

Product Design Practice and Industry

2.1 INTRODUCTION

Product development and design is closely linked with industrial activity and production. When a new product is planned, the designer has to bear in mind the available resources of the plant and the possible impact of the firm having to acquire, modify or substitute existing machines and equipment or buy various components from other suppliers. It is therefore obvious that product development and design is at the core of the development and growth of the production centre and its departments. Thus, product design is one of the fundamental elements of management policy. Eilon [1] has emphasized the close relation between product development and production planning and control.

2.2 PRODUCT STRATEGIES

What is the product strategy of an organization, and how does it affect the design of the product? Surveys in industry, by use of questionnaires and interaction with executives of manufacturing firms, have revealed that there is no such common policy for all organizations.

2.2.1 Pricing Strategy for Product

As an example of pricing strategy, one large chain of departmental stores aims at offering commodities to the public at a minimum price, whatever be the quality. In fact, one may be quite sure that articles bought at this stores cannot be obtained cheaper or even at the same price elsewhere. The company bases this policy on the assumption that the type of goods it offers need not have a very long life and that, if sold cheaply enough, the volume of sales is likely to be very large, so that even a very marginal profit per unit will lead to substantial gains. This strategy is termed pricing strategy.

2.2.2 Product Quality Strategy

Other manufacturers (e.g. the aircraft industry and many precision instrument makers) define their aim as *high quality*, whatever be the cost. The Chairman of Bajaj Auto Ltd. has recently expressed that for his company, product quality is the secret of success for over the last three decades. The high quality is manifested in minimal maintenance, high reliability and ergonomic superiority of the Bajaj scooter for Indian conditions. Similarly, *LML Vespa* and *Kinetic Honda* have been able to capture substantial market share due to their superior product quality.

2.2.3 Product Luxuriousness Strategy

In some cases, luxury and comfort are the prime considerations that cost becomes secondary, e.g.

Rolls Royce. However, in others, precision and prestige play an important part, for instance, Mercedes, BMW and Toyota. The manufacturers of these automobiles produce luxurious models (of course, Toyota has several popular models besides the luxury models), but the number produced is not very large, and in spite of the high price of the finished product, the firm cannot expect to get high profits from this line of production alone.

2.2.4 Product Utility Strategy

Other automobile firms like Monto aim at large volume production of a low-priced car that will compete with more expensive models (Esteem) by having some of their successful and popular features and innovations. Most companies, however, say they aim at striking a satisfactory balance between very high quality and a reasonable price. Others go further and try to improve this balance in favour of the customer, by improving quality and leaving the price unchanged or by improving production methods and offering the same quality at a reduced price.

2.3 TIME TO MARKET

The importance of product development and design for long-range planning by management is further emphasized by the amount of time that elapses from the inception of the idea for the new design until production starts. Some surveys in industry, reported by Eilon [1] revealed remarkable figures for this "incubation" period or time to market:

Survey by Eilon reported time to market as

Automobile bodies	2 years
Automobile engines	4-7 years
Radios and television sets	6-12 months
Specialized welding equipment	6 months
Telecommunications equipment	4 years
Aircraft	10-15 years
Household equipment	2 years
Metal-cutting equipment	4-5 years
Shipbuilding (depending on size of vessels;	6-12 months
Special shipbuilding design may be developed over several years)	
Fashion	Several weeks

In defence projects, where development and design take somewhat long time, because of the complexity of the problems involved, some design may become "obsolete" even before their production has begun, as new models are being developed at the Computer Aided Design workstations and in the testing laboratories by competitors at a very fast rate.

2.4 ANALYSIS OF THE PRODUCT

Many factors have to be analyzed in relation to development and design factors which vary in character and complexity, and factors related to different fields in production and industrial engineering. Some of these may be grouped as follows:

1. Marketing aspect
2. Product characteristics
 - (a) Functional aspect
 - (b) Operational aspect
 - (c) Durability and dependability aspects
 - (d) Aesthetic aspect
3. Economic analysis
 - (a) Profit consideration
 - (b) Effect of standardization, simplification and specialization
 - (c) Break-even analysis
4. Production aspects.

Aspects 3 and 4, i.e. Production aspects and Economic analysis are considered in Chapters 6 and 10, respectively in the book.

All these factors are interrelated and each presents many issues that have to be carefully considered, as indicated by Fig. 2.1. Market research may guide product designers in their work to improve existing products or to develop new ones. The design and its characteristics have to undergo an economic analysis and must be researched in the light of available production facilities and techniques. A costing analysis is naturally dependent on the sales volume; hence the proposed design has to be re-evaluated by market research so that a sales projection can be done. This expected sales volume provides the basis for a further study from the production methods aspect, and the economic analysis has to be rechecked and perhaps modified. Thus product development and design is an excellent example of interdependence of a multitude of factors that have to be unified and integrated into a final composition.

2.4.1 Product and Market

First, it is necessary to establish that the proposed product will fulfill a demand in the market, what it is supposed to do, and the services it can offer are both desirable and acceptable. If no consumption is expected, it is futile to go ahead with product design.

The demand for the product in the market may already exist, and its volume can then be assessed by market research and sales figures for similar products. Demand can also be created with the introduction of a new product, either by filling in a gap in the market or by offering new attributes, such as novelty, form and shape, or some other specific quality. The volume of such a demand is more difficult to forecast. Market research is a useful tool in these cases, but experience and sound judgement are required to evaluate and apply the results of such research, and in some cases a certain amount of speculation cannot be avoided.

The volume of demand is a function of several factors, such as trends, cyclic effects, seasonal effects etc., some of which are closely related to local conditions and are sometimes difficult to define or measure. It is therefore essential for an enterprise to keep in touch with the market and "feel" its trends, especially when this market is remote and different in character from the local one. This is of particular importance to firms depending on export trade for the distribution of their products.

to potential customers, the management opts for an advertising campaign, the policy of which is dependent on the characteristics of the "compromise design" and on how far it conforms to, or differs from, the expressed desires of the market to which such a campaign is directed. Generally, the main objective of advertising is to expand the market, this being achieved by

1. providing general information about the existence of the product,
2. providing technical information about its functional characteristics or utility;
3. drawing the customer's attention to those attributes of the product which he wants,
4. winning the undecided customer by exhibiting possible attractions (such as colour, design, novelty and price) that may persuade him to prefer the product to the one offered by competitors,
5. creating demand among a passive population of customers, and
6. educating the customer, or telling him what he should want.

2.4.2 The Product Characteristics

The various relationships in design have already been illustrated in Fig. 2.1. Now it can be seen how market research starts driving the 'design-production-consumption' cycle. Needs analysis generates functional requirement which in turn generates specification for product development. Apart from the functional aspects, other aspects, termed *standards of performance*, e.g. cost durability, dependability, and ergonomics, are essential inputs to product development. Production design which considers incorporation of production into the design is another important aspect of design and development. Aesthetics or considerations of product appearance usually enter product design at a later stage rather than at the development stage. After the product design is complete, the subsequent steps are prototype production and later on, batch or mass production. The next step involves the actual selling of the product to the appropriate market. From the market, the feedback loop too needs analysis is complete.

(I) Functional aspect. When the marketing possibilities have been explored, the functional scope of the product has to be carefully analyzed and properly defined. Sometimes, functional aspects are multiple, and usage of the product can be left to the customer's choice. A steam iron is a case in point. The additional function of dampening the cloth when required, prior to or during ironing, is incorporated in the steam iron, the main functions of which is to iron the cloth. The customer can decide whether and when to exploit this characteristic of the apparatus.

There is a trend to offer functional versatility of the product, thereby increasing the range of applications and sometimes combining several tools in one. A mixer, for example, allows for a large number of attachments to be added for a variety of duties. It is labelled as a "kitchen machine" to enhance its positioning. Basically, the mixer housing contains a power unit and a speed regulator, but it has to be so designed as to serve all the attachments, and the customer has to decide and define for himself the functional scope to be compatible with his needs, his taste and his pocket. Again, household power-tool sets are designed on very much the same principle: The hand drill such as Wolf Cubmaster is the basic unit, and with attachments it can become a table drill, a lathe, a grinder, etc. Versatility of production machinery may quite often result in substantial savings in production shopfloor space and capital expenditure, and this may become one of the fundamental factors affecting design policy. Another example of versatility in design is seen in multifunctional modular office furniture designed by furniture designers.

(II) Operational aspect (Ergonomic considerations). After determining the functional aspect, the operational aspect has to be considered. Not only must the product function properly, it must be easy to handle and easy to operate. Sometimes it has to be adaptable to various operational conditions, and very often it is subjected to varying degrees of skill of potential operators. The designer's problem becomes all the more critical with the rising trend for increased versatility because this characteristic implies using basic attachments as elements for building suitable combinations for specific purposes. This requires a certain amount of operator intelligence and skill, which increases with the complexity of the machine. The scarcity of skill is a constraint in this respect on the product designer.

The "start" stage before the proper operation and the "cleanup" time (including cleaning) should be carefully analyzed with respect to the expected skill of the operator. Too often, one finds highly efficient gadgets (e.g. in the field of household equipment) that are capable of performing an operation in a fraction of the time normally required but which involve such complicated preparations or such lengthy cleaning and "put away" subsequent operations, that the ratio of net machine time to overall machine time becomes too insignificant. The beneficial features attributed to the gadget in such cases are rather debatable.

Versatility of equipment should also be analyzed in the case of multiple chucks which should be a 'quick change chuck'. Especially, when subsequent operations are to be carried out with the aid of different attachments, the designer should always bear in mind the time required for an operator to perform the changeover and should ensure that the changeover time is in reasonable proportion to the operation time.

(III) Ease of maintenance and durability. These are two factors closely related to the selection of materials and class of workmanship and hence to the design of the product and the economical analysis of its cost. Quality is not always a simple characteristic to define, but durability and dependability are two factors that often determine quality and have to be carefully considered by the designer. Durability is defined mainly by the length of the service life or endurance of the product under given working conditions, but a measure of the product capability to idle or withstand storage is also often considered in assessing durability. Selection of good materials alone does not guarantee the durability of a product. The actual service life of a match or a rocket motor may be rather limited, but that does not mean that materials for these articles may be of low quality. An additional criterion, therefore, has to be considered, that of reliability, or the capability of the product to do its job. In the case of matches, for instance, reliability may be related to the number of sticks in a box, and while the manufacturer is eager to reduce this number to a minimum, he need not choose the very best raw materials to ensure that not even one match will fail. Dependability of rocket motors, however, may be more rigidly defined, and quality materials are chosen in spite of the short active life envisaged for them in some applications. The standard of performance and specifications of different products should be assessed with caution.

Another aspect of durability is that of *maintenance and repair*. The amount of repair and preventive maintenance required for some products is closely related to quality and design policy. This is of particular importance when the equipment is supposed to operate continuously and when any repair involves a loss of running time.

(IV) Aesthetic aspect. In what way does the appearance of a product affect its design? In most cases where the functional scope, durability and dependability have already been defined,

the aesthetics aspect is mainly concerned with moulding the final shape around the basic skeleton. This moulding of shape may very often be severely limited in scope, and what finally emerges is sometimes termed a *functional shape*. The view that functional shape is necessarily divorced from aesthetics is well illustrated by bridges, locomotives, or machines of the late 19th or early 20th century.

However, a study of the gradual changes in shape of these objects in the past few decades should convince us that there has been an increasing recognition of the role of aesthetics in design. This is perhaps partly due to man's aesthetic taste being reconciled to accepting these objects as an integral part of the landscape or everyday life, thereby leading to a modification of the original attitude that these freaks are hopelessly ugly and should be discarded.

Functional shape is a concept in its own right among designers. Those who believe in functional shape argue that compatibility of function with shape is logical and should therefore be accentuated and exploited, rather than covered up. A standard lamp is first and foremost a lamp and not a butterfly, and there is nothing wrong with its looking like a lamp. This approach is illustrated in Fig. 2.1. In this approach, the aesthetic aspects are examined at the design stage, after all the other aspects of the proposed product have been analyzed.

In some cases, however, plastic moulding of shape may have financial implications; for instance, when special materials have to be used or added to those basically required from the functional point of view or when additional processes are involved. Such cases will require careful cost analysis of the aesthetic aspects. In some cases, aesthetics is the governing factor in design and completely dominates it. This is especially true for many consumer goods or fashion goods. In the case of these goods, both variety and rate of design change are very high. Arthur D. Little Inc., USA classify such products as *turbulent products*.

Whereas styling is a dominant factor in product design, it is often used as a means to create demand. In such products, appearance is the sole reason for purchase of the product. Changes in fashion and taste, evolution of form, and the introduction of new ideas quickly replace previous designs. If the market is turbulent and eager to discard outdated designs in favour of new ones, styling becomes a race against time, a race that determines the salability of the product. Eilon [1] recommends the following techniques to enhance aesthetic appeal in product design:

1. *Use of special materials, either for the parts of the housing or as additional decorations.* Notable is the use of chromium strips, plastics, wood, glass and fabrics for the purpose.
2. *Use of colour, either natural colour of the material or colour provided by paints, platings, spraying, or even lighting.* Composition and contrast of colours is of great importance to the industrial designer in creating a design with convenient operational and aesthetic characteristics.
3. *Texture supplements colour, either by appropriate treatment of the given surfaces or coatings.* Surface finish and requirements of brightness as determined by styling may in turn affect the production processes in the finishing stages. Matt finish, mirror finish, and mottled finish are examples of surface finish varieties which are in vogue.
4. *Shape denoted by outer contours and similarity to familiar objects.* Shape can be exploited to accentuate particular features, to create a sense of spaciousness or illusions of size, richness and dependability.
5. *Use of line to break the form.* It is also used for the purpose of emphasizing parts of it, or to give a sense of continuity, graciousness and attainability.
6. *Scaling the product, either to a blown-up size or to a small size (modelling).* This creates