British Standard

BRITISH STANDARD

BS 7000 :
Part 4 : 1996

Design management systems

Part 4. Guide to managing design in construction

STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee MS/4, Design management systems, upon which the following bodies were represented:

Association of Consulting Engineers
Association of Project Managers
BEAMA Ltd.
British Photographic Association
British Standards Society
Cambridge University
Chartered Society of Designers
Consumers' Association
Defence Manufacturers' Association
Design Council
Department of Trade and Industry (Enterprise Initiative Division)
Electricity Association
Federation of Small Businesses
Health and Safety Executive
Institute of Quality Assurance
Institution of Civil Engineers
Institution of Electrical Engineers
Institution of Engineering Designers
Institution of Mechanical Engineers
Ministry of Defence
Royal Institute of British Architects
University of Leeds
University of Westminster
Coopted members

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Contents

Foreword

In October 1993, BS 7000 *Guide to managing product design* was renumbered BS 7000 : Part 1 to accommodate further Parts. It is intended that BS 7000 *Design management systems*, will comprise initially the following Parts.

Part 1: *Guide to managing product design*
Part 2: *Guide to managing the design of manufactured products*[1)]
Part 3: *Guide to managing service design*
Part 4: *Guide to managing design in construction*
Part 10: *Glossary of terms used in design management*

Other parts may be added.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

[1)] In preparation.

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Introduction

This Part of BS 7000 gives guidance on managing the design process within the construction industry. This design process should enable sufficient information to be produced to satisfy client requirements.

The client may be a user, owner occupier, investor or contractor.

A basic design process should be followed irrespective of the method of design or construction procurement, although the method selected will affect the divisions of responsibility and the form of communication network required.

Three aspects of design procurement are common to all methods of procurement as follows.

1) A clientele having an ongoing need for construction work involving an element of design; this leads to the setting up of a project management structure within which design management operates.

2) A design capability, established by the construction industry, that is distributed among many organizations in the form of managed design facilities.

3) The design content of a project that has been created by a client and defined in an agreed brief.

A design team is selected from the available design facilities that has the ability to satisfy both the technical and design management needs of the project.

The clientele and the design capability are permanent features of the construction industry, whereas the execution of a particular design project is transitory. The relationship between the client and the construction industry is shown in figure 1.

These three aspects of design procurement are covered in sections **2**, **3** and **4** respectively.

An hierarchy of management functional titles has been defined in **1.3**. These titles have been chosen as representing the functions identified in this standard and may not correspond with terms used for equivalent functions in any particular organization.

The relationship between the principal management functions, shown in figure 2, is as follows.

a) The design team leader is part of the project management structure and provides the primary link between project management and design management.

b) The design team leader is responsible for co-ordinating the work of a design team that consists of one or more design units with the capacity to cover the scope of the project. The composition of this design team may vary during the project and may be supplemented by specialists.

c) Each design unit should be formed from resources under the control of the design facility manager. A design unit should be supervised by a design unit leader.

For large projects such divisions of managerial responsibility may be apparent, but as projects reduce in size the distribution of responsibilities and functions simplifies to the point where all project and design management may be the responsibility of one person. Such simplification should not be allowed to obscure the range of management functions being undertaken and the managerial skills involved.

NOTE. The Construction (Design and Management) Regulations : 1994 [1] require the client to appoint a planning supervisor. These regulations place statutory duties on clients, designers and constructors to plan, co-ordinate and manage health and safety aspects throughout all stages of the construction project.

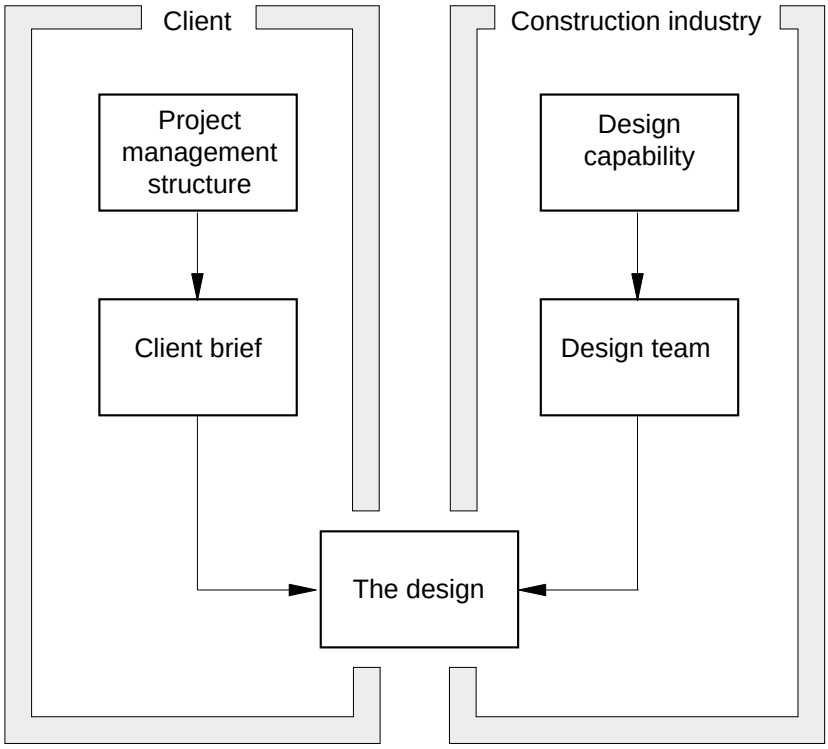

Figure 1. Organization of the design element of a construction project

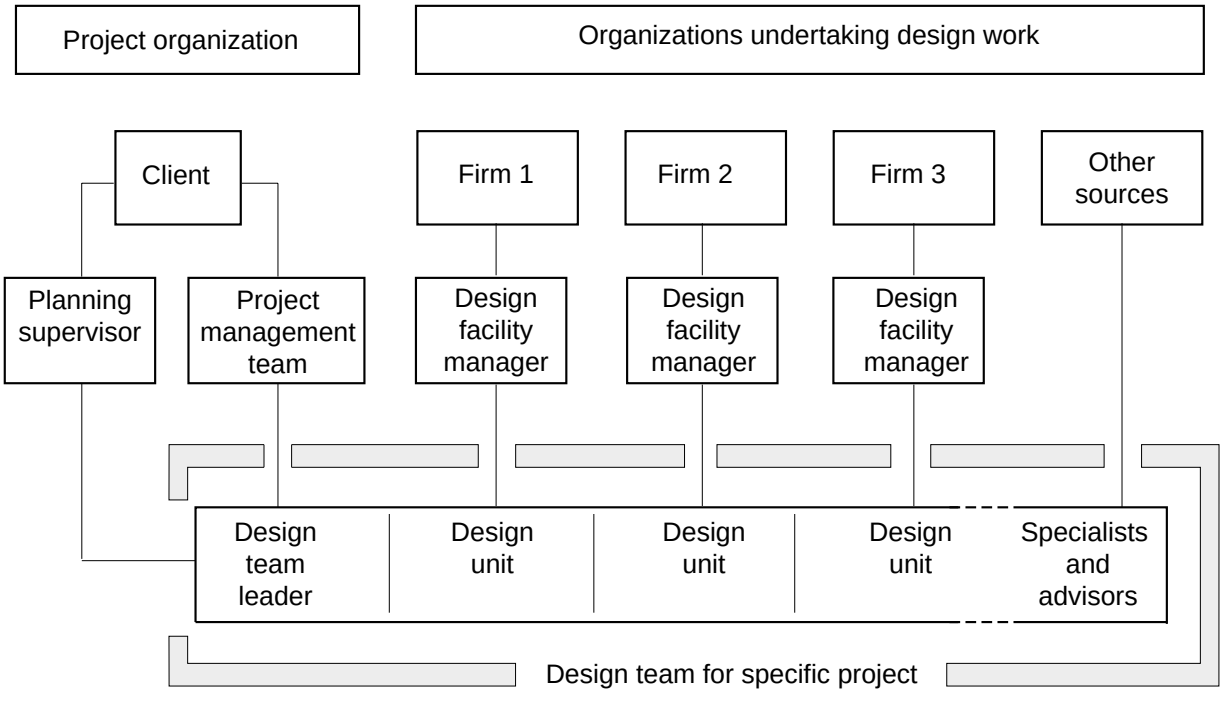

Figure 2. Design team organization

Section 1. General

1.1 Scope

This Part of BS 7000 gives guidance on management of the construction design process at all levels, for all organizations and for all types of construction projects. It is intended for those who work in, or interact with, the construction industry. Where general management principles are given, they may be adapted to suit any size of design organization or construction project.

The guidance given covers the management of design activities throughout the life-cycle of a construction project, from the point when the client initiates a project. It does not include any actions taken by the client in reaching a decision to initiate the project, or the factors considered by the client when selecting the most appropriate form of construction procurement.

The management process described in this Part of BS 7000 relates exclusively to purpose-built constructions, equipment and components and is intended to relate to catalogue items and services only in regard to their selection or adaptation to suit a particular purpose.

NOTE 1. Guidance on the design of manufactured products and services is given in BS 7000 : Part 2 and BS 7000 : Part 3 respectively.

NOTE 2. This Part of BS 7000 complements BS EN ISO 9001 : 1994, to which reference should be made.

1.2 References

1.2.1 Normative references

This Part of BS 7000 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to, or revisions of the cited publication apply to this Part of BS 7000 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This Part of BS 7000 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this Part of BS 7000, the definitions given in BS 7000 : Part 10 : 1995 and BS 4778 : 1991 apply together with the following.

1.3.1 acceptance criteria

The factors used to determine whether or not a design meets the stated and agreed requirements.

1.3.2 initial brief

A preliminary statement of the client's requirements.

1.3.3 project brief

A statement covering technical and managerial intentions derived from, and meeting the requirements of, the initial brief.

1.3.4 design brief (in construction)

A document, derived from and compatible with the project brief, that defines all design requirements. It may be sub-divided to identify the requirements relevant to each design unit and specialist.

1.3.5 consolidated brief

The brief resulting from the brief development process that will be used as the basis for detailed design.

1.3.6 design facility

The resources, equipment, procedures, management infrastructure and accommodation providing the capability to undertake design commissions.

1.3.7 design package

The documentation and associated material compiled in the course of a design process.

NOTE. The design package should be assembled and delivered in a form suitable for a defined purpose or identified recipient.

1.3.8 design process

All the activities necessary to convert design input into design output.

1.3.9 design team

The total capability required to undertake a design, comprising an appropriate mix of design units and specialists under the direction of a design team leader.

1.3.10 design team leader

A person responsible for overseeing and co-ordinating the work of the design team.

1.3.11 design unit

An individual or group of designers from one design facility appointed to fulfil some part, or the whole, of the design requirements of a particular project.

1.3.12 design unit leader

A person responsible for leading a design unit in producing such elements of design as are the responsibility of that unit.

1.3.13 planning supervisor

As defined in Clause 2 - (1) of The Construction (Design and Management) Regulations 1994 [1].

1.3.14 project

A unique process consisting of a set of co-ordinated and controlled activities, with start and finish dates, undertaken to supply a product conforming to specific requirements within the constraints of time, cost and resources.

NOTE. Within the construction industry a project encompasses the totality of the design and construction process.

1.3.15 project plan

A document setting out the specific practices, resources and sequences of activities required to meet the project objectives.

1.3.16 project team

A group responsible for executing a project, including both design and construction personnel.

Section 2. Framework for design management

2.1 General

This section is mainly concerned with the initial stages of a construction project in terms of the project brief, project plan and creation of a management structure that will affect all ongoing activities including design management.

Consideration is given to the briefing process from which a consolidated brief should be derived. Project and design management activities should be structured in the form of a plan of work. The management control features that find their counterparts in design management are also discussed.

The client should set up an advisory group to assist in determining the most appropriate design procurement process and in preparing an initial brief. This advisory group, or a similarly constituted group, should then form a project management team to execute the project.

The client may choose one of many available methods of procurement. This may result in different contractual and managerial relationships with the design team. The whole design team, or any particular design unit, may be within the client's own organization, an independent consultant or part of a contractor's organization. Regardless of the procurement method selected from the design management point of view, the most significant management function undertaken within a construction project is that of the design team leader.

2.2 Management of the design team

2.2.1 Design team features

The design team leader should contribute to the overall planning of the project and be directly responsible for planning, programming, controlling and delivering its design content. The design team leader should co-operate with the planning supervisor, liaise with other design units and ensure that effective communications and decision making systems are applied.

Detailed planning and programming will require input from design units, when appointed, which may lead to revisions of the initial estimates of design cost and time targets.

2.2.2 Design team leader's responsibilities

The design team leader's responsibilities normally include the following aspects of management:

a) establishing the design related client requirements and defining them in a project brief;

b) advising on and possibly undertaking design procurement;

c) participating in the overall development and monitoring of the design related elements of the project plan;

d) preparing the design related aspects of the plan of work;

e) formulating overall targets for the design team that are consistent with the project plan;

f) collating cost and time data from design units and establishing a consolidated programme;

g) collating contributions from the design units and establishing a consolidated brief, see **2.3** and **4.5**;

h) co-operating with the planning supervisor;

i) co-ordinating the activities of the design team;

j) monitoring and controlling progress;

k) assisting in the development of the health and safety plan;

l) establishing compatible design information interfaces and a verification strategy;

m) determining the form and content of design output.

2.3 Establishing the brief

2.3.1 Briefing process

Preparing a satisfactory brief usually requires considerable effort by both the client and the design team. It may also involve other parties, such as planning authorities and local utilities. The briefing process continues through the early design stages to a point prior to detail design, when the consolidated brief should be agreed between the client and all the contributors to the project. An important objective of producing a consolidated brief is to avoid abortive work arising from late changes.

2.3.2 Initial brief

An initial brief may range from a broad statement of intent to a comprehensive technical statement of a client's requirements. The initial brief should be analysed and resolved into a clear statement from which a more specific project brief is developed.

It is imperative that the client imparts to the design team a clear understanding of the fundamental requirements of the project, such as the following:

a) the purpose of the construction;

b) functional requirements;

c) special, innovative or unusual features;

d) health, safety and environmental constraints or requirements: for example, process hazards, close environmental control and occupant's special needs;

e) financial policy: for example, lowest first cost, lowest cost in use or lowest life cycle cost and method of funding;

f) time policy: for example, shortest overall time, time required for the lowest cost programme or a precise programme leading to an absolute finish date;

g) quality strategy: determined, for example, by expected domestic, commercial or industrial usage, exposure to vandalism and anticipated life span;

h) aesthetic considerations, for example, house style, landscaping and colour and finish preferences.

Some of these requirements may need special study, including research and risk analysis, that may be carried out by the design team or specialist advisors appointed by the client.

2.3.3 Brief development

A client's initial brief will rarely provide sufficient information for design development. Considerable resources may need to be expended by a project team in investigating a client's requirements. Research and development may be necessary to supplement initial information.

The actions that follow may include work on separate commissions that would need to be processed as projects in their own right. The additional work might include the following:

a) technical and economic feasibility study;

b) need evaluation;

c) prototype or model evaluation;

d) preliminary design;

e) site surveys (including assessing the condition of construction elements or equipment to be retained in a refurbishment project);

f) environmental impact assessments;

g) planning submissions.

A project brief should be compiled, based on these findings, that forms the starting point for the development of a design brief, see **4.5**.

NOTE. Further information on briefing can be found in *Better briefing means better buildings* [2].

2.4 Project planning

Planning the design management related aspects of a project involves identifying all significant work elements, assessing their interdependence and organizing the work so that orderly progress can be achieved. Such planning should include the following:

a) establishing the range and extent of professional contributions required to fulfil the brief and hence identify the composition of the design team;

b) identifying the need for other resources and equipment, such as secretarial support, accommodation, storage, technical information, instruments and computers and relating these to the programme;

c) establishing key dates for specific objectives and start and finish dates for identified tasks. This should enable the setting of targets against which progress may be measured;

d) establishing a project cost plan covering all relevant costs and showing when the client will be required to provide funds;

e) determining intervals for, and the form of, submissions of cost, time and achievement information for control purposes.

2.5 Plan of work

The design and construction process usually follows a sequence of activities that varies only in detail and extent for various types of project. This process may be seen as a linear function and is commonly referred to as a plan of work.

A plan of work should set out the various activities to be undertaken during the design and construction process. It should also describe the purpose of each stage of the work, the decisions to be taken and the tasks to be completed; it may give guidance on who needs to be involved in implementing each stage.

A plan of work may be prepared either from a model sequence, for example the plan of work described in the *RIBA Model plan of work* [3], or it may be derived from the list of duties set out in the relevant conditions of engagement.

A model plan of work may be adapted to accommodate particular project features that may include some overlap of stages or parallel working. This provides a project plan of work. The client should be involved in preparing the project plan of work so that client-related activities, such as decision points, are recognized. Typical plan of work stages are as follows:

a) inception and initial brief;

b) feasibility study and brief development;

c) conceptual design;

d) scheme design;

e) detail design;

f) construction information;

g) construction;

h) post-construction.

Plan of work stages in respect of elements of the project should not be started until everything in the previous stages of those elements has been finished. Completion of a stage is conditional on co-ordination of design between all team members and the approval of the design team leader and possibly the client. To anticipate approval may result in work having to be corrected at a later stage.

2.6 Programming

An outline design programme should be prepared by the design team leader, based on the key dates contained within the project programme and should subsequently be expanded to cover all aspects of resource management and decision taking.

Each design unit or specialism within the design team should have its own programme. The inter-dependence of design units needs to be established so that the compatibility of the separate programmes can be tested against each other and the requirements of the project plan.

The key dates for inputs from specialist advisors, internal and external, should be noted in the programme for each respective discipline.

Decisions to be taken by the client that affect the programme should be identified and shown on the programme.

The need for some components or items of equipment with unique features may have to be identified at an early stage. If there is a long lead time between ordering and delivery, items will need to be preselected and the client may have to place firm orders in advance of completion of the design programme. It is important to check with the supplier that preselected items will still be available at the time of ordering by the contractor.

The accuracy of the predictions included in the programme will depend upon the information available when it was prepared and the length of time being projected. The programme will need to be updated as new information becomes available and where this leads to a major change in the programme, its impact will need to be assessed by all the parties affected.

2.7 Project communications

2.7.1 General

The design team leader should contribute to the development of a project communications plan that identifies all communication channels and the procedures to be used for preparing, identifying, distributing, storing and clearing all items to be communicated. The communications plan should be incorporated in the overall project plan.

NOTE. The Construction (Design and Management) Regulations 1994 [1] require the designer and the client to bring to the attention of the planning supervisor the following:

– any unresolved aspect of the design that may affect the health and safety of any person during the construction phase; or

– any provision of the design, that should be placed in the health and safety file for information, to ensure the safety of any person at work, or anyone affected by subsequent cleaning, maintenance or adaptation of the structure.

2.7.2 Communications methods

Various methods of information transmission may be used, such as postal and courier services, telephone, facsimile (fax), electronic mail (e-mail), telex and electronic data interchange (EDI). The extent to which the use of these services needs to be regulated may depend upon time and cost constraints and the complexity of the communications network required to support the project. Methods of communication that do not require the transmission of hard copy documents, particularly on the telephone where there is no logging of transactions, should be controlled and important information or agreements confirmed in writing.

2.7.3 Communications channels

To maintain effective communications between the design team, client and the project management team, the routine methods of communication should be specified; the following aspects need to be considered.

a) The design team leader should be the focus for communications within the design team and, where necessary, approve all communications between the design team, external agencies and the client.

b) Where communications relate to changes to design team resources or design management issues, the relevant design facility manager should be consulted.

c) Design unit leaders should be aware of and approve where necessary all communications between their design unit, other design units and the design team leader.

d) Designers should communicate formally through established channels such as team meetings; they may also communicate informally provided the outcome of such communications is recorded and validated.

2.7.4 Progress reporting

The design team leader should issue regular progress reports on the state of the design programme in keeping with the communications plan. Progress reports need to highlight the actual or potential deviations from the project plan and the reasons for such deviations. The design team leader should be responsible for ensuring that corrective action is taken to resolve problems.

Design unit leaders should provide the design team leader with progress reports with an agreed frequency, content and format, for consolidation into the design team leader's progress report.

2.7.5 Document distribution

The design team leader should be responsible for ensuring that design documentation is strictly controlled and disseminated efficiently to the intended recipients. A document distribution system may be used for the most significant design team documents, with the objective of reducing the number of copy documents in circulation.

A standard method of identification should be used for all formal project documents. The minimum requirement is a short project title and project reference code, which should be applied to each document regardless of any other methods of identification used by participants for their own purposes. Each formal project document should also be given a unique descriptive title and reference number, thereby providing full traceability and control of design documentation.

2.8 Controlling cost

2.8.1 Costs to the client

The client will usually incur costs for the following:

a) internal provision of information, decision-making and monitoring the design and construction processes;

b) financial, legal or other professional services for determining needs, obtaining the site, seeking planning permission etc.;

c) employing a project management team;

d) employing a design team, see **2.8.2**;

e) construction, see **2.8.3**;

f) operating and maintaining the finished construction (cost in use or cost of ownership).

Items d) and e) may be combined for some forms of procurement. The costs should be optimized wherever possible to arrive at the most advantageous overall cost plan in keeping with the client's financial policy (see **2.3.2**e)

2.8.2 Controlling design cost

The cost to the client of employing the design team may be a fixed or variable fee and it is usually dependent on the need for additional work and other changes to the brief.

The costs to the design facilities of preparing designs should be monitored by the relevant design unit leaders and the design facility manager.

Procedures should be established for monitoring design costs and comparing them with budget targets agreed between the design team leader and the client. Using such estimates, profiles should be developed to show how costs are expected to accrue throughout the design programme. Time and cost data should be recorded at predetermined intervals throughout the project.

2.8.3 Construction cost planning

At an early stage in the construction procurement process the client will need to consider the limits within which the construction cost is expected to lie. This forecast cost is important for funding purposes and if higher than anticipated might lead to a reduction in the form or quality of construction or even abandonment of the project.

As design work progresses more accurate forecasts of construction costs inherent in the design can be made. The design team manager and client should agree at what stages forecasts should be made. Forecasts should be presented in an agreed format, using recognized methods of measurement and reliable cost data. Comparison should be made with the original cost forecast and steps taken to reconcile any differences. The target forecast cost should be adjusted in accordance with the latest estimate if agreed with the client.

The client should be made aware of the factors likely to cause the actual construction cost to vary from the cost forecast during design and the effect of inflation on future construction cost. The client also needs to be informed of the magnitude of any cost estimate inaccuracies that may arise because of a limitation in the amount of design time or information provided to the design team.

2.8.4 Cost in use

The cost of operating a construction, such as energy consumption, maintenance and repairs, will be significantly affected by design decisions. The design team manager will need a clear statement of the client's strategy in respect of capital expenditure versus operating cost, durability, life expectancy and usage, see also **2.3.2**. It is the design team leader's responsibility to obtain clear guidance on these aspects from the client.

Section 3. Design resource management

3.1 General

This section describes the principal features of an organization that provides a design service through the operation of a design facility. It is directed at those in the organization who determine the policies and business strategies that affect the operation and management of a design facility.

Some design organizations are independent, providing a service for external clients in which the principal product is a design; others are internal departments focusing on a single commercial enterprise, possibly a contractor or an industrial concern, where a design is no more than a stage towards an ultimate product. Regardless of the form of the organization, it is assumed that the design service is provided by design units operating within a design facility.

The divisions within an organization may encompass marketing, sales, finance, human resources and technical functions. Other activities that need to be seen as independent of a particular function and which also operate across functions, such as quality assurance and project management, may also be separately identifiable in the organization. The complexity of the management hierarchy will depend upon the size and scope of the organization. At the most senior level, by suitable combination of responsibilities where necessary, all aspects of the management need to be assigned. Individuals may need to perform several functions for instance, within a design practice a principal may have several differing roles to play, as follows:

a) as a member of the executive, having responsibilities for the well-being of the practice;

b) as a senior functional manager, having specific duties such as design facility manager or administration manager;

c) as a design unit leader, having responsibilities for managing a design unit and executing a particular commission;

d) as a specialist, providing a consultancy service to other designers.

The management hierarchy should be described in an organization chart that shows the formal relationships between levels of management and staff and the delegated responsibilities. Each member of staff should be provided with a written job description.

3.2 Design facility

All design personnel and associated equipment within an organization constitute a design facility under a design facility manager. For each commission, a design unit should be selected or created with a mix of managerial and technical personnel and an availability consistent with the scope of the commission and the programme.

Other managerial or operational personnel functions may be part of the design facility such as a computer-aided design (CAD) manager, librarian and technical secretary, or may be available on a shared basis from a common source. Some people in these functions may be allocated to particular commissions as the need arises.

3.3 Design facility manager's corporate responsibilities

The design facility manager will usually have both corporate and operational functions. The latter are listed in **4.2**. Corporate functions are those concerned with maintaining the viability and efficiency of the design facility and carry the following responsibilities:

a) contributing to definition of the corporate objectives, policies and strategies concerning design services;

b) participating in the development of business plans and budgets by:

1) providing input to the marketing strategy;

2) determining the required combination of professional, technical and support staff to meet the organization's objectives within budget constraints;

3) determining the capital equipment and accommodation requirements for the design facility;

4) preparing and maintaining technical and design management procedures;

5) preparing cash flow forecasts and income predictions;

6) providing management information on project progress and financial returns such as expenditure against budget;

7) determining and implementing training and continuous professional development programmes.

3.4 Objectives of a design facility

Objectives should be set out clearly and communicated to all those concerned. The organization's strategy for operating and developing the business should also be defined and understood.

The primary objective of the design facility should be consistent with the organization's policies and objectives and should define the type and extent of the design services to be provided. The following factors should be considered when defining the design facility objectives:

a) the disciplines and professions that underpin the services provided;

b) constraints on type, size and location of projects;

c) the scope of expertise and specialisms;

d) financial policy for raising funds, costing jobs, recovering overheads, pricing and profit margins;

e) future intentions related to a programme in respect of growth of the design business and marketing;

f) the organization's image, for example, whether conservative in approach or innovative, traditional or modernistic.

3.5 Preparing a business plan

3.5.1 General

The design facility manager should provide input to the business plan on the provision of a design service and the resources required to provide it.

To be able to operate effectively and achieve its corporate objectives, an organization needs to set realistic targets based on judgements about the future. Future intentions and the means for achieving them will form the substance of a business plan, which should include aspects that will influence project execution and design management.

The business plan should include an appraisal of the principal factors affecting the ability of the design facility to comply with corporate policies and objectives, as described in **3.5.2** to **3.5.6**.

3.5.2 Forward planning

Forward planning should be based on anticipated workload in terms of both quantity and type of work. Confidence in forecast demand will diminish as the timescale is extended into the future. Comprehensive short-term plans covering the current and following financial year should be maintained and used for forecasting and managing resource requirements. Longer-term plans should be made particularly for the development of the organization and for capital investments.

Marketing effort should be directed at securing a mix of work type and quantity to suit the forward plan.

3.5.3 Staff

Suitably skilled and experienced professional and technical staff should be available to match the anticipated workload; the number of secretarial, administrative and accounting staff needed to meet requirements should also be planned. Although permanent staff levels should ideally be kept constant, arrangements should be made for dealing with short-term overloads (such as using agency staff or sub-letting work).

During the planning process factors that might affect the future availability or effectiveness of staff should be identified. Any new staff will require time to reach full effectiveness. It is essential to allow adequate time for staff training and the demands of continuing professional development.

3.5.4 Facilities

All staff should be provided with suitable workstations and equipment appropriate to the activities they are required to perform. Efficiency is generally related to working environment which should be pleasant and functional. As design comes to depend more on information technology, attention needs to be paid to obtaining equipment and software specifically designed for the purposes identified. Adequate library facilities should be available to meet the technical needs of design staff. The type and extent of equipment required to support a design facility depends on the work the organization plans to do.

3.5.5 Finance

The profitability and therefore the continued existence of an independent design organization relies on effective financial planning and management. These are necessarily closely related to the planning and management of other aspects of the organization's activities. Financial management is important in controlling the cost-effectiveness of a design facility.

Financial plans are needed to forecast the cash flow and capital requirements and to show how funds are to be made available when needed. Income and expenditure should then be monitored closely against forecasts to identify any discrepancies and thus enable corrective action to be taken. A minimum turnover needs to be set in order to generate the necessary operating funds.

Income is dependent on commissions being gained, on progress being achieved, on fees being invoiced and on timely payment. Whether or not receipts are sufficient to repay expenditure and to provide a surplus for further development depends largely on accurate forecasting of design costs and on negotiations for commissions culminating in adequate fee arrangements. Forecasting of costs is dependent on the availability within the organization of up-to-date information on unit costs such as those for staff, for production of drawings and for the services the organization provides.

There are two types of operating costs: those largely independent of workload and those that vary with the level of activity. The former are often treated as overheads for estimating purposes so that the direct cost of doing any task can be identified more precisely.

Decisions on capital expenditure require long-term planning and are dependent on investment policy; finance may be provided by reserves or loans. In the latter case interest and repayment should be met from current cash flow. The payback time for expenditure on capital investments should be decided, as well as the minimum turnover required to justify the investment.

3.5.6 Systems management

Resources should be assigned to the development and maintenance of procedures and documentation and should include means for identifying and exploiting opportunities for improvement, such as systems audit and feedback.

The following procedures may be considered:

a) the negotiation of new commissions including reviews of resources, bidding and fee strategies;

b) design management;

c) technical support and management;

d) feedback;

e) management systems audit;

f) administrative and clerical, including means of communication;

g) accessing information and advice, whether provided internally or externally;

h) training;

i) testing and research.

3.6 Quality policy

Quality policy should be relevant to an organization's objectives and the expectations of its clients. It should be written into management instructions and may significantly influence the degree of freedom allowed to designers, particularly in respect of innovation.

Quality policy should effect examination and improvement of an organization's managerial and technical procedures through a positive programme of audits, reviews and feedback. It should relate to training policies.

Quality policy should ensure that adequate time and resources are allocated to validation and verification activities associated with design input and output respectively. Further guidance is given in annex A.

If an organization is registered under a formal quality assurance (QA) system to BS EN ISO 9001, its quality policy will be clearly identified in a quality manual.

3.7 Innovation

In managing innovation, it is necessary to identify, assess and control attendant risks. Study of the results of research and development into these risks as well as the identification of testing requirements during the execution phase of the project are crucial to the success of innovative projects. A corporate policy and attendant procedure should be developed to provide satisfactory control of innovative design. The client should be informed of proposals to apply innovative features and approval should be confirmed.

Innovation can be an essential consideration for promoting the success of a project or organization and as such should be actively encouraged.

3.8 Communications

A communications policy should ensure that those concerned with design are informed about everything that may affect what they are doing, but they should not be inundated with irrelevant information.

Lines of communication should not be confused with lines of authority; communication may legitimately occur in any direction through an organization structure.

3.9 Management information

Accurate and timely information is essential to enable managers to perform their duties effectively. Clear instructions should be issued covering the following:

a) what information is required, by whom and for what purpose;

b) who will generate the information and maintain it;

c) how it will be sorted and distributed;

d) how frequently it is issued, if distributed regularly;

e) what actions should be taken on receipt of the information.

3.10 Design support systems

To allow designers to operate effectively, appropriate systems should be available. These may include the following:

a) technical information, see **3.11**;

b) drawing materials and equipment, and printing facilities, see **3.12**;

c) a CAD system, see **3.13**;

d) a specification system, see **3.14**;

e) administration and clerical services including text processing and document reproduction and computational facilities, see **3.15**;

f) measuring and recording instruments, cameras etc., see **3.16**.

3.11 Technical information

Technical information may include statutory instruments, standards, codes of practice, and other published information including trade literature. Such information will normally be available from one or more of the following sources:

a) an internal library;

b) external libraries (public, institutional, educational);

c) information databases;

d) manufacturers;

e) specialist and proprietary sources.

It should be the responsibility of the design facility manager to ensure that suitable sources of technical information are available and that effective validation procedures are applied before it is incorporated into a design. Further guidance is given in annex B.

3.12 Drawing materials and equipment

The drawing office should be suitably equipped for the type of work undertaken and the anticipated workload.

Prescribed procedures should be adopted for the production of drawings to ensure an acceptable degree of reliability and to maintain a house style. The house style may need to be adapted to suit a client's or a design team's requirements.

These procedures may involve consideration of the following:

a) planning, organizing and recording drawing production;

b) selecting preferred sizes of drawings for particular purposes;

c) layout, style, annotation and composition;

d) use of standard or reference drawings and schedules;

e) use of symbols and referencing conventions;

f) line form, hatching, shading interpretations;

g) titling, numbering, set arrangement;

h) checking, approving, authorizing;

i) revisions;

j) issuing, storing and archiving in an appropriate manner.

NOTE. Guidance in these aspects is given in BS 1192, and *CPI Production drawings — A code of procedure for building works* [4].

3.13 Computer-aided design

The responsibility for introducing, developing and supporting a CAD system should be clearly defined. This should include co-ordination of CAD and manual draughting practices, developing instructions for the retention of record drawings and authorization of individuals entitled to effect change. Procedures for the control and secure storage of backup copies of CAD system data should be defined and enforced.

Detailed guidance for system users should be given in the supplier's manuals and in-house documentation. Training and ongoing technical support should be provided by in-house specialists or system suppliers.

The drawings produced on a CAD system should meet the same requirements, including verification, as those that are manually produced.

When selecting computer hardware and software consideration should be given to their compatibility with the systems used by the clients, other design offices and contractors with which the organization works.

3.14 Specification systems

Materials and equipment should be specified in one of the following ways.

a) *By performance*: the required characteristics or features of the item should be stated; conformity to a standard may be used as a form of performance specification.

b) *By prescription*: an item should be identified by a specific reference, such as a catalogue number or a drawing.

c) *Combined performance and prescription*: a performance specification may not be sufficient where some special features are required. This can arise when an item is required to match a previous item or where there are dimensional limitations. These characteristics should then be prescribed.

Most project specifications are produced by adapting stored text. The following two types of text are commonly used.

1) *Reference specifications*: text that has been used successfully on previous projects and is held in a generalized form, may be adapted to suit new requirements. Where very similar specifications need to be repeatedly produced, this is probably the quickest method. However, it contains the inherent danger that inadequate thought may be given to the special features of a particular project during the adaptation process.

2) *Specification clause library*: text is held in the form of clauses, often giving alternative methods or material, set out in a convenient arrangement of work sections, system types or materials. This provides a very flexible means for preparing specifications by the selection of appropriate clauses. During the selection process, the designer has to consider the options carefully, as the clause library cannot simply be reproduced as a project specification.

Both methods may be used in a design office to cater for different types of work. A procedure for checking, approving and authorizing specifications and dealing with revisions should be available.

It is important that stored text for either of the above methods is frequently reviewed to take account of changes in legislation, standards, materials availability, new construction methods and other relevant information. This responsibility needs to be clearly defined and adequately resourced.

NOTE. Further guidance on specifications is given in *CPI Project specification — A code of procedure for building works* [5] and *CPI Common arrangements of work sections for building works* [6].

3.15 Administration

Design teams need properly managed administrative support if they are to work to maximum efficiency. The scale of this support will depend on the size of the organization; it may be led by an office manager. Procedures need to be defined and staff made available to provide the following services:

a) correspondence such as incoming and outgoing mail, facsimile, recording of telephone conversations;

b) filing and documentation management, for example storage and retrieval systems, weeding and destruction programmes, archiving;

c) security to safeguard confidential information and valuable equipment;

d) the provision of stationery and other consumables;

e) accounting and cost control for authorization of cheque signatories, maximum and minimum balances, arrangements for annual audits, payment of wages and salaries, VAT, dealing with the Inland Revenue;

f) insurance to cover professional indemnity, employers' liability, buildings and contents;

g) transport including vehicles, maintenance, hiring, drivers;

h) health and safety in respect of staff, premises and sites;

i) sources of legal advice, copyright;

j) maintenance and cleaning of premises;

k) staff welfare.

3.16 Instruments and technical equipment

An organization's requirements for measuring and inspection instruments and other technical equipment should be regularly assessed. Training in the use of such equipment should be provided where necessary. If measuring instruments are held, these need to be properly stored, checked, calibrated and maintained. The equipment should be listed on an inventory showing the calibration, maintenance and repair history. Responsibility for holding and issuing equipment should be clearly defined.

Instrument hire may be a sensible alternative to ownership for equipment used only occasionally.

Section 4. Design process management

4.1 General

This section provides guidance to those whose prime responsibility is to manage design. The design management function appears at three principal levels as follows:

a) the design team leader, as part of the project management team, is responsible for managing all design work for a particular project. The design team leader's main objectives should be to see that the design work is properly co-ordinated between the design units and that it is completed within the time, cost and technical constraints imposed by the client;

b) the design facility manager is responsible for appointing a design unit leader and assigning suitable design and support staff. The design facility manager is responsible for accepting commissions;

c) a design unit leader is responsible for managing that part of a design commission assigned to a particular organization under the direction of a design team leader. A design unit leader's main objective should be to complete a design commission in collaboration with other design units within the time, cost and technical parameters agreed with the client.

The design facility manager is a permanent managerial position whereas a design team leader and design unit leaders are appointed for the duration of a commission or other defined task.

It follows that a design unit leader is responsible to both the design team leader and the design facility manager and it is important that these two duties do not conflict.

4.2 Design facility manager's operational responsibilities

The design facility manager will usually have both corporate and operational functions; corporate functions are described in **3.3**.

Operational functions are concerned with the management of projects from the organization's point of view, which includes an assessment of the merits of all new work to ensure that it is within the scope and resources of the design facility and otherwise acceptable. Following the acceptance of a project, a design unit leader needs to be appointed for each design unit. Projects should then be monitored throughout the design process.

The design facility manager's operational responsibilities should include the following:

a) assessing the acceptability of the terms for a potential new commission by analysis of the initial brief and any other relevant information from the client or project team (see **4.3**);

b) completing any further investigations following analysis of the initial brief, this might include discussions with the client, technical and commercial risk analysis, site visits and assessment of available resources to undertake the project;

c) accepting or rejecting potential new commissions, or submitting bids for work on behalf of the organization;

d) appointing a design unit leader, deciding the composition of the design unit and allocating the financial and technical resources needed to complete the commission;

e) planning the work schedule and the form and frequency of progress reports;

f) establishing a verification strategy and approval procedures;

g) monitoring progress and performance of design units;

h) authorizing the issue of all documentation;

i) ensuring that invoices and supporting documentation are prepared;

j) at the end of the commission, ensuring that all commitments to the client have been fulfilled and releasing the design unit leader and other staff for other duties.

4.3 Pre-commission review

Before a commitment is made to proceed with a project, the design facility manager, in discussion with the design unit leader, if appointed, should confirm that a commission can and should be accepted. The following should be established:

a) if the proposed commission is financially acceptable;

b) that sufficient information is available to judge the technical and resource requirements;

c) that adequate technical and support resources are expected to be available to undertake the proposed commission;

d) that, by carrying out a risk analysis and applying effective risk management techniques, all perceived risks can be contained within acceptable limits. A checklist should be available requiring a judgement to be made concerning the features most likely to cause concern. These features may fall into the following categories:

1) tight programme;

2) complex team structure;

3) extreme or innovative technical or operational requirements;

4) unfamiliar materials or construction methods;

5) international projects that might involve communication in different languages, conformity with unfamiliar legislation and standards, extreme climatic conditions, access and handling problems and availability of materials and equipment.

This list is not exhaustive and should be expanded from an investigation of past problems and opportunities.

Having completed these investigations the design facility manager should decide whether to recommend acceptance of the commission (with conditional internal or external changes if necessary), or rejection. The final decision may lie at a higher management level within the organization. It may need to take account of the wider strategic and commercial issues outside the scope of the design facility manager's investigation, for example, whether to accept marginal commissions in order to secure a future stream of profitable work.

4.4 Design unit leader's responsibilities

A design unit leader should normally be appointed on commencement of a commission to undertake the management of resources and produce a cost-effective design within the parameters of cost and programme, in keeping with the design brief and good practice.

The design unit leader should report to the client through a design team leader unless there is a specific requirement for direct communication. The design unit leader should inform the design team leader of the outcome of any direct communication with the client.

The responsibilities of a design unit leader, for a specific project, may include the following:

a) establishing a rapport with and between design unit personnel;

b) liaising with the design team leader, client and specialist advisers and obtaining the necessary approvals;

c) participating in the development of a design brief;

d) advising on the selection of the necessary resources for the design activity and establishing a resource profile related to design stages (see **4.6**);

e) establishing channels of communication, including communication with other design units, and arrangements for the distribution of information;

f) identifying the need for sub-consultancies and specialists;

g) identifying relevant design procedures and sources of design data;

h) ensuring that all aspects of the commission are designed professionally and competently;

i) managing the overall design function for the commission including applying cost and design control procedures and ensuring that the outcome is of acceptable quality;

j) obtaining planning and other essential approvals at predetermined stages;

k) monitoring the production and issue of design information in keeping with the programme;

l) appraising designs from contractors, sub-contractors and others according to relevant tender drawings, specifications and contractual requirements;

m) visiting the site during construction if required by the commission.

4.5 Design brief

4.5.1 Interpretation of the project brief

The project brief is rarely sufficiently detailed to meet design requirements and a design brief therefore needs to be developed. The design brief should provide a comprehensive technical interpretation of the project brief for the component disciplines within a design team. It should also be linked to a plan of work. Some guidance on project and design brief development is also given in **2.3.3**.

It is usually the responsibility of the design team leader, through the co-ordination of contributions from design units, to develop a design brief and to see that design is carried out accordingly, within cost and programme constraints.

4.5.2 Assigning responsibilities

Depending on the way that overall design work is to be divided between organizations, sections and individuals, it may be necessary to subdivide the project brief to identify the requirements specific to each design unit.

4.5.3 Brief development

The development of the design brief from a project brief should require the project team or individual design units to undertake the following:

a) assemble all relevant information;

b) initiate studies, if appropriate;

c) try out various solutions;

d) prepare an outline scheme;

e) prepare an outline cost plan covering design and construction costs.

The requirements identified by the client should be related to other factors that the client may not be aware of, such as the following:

1) legislation;

2) standards;

3) good practice;

4) needs of subsequent processes.

Data that are obtained or generated during a brief development process, for use in a design, should be recorded.

4.5.4 Consolidated brief

When the design brief has been developed to the point where it can be used for detailed design it should be presented to the client as a consolidated brief. This should be in the form of a client report and should give sufficient information about the design intentions so that both the client and the design team are clear about what is to be designed.

A client report should contain the following information:

a) introduction (purpose of the client report and its significance to the client);

b) list of principal participants (client, architect, engineer, planning supervisor, other consultants);

c) identification of design personnel and other significant resources;

d) research undertaken and outcome;

e) discussion of options, constraints and conclusions;

f) description of proposed design solution including:

1) meeting/interpreting the client's requirements;

2) assumptions (environmental conditions, etc.);

3) data;

4) special requirements and provisions;

5) legislative aspects (health, safety, environment, etc.);

6) limitations (aspects that may fall short of the client's expectations);

7) technical risk (use of materials, etc.);

8) construction problems;

9) operating, maintenance and reliability aspects;

g) cost plan;

h) on-going design programme;

i) drawings;

j) supporting calculations.

The client report should be submitted to the client for comment and approval.

4.5.5 Brief change control

Changes in client requirements after approval of the consolidated brief are likely to lead to the abandonment of previously completed work. The client should be advised when this transition occurs and that such changes are likely to incur a time and/or cost penalty.

All subsequent brief changes should be recorded and the client informed of the likely consequences. Where a change could have a significant effect in respect of health, safety, cost, time, reliability, etc., the implications should be assessed by going back as far as is necessary in the design process. The parties likely to be affected should be informed of any increased risk that might result from such changes.

The current form of the consolidated brief should always be identifiable and observed by all those involved in the design process.

4.6 Design stages

4.6.1 General

The design stages within the overall plan of work are identified in **2.5**. These are conceptual design, scheme design, detail design and information for construction, each of which is discussed in **4.6.2** to **4.6.5**.

Planning and other authorities should be consulted at appropriate junctures during the design process.

4.6.2 Conceptual design

Conceptual design is the stage of a design process at which ideas and outline proposals are conceived. Such ideas need only contain those details necessary to define the essential characteristics and features.

Methods such as group working or brainstorming can be used during this stage. Evaluation of the concepts against the requirements of the client should be undertaken. Relationship charts and optimization techniques may be employed.

The primary aim should be to provide a client with an appraisal and recommendation on the development of the project so that decisions can be made on the functional, technical and financial aspects.

4.6.3 Scheme design

Scheme design should lay the foundation for good detail design through structured development of the concept.

Decisions need to be made on particular proposals including planning arrangements, appearance, spatial relationships, loading, construction methods, outline specification and costs.

Completion of this stage should be accompanied by the establishment of a consolidated brief (see **4.5.4**).

4.6.4 Detail design

All information for construction purposes should be developed during this stage.

Where circumstances require it, the output should be in a form suitable for tendering purposes.

4.6.5 Information for construction

The required production information and fabrication drawings, including the appropriate part of the health and safety plan, should be prepared during this stage, together with relevant specifications.

Tender action may be completed using the information provided.

All remaining design activities should be completed, including those occurring during the construction period and those that are necessary for completion of all site works and hand over to the client.

4.6.6 Briefing related to design stages

The relationship between the brief evolution and design stages is shown in figure 3.

4.7 Design procedures

4.7.1 General

All design procedures should be clearly written and presented in controlled documents. They should be structured into three principal elements of input, process and output, together with the associated management and control functions.

4.7.2 Procedures

For design office control and consistency of working practices, formal procedures should be used for all projects. These procedures need to be independent of the individual requirements for each project and should relate to the use of standard forms and practices. They should be based on published methods and data from reputable sources. Engineering design procedures tend to be more prescriptive than architectural procedures.

As it is not always possible or completely desirable to constrain the design process, designers should be allowed to use their judgement in reaching design solutions, particularly at early design stages. Innovation should be encouraged where it is appropriate to the subject and is acceptable to the client. These procedures should rely significantly on a designer's experience and flair.

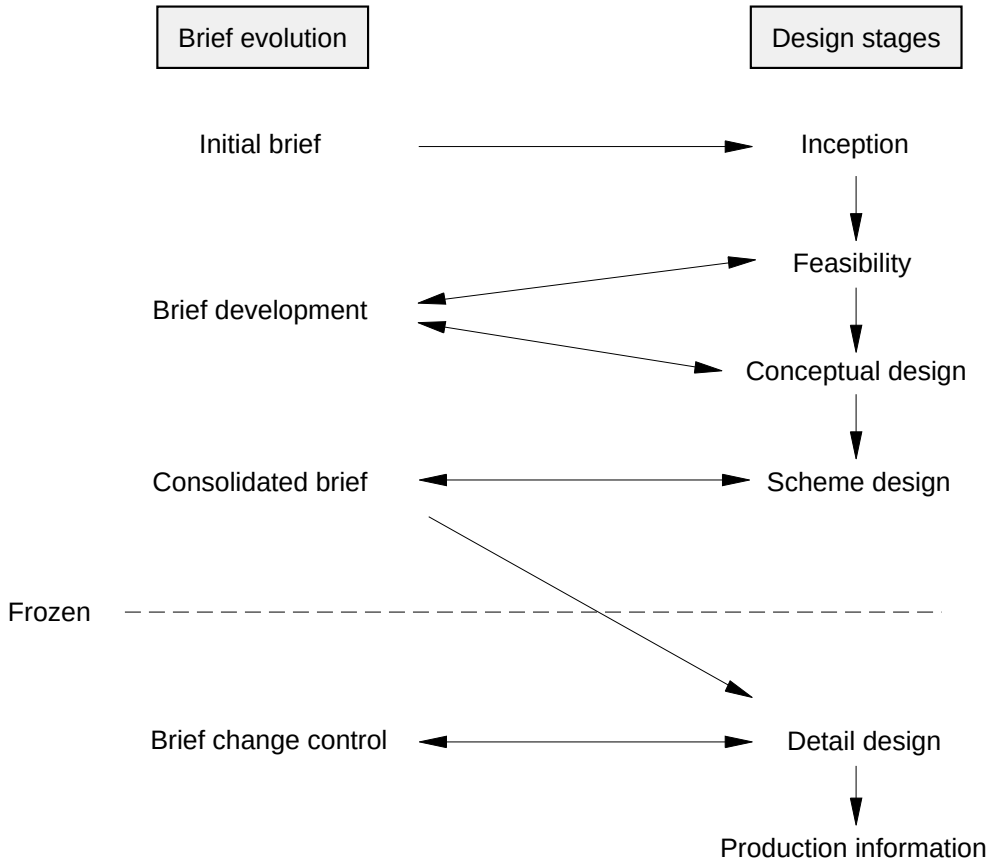

Figure 3. Relationship between brief evolution and design stages

The relevant design criteria and constraints should be listed to allow verification of value judgements. When required, a designer should be able to show that a particular design solution meets the criteria and constraints listed. For each project a design unit should be required to comply with procedures identified and validated by the design unit leader.

4.7.3 Design input

Design input may include the following:

a) the design brief;

b) information from previous stages;

c) output from other design disciplines or specialist advisers;

d) design methodology and data;

e) product information;

f) codes, standards and legislation;

g) staff expertise and knowledge.

All staff involved in design should use professional judgement so that sensible data are used and appropriate design procedures are adopted. Design guides should be used as sources of design methods and design data. British Standards should be used where relevant.

All design input should be validated according to procedures given in annex A.

4.7.4 Design process

Various forms of design input need to be manipulated to produce design output. This involves intellectual processes such as analysis, synthesis, calculation, selection and comparison, some of which may be computer-aided. These processes are usually iterative and convergence needs to be achieved within one design stage, otherwise the resultant feedback may lead to difficult design change control situations.

Significant design assumptions and decisions should be recorded as the design proceeds, to allow traceability.

Recognized methods are available for making the most common calculations and a standard format for such calculations should be used. Calculations need to be presented in a logical and orderly manner, so that they can be readily understood by any technically competent person who may become involved, without assistance from the originator.

Contractors and specialist suppliers are frequently called upon to contribute to the design process. This contribution can range from specific advice to the preparation of major working drawings. A co-ordinated approach should be adopted to ensure that the necessary exchanges of information take place during the design stages.

Models and samples may be an important aspect of the project. They provide an early opportunity to view and appraise details, quality and standards. Prototypes may be justified where repetitive constructional elements are involved.

At intervals appropriate to the size and complexity of a project, design reviews should be conducted, see **A.5**. Design reviews are additional to routine checking and approving activities and to routine managerial and technical meetings. They may be instigated by the design team leader to review the design as a whole or by individual design units to review their own part of the design.

4.7.5 Design output

The form of design output will be determined by the design approach adopted for each project and will vary according to the design stage from which it is generated.

During the conceptual and scheme design stages, output may be of a highly visual nature in the form of three-dimensional drawings, computer generated and physical models.

During the detail design stage output is intended primarily for other project participants and should mostly be in the form of drawings and support information. Co-ordinated drawings may be required to deal with complex spatial situations. Physical or computer generated models may also be required, to assist in the visualization of spatial relationships.

At the production drawing stage output should consist of a precisely defined collection of documents (paper or electronically based), constituting the complete design package.

All drawings and specifications should conform to in-house procedures and recognized guidance documents. All design outputs should be subject to a stated verification strategy, see **A.6**. Verification should demonstrate conformity to the requirements listed in the design review, see **A.5**.

The purpose of drawings is to transmit a designer's intentions to those who need such information. The recipient may be a client, planning supervisor, other designers, planning authorities, tenderers, constructors, or maintainers. The form and content of design information should be appropriate to the purpose.

Where design output is being produced by several design units, the client or design team leader may require drawings to adhere to a common format. The use of an integrated CAD system with three-dimensional modelling capability should be encouraged as a means of identifying areas of interference that otherwise might only be revealed during the construction phase.

4.8 Progress checking

The following actions should be taken at the end of each plan of work stage and at other significant points in the project as necessary:

a) see that the stage or overall objectives are being met;

b) prepare for the next stage by re-assessing resources and the programme;

c) see that all authorizations (e.g. for expenditure) have been obtained.

Design progress meetings should be held at agreed intervals to monitor progress against the programme. Outstanding information or actions should be identified and recorded.

The issue of drawings and documents should be consistently monitored.

4.9 Design change control

Procedures for monitoring and recording changes at all stages should be established at the beginning of the project, together with those for seeking client approval to changes and the associated costs, as required. Criteria affecting the monitoring and recording of changes in design will depend on the scope and nature of the 'Terms of appointment' and the initial brief.

4.10 Documentation control

4.10.1 Distribution plan

A document distribution plan, based on need to know, should be drawn up by the design team leader at the start of the project, agreed by all participants and revised as necessary. This plan should provide the following:

a) a full set of current drawing lists;

b) the latest issue schedules;

c) a project related drawings register;

d) a schedule of associated documents (specifications, instructions, record of documents issued: to whom and when).

Drawing/specification title blocks, revisions and status should conform to specified procedures that relate to a drawing numbering system.

An originator should ensure by suitable annotation to the documentation that the recipient knows whether a particular document is for action or information.

4.10.2 Form of transmission

Communication of project information, such as text, schedules and drawings, may be in verbal, or in written or electronic form. Whatever form of communication is used, the source, status, purpose and intended recipients of the information should be clearly identified. The design unit leader should see that suitable communications procedures are put in place, in conformity with the project plan.

If electronic transmittal is to be used, early project planning should specify the preferred system so as to maintain compatibility between project team members. Care should be taken to verify electronically transmitted drawings and data before authorizing its issue. A common design change control procedure should be agreed between design units, so that one design unit's work is not modified by another.

4.11 Design team's activities during construction

4.11.1 Design during construction

The degree of involvement of members of the design team during construction will vary considerably from one project to another and will depend upon the extent of the duties defined in the commissions. Members of the design team may be required to undertake the following:

a) approve samples (for example, brickwork, finishes);

b) supervise the setting up and examination of prototypes and mock-ups:

c) evaluate and approve design changes and prepare record drawings as appropriate.

4.11.2 Monitoring during construction

Members of the design team should comply with agreed duties in respect of monitoring during the construction period. Team members should ensure that these duties are sufficient to cover their obligations to the client and other parties involved.

Designers may need to visit or reside on-site to resolve design problems. This is particularly relevant when ground conditions or the details of existing structures cannot be evaluated until the contractor has access to the site and has started to excavate or open it up.

4.11.3 Testing

Testing should include inspection and witnessing of testing during manufacture and assembly of electrical and mechanical components, materials and machinery, and plant for incorporation into the construction. Tests on soils, bituminous material, concrete and similar materials may be required. Arrangements should be made to witness acceptance tests during commissioning; reports should be made on all such tests.

Test methods should be specified by the relevant design unit leader and, where available and appropriate, should be taken from a standard, code of practice or similar reliable source.

4.11.4 Completion

On completion of the work, the design team leader's duties should include the following:

a) assemble record drawings and contribute to the health and safety file;

b) assemble operating instructions and maintenance schedules provided by contractors and suppliers.

Where required, the design team should inspect the work with site staff and should record any non-conformities and agree corrective action.

The design team may be involved in providing or organising training for the client's personnel who may be required to operate complex equipment.

4.12 Design management appraisal

4.12.1 General

On completion of a project an appraisal of the process and design management should be undertaken by each design unit for its own purposes.

4.12.2 Design process assessment

Consideration should be given to all relevant aspects of the design process, such as the following:

a) information from the client, including the brief;

b) information and input from other team members;

c) information from suppliers;

d) planning authority negotiations;

e) innovation;

f) contributions from specialist designers;

g) CAD systems;

h) verification methods;

i) design reviews.

4.12.3 Design management assessment

Consideration should be given to all relevant aspects of the design management process, such as the following.

a) programme and targets;

b) team composition and structure;

c) management information;

d) reporting and control procedures;

e) co-ordination and communication;

f) decisions and authorization;

g) project reviews;

h) fee receipts and profitability.

4.12.4 Appraisal report

A design appraisal report should be prepared by the design unit leader showing where changes in policy, procedure or resources would be beneficial on future projects. The design facility manager should be responsible for making such changes.

Annexes

Annex A (informative)
Validation and verification

A.1 General

The rigour of validation and verification procedures should be determined by an assessment of the risks and penalties that might be incurred against increasing cost of more extensive validation and verification actions.

The important relationship is the cost of increased rigour against the risk of an increased penalty.

The following argument applies: a given risk (for example uncertainty of finding a mistake on a drawing) may lead to the imposition of a penalty (for example a claim for abortive work), but this risk can be reduced by more rigorous methods (for example better checking), with increased cost.

This introduces the concept of verification strategy whereby a professional judgement is made as to the risks and corresponding degree of rigour appropriate to the various aspects of a given project.

A.2 Validation

All design methods and sources of design data should be validated.

Validation of design input may be by any of the following.

a) *Usage (custom and practice, long-term satisfaction):* care should be taken to check that design methods and data sources validated some time ago are still suitable in view of technical changes, new design concepts or new materials.

b) *Status of source*: the status of a source (e.g. professional organization) can only apply if the item being validated is of recent origin and is appropriate for the purpose intended. Evidence of appropriate tests or derivations should be expected.

c) *Technical judgement based on analysis*: it may occasionally be necessary to use unfamiliar design procedures or data. These should be scrutinized to confirm that they are based on sound principles, have been derived from reliable test methods and that they are consistent. Such material should be used with caution and the outcome of the design procedure in which it is used should be judged for conformity to good practice and 'rules of thumb'.

d) *Test*: testing is expensive and only justified where other validation methods are not adequate. Testing may be necessary if the design method is to be applied in an unfamiliar situation, when data are being used at the boundary of the range and where there is a high risk associated with the design.

Testing may be carried out using comparative methods (e.g. a known design against an unknown method) and physical testing (e.g. for performance data). Testing should be undertaken by experts with experience in designing tests and interpreting results.

The validation process should be documented in each case.

A.3 Verification

Verification should be applied at any point in the design process when design output is to be issued or incorporated into other design procedures.

Basic considerations should be as follows.

a) The originator should be responsible for ensuring correctness.

b) Verification procedures should be targeted at reducing causes of significant problems; obvious errors may not necessarily cause the most problems.

c) Lack of care is a greater source of error than lack of skill.

d) Checking is not a substitute for getting it right first time.

e) Checklists are useful but can give a false sense of security if followed blindly.

f) The cost and extent of verification procedures should be commensurate with risk.

g) Verification practices should be based on the principle of reasonableness in the application of professional skill and care.

h) Due account should be taken of individual or team strengths and weaknesses in defining verification practices and responsibilities.

A.4 Verification methods

The following methods are available for verifying design output:

a) design reviews (see **A.5**);

b) checking, approving, authorizing; procedures should be applicable to calculations, drawings, specifications and bills of quantity, and described in the relevant procedures;

c) testing; difficult design configurations may be tested by using scale models or full size mock-ups. Design data should be verified by product prototype testing, particularly where the application is unusual or is at the extreme end of the product's stated performance; where such situations can be foreseen, the need for testing should be identified and agreed with the client if necessary (e.g. if a cost is involved);

d) repetition; a design calculation may be repeated using a different method (e.g. by hand instead of by computer) or by a different qualified person;

e) comparison; this may involve a 'rule of thumb' type of comparison or comparing the design with a similar proven design.

Verification procedures that have been used and any resultant corrective action should be documented.

A.5 Design review

The timing of design reviews should be such that any adverse finding would limit the amount of abortive work carried out. The design team leader (when the review relates to the team), the design unit leader and senior technical staff should participate in design reviews.

Design reviews should take place at the end of each design stage, see **4.6**. The later design stages should take particular account of co-ordination. For small projects a design review may be combined with a team meeting if the purpose of each is identified, satisfied and recorded.

Design review notes should be produced with the need for actions clearly defined. The design team leader should ensure that all the required actions are taken. The design review report and the record of actions taken should be placed in the project file.

A design review should establish that:

a) the requirements of the brief and any inadequacies, have been recognized;

b) the special features of the project have been addressed such as: intended use, environment, aesthetic characteristics, size and relationship of functional spaces and elements, accommodation standards, facilities, services, temperature, humidity, safety, health, security, finishes and durability;

c) acceptance criteria have been met, see **A.7**;

d) the design follows good practice;

e) all relevant statutory and planning requirements have been met;

f) all relevant standards have been met;

g) due regard has been given to health and safety, fire prevention, safety, security and environmental impact;

h) due regard has been given to durability, reliability and maintainability;

i) validated/approved data, guides and other references have been used;

j) approved or appropriate materials have been used;

k) correct design criteria and conditions have been assumed;

l) all calculations have followed approved procedures;

m) drawings have been prepared generally in accordance with BS 1192 or in-house standards and are well presented;

n) all project documentation is co-ordinated and cross-referencing is satisfactory.

The significance of each of these aspects may vary according to the type of project and the plan of work stage.

A.6 Verification strategy

The quality of a set of documents depends on the quality of professional skill and judgement employed to produce them and verification procedures and methods should be developed that recognize these human characteristics. For this purpose a verification strategy should be introduced for each project.

A verification strategy should take account of all relevant features of a project, particularly where they involve risk in respect of health, safety and environment.

The rigour of checking procedures, the form and frequency of design reviews and the degree of inspection leading to approval should be decided according to the type of project.

As part of the verification strategy an issuing authority should be identified with the responsibility for ensuring that verification is complete before project documents are issued.

The agreed verification strategy should be documented.

A.7 Acceptance criteria

The objectives of the design process should be clearly understood at the beginning. When the process is complete, it should be possible to decide whether those objectives have been met; this is achieved by setting acceptance criteria at the outset of the project.

Consideration should be given early in the design process as to how the output should be judged to show that it fulfils its objectives. These should then become the acceptance criteria which should be applied at appropriate stages, such as design reviews.

Acceptance criteria may be in terms of size and relationship of functional spaces, accommodation standards, facilities, services, temperature, humidity, air change rate, safety, health, security, finishes, durability, etc.

Annex B (informative)
Technical information

B.1 General

Design is heavily reliant on the use of standards, codes of practice, and other recorded information including trade literature. Nearly all such sources are subject to amendment and it is important that the information used is current. This requires well organized procedures for finding out what is available and relevant, obtaining and cataloguing such information and keeping it up to date.

Much of the information is only available, or is most conveniently used, in hard copy although some information databases are available through electronic data links. Technical information is an essential design tool and should be adequately funded; small organizations may find benefit in pooling resources together or in subscribing to a data service.

Public and technical libraries may be able to provide a valid source of technical information, such as standards.

Manufacturers and suppliers should assist designers by providing technical information in a form consistent with the recommendations given in BS 4940 : Parts 1, 2 and 3.

B.2 Extent of technical information

For most design organizations the need for technical information should largely be met by or through an internal library. The appropriate material, consistent with the needs of designers, should be obtained and maintained. Examples of the types of information required are as follows:

a) statutory requirements and related guidance material;

b) circulars issued by government departments;

c) standards and codes of practice;

d) technical journals;

e) design guides and data sources;

f) catalogues and buyer's guides;

g) other technical information such as technical reports and digests;

h) standard references such as dictionaries;

i) sources of further information, including non-confidential data previously supplied by clients;

j) information derived from in-house or general feedback.

The content of the library should be decided by technical staff; it may be constrained by limited funds. Reasonable steps should be taken to see that information in the library is well maintained and up to date. Ultimately it is the user's responsibility to confirm that the information used is suitable for the purpose intended and is valid.

B.3 Technical journals

Journals provide current information and may be important for legal and technical reasons; they should be regularly scanned, although this can be a time consuming process if not well organized. The design office should identify significant journals. A first reader system should be introduced by which staff are assigned to read selected journals. Each first reader should be required to scan assigned journals within a reasonable time of receipt, say one week, and to note articles to be drawn to the attention of other staff or extracted. An indexing or referencing system is essential so that articles can be recalled when needed.

B.4 Standards

Current editions of selected standards should be held, listed and updated. Other standards should be obtained to meet the needs of any particular project and retained in the project file.

Relevant technical reports should be held, listed and updated.

Superseded standards may need to be retained; they should be kept separate from current standards and marked 'Superseded'.

B.5 Statutory instruments

Relevant statutory instruments should be held and updated. The design team leader should ensure that all design staff are aware of this facility and that it is consulted when necessary. Some proprietary databases provide lists of construction-related statutory instruments.

B.6 Design guides and data sources

The source documents for all prescribed design procedures and design data should be held. When information or data are required beyond the scope of the design guides held in the library, design unit leaders should seek suitable material and validate it.

B.7 Catalogues

Catalogues should be set out according to some prescribed arrangement. This should be one of the following:

– by source (e.g. manufacturer) alphabetically;

– by subject (bricks, doors, fans etc.) alphabetically; or

– by a formal arrangement, such as CI/SfB [7].

Catalogues of all approved suppliers should be held and maintained. This may be called the core set of catalogues. Other catalogues should then be regarded as for information only and the information they contain should not be used unless specifically validated.

Catalogues obtained and used specifically for an individual project should be held with the project file.

B.8 Other technical material

This may include text books, reference books, occasional papers and reports. Such material should be validated by the user on each occasion that it is used.

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List of references

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 4778 :	*Quality vocabulary*
BS 4778 : Part 2 : 1991	*Quality concepts and related definitions*
BS 4778 : Part 3 :	*Availability, reliability and maintainability terms*
BS 4778 : Part 3 : Sec 3.1 : 1991	*Guide to concepts and related definitions*
BS 4778 : Part 3 : Sec 3.2 : 1991	*Glossary of international terms*
BS 7000 : Part 10 : 1995	*Glossary of terms used in design management*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 1192 :	*Construction drawing practice*
BS 1192 : Part 1 : 1984	*Recommendations for general principles*
BS 1192 : Part 2 : 1987	*Recommendations for architectural and engineering drawings*
BS 1192 : Part 3 : 1987	*Recommendations for symbols and other graphic conventions*
BS 1192 : Part 4 : 1984	*Recommendations for landscape drawings*
BS 1192 : Part 5 : 1990	*Guide for structuring of computer graphic information*
BS 4940 :	*Technical information on construction products and services*
BS 4940 : Part 1 : 1994	*Guide for management*
BS 4940 : Part 2 : 1994	*Guide to content and arrangement*
BS 4940 : Part 3 : 1994	*Guide to presentation*
BS 7000 : Part 2 :[1)]	*Guide to managing the design of manufactured products*
BS 7000 : Part 3 : 1994	*Guide to managing service design*
BS EN ISO 9001 : 1994	*Quality systems — Model for quality assurance in design, development, production, installation and servicing*

Other references

[1] GREAT BRITAIN. The Construction (Design and Management) Regulations, 1994. LONDON: HMSO.

[2] O'REILLY, J.J.N. *Better briefing means better buildings*, Building Research Establishment report, 1987, ISBN 0 85125 213 3.

[3] ROYAL INSTITUTE OF BRITISH ARCHITECTS (RIBA). *Model plan of work for design team operations*. Obtainable from RIBA Publications, Finsbury Mission, 39 Moreland Street, London EC1V 8BB.

[4] *CPI Production Drawings — A code of procedure for building works*, Building Project Information Committee, 1987, ISBN 0 9512662 1 7.

[5] *CPI Project specification — A code of procedures for building works*, Building Project Information Committee, 1987 ISBN 0 9512662 2 5.

[6] *CPI Common arrangements of work sections for building works*, Building Project Information Committee, 1987.

[7] ROYAL INSTITUTE OF BRITISH ARCHITECTS (RIBA). *CI/SfB Construction indexing manual*. RIBA, 1976, abridged reprint 1991. Obtainable from RIBA Publications, Finsbury Mission, 39 Moreland Street, London EC1V 8BB.

[1)] In preparation

BSI — British Standards Institution

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BSI
389 Chiswick High Road
London
W4 4AL