

BRITISH STANDARD

**Design management systems –
Part 2: Guide to
managing the design of
manufactured products**

ICS 03.100.99



NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© BSI 2008

ISBN 978 0 580 58521 0

The following BSI references relate to the work on this standard:

Committee reference MS/4

Draft for comment 07/30163146 DC

Publication history

First published March 1997

Second edition, March 2008

Amendments issued since publication

Amd. no.	Date	Text affected
-----------------	-------------	----------------------

Contents

Foreword *iii*

Introduction *1*

- 1** Scope *3*
- 2** Normative references *4*
- 3** Terms and definitions *4*
- 4** Managing the design of manufactured products at organizational level *7*
 - 4.1** Taking organizational responsibility for design *7*
 - 4.2** Organizational design philosophy, objectives and strategy *12*
 - 4.3** Providing investment *13*
 - 4.4** Putting infrastructure in place *17*
 - 4.5** Market positioning *20*
 - 4.6** Promoting and selling products *22*
 - 4.7** Planning and communication *24*
 - 4.8** Audit and evaluation *25*
- 5** Managing the design of manufactured products at the project level *27*
 - 5.1** Establishing the design process *27*
 - 5.2** Managing product design projects *29*
 - 5.3** The “new product identification” phase *36*
 - 5.4** The “product definition” phase *41*
 - 5.5** The “design and development” phase *46*
 - 5.6** The “manufacturing” phase *49*
 - 5.7** The “support and termination” phase *52*
 - 5.8** The “verification and validation” phases *54*
 - 5.9** The “evaluation and continual improvement” phases *56*

Bibliography *60*

List of figures

- Figure 1 – Checklist of key actions for senior executives/principals *2*
- Figure 2 – Checklist of key actions for managers responsible for design projects *3*
- Figure 3 – Organizational elements of responsibility for product development *8*
- Figure 4 – Table of roles and responsibilities *9*
- Figure 5 – Checklist of design management responsibilities at organizational level *11*
- Figure 6 – Profile of cash flow during project lifecycle *14*
- Figure 7 – Financial commitments during product design, development, manufacture and support *15*
- Figure 8 – Risk v potential *18*
- Figure 9 – The design process at project level *27*
- Figure 10 – Balancing the key project drivers *28*
- Figure 11 – Key tasks of design project managers *29*
- Figure 12 – The project risk management process *33*
- Figure 13 – Risk management questions *33*
- Figure 14 – Some triggers that could lead to a new design projects *37*
- Figure 15 – Checklist of factors to consider when formulating a proposal *39*
- Figure 16 – Tools that can be used when undertaking a feasibility study *40*

Figure 17 – Checklist for evaluating product requirements	42
Figure 18 – Generation of ideas over time during brainstorming sessions	43
Figure 19 – Typical elements in a product specification	45
Figure 20 – Information contributing to the detail design	48

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 62, an inside back cover and a back cover.

Foreword

Publishing information

Presentational conventions

This part of BS 7000 is published by BSI and came into effect on 31 March 2008. It was prepared by Technical Committee MS/4, *Design management systems*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7000-2:1997, which is withdrawn.

Relationship with other publications

BS 7000 *Design management systems*, consists of the following parts:

- *Part 1: Guide to managing innovation;*
- *Part 2: Guide to managing the design of manufactured products;*
- *Part 3: Guide to managing service design;*
- *Part 4: Guide to managing design in construction;*
- *Part 6: Managing inclusive design – Guide;*
- *Part 10: Vocabulary of terms used in design management.*

Other parts may be added.

Information about this document

BS 7000-2 is intended for use by those operating in the consumer and industrial product sectors of industry. It has been updated to take account of advances in product development since its last publication in 1997.

Users are advised to consider the guidance given in the BS 7000 series when devising or enhancing design management systems that are required to conform to any of the following standards: BS EN ISO 9001, BS ISO/IEC TR 10000 and BS EN ISO 14001, as well as BS 6079 and BS 7373.

Users are also invited to submit technical comments, observations and suggestions to the technical committee MS/4 secretary at BSI (see address on back cover). This will assist the committee when it reviews the standard in due course and when it considers additional parts to the series.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

Creating and delivering excellent products with market appeal and high levels of customer satisfaction requires an integrated approach to design, from the board of an organization to project managers and their multi-disciplinary teams.

Excellence in design is an important differentiating factor between competing products, and can be the key to company survival in increasingly competitive world markets.

The complex intellectual challenges presented in product design demand that the process is managed effectively if the outcome is to be successful. The concepts, principles and quality system elements described in this standard are applicable to all forms of manufactured products. Applying the principles described will facilitate the creation of products that are produced on time and within budget, meet customer and organizational requirements, and have a better chance of competing successfully in world markets.

This standard sets out the tasks and responsibilities for creating and implementing an effective design policy for:

- a) senior executives (see Clause 4);
- b) project managers and those involved in the design process (see Clause 5).

Figure 1 and Figure 2 provide a summary of key issues for each of these management levels.

In large organizations, these tasks and responsibilities are usually taken on by different individuals or groups. In small organizations, they are often undertaken by a single person but are, nevertheless, distinct and different. All those involved need to be aware of what is required of them. It is therefore recommended that they understand the full content of this standard and pay particular attention to the clauses that are directly relevant to their particular role.

Figure 1 Checklist of key actions for senior executives/principals

Design should be formally directed on a strategically planned basis; the following is a summary list of key actions:

- a) reinforce the strategic importance of design by addressing design management issues regularly at top executive meetings;
- b) specify and periodically update the organization's design objectives and strategies that facilitate the fulfilment of the organization's goals;
- c) formulate the organization's design philosophy and promote it enthusiastically;
- d) establish a design programme and control, review and update it at appropriate intervals to maintain its relevance to the fulfilment of the organization's objectives;
- e) ensure that the design programme complements, enhances and is compatible with the other major plans of the organization;
- f) understand the risks, and take steps to mitigate their effects;
- g) determine the return on investment on all resources committed to design (not just capital);
- h) plan to provide the necessary finance and other resources to enable the organization's design programme to be implemented effectively;
- i) assign design responsibilities to competent and qualified executives, then motivate them to acknowledge these responsibilities and their ability to perform to specification;
- j) communicate the organization's design objectives, strategies and programmes to all involved, and ensure that there is a common understanding of their substance and implications;
- k) introduce and reinforce an appropriate design management system and infrastructure to sustain design work to the required standard, ensuring that it is integrated with other disciplines;
- l) monitor and control expenditures against plans and time, and record achievements;
- m) use the most appropriate skills available and bring others up to the required standard of performance through design awareness and training in design management skills;
- n) underpin the importance of design as a strategic resource by maintaining a genuine and visible commitment to it.

Figure 2 Checklist of key actions for managers responsible for design projects

Summary of key actions to manage design at a project level:

- a) understand customer requirements, always undertaking market research as part of the design process;

NOTE The main cause of failure of a product to gain market acceptance is that of not understanding customer requirements.

- b) make changes during the relatively low-cost early stages of the design process;
- c) consider areas for concurrent working at the start of the project and assemble a multi-disciplinary team that includes all relevant specialisms;
- d) review the design process at regular intervals against the design brief and specifications;
- e) control costs through continuous review against the budget, using techniques such as earned value analysis;
- f) control the configuration of the product from the generation of the specification through to final disposal (see BS ISO 10007 for guidance on configuration management);
- g) evaluate the project and deliverables on completion of the design activity, with a view to making improvements in the future;
- h) identify any areas for improvement in management processes during the periodic reviews, audits and final evaluation, making changes as required for the benefit of future projects;
- i) retain control over the design project at all times.

1 Scope

This standard gives guidance on managing the design of all types of manufactured products. It deals with every stage of the process from product concept through to delivery, use and ultimate disposal.

NOTE 1 This standard recognizes that small enterprises or those specializing in one-off products or special purpose machinery or equipment often need to adapt the process to suit their own needs and size of operation.

It addresses all levels of management, in all types of organizations involved in design.

Guidance is given on the application of general principles and techniques to the management of design, raising awareness of management issues and emphasizing the need for an integrated approach to product design. It is not the purpose of this standard to define design techniques.

NOTE 2 For many products, particularly those that are complex, an integrated multi-disciplinary approach to design is needed, preferably embodying systems engineering techniques. Guidance on systems engineering is widely available, including from ISO, IEC, ANSI and EIA standards listed in the Bibliography. Documents recommended for guidance on general management techniques are also listed in the Bibliography.

Guidance on the management of innovation, service design and construction design is given in BS 7000-1, BS 7000-3 and BS 7000-4 respectively.

NOTE 3 Guidance on procedures needed to meet statutory requirements, such as health and safety, or product certification and liability, is not intended to be comprehensive. Reference needs to be made to other documents where appropriate.

NOTE 4 This standard is intended to complement BS EN ISO 9001.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 6079-1:2002, *Project management – Part 1: Guide to project management*

BS 6079-3, *Project management – Part 3: Guide to the management of business related project risk*

BS 7000-10:2008, *Design management systems – Vocabulary of terms used in design management*

BS 7373-2:2001, *Product specifications – Part 2: Guide to identifying criteria for a product specification and to declaring product conformity*

BS EN ISO 9001:2000, *Quality management systems – Requirements*

BS ISO 10007, *Quality management systems – Guidelines for configuration management*

BS ISO/IEC 90003:2004, *Software engineering – Guidelines for the application of ISO 9001 to computer software*

3 Terms and definitions

For the purposes of this part of BS 7000, the definitions given in BS 7000-10 and the following apply.

3.1 analogy

aid to creativity that compares a concept with something that exists elsewhere

3.2 audit

systematic examination to measure conformity with predetermined requirements

3.3 chain of custody

process whereby an organization monitors its products through every stage of the supply chain, including all stages of manufacturing, transportation and distribution

3.4 combination

utilization of two or more existing design methods to reach a design solution

3.5 configuration management

co-ordinated activities to direct and control configuration

NOTE Configuration management generally concentrates on technical and organizational activities that establish and maintain control of a product and its product configuration information throughout the lifecycle of the product.

[BS ISO 10007:2003, definition **3.6**]

3.6 design control

component of a quality system that ensures the integrity of a design throughout its lifecycle

3.7 design policy

general rules relating to design discipline within an organization

NOTE Can help to guide corporate behaviour in circumstances that tend to recur, though it might not prescribe for every eventuality

3.8 design programme

specific activities and investments to be undertaken over a specified period, broken down into stages, with resources and associated timescales

3.9 design strategy

chosen path formulated to achieve business and design objectives, supported by an indication of how resources will be committed

NOTE Could relate to particular categories of design, types of project, sections of an organization and/or use of resources.

3.10 earned value analysis

determination of the monetary value of work performed in any stage of the design process through assigning a value to the achievement of project work completed and comparing this with the actual and planned costs of the project

NOTE Also known as “budgeted cost of work performed” (BCWP).

3.11 evaluation

systematic examination of the outcome of an activity to determine the extent to which specified objectives have been fulfilled

NOTE 1 Usually linked to a specific activity, e.g. system evaluation, project evaluation and design evaluation. Results are usually measured in terms of time, cost and achievement.

NOTE 2 Generally takes place at the end of an activity, but progress can be maintained by carrying out intermediate or stage evaluation, particularly where intermediate stage achievements have been planned.

3.12 general arrangement

overall scheme, usually a drawing, which shows the main components of a design

NOTE Also known as “design layout”.

3.13 inversion

aid to creativity that considers the idea inside out or upside down

3.14 product specification

reference specifying the features, characteristics and properties of a product, giving all the information that is required to create it

NOTE Sometimes referred to as a technical specification or brief.

3.15 risk management

process whereby decisions are made to eliminate, mitigate or accept a known risk or hazard

3.16 specification

reference stating requirements that a product has to fulfil

NOTE 1 A qualifier should be used to indicate the type of specification, such as product specification, test specification, etc.

NOTE 2 Normally includes or mentions drawings, patterns and other references and indicates the means and criteria for checking conformity.

3.17 technical file

product technical information collated to satisfy the documentation requirements of European Directives applicable to the product (e.g. CE Marking)

NOTE May comprise specifications, drawings, items lists, design descriptions, risk assessments, test reports, copies of instructions for installation, use and maintenance (this is not an exhaustive list).

3.18 test plan

plan outlining the test work to be undertaken to ensure that the performance requirements of the eventual product can be achieved

3.19 validation

confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

NOTE 1 In design and development, validation concerns the process of determining a product's suitability and conformity with user needs.

NOTE 2 Validation is normally performed on the final product under defined operating conditions. It may be necessary in earlier stages.

NOTE 3 The term "validated" is used to designate the corresponding status.

NOTE 4 Multiple validations may be carried out if there are different intended uses.

3.20 validation protocol

statement of the method by which validation will be carried out, typically comprising a list of each product specification element, and for each a description of the nature of the validation

NOTE Could be an inspection, test or review.

3.21 validation report

written report describing the results and outcome of conducting validation

3.22 value chain

all factors and activities undertaken by, or on behalf of, an organization that contribute to the value of its products as perceived by customers and users, from first conception through to final disposal and recycling

3.23 verification

confirmation, through the provision of objective evidence, that the specified requirements have been fulfilled

NOTE 1 The term “verified” is used to designate the corresponding status

NOTE 2 Confirmation can comprise such activities as:

- *performing alternative calculations;*
- *comparing a new design specification with a similar proven design specification;*
- *undertaking tests and demonstrations;*
- *reviewing documents prior to issue.*

4 Managing the design of manufactured products at organizational level

4.1 Taking organizational responsibility for design

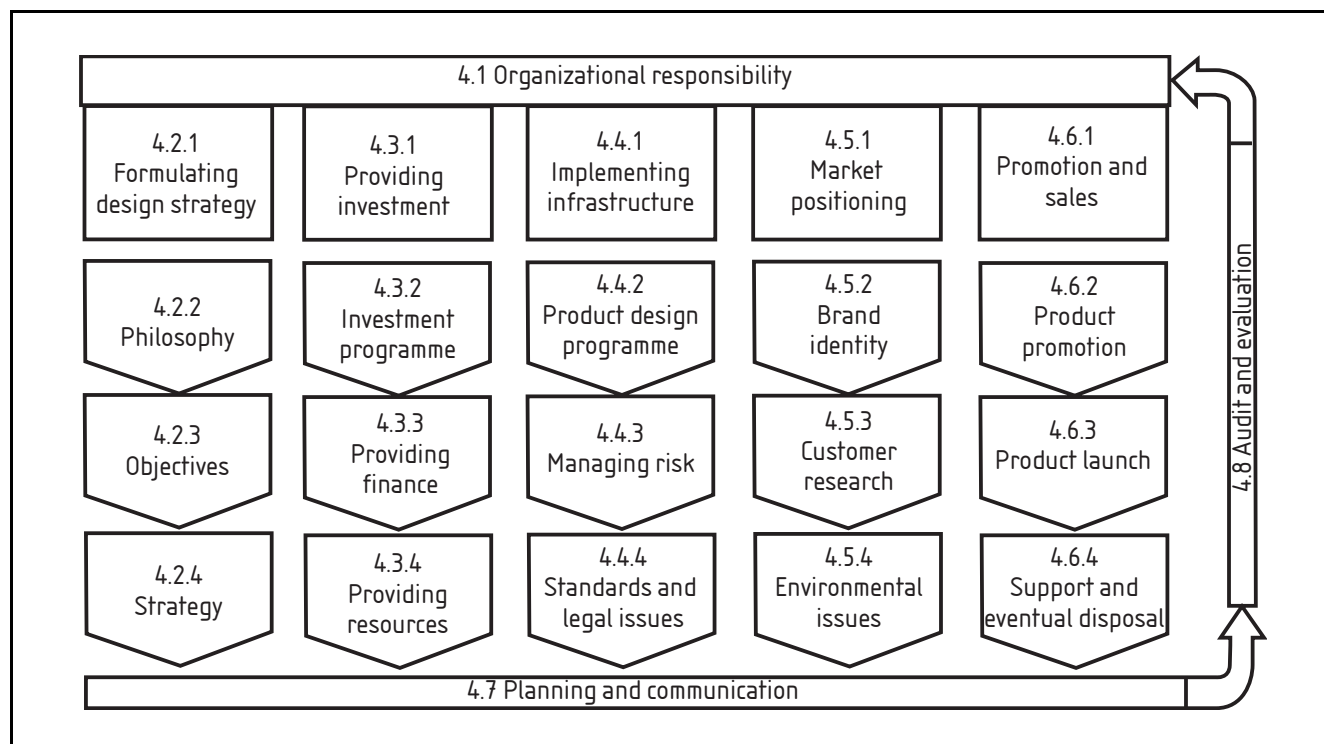
This clause addresses the management of design from the perspective of the organization as a whole. It focuses on the direction and guidance that those involved in undertaking or administering design activities are entitled to expect from board directors and principals. In small organizations, this guidance should come from owner-managers and partners.

NOTE For the sake of brevity in the following text, the term “principals” is used to denote these individuals.

Typical areas of organizational responsibility for design are shown in Figure 3. This is intended to illustrate the context of corporate design management and the interrelationship of the topics (in each column) that are covered later in this clause.

It does not imply these elements should necessarily be tackled in the sequence shown, and iteration may be necessary. A corresponding model for design management at project level is given in Clause 5.

Figure 3 **Organizational elements of responsibility for product development**



Ultimate responsibility for the excellence of designs produced by, or on behalf of, an organization, rests with the board of directors, owner-managers or partners.

It is the board's collective responsibility to ensure that the organization has a clear sense of direction with respect to design, so that all contributions may be harnessed to their full potential. It is the chief executive's responsibility to ensure that this direction is followed effectively and that design makes a full contribution to the organization's performance. Chief executives may assign day-to-day executive responsibility for design to other members of the board or executives in the management hierarchy who report directly to them. A chief executive's design committee, or design policy group, may be established to oversee the management of design at the organizational level. Figure 4 gives an example of how design project responsibilities may be shared between different senior staff.

Figure 4 Table of roles and responsibilities

Job function	Project manager	Financial director	Marketing director	Production director	Design director	Sales manager	Service managers	Agents	Customers, etc.
Stage in the process	Write the names (or number of people) who should be involved at each stage of the process								
Design concept									
Outline design									
Detail design									
Prototype construction and test									
Provision for manufacture, delivery, erection and commissioning									
Product launch									
Selling									
Monitoring									
Evaluation									
Decommissioning									
Disposal									

Principals should demonstrate their understanding of responsibilities for and commitment to design through their statements and actions. In particular they should ensure that competent and committed teams are brought together to address design requirements. Design responsibilities should be clearly articulated and communicated to colleagues throughout the organization. Executives and staff should be given guidelines within which to operate. They should know who to turn to for guidance, authorization to proceed with a particular design idea or project, or other design-related decisions.

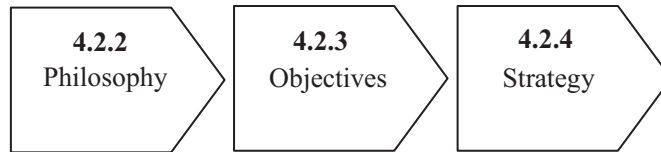
It is also vital that all executives who have design responsibilities, or otherwise get involved in design activities, should have these responsibilities and activities stated in their contract of employment. These factors should be reviewed periodically.

Organizations develop their competence in design management over time. Figure 5 provides a checklist of design management responsibilities.

Figure 5 Checklist of design management responsibilities at organizational level

- a) Establish clear ownership of design responsibility.
- b) Provide a vision of the future with clear objectives.
- c) Demonstrate genuine and visible commitment to effective design.
- d) Show awareness of customers' interests and needs.
- e) Formulate the organization's design strategy and policy.
- f) Establish and maintain the organization's design standards and guidelines.
- g) Provide organizational systems.
- h) Encourage an understanding of the environmental dimension of design.
- i) Ensure there is an understanding of the legal requirements of design.
- j) Establish the organization's design team.
- k) Provide for training in design management skills.
- l) Motivate staff involved.
- m) Harness appropriate technologies.
- n) Promote awareness of competitors and their external activities and innovations.
- o) Assess opportunities and risks attached to investments in design.
- p) Fund design activities.
- q) Provide adequate resources (personnel, equipment, information and facilities).
- r) Understand organizational capabilities and limitations.
- s) Ensure production capabilities and requirements and their consequent effects on design are understood.
- t) Demonstrate a commitment to quality and reliability.
- u) Audit the organization's design and design management practices.
- v) Understand the impact of design on corporate identity.
- w) Evaluate the contribution of design to corporate performance.
- x) Nurture an environment that encourages innovation and creativity.
- y) Address corporate social responsibility issues.

4.2 Organizational design philosophy, objectives and strategy



4.2.1 General

Given the strategic significance of design in the development of new products and services, design should be given serious consideration at board level. Using design as a tactical tool on an ad hoc basis, or in an unstructured way, severely limits its contribution to the success of the organization.

Organizational design philosophy, objectives and strategy together define the boundaries of what is acceptable to the organization in terms of design activities and investments

4.2.2 Organizational design philosophy

Consideration should be given to establishing the organization's design philosophy. This will include the organization's general stance towards design, the basic reasons for design discipline and its contribution to the organization's performance.

4.2.3 Setting the organization's design objectives

The organization's objectives should provide the foundation and motivation for all activities, including design.

Principals should formulate corporate objectives in a precise and, whenever possible, quantifiable manner. These objectives should be documented at the organizational level and cited in operating and departmental plans.

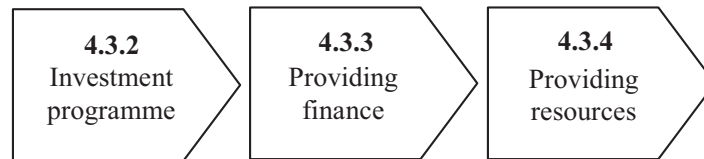
Principals may also wish to publicize and explain their aims in communications such as annual reports, briefings to financial institutions, and staff training programmes.

4.2.4 Formulating the organization's design strategy

The organization's design strategy should be drawn up as a prescription of approaches to be taken and how resources will be harnessed to achieve the objectives.

Where appropriate, these can be developed into short- to medium-term design activities and longer-term investments in design that are reviewed before being sanctioned for implementation.

4.3 Providing investment



4.3.1 General

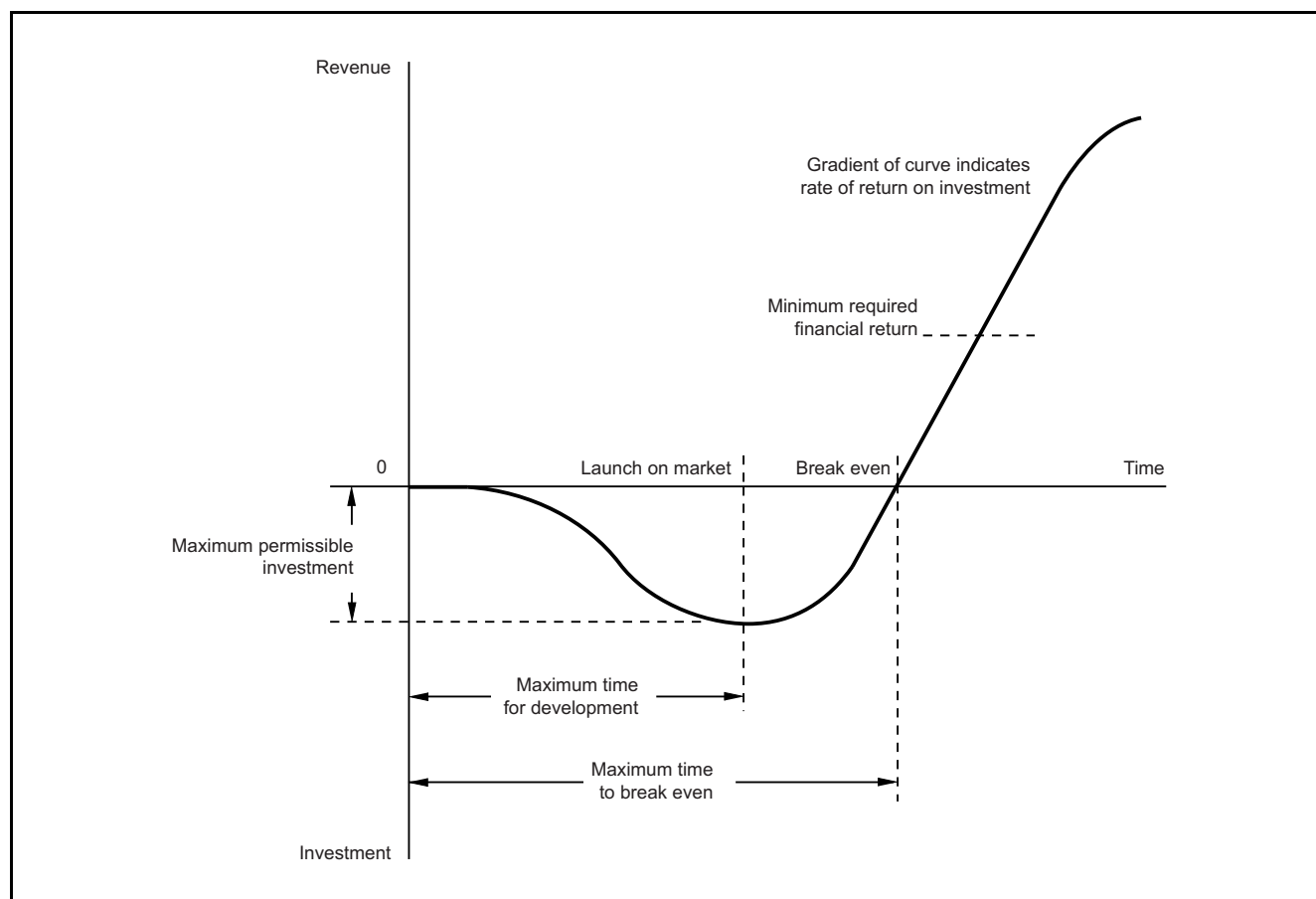
Products and associated services are the lifeblood of an organization. Skimping on investment in new product development is likely to jeopardize future competitiveness and profitability. Principals should ensure that appropriate resources are made available when required to undertake the research, design and development work, as well as the associated training needed. Continuity of adequate resources is essential to raise performance, and to sustain excellence over time.

4.3.2 Formulating the organization's investment programme

The financing of product design activities should be written into the organization's business plan. The achievement of excellence in design requires funds to be allocated from clearly identified budgets well in advance to cover the approved project plans. The investment requirements and cash flow implications of design activities should be forecast (see Figure 6) and set out in the organization's design programme.

This programme should set out all areas of design activity, the outcomes sought and the contribution to the attainment of the organization's objectives. The programme should also summarize design briefs and specifications, with the planned work broken down into stages. Skills and other resources to be committed and outputs to be generated at each stage should be specified, together with associated timescales.

Figure 6 Profile of cash flow during project lifecycle



An easily-comprehensible system of budgeting, with approved benchmarks on typical expenditure for different elements of work as well as the fair allocation of overheads, should facilitate financial planning for, and costing of, new or improved products.

Among the details that may be specified in the financial plans are:

- a) cash flow forecasts;
- b) sales forecasts;
- c) gross profit forecasts;
- d) nett profit forecasts;
- e) payback periods;
- f) returns on investment;
- g) rating of risks involved;
- h) maximum project budgets;
- i) other budgetary constraints;
- j) monitoring of expenditure;
- k) revision of allocated budgets where necessary;
- l) contingency planning.

Principals should ensure that funds allocated to product design and development are spent as intended and not withheld or diverted unless there are overriding reasons. These should be clearly stated and carefully checked. If funds have to be reallocated, the impact upon the project and the overall design programme should be taken into consideration and the plans revised as necessary.

4.3.3 Providing finance

A balance should be established between funding activities from sources such as departmental budgets, and organizational funding.

Principals should make clear those projects that will be sustained entirely from corporate funds, those that will be financed entirely from departmental budgets, and those where different parts of an organization will be expected to contribute a proportion of the budget. These should be agreed in advance.

The required funding may be split between capital and revenue accounts. Capital allocations should be made for anticipated changes in facilities and equipment to take advantage of enhancements in technology and systems.

Figure 7 illustrates financial commitment incurred during design, development and manufacture.

An easily comprehensible system of budgeting, with approved benchmarks on typical expenditure for different elements of work as well as the fair allocation of overheads, should facilitate financial planning for and costing of new or improved products.

Figure 7 **Financial commitments during product design, development, manufacture and support**

