project, the aim was changed from:

Export a nutritional product to Thailand with a market size of \$5 million.

to:

Export a protein product, minimum 20% protein, to the Thai middle class, urban market, marketed through gyms and supermarkets; processed in the spray drying plant or the UHT plant and distributed at ambient temperatures. It must have sales greater than \$4 million.

1. Study the aims and discuss how the first aim has been improved in the second aim as a focus for the project.
2. How would you improve the second aim to make it clearer for all people in the project?



Fig. 3.1 Defining the project: activities, outcomes and constraints.

The second aim allows two different methods of processing. In other aims there may be two target markets, or two methods of marketing, as it is not clear at that time just which is the direction to go. Aims can be adjusted during the project but there must be agreed reasons for doing this.

The **outcomes** for the different stages of the PD Process are developed from the aim, the company's PD Process for this type of product, and the decisions that the top management has indicated for different times in the project. In particular the decisions identified are used to determine the outcomes as shown in Fig. 3.2. There are both product and project decisions to be made, the product decisions and outcomes are ovals in Fig. 3.2. The general decisions are similar for many projects but there will also be specific decisions for each project. Therefore other outcomes will be needed. It is important to recognise the decisions that have to be made, and by whom, and to then select the knowledge needed in the outcomes to make these decisions. Outcomes are sometimes called objectives; they are the knowledge goals that have to be reached at the end of the different stages of the PD Process. In some projects, especially large projects,

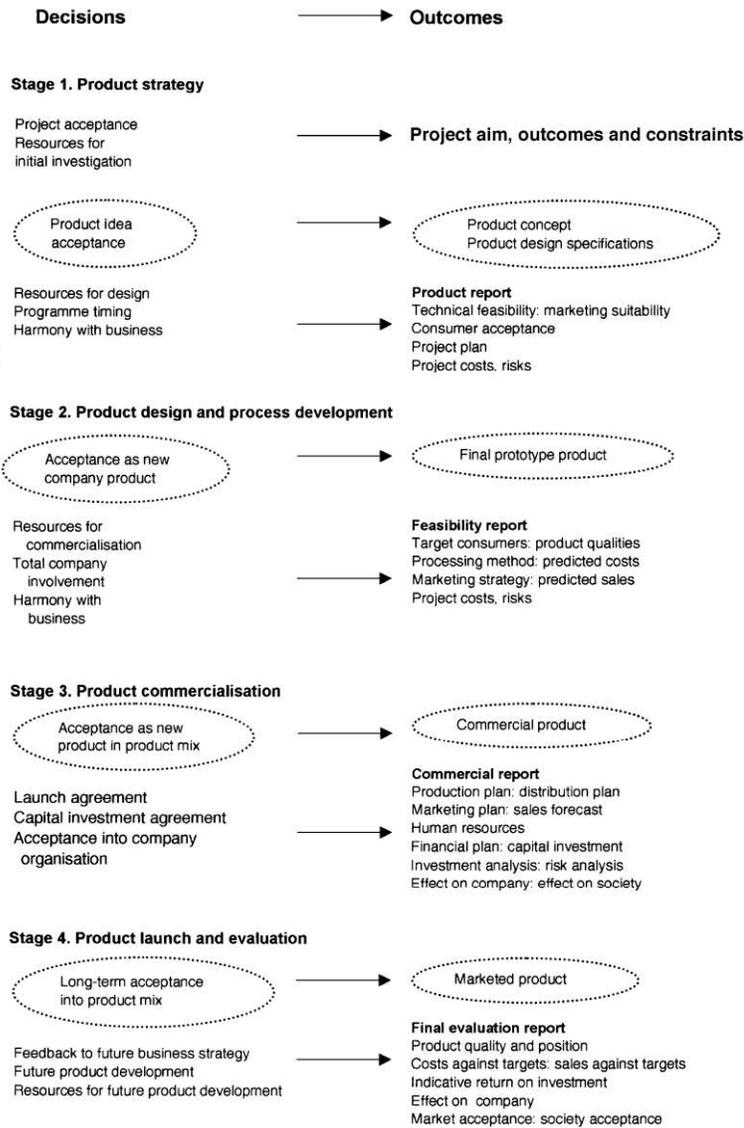


Fig. 3.2 Identifying the outcomes necessary for the decisions (After Earle and Earle, 1999, by permission of Chadwick House Group Ltd).

critical decisions may be made more often in the project; again these decisions have to be recognised and the required outcomes defined.

It is important to select the outcomes by balancing the need for knowledge against the resources and time needed for the activities to give the outcomes. With the recent emphasis on faster but quality product development, more attention is being paid to selection of outcomes. The choice of outcomes and

therefore of project activities depends on the risk of failure the company is prepared to take. Teams often seek extensive knowledge so that they are surer of the whole picture, but this can be expensive and take too long and even sometimes result in failure. There is history of some companies seeking too much information in the test markets, and being overtaken by other companies. Outcomes that are fundamental to the project and whose completion is necessary for the project are always included. Identifying possible outcomes at the beginning of the project and selecting the critical outcomes for the company and its environment, which are within the money and time the company is willing to provide, ensure a project that is efficient and effective.

The **constraints** are any factors defining the area of the project. Some of these, such as financial resources and time for launching, will have been specified in the product development programme. At this time it is important to identify constraints on the product, processing and marketing, and also the constraints placed by the company and by the social and political environment. For example, the constraints from the food regulations and from society's attitudes to production, processing, food additives and safety need to be identified before product design starts. There are sometimes constraints caused by the availability of people and equipment. A checklist for studying constraints is shown in Table 3.1.

The constraints need to be recognised but they must not be too tight as this could stifle the creativity in product design and process development. For example, specifying the protein level as exactly 20% for a perceived consumer need and not a requirement of the regulations could restrict the other product characteristics. But a protein range of 20–30% could satisfy the consumer but allow more freedom in design. It is important to criticise the constraints – are they all needed, are they too tight? Sometimes a company constraint may stifle the project, and it is important to revisit it with management to see if it can be changed.

The aim(s), outcomes and constraints direct and control the project. They are used as factors in screening and evaluating the product ideas and product concepts, and then in evaluating the different prototype products. They are the

**Table 3.1** Project constraints: a checklist for product development projects

Product	Processing	Marketing	Financial	Company	Environment
Eating quality	Equipment	Channels	Fixed capital	Strategy	Local government
Composition	Capacity	Distribution	Working capital	Structure	National government
Nutrition	Raw materials	Prices	Investment	Expertise	Industry agreements
Packaging	Wastes	Promotion	Project finance	Location	Farmers' agreements
Shelf life	Energy	Competitors	Cash flows	Management	Economic status
Use	Water	Size	Profits	Innovation	Business cycle
Safety	Personnel	Product mix	Returns	Size	Social restrictions

Source: From Earle and Earle, 1999, by permission of Chadwick House Group Ltd.

basis for identifying the activities and choosing suitable techniques and for the project plan, which directs and controls the process.

The **outline project plan** is based on the PD Process selected for the project and the outcomes identified. The PD Process varies according to the type of product – industrial, consumer and food service, and also whether the product is incremental or a major innovation. The activities are selected to give the outcomes previously identified. Choice of activities is not only determined by the knowledge needed in the related outcome, but also by the resources and time available. The **description of the activity** defines the outcome needed, the time frame to be met and the resources that can be used. The outline plan is set up so that everyone in the project can identify their place in the project and what they are aiming to achieve. They can start to select the techniques for their section of the project, particularly for the early stages.

### ***Think break***

In Chapter 3, we are going to do the initial stage of a PD project, either a project from your company or using the Case Study in Section 7.4. Obtain from the management of your company the general aim, constraints and resources for this project. In this Think Break, search for more information and develop the final aim(s), outcomes and constraints for management's approval.

1. What is the market type – consumer/retail, consumer/food service, business to business/industrial, business to business/food service? Identify the target market, its possible size, needs and competing products. Use Fig. 3.1 as a guide, try to find information to answer the market/consumer questions.
2. Identify the type of product development in the project – me-too, improvement, product line extension, innovation on the same product platform, a new platform; and also the type of market. Then select/design the PD Process
3. Using Fig. 3.2, identify the possible decisions to be made and then discuss them with management. Select the final decisions.
4. Determine what knowledge is needed to make these decisions and then select the outcomes that are needed for the decisions at the various stages of the project.
5. What are the principal constraints already identified for this project – economic, physical, political, social? Now use the checklist in Table 3.1 to discover any other constraints that might be important. Rank the constraints from critical to not important and select the final constraints for the project.

### **3.1.2 Developing the product concept**

The food industry has seldom used the word design except as related to packaging and to advertising. The development of the product has usually been called 'product development' and had connotations of laboratory formulation

and sensory panel. But today, there may be real benefits in adopting food product design and in associating food product design with other areas of design.

The product is an amalgam expected by the consumer of the hard values or the basic qualities and the soft values or the differentiating qualities such as aesthetic appearance and environmental friendliness. Product design, or the product creation process, is therefore an amalgamation of the disciplines of consumer and market research, technology and engineering research with design practice as shown in Fig. 3.3. Product design is an essential part of the product creation process in equal cooperation with engineers, marketers and consumer researchers (Blaich and Blaich, 1993). All come together in the technology of the product.

- Consumer researchers build the consumer/product relationship throughout the PD Process.
- The market researchers analyse markets and design the marketing and distribution methods in the market strategy.
- The food engineer and technologist research the product and the process together in co-engineering and design the production and physical distribution methods.
- The food product designer researches the social and cultural backgrounds and designs the holistic product.

It is important that these are all integrated from the beginning of the PD Process. As the product concept and the product design specifications are built up, all aspects are brought together; then as the project progresses, the people involved understand what is needed in the design of product, production and marketing to satisfy the consumers' needs, wants and behaviour.

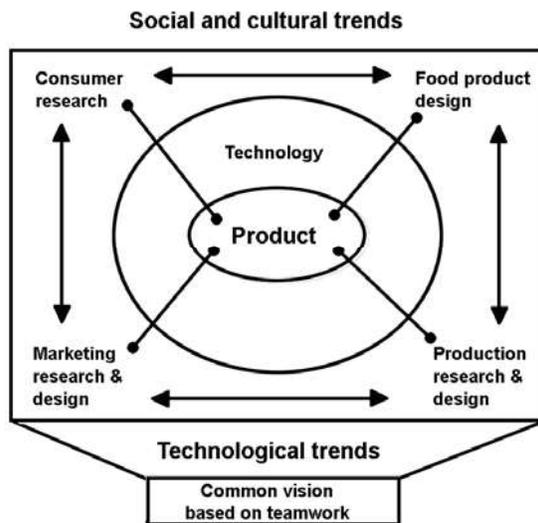


Fig. 3.3 Integrating the main disciplines in product creation (Source: After Blaich and Blaich, 1993).

The product design process is subject to a set of requirements (product design specification), including basic and desirable product functions, performance, aesthetics and cost (Dasgupta, 1996). This is common to many industrial areas but is now only becoming accepted in the food industry. Firstly, the consumers and product designers, very often with marketers, come together to develop a product concept, and then the technologists and engineers are brought in to develop the product design specification. Some of you may be thinking that this is sounding rather complicated, but actually you do it all the time but may be doing it without clear directions. Designers and the consumers have difficulty in working in the abstract and there is some design taking place either in drawings, computer descriptions or 'mock-up' products. Creativity starts here. It is a useless exercise for marketing to work alone with consumers to develop a product concept and then hand it to the food designer/technologist and say make this! That seldom leads to unique products. There needs to be cooperation among marketing, consumer and the product designers (or food technologists/product developers as they are often called in the food industry).

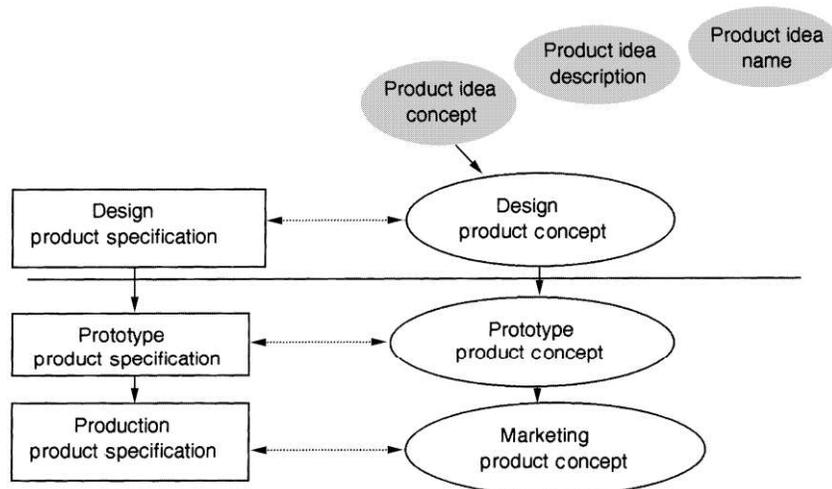
The areas in building the product concept for design are (Ulrich and Eppinger, 1995):

- identifying consumer needs;
- establishing target product brief;
- analysis of competitive products;
- concept generation;
- concept selection.

The project team works between these areas. Firstly they study consumers, trying to build their needs into more specific terms in the product brief, and at the same time studying the competing products. Then they go back to the consumers with more defined product types to generate specific product concepts. Finally they work the product concepts into more specific and detailed product descriptions and go back to the consumers to find their reactions.

The product concept progresses through the product development project from the original idea to the final product specifications controlling production and the final product proposition that is the basis for the marketing. It is refined and expanded in two different ways because of the different end uses – in a technical, quantitative description and in a consumer-based, in-depth, description as shown in Fig. 3.4.

The outcomes needed in the first stage are the design product concept and the design product specifications. These start from a name or a simple description in the product development programme, and firstly the team generates ideas for the product and then with consumers builds simple product idea concepts. After evaluation these are reduced to one or two product ideas, and research with consumers and the market gradually builds up the product concept for design. This is then integrated with the processing and marketing technologies, and the product concept is built up by product concept engineering into metric descriptions in the product design specification. The design product concept is



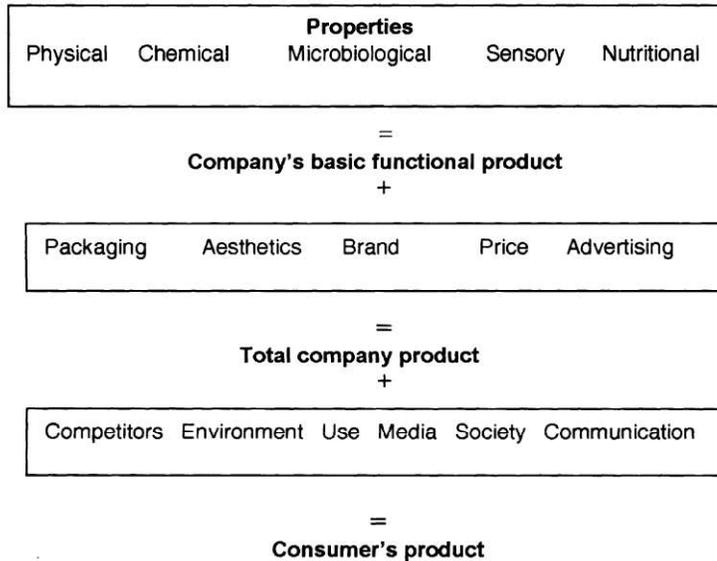
**Fig. 3.4** Product concepts and product specifications in the product development project.

the consumer's description of the product and includes the product characteristics, benefits and position in the market as identified by the consumer. The design product specification is developed from the product concept with reference to the technical aspects of the product, processing and distribution. It is the precise definition of what the product has to do, it is metric and has a value (Ulrich and Eppinger, 1995).

A product has several layers and these are being built up gradually during the product development. There is the company's basic functional product, the total company product (with packaging, aesthetics, brand, price and advertising) and the consumer's product (which relates it to the competitors, the environment, the media, the society, as well as its communication and use) as shown in Fig. 3.5. There is a continuing interaction between these three layers of the food product, and therefore between the four groups of people – consumers, product designer, technical and marketing – during the development of the product concept and the product design specifications.

To research the products, there is a need to identify the following:

- **Product morphology**, the breakdown of a product into the specific characteristics (or attributes) that identify it to consumers or/and business customers. Determined by analysis of the product family and the individual product (Schaffner *et al*, 1998).
- **Product characteristics** (or attributes), the features identifying the product to the company, the market and the consumer. Identified by consumers and designers in the creation of the product concept.
- **Product benefits**, the product characteristics important to the consumer. Identified in the consumer/product designer discussion groups. The product benefits are in four main areas – basic product benefits, package benefits, use



**Fig. 3.5** The total food product (Source: From Schaffner, Schroder and Earle, *Food Marketing: An International Perspective*, © 1998, by permission of the McGraw-Hill Companies).

benefits and psychological benefits – and these need to be integrated into the final consumer preference.

- **Product profile**, the group of product characteristics which is the unique identification of the product – it is the product’s DNA or fingerprint.

In developing a product strategy to introduce meat pies to Malaysia by a New Zealand company, the activity was to identify the product benefits required by Chinese and Malaysian consumers; three techniques were used – focus group, consumer survey, and multidimensional scaling (MDS) as shown in Table 3.2.

**Table 3.2** Product benefits for meat pies in Malaysia

Multidimensional scaling*	Focus group <sup>†</sup>	Consumer survey*
Taste (sweet–savoury)	Convenience	Taste
Product type (bread–non-bread)	Freshness	Cleanliness
Origin of product (local–foreign)	Smell	Freshness
	Local flavour	Healthy (good for you)
	Healthiness	Convenient to obtain

\* Chinese and Malay women in Malaysia.

<sup>†</sup> Malaysian students in New Zealand.

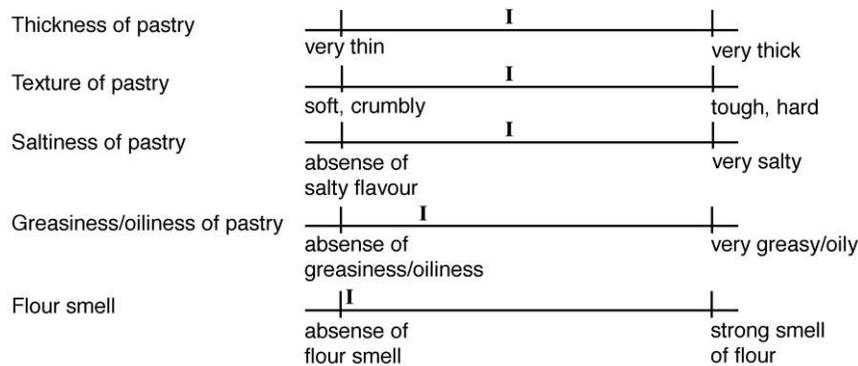
Source: After Lai, 1987.

The consumers compared the pie, particularly in the MDS, against the sweet and savoury baked/fried snacks already eaten in Malaysia. The MDS identified the main characteristics, and the focus group and the consumer survey identified general product benefits. To design the products more information was needed, and a sensory ideal product profile was identified by a small group of the consumers tasting the preliminary experimental products. The consumers' sensory characteristics were 7 for the pie top, 5 for the pie bottom and 14 for the pie filling. The five scales for the pastry bottom with the consumers' ideal scores are shown in Fig. 3.6.

The scales with their ideal points were included in the product design specification. The product profile needed to be analysed in two ways – what do the consumers mean by an ideal score of 5 for the pastry thickness? Can a physical measurement mimic this sensory characteristic? It is easy for thickness. Texture can also be measured in a physical instrument, but it may be necessary to train a panel to judge 'flour smell' and 'oiliness' unless a chemical test can be found for them.

The important product benefits may include the type of raw materials and processing, as in organic foods and environmentally friendly foods, as well as the recognised consumer concerns of nutrition, safety, eating qualities and the psychological benefits such as prestige and fun (Earle and Earle, 2000). There has been a concentration on sensory benefits as shown by the rapid development of sensory science but this needs to be made much wider to include all benefits. An example of a product concept strongly based on the psychological needs is described in Box 3.1, a product concept for pet foods.

The concept of the package often follows the more traditional path of industrial design, developing a product architecture that defines the major subsystems of the package such as the inner, outer, closure, seals. Product architecture can also be useful in building up products such as complete meals with various meat, vegetables and noodles in some type of display pack.



**I is the ideal score**

**Fig. 3.6** A product profile for pastry (Source: After Lai, 1997).

### **Box 3.1 Four-legged trends**

How many times have you seen a cat prey on a chicken or, heaven forbid, a turkey? But then cat food with blackbird or field mouse doesn't sound very discerning to a petfood shopper. Let there be no doubt that Britain's petfood shoppers are discerning and willing to show the colour of their money to satisfy their pet's taste buds.

The dominant trend over recent years has been the humanisation of petfood. Supermarkets stock an awesome display, encompassing not just a plethora of brands but also variants. A cosseted cat can start the day with a bowl of muesli and a splash of cat milk, enjoy chicken in jelly for lunch and perhaps have some tuna for supper. Meanwhile, the family dog can enjoy beef chunks at noon and 'a complete dry meal' to round off the day. In essence, the petfood sector has expanded to cater for owners' perceptions of what their pet requires. This is echoed in pack design.

In design terms, humanisation manifests itself by mimicking the same brand-building cues used for human brands. For example, Trix dog snacks bear a striking visual similarity to the human treat Minstrels, or equally they could be mistaken for a beef flavour packet of crisps. Similarly the packaging of Whiskas cat milk seems to draw inspiration from Carnation long-life milk. There is also a move towards injecting 'appetite appeal' into petfood packaging, with stylised displays of the product depicted on-pack. The use of expensive illustrations and top food photographers confirms this move. It has reached the point where the only difference between human and petfood packaging is the animal images on-pack.

The way forward for packaging design in the petfood sector is to aim for the right balance between traditional petfood brand values and those of the tinned food destined for human consumption. Yes, appetite appeal is a very important sales tool in this arena, but the trade-off shouldn't be a loss of whimsy and humour.

Source: From Petrie, 1995 by permission of *Marketing Week*, published by Centaur Communications (London).

### **Think break**

For the project identified in the previous Think Break

1. Generate five ideas for new products within the area of the aims.
2. Consider these product ideas against the aims and constraints for the product and choose the three most suitable products.

3. With some consumers build simple product idea concepts for these product ideas.
4. Expand the product idea concepts with knowledge of the processing, marketing and the technical characteristics of the product. Select the two most promising product idea concepts with the consumers.
5. Finally with the consumer group, build product concepts for design of the two remaining products.

### 3.1.3 Product design specification

Building the product design specification from the product concept includes both research and design. Market research provides more details about the target market characteristics and size, the methods of marketing that might be used and the position of the product as compared with the competitors. The market study is progressing into consumer and retailer surveys in consumer marketing and customer surveys in industrial marketing. The technical research involves the searching of the scientific and technological literature, including patents, as a preliminary investigation into the possible products, processing and physical distribution. The designer is starting to create the products and often needs to make models so that ideas on the product characteristics can develop. The modelling can be on paper or computer, and some preliminary laboratory research makes the products on a small scale. Of course in incremental development, the basic product is already known and both the marketing and the technical research, and product model building are much less and indeed may not be done at all.

The product design specification has for a long time played an important part in design in other industries and now is considered the area that has a major effect on quickening development and ensuring product success. The use of computer techniques such as CAD (computer aided design), CAID (computer aided industrial design), CAM (computer aided modelling), especially with more modern versions, has given the opportunity to design on the computer and to present the product ideas on the computer to other project members and even to consumers. The computer designs can be transferred into engineering design and linked to small-scale production units producing the experimental prototype for the consumer to discuss. Some of the newer tools in product design are shown in Table 3.3.

All of these new developments are changing industrial design and making it quicker. These techniques can be used for food packaging and for a structural food such as a loaf of bread and snacks. Snacks have already been designed using earlier CAD versions. Word descriptions of food product characteristics have been used in computer techniques such as conjoint analysis for a number of years to build and evaluate food product concepts (Moore *et al.*, 1999). The question is how far can the food industry use computer design techniques in building up product concepts and product design specifications? Certainly the