BS 7000-4:2013

Incorporating Corrigenda Nos. 1 and 2

BSI Standards Publication

Design management systems

Part 4: Guide to managing design in construction

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January 2014	Correction to Figure 1
October 2014	See Foreword

Contents

List of tables

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 38, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 December 2013. It was prepared by Technical Committee B/555, *Construction design, modelling and data exchange*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7000-4:1996, which is withdrawn.

Information about this document

Text introduced or altered by Corrigenda Nos. 1 and 2 is indicated in the text by tags [C1] ⟨C1⟩ and [C2] ⟨C2⟩. Minor editorial corrections are not tagged.

Relationship with other publications

This part of BS 7000 relies significantly on methods and processes described in BS 1192, PAS 1192-2, and BIP 2207[1].

Use of this document

As a guide, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

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.

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0 Introduction

0.1 General

The aim of the design process is to provide information that enables a project to be completed in a manner that satisfies client requirements. These requirements might include the provision of information useful to the period of operation of the building/facility. The manner of that provision might be in the form of a Building Information Model (BIM) [1)].

The client could be a user, owner occupier, investor or construction contractor. The role is sometimes described as employer, emphasizing the financial relationship and the authority and control that this position carries.

0.2 Collaborative working

The introduction of new technologies, in particular BIM, brings with it a greater imperative for operating a collaborative design process across the recognized design disciplines and incorporating economic and process considerations. This increases the need for greater rigor in the management of that process, and for the application of appropriate measures and techniques. The benefits of true collaborative working have been known for many years, but it has struggled to gain favour due to perceived liability/financial risks involved in the interdependencies necessary to operate in this way. A properly managed process minimizes these risks significantly. A part of that process is placing any residual risk with those best placed to resolve it in a properly managed environment. Construction agreements do not generally prescribe management processes but the application of good processes is expected and accommodated within standard and conventional contract forms. This British Standard seeks to provide guidance that is appropriate for a wide range of procurement routes/choices and the agreements that support them; and for the application of technology at levels 0, 1 and 2 of the Bew/Richards maturity model (Figure 1) for the application of CAD and BIM technology. The guidance is also generally appropriate where primarily manual or a mix of manual and computer drafting methods are used.

0.3 The influence of new technologies

The speed of uptake of new technologies in the construction and related industries is increasing, and advanced CAD and BIM systems are becoming more widely adopted. Figure 1 shows a model against which this British Standard assists in the implementation of Building Information Modelling and Management [BIM(M)]. The purpose of the levels is to categorize types of technical and collaborative working to enable a concise description and understanding of the processes, tools and techniques to be used.

The levels are as follows.

- Level 0, CAD: usually 2D with paper or electronic paper, e.g. PDF, as the most likely data exchange mechanism. Management is likely to be post design coordination requiring the resolution of discrepancies rather than collaboration.
- Level 1, Managed CAD: in 2D or 3D format using BS 1192, with a collaboration tool providing a common data environment, possibly some standard data structures and formats. Commercial data managed by stand-alone finance and cost management packages with no integration.

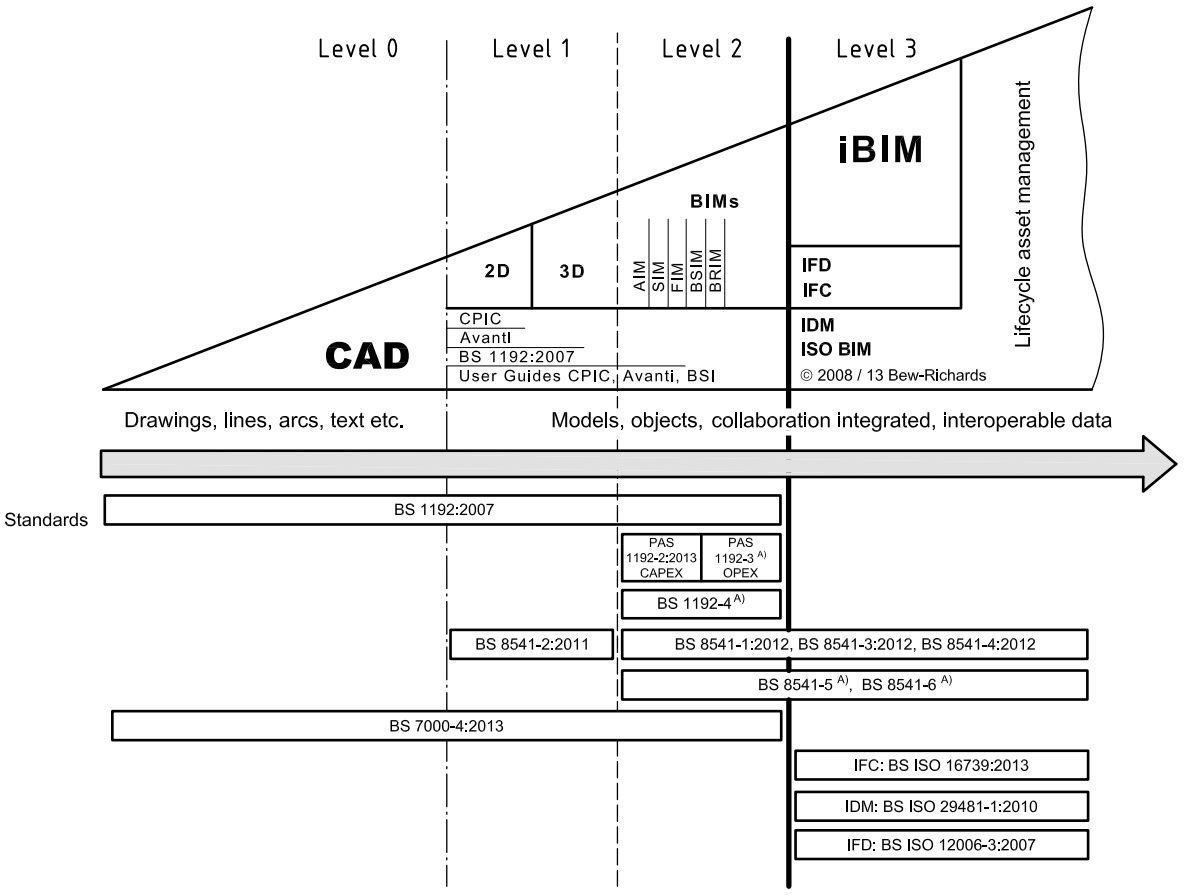
[1)] The acronym BIM is used for all building activity including engineering infrastructure works such as road and railway construction.

- Level 2, Managed: 3D environment held in separate discipline BIM tools with attached data.
- Level 3: Fully open process and data integration enabled by IFC/IFD. Managed using a collaborative model server.

This British Standard is a part of a range of documents applicable to the developments in the use of new technologies, and relates to levels 0, 1 and 2 of the maturity model (Figure 1). For the foreseeable future, any design or construction business is likely to be operating at any or all of these levels concurrently, so this British Standard is equally applicable to all the levels. Within level 3, additional guidance is required, in particular to cover references to managing the process related to both capital and operational expenditure aspects. Within level 3 those responsible for design management require a greater understanding of the function of the 〚C2〛 systems. 〈C2〉

Figure 1 **Maturity model showing standards and guidance applicable**

〚C1〛



〈C1〉

A) In preparation

0.4 The effect of construction procurement

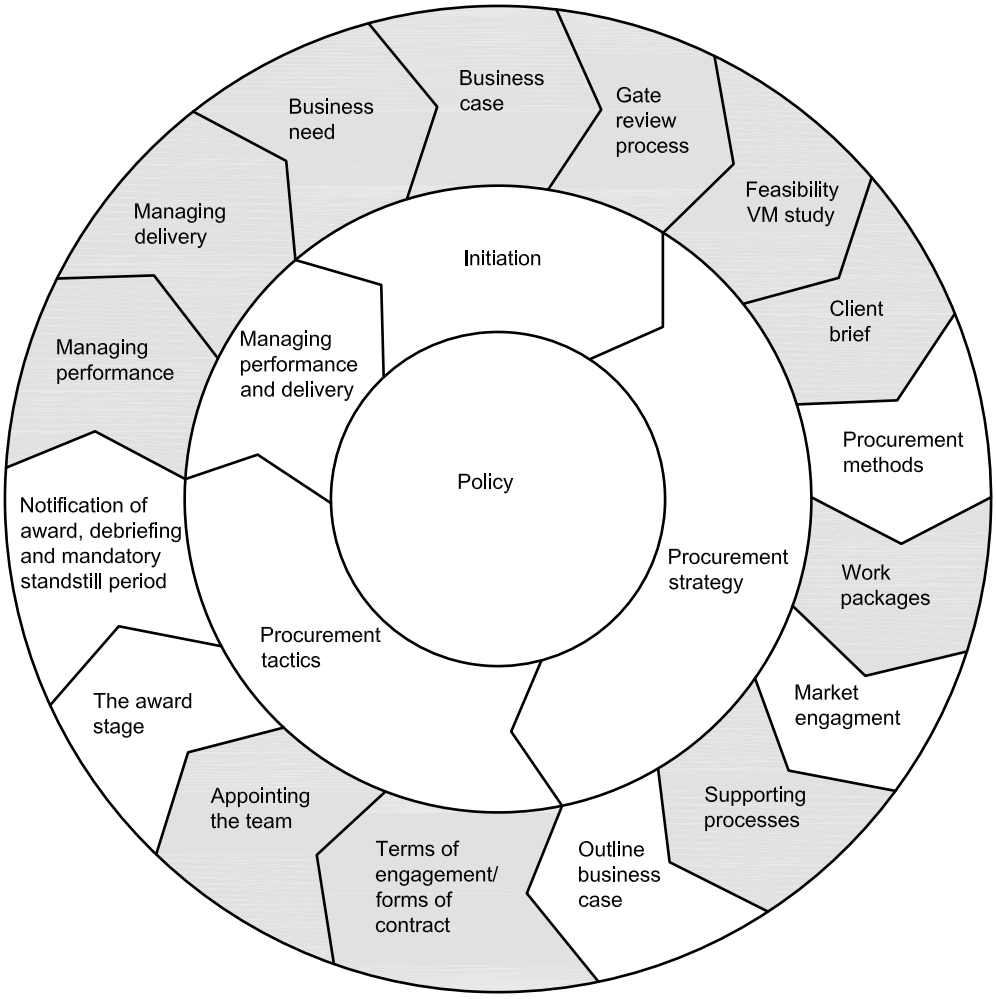
Construction procurement takes various forms, and BS 8534 gives recommendations on the development within a public or private sector organization of policies, strategies and procedures for the procurement of construction in the built environment.

Three basic aspects of design procurement are common to all methods of construction procurement:

- Clients/employers having a business need for construction requiring design that leads to the creation of a project with an overall management structure within which design management operates.
- Design capability, provided by the construction industry, and often distributed among many organizations in the form of managed design facilities providing design services referred to in this British Standard as tasks.
- Client/employer requirements that are set out in an agreed brief that is realized through various agreements.

This British Standard gives guidance on achieving a managed design, the objective of which is to fulfil the brief. It does not set this within any particular procurement organizational frameworks.

Figure 2 **Procurement as defined in BS 8534**



Shading indicates aspects critical to the design process.

0.5 Roles and responsibilities (see Figure 3)

With the increase in the use of BIM, the publication of PAS 1192-2 and the CIC BIM Protocol [2] the role of Information Manager has been formalized (see Note 3 to Table 1).

Table 1 **Functions and titles used in BS 7000-4**

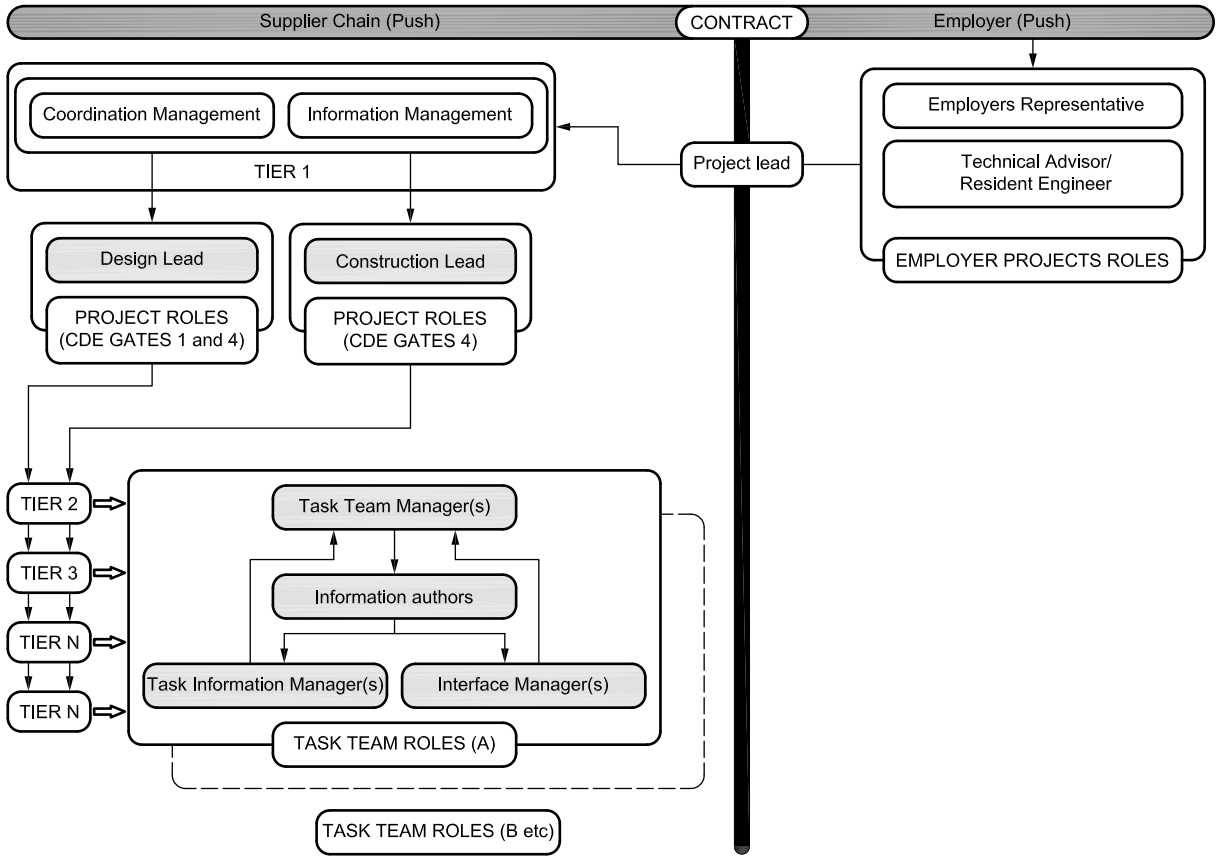
Function	Functional titles
Overall	
Total project delivery – see Note 2 (Information management – see Note 3)	Project Lead: PL (Information Manager: IM)
Design	
Total project design (Information management, design – see Note 3) (Interface management, design – see Note 3)	Design Lead: DL (Information Manager, Design: IMD) (Interface Manger, Design: IfMD)
Design tasks: DT1, DT2, DT3, etc.	Task Team Managers: TTM1, TTM2, TTM3, etc.
(Information management, task design – see Note 3)	(Information Manager, Task Design: IMTD
Construction	Construction Lead: CL
Total Construction delivery (Information management, construction – see Note 3)	(Information Manager, Construction: IMC)

NOTE 1 The single point of responsibility for total project delivery can operate on either side of the construction arrangement. Most commonly this is on the supply side but for procurement methods such as construction management it might be on the employer side. On small projects an individual might have several roles.

NOTE 2 Depending upon the size and nature of the project, any of the positions in this table might have an internal support team with various levels of formal, delineated and agreed delegations in place, for example related to particular zones of the total project.

NOTE 3 PAS 1192-2 and the CIC BIM Protocol [2] set out a specific function of information management and role of Information Manager. This role can be undertaken by another member of the team, for example the Project Lead, with the scope of services incorporated into the appointment of that person. CIC has published a Scope of Services (CIC/INF MAN/S) [3] for the role of Information Manager the most significant feature of which is that the Information Manager has no design responsibility or duties.
PAS 1192-2 also introduces the function of interface management and role of Interface Manager primarily responsible for spatial coordination particularly for issues that have compromised the design process protocols and become flagged using clash rendition as clashes in the model.

Figure 3 **Roles and responsibilities in the management of design (adapted from PAS 1192-2)**



Task teams are any team assembled to complete a task (e.g. architictural task teams, structural task team, multi disciplinary task team) to design a specialist part of the project such as a bespoke curtain wall. This might also include collaberation between the specialist and professional design team.

In an infrastructure project there might be rail or road task teams, station task teams or bridge task teams.

The Project Lead is responsible to the employer for total project delivery. The placing of this role depends on the procurement method chosen. For example, in the case of design and construct "turnkey" contracts it is to the left of the contract line, and in the case of construction management to the right.

0.6 The effect of scale

For large projects, divisions of managerial responsibility might be clearly apparent and follow the pattern set out in Figure 3, deploying separate roles and possibly teams to all of the functions listed in Table 1. Other related specific project or organization roles requiring, for example, particular specialist knowledge might also be introduced. However as projects reduce in size and/or complexity, the distribution of responsibilities and functions reduce, eventually to the point where all project and design management is the responsibility of one person working with design originators.

Section 1: General

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. The guidance given is applicable to purpose-built constructions, equipment and components. It is intended for those who work in and with the construction industry, particularly designers and those managing design. Where general management principles are given, they may be adapted to suit any size of design organization or construction project. The guidance given is applicable to management of design activities throughout the life-cycle of a construction project, and the principles of the facilities management function.

This part of BS 7000 makes reference to, but does not cover activities prior to client/employer initiation of a project or factors considered by clients/employers when selecting the most appropriate form of construction procurement.

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

NOTE 2 This part of BS 7000 complements BS EN ISO 9001.

2 Normative references

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

BS 1192*, Collaborative production of architectural, engineering and construction information – Code of practice*

BS 4778-*2, Quality vocabulary – Part 2: Quality concepts and related definitions*

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

BS EN 12973, *Value management*

BS EN ISO 10012, *Measurement management systems – Requirements for measurement processes and measuring equipment*

BS ISO 12006-*2, Building construction – Organization of information about construction works – Part 2: Framework for classification of information*

PAS 1192-2*, Specification for information management for the capital/delivery phase of construction projects using Building Information Modelling*

3 Terms and definitions

For the purposes of this part of BS 7000, the terms and definitions given in BS 7000-10, BS 4778-2, BS 1192 and PAS 1192-2 and the following apply.

3.1 CDM Coordinator
employee whose role is to "advise and assist the client to comply with their duties under the Construction (Design and Management)] Regulations" [2)]

[2)] From *Explanatory Memorandum to the Construction (Design and Management) Regulations 2007 No. 320* Avaliable from http://www.hse.gov.uk/construction/cdm/legal.htm

3.2 industry foundation classes (IFC)
neutral and open specification, object-based file format with a data model developed by building SMART to facilitate interoperability in the architecture, engineering and construction (AEC) industry

NOTE See BS ISO 16739 for further information.

3.3 international framework for dictionaries (IFD)
standard for terminology for libraries or ontologies

Section 2: Framework for design management

4 General

Figure 2 illustrates construction procurement processes within which design management takes place as a critical activity. Initiation involves a business needs assessment, the preparation of a business case and the establishment of a gate review process. A feasibility/value management (VM) study informs client brief development and the selection of a procurement strategy aligned with the clients requirements, particularly programme, cost surety and quality.

After confirming that the business needs and business case for the project have been established, a consolidated brief should be derived. Project and design management activities should be structured in the form of a process plan (see Clause **9**).

5 Formation and management of the design team

The choice of procurement method affects the contractual and management relationships within the design team, but not usually the technical tasks that need to be undertaken to produce a design. The whole design team, or any particular task team, can be within the client/employer's own organization, an independent consultant or part of a construction contractor's organization or most commonly, permutations of these. For all procurement methods there should be a consistent and coordinated overview and management of the design functions and design. Where there is consensus that the design arrived at is the best resolution of the client brief and employers requirements (including cost aspects), design issues ideally should not be compromised by other considerations. Suggestions from those responsible for production can inform and enhance design; these should be fed formally into the design process and be properly managed. Where such suggestions are introduced via the Construction Lead this process is the responsibility of the Project Lead supported by the Design Lead and Task Team Managers.

The Project Lead should contribute to the overall planning of the project and be responsible to the employer/client (preferably directly) for planning, programming, controlling and delivering the design content. The Project Lead should cooperate with the CDM Coordinator, liaise with the Design Lead and other design task teams and ensure that effective communications and decision making systems are applied. On projects carried out in accordance with PAS 1192-2, the CIC BIM Protocol [2] and the CIC Outline Scope of Services [4] for Information Management the Design lead liaises closely with the Information Manager (see Figure 3).

Detailed planning and programming requires input from design task teams, when appointed, which can lead to revisions of the initial estimates of design cost and time targets.

6 Responsibilities

On projects carried out in accordance with PAS 1192-2, the CIC BIM Protocol [2] and the CIC Outline Scope of Services for Information Management [5], some information exchange activity management responsibilities are tabulated and scheduled (CIC/INF MAN/S) for the Project Lead, Design Lead, various Task Team Managers and members, the Information Manager and interface manager in order to deliver a coordinated design.

Table 2 lists additional management responsibilities which should be covered by agreement and allocation by the Project Lead, Design Lead and various Task Team Managers in order to deliver a coordinated design. This list is not exhaustive and is intended to provide a basis for project specific checklists.

Responsibilities follow the hierarchy in Figure 3.

Table 2 **Checklist for management responsibilities**

Responsibility	Primary responsibility (singular) (R) [A)]	Subsidiary responsibilities (could be multiple) (R A C I) [A)]	Notes
Add-to, delete-from or amend/elaborate on the items in this column	PL – R	All – A.C.I	Project Lead takes ultimate authority for this list as developed for the project.
Establishing the design related client requirements and defining them in a project brief and participating in the development of a design brief			
Aligning client requirements with those of other stakeholders			
Establishing employer's information requirements (EIR)			
Advising on and possibly undertaking design procurement			
Establishing protocols for aspects of inovated design from an overall project perspective and from the perspective of individual design task teams			
Coordinating the activities of the design team with particular emphasis on space/tolerances strategy			
Establishing a relationship with and between task team personnel and formulating overall targets for the design team that are consistent with the project plan			
Participating in the overall development and monitoring of the design related elements of the project implementation plan (PIP) [B)] and master information delivery plan (MIDP) [B)] and task information delivery plans (TIDP) [B)]			
Advising on the selection of the necessary resources for the design activity and establishing a resource profile related to design stages			
Identifying any need for sub consultancies and specialists.			
Preparing the design related aspects of the process plan paying particular attention to the relationships and dependencies of information content and delivery programme			
Ensuring that all aspects of the commission are undertaken by design personnel of appropriate competence.			
Co-operating with the CDM Coordinator and assisting in the development of the health and safety documentation.			
Collating cost and time data from design task team and establishing a coordinated programme			
Collating contributions from the design task team and establishing a consolidated brief.			

Table 2 **Checklist for management responsibilities**

Managing the overall design function for the commission, including applying cost and design control procedures and ensuring that the outcomes maintain acceptable qualities and value			
Monitoring and controlling progress &monitoring the production and issue of design information in keeping with the programme			
Establishing channels of communication, including communication between design task teams, and arrangements for the distribution of information			
Establishing compatible design information interfaces and a verification strategy, and determining the form and content of design output including classification (e.g. Uniclass) and indexing			
Establishing value engineering (VE) protocols and undertaking VE exercises			
Establishing, maintaining and acting upon a project risk register			
Liaising with the design task teams, client/employer and specialist advisers and obtaining the necessary approvals			
Obtaining planning, building control and other essential approvals at predetermined stages.			
Identifying relevant design procedures and sources of design data including issues such as space strategy and tolerance and fit within and between construction elements			
Appraising commissioned designs from construction contractors, their sub-contractors and others according to relevant contractual requirements			
Appraising designs related alternative proposals from construction contractors, their sub-contractors and others particularly in respect of value engineering outcomes.			
Visiting the site during construction if required by the commission or to properly execute the role			
Setting up procedures including all client liaisons for post occupancy evaluation exercises such as Soft Landings			
Completing all client/employer acceptance and approval processes			

[A] R = Responsible, A = Authorise, C = Contribute, I = Inform (keep informed).

[B] As defined in PAS 1192-2.

7 Establishing the brief

7.1 Briefing process

NOTE Preparing a satisfactory brief is a complex task and a comprehensive description of how this can be undertaken is beyond the scope of this British Standard.

A construction brief is a clear, concise and comprehensive description of the employer/client's needs. Briefing typically requires input from the client/employer and design task teams. It can also involve other parties, such as user groups, planning authorities, local utilities, etc. The briefing process continues through early design to a point within the design development stage, when a consolidated brief should be agreed between the client/employer and all the contributors to the project and finalized. The brief is always owned by the client/employer, but its preparation is often commissioned from and undertaken by members of the design team. An important objective of producing a consolidated brief is to avoid abortive work arising from late changes. The earlier in the design development stage this can happen the lower the risk of abortive work. However, some design decisions that can affect the brief have to be proved by further development, coordination, costing and possibly consultation. Use of a formal data exchange scheme creating an approval gateway that is signed-off by the client/employer and agreed by the design and construction team is fundamental in achieving this. For BIM projects, EIR schedule should be incorporated with tender documentation in accordance with PAS 1192-2. Early consideration should be given to the preparation of the EIR and it is preferable to start this at the initial briefing stage.

7.2 Initial brief

An initial brief might range from a broad statement of intent to a comprehensive technical statement of client/employer requirements (incorporating an EIR). The initial brief should be analysed and resolved into a clear statement from which a more specific project brief is developed.

The design team should have 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 of the client/employer requirements;

NOTE Not the design response at this stage.

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

e) consideration and articulation of regulatory and statutory requirements;

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

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

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

i) aesthetic considerations, for example, house style, landscaping and colour and finish preferences; and

j) client/employer sign off.

Some of these might need particular study such as a formal VM study (see BS EN 12973) including research and risk analysis that could be carried out by the design team or specialist advisers appointed by the client/employer. The source and status of such input should be recorded in the initial brief.

7.3 Brief development

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

The actions that follow can include work on tasks that are separate commissions that might need to be processed as projects in their own right. The additional work might include:

a) technical and economic feasibility study;

b) need evaluation;

c) prototype or model evaluation;

d) design exploration;

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

NOTE These might require the production of point clouds or LiDAR. [3)]

f) environmental impact assessments;

g) planning investigation, negotiation and submissions;

h) maintenance and operation strategies in accordance with PAS 55;

i) any shared data environment for the project; and

j) client/employer sign off.

A project brief that forms the starting point for the development of what is to become a consolidated brief should be compiled based on these findings (**25.3**).

NOTE Further information on briefing can be found in BIP 2207 [1].

8 Project plan

Planning the design management related aspects of a project involves identifying all significant work elements and their content, representing them as tasks, assessing their interdependence and organizing the work so that orderly progress can be achieved.

This planning should include:

a) establishing the range and extent of all design contributions required to fulfil the project as identified in the brief (and EIR) and therefore identifing the composition of the design team;

b) identifying the need for other resources and equipment, such as administrative support, accommodation, storage, technical information and distribution protocols;

c) establishing key dates for specific objectives (particularly critical data exchanges) and start and finish dates for identified tasks such as fabrication lead-in, commissioning and handover, particularly if phased and/or post

[3)] LiDAR refers to remote sensing technology that measures distance by illuminating a target with a laser and analysing the reflected light. The term LiDAR comes from combining the words light and radar.

occupancy evaluation such as Soft Landings, (including initiating the client's facility operations team) to enable the setting of agreed targets against which progress can be measured;

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

e) determining intervals for and the form of, submissions of cost, time and success criteria (quality) for control purposes including gateways/information exchanges.

9 Process plan

The design and construction process follows a sequence of activities that varies in detail and extent for various types of project and in terms of overlap of certain activities dependent on the procurement method chosen. In this British Standard these are referred to as process plans. The best known process plan is the RIBA Plan of Work [5] but there are others, mostly prepared by organizations representing particular construction disciplines. Some, such as Governance for Railway Investment Projects (GRIP) [6] and the Office of Government Commerce (OGC) Gateway system [7] are from the perspective of the employer/client.

A collaborative and unified approach to process planning is advantageous and significantly, and in particular in response to the introduction of BIM and its need for an integrated approach, the CIC has developed a process plan based upon the Scope of Services [4] as originally published in support of the Conditions section of the CIC Consultants' Contract. The multi discipline nature of the CIC document is expected provide a reference for those published by single discipline organizations to align with.

NOTE The 2013 version of the RIBA Plan of Work [5] has already aligned in terms of detailed content, though it uses stage titles consistent with the needs of the architectural profession.

A process plan should state the activities to be undertaken during the design and construction process into occupation against time, including issues such as planning and building control applications. It should also describe the purpose of each stage of the work and the decisions to be taken. The tasks to be completed and the outputs should be defined (data/information exchanges) along with the responsibilities for their delivery.

A generic process plan at its more detailed level may be adapted to accommodate particular project features that could include, for example, particular overlaps of activities or parallel working. This provides a project specific process plan. Ideally, the client/employer should be involved in preparing the project process plan so that client-related activities, such as decision points, formal information exchanges and durations, are properly recognized, understood and agreed by all of those involved in the delivery of the project from both the supply and demand sides.

Figure 4 **CIC Scope of Services [4] as a high level process plan set against other industry process plans [5, 6, 7, 8, 9]**

CIC schedule of service (derived)	Brief	Concept	Definition	Design	Construct and commission	Handover and close out	Operation	In use
RIBA plan of work 2007	Appraisal and brief	Concept	Design development	Technical design	Production information	Mobilization	Construction	Post practical completion
RIBA plan of work 2013	Strategic definition	Preparation and brief	Concept design	Developed design	Technical design	Construction	Handover and close out	In use
BSRIA handbook of P. M.	Preparation	Design	Pre construction	Construction	Commissioning of services	Pre handover	Initial occupation	Occupation aftercare
NETWORK RAIL GRP	Output definition	Pre feasibility	Option section	Single option section	Detailed design	Construct test commission and hand-back		Project closeout
OGC gateways	1 Develop business case	2 Dev. delivery strategy	3A Design brief and concept approval	3B Detailed design approval	3C Investment decision	4 Readiness for service		5 Benefit evaluation

NOTE 1 This illustrates sequences not alignment of content

NOTE 2 The granularity of data maturity is defined through detailed process plans

Generally, successive process plan stages should not be started until everything in the previous stages of those elements has been completed. However the phasing of different parts of large projects that are split into separate sections might mean that this is not always practicable. Completion of a stage of the plan is conditional on coordination of design between all team members, including any construction contractor designed elements, and the approval of the Design Lead and, where appropriate, the Project Lead and/or the client/employer. Anticipation of approval could result in work having to be corrected at a later stage, risk a liability being incurred and cause delays in excess of and more costly than the original time gained. Changes should only be made to the process plan as a result of a full risk assessment and an agreed resolution of the issue(s) with all parties involved in that process.

The project process plan should identify and accommodate the briefing and EIR and identify client/employer defined information exchanges. Intra team data exchanges are much more frequent and iterative in nature but ultimately relate to the client/employer information exchange, as shown in Figure 5.

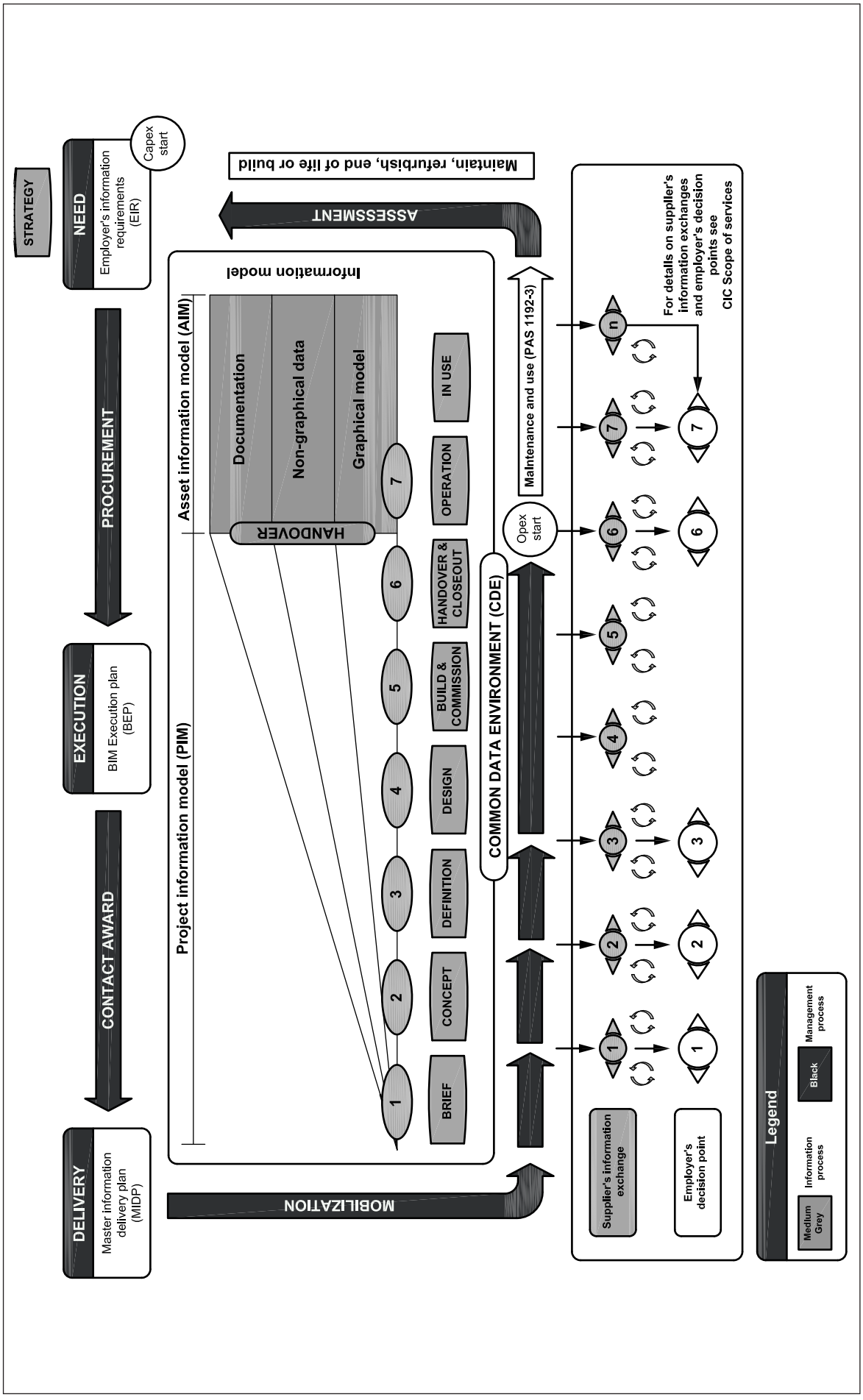


Figure 5 The information delivery cycle

10 Programming

An outline master design programme should be prepared by the Design Lead and approved by the Project Lead. This should be based on the key dates in the project programme and subsequently be expanded to cover all aspects of resource management and decision taking. This should include a project implementation plan that allows the client/employer to assess the capability, competence and experience of design task teams in IT, CAD, BIM and other resources. CPIx [10] provides checklists and proformas. The Design Lead, in consultation with the Project Lead, should prepare and update the programme when any new information (e.g. funding issues, planning issues) becomes available. Where this leads to a major change in the programme, the impact of these changes should be assessed and agreed by all the parties affected. The programme should normally be reviewed in conjunction with project gates and any interim progress reporting. Various software packages are available that can coordinate with other IT systems. The choice of which to use should be made following completion and analysis of the CPIx IT Assessment Form [10] or similar protocol.

Each design task team should agree its contribution to and method of engagement with the project plan. The inter-dependence of design task teams should be established so the compatibility of any separate programme constraints can be tested against each other, and the requirements of the project plan and alignment achieved.

The key dates for inputs from internal and external specialist advisers and decisions to be taken by the client should be included in the programme. The programme should identify time required for necessary approvals.

Timing requirements to enable early groundworks or lead-in times for assemblies, components or items of equipment, particularly those with unique features, should be identified at an early stage. This could involve preselection by the client/employer or construction contractor and the placing of firm orders in advance of completion of the design programme. Preselected items should be reserved with the supplier so they are available at the time of ordering. The accuracy of the predictions included in the programme depends upon the information available when it was prepared and the length of time being projected. It is normal for the programme to be revised and additional detail added to it regarding downstream stages and tasks as more information is known. All revisions to the programme should be subject to notification and change control procedures.

11 Classification

All documents, including project information such as drawings and specification, cost information, and models (model data), should be classified using a classification system in accordance with BS ISO 12006-2. PAS 1192-2 includes information on the application of the various classification tables available and their uses, which include:

a) concept cost information;

b) detailed cost information;

c) concept design information;

d) developed design information;

e) production information;

f) installation information;

g) as constructed information;

h) in use design information; and

i) maintenance cost information.

Current classification systems are being revised to accommodate the use of BIM. Classification is applicable to all types of working and it should support operational issues such as apportioning work, measuring and managing progress and costing work and changes. It should do this in a logical way, and BS ISO 12006-2 provides a framework for national adoption that helps achieve this.

12 Project communications

12.1 General

The Project Lead and the Design Lead should develop a project communications plan that identifies all communication channels and the procedures to be used for preparing, identifying, distributing, storing and clearing of all communications. The core project information should follow the processes described in BS 1192 and PAS 1192-2 which should be built into the project communications plan. The communications plan should be incorporated in the overall project plan.

12.2 Communications methods

Modern communications methods have greatly increased the speed at which people can communicate, but they are sometimes used in an uncontrolled way. Methods of communication that do not require the transmission of definitive formats, such as hard copy documents, or operate to a controlled electronic communication protocol (e.g. use of the telephone where there is no logging of transactions), should be controlled, and important information or agreements confirmed definitively and traceably. As a minimum, procedures should make clear what constitutes delivery, recording and acknowledgment of transmissions.

12.3 Communications channels

The processes of collaborative working described in BS 1192 and PAS 1192-2 ensure that members of the design task teams are aware of each other's general activities and progress and the details of technical design solutions through the Common Data Environment (CDE). However to maintain effective communications between the design team, client/employer and the project management team, the routine methods of communication should also be specified.

The Project Lead, Design Lead, and Task Team Managers, should establish and agree a focus for communications within the design team and, systems for, approval of all communications between the design team, external agencies and the client. For projects carried out in accordance with PAS 1192-2 this might involve the Information Managers.

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

Task Team Managers should be aware of and approve where necessary all communications between their design task unit, other design task units and the Design Lead.

Design originators 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.

12.4 Progress reporting

The Design Lead should issue regular progress reports on the status of the design programme to the Project Lead and the relevant task team personnel. Progress reports should highlight any actual or potential deviations from the project plan and the reasons for them. The Design Lead should be responsible for ensuring that corrective action is taken to resolve any problems that arise.

Task Team Managers should provide the Design Lead with progress reports at an agreed frequency, content and format, for consolidation into the Design Lead progress report.

12.5 Document and data distribution

The Project Lead should be responsible for ensuring that design documentation and data is strictly controlled and disseminated efficiently to the intended recipients. A formal document/data distribution system aligned with the CDE principles (see Note 2) should be devised, agreed by all participants and used. It is the responsibility of each Task Team Manager and other participant to determine when an informal communication is formalized within the system. Electronic documents should be subject to systems of equal rigour to those for paper documents.

The document distribution system should include a standard method of identification for all formal project documents/data sets including as a minimum a short project title and project reference code that is applied regardless of any other methods of identification used by participants for their own purposes. The objective is to provide full traceability and control of design documentation.

NOTE 1 The CPIx provides guidance and downloadable pro-forma checklists, meeting agenda and monitoring protocols covering aspects of formal communications [10].

NOTE 2 The Common Data Environment (CDE) described in BS 1192 and BIP 2207 [1] is the core coordination and delivery process for production information. PAS 1192-2 adds additional requirements for non-graphical data.

13 Costs to the client/employer

Costs to the client usually include 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;

e) construction, and

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

Some of the above can be combined within certain methods of procurement. The relative magnitudes of costs and their effect on the eventual lifetime project outcome should be taken into account. For example, professional fees are a very small part of the overall costs in the capital phase of a project when considering its whole life, yet they have the biggest effect on the whole life effectiveness of the construction. Inadequacies in design can rarely be rectified and can affect the performance of the construction significantly but also particularly inspired design can create greater than envisaged efficiency in the way the finished project operates. All costs should be optimized wherever possible to arrive at the most advantageous overall cost plan in keeping with the client/employer's financial policy. Operational costs [see Clause **13**f)] should be defined using agreed methods for demonstrating long term cost benefits.

Section 3: Design resource management

14 Staff resource

The skills and availability of professional and technical staff should be commensurate with the anticipated workload. This is a provision of most codes of conduct issued by professional institutions.

The appropriate management, administrative and other staff needed to meet requirements should be assessed so that adequate resource can be planned. Although permanent staff levels should ideally be kept constant, arrangements should be made for dealing with short-term overloads (such as the use of agency staff or sub-letting work) under controlled conditions and appropriate approvals where relevant.

During the planning process factors that might affect the future availability or effectiveness of staff should be identified. New staff should be adequately trained and time should be allowed for continuing professional development.

15 Innovation and value management (VM)

In managing innovation attendant risks should be assessed and controlled. Innovation might be clearly present, such as in obviously innovative overall design, main design features or materials use, or could be less obvious and more likely to be overlooked, such as the introduction of elements of off-site construction. They might involve less familiar processes such as formal Design for Manufacture and Assembly (DFMA). 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 policy and attendant procedure should be developed to provide satisfactory control of innovative design. Anything that is genuinely innovative should be entered into the risk register and the client should be informed of proposals to apply innovative features with all approvals confirmed.

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

VM should be carried out in accordance with BS EN 12973, which describes the process in detail and shows how VM activities within a generic process align with the VM contributions to the exercise shown in Table 3.

Table 3 **Value management**

BS 12973 process stage	VM Contribution	CIC Scope of services (indicative)
Inception	Establish need and outcome	Brief
Concept	Improve strategy	Concept Definition
Feasibility	Enhance viability	Design
Implementation	Maximise cost effectiveness	Construct and commission Handover and closeout
Use	Improve product or process	Operation In use

NOTE The CIC Scope of Services column is included here for comparison purposes, it is not included in BS 12973.

16 Technical information

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

a) internal libraries;

b) external libraries (public, institutional, educational industrial/commercial);

c) information databases [see also f)];

d) manufacturers;

e) specialist, consultants and proprietary sources; and

f) electronically via storage media and the internet either as electronic version of conventional information or as interoperable data for use within a BIM system.

It should be the responsibility of the Task Team 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.

17 Manual, CAD and BIM production

The responsibility for introducing, developing and supporting the use of CAD and/or BIM system should be clearly defined. Where necessary, this should include coordination of these systems and manual drafting 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 and BIM system data should be defined and strictly enforced. BS ISO/IEC 27000 comprises information security standards published jointly by ISO and the International Electro-technical Commission (IEC). It provides recommendations on best practice in information security management, risks and controls within the context of an overall information security management system (ISMS).

Some clients/employers might have particular requirements that are a prerequisite of the commission. Guidance such as BS 1192, PAS 1192-2 and support processes such as the CPIx protocol [10] is likely to lead to procedures becoming more standardized and generally applied in recognizable formats to different projects.

The use of technology requires specific training related to hardware and software. Appropriate procedures, such as training provided by software vendors, should be in place to secure and monitor this need. The drawings and data produced using a CAD or BIM system should, as a minimum, meet the same requirements, including verification, as those that are manually produced.

When selecting computer hardware and software, their compatibility with the systems used by the clients/employers, other task teams and construction contractors with which the organization works should be taken into account. The CPIx protocol [10] provides a format for IT assessment and alignment.

18 Records management

Design teams need properly managed administrative support to work effectively. The scale of this support depends on many factors such as the size and nature of the organization and the size and complexity of the project, etc.

Procedures should be defined, and appropriately managed staff made available to provide services such as:

a) correspondence e.g. incoming and outgoing mail, facsimile, recording of telephone conversations;

b) filing and documentation management, e.g. storage and retrieval systems, weeding and destruction programmes, archiving;

c) the provision of stationery and other office consumables, general IT and communications;

d) security to safeguard confidential information and valuable equipment;

e) finance, accounting and cost control, services such as payment of wages and salaries, V.A.T., dealing with the HM Revenue and Customs;

f) insurance to cover professional indemnity, employers' liability, the various construction insurances necessary, 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 such as copyright;

j) premises facilities management;

k) staff welfare;

l) documentation relating to Instruments and technical equipment.

BS ISO 15489-1 provides guidance on managing records. BIP 0008-2 [11] provides guidance on managing electronic records and particularly their legal admissibility.

19 Technical equipment

An organization's requirements for surveying, measuring and inspection instruments and other technical equipment should be assessed regularly. Where necessary, training in the use of equipment should be provided. If surveying or measuring instruments are held, these should be properly stored, checked, calibrated and maintained in accordance with BS EN ISO 10012. Each item should have its calibration and maintenance record recorded in an inventory, filed in an accessible way and archived in accordance with the records management procedures to provide a calibration, maintenance and repair history. Responsibility for holding and issuing equipment should be clearly defined.

Instrument hire is an alternative to ownership for equipment that is used only occasionally. Checks of calibration and accuracy should be as rigorous for hired equipment as for owned equipment and should be carried out in accordance with BS EN ISO 10012.

20 Procuring design, surveying and other related services

Procurement processes for procuring design and surveying services are in part determined by the choice of procurement route (including professional appointment contracts), particularly with regard to the point at which final decisions on procurement made and construction prequalifying questionnaires (see PAS 91 for further information).

Factors might include:

a) experience and qualification which may include membership at a particular level of the professional institution or similar body. Experience may include:

   1) client sector;

2) facility type;
3) construction methods/type;
4) previous relationships with others in team;
5) other feedback; and

b) resources/people in terms of general capacity and particularly any critical individuals;

c) systems:
1) quality management;
2) environmental management;
3) health and safety;
4) equal opportunities;

d) insurances; and

e) financial standing.

21 Extracting data requirements

Ideally, briefs from employers/clients are comprehensive and specific but they are sometimes inadequate. In cases where the brief is inadequate the information should be interpreted and explained such that the employer/client can understand and take ownership.

The Design Lead should ensure that the appropriate Task Teams have the expertise necessary to extract a brief that data requirements can be built upon, see ⟦C2⟩ PAS 1192-2 ⟨C2⟧ for further information.

This is particularly important for BIM projects as in their case levels of definition/detail are consistently built. The flow and exchanges of information should also be managed.

In order that BIM can be used effectively, the brief should specify formal plain language questions against which data requirements should be entered.

These questions and data requirements relate to each stage of the process. Some are of a general nature and can be used as a standard question set, some are employer/client specific and others are project specific. PAS 1192-2 provides detailed and specific guidance on this. Information on projects that are not in BIM format is in BS 1192.

22 Intellectual property and copyright

When individuals create material that forms part of a design they generate intellectual property (IP). The employer/client generally has the use of this IP for the purposes of realizing the works that they have commissioned, but those working on a project and contributing IP have an interest in retaining a degree of control over it. The Design Lead is responsible for ensuring compatibility of all contract conditions and operating procedures, including those related to IP, in collaboration with the Task Team Mangers.

For BIM projects up to level 2 (see Figure 1), this principle is retained and the CIC BIM Protocol [2] which is intended to be incorporated into all direct contracts between the employer and project team members includes provision to achieve this with shared electronic data. It states that the employer/client is responsible for ensuring that the same conditions are in place with each project team member. The employer/client normally delegates this responsibility to the Design Lead and Task Team Managers, seeking advice from the Design Interface Manager over issues, such as pre-existing IP.

When material that has been created by third parties is necessary to a BIM system, the BIM owner should ensure that they have the IP rights to use that material.

Copyright follows the same pattern as IP. Standard UK practice is that the creator of the original information retains ownership of that information and the copyright. They then agree licenses to other parties under certain conditions.

Section 4: Design process management

23 General

The process of winning a design commission is not within the scope of this British Standard. For information on the procurement processes see BS 8534.

As far as possible, detailed design of the building should be complete before production information begins, and drawings and the specification should be complete before tender action and construction. However, in practice the preparation of production information often overlaps with both detailed design and construction. Sometimes overlap can be advantageous, for example, in compression of overall project programmes and making best use of the design skills of specialist constructors. However, overlap can also give rise to poor technical and dimensional coordination, resulting in wasteful reworking and defects. Design is a highly iterative process, with many complex dependencies between elements, and many review and revision cycles. Generic and project specific process plans (see Clause **9** and Figure 4) guide this overall process.

Application of the processes described in BS 1192 and the guidance in BIP 2207[1], and for BIM projects PAS 1192-2, provides the framework for the project information management requirements for drawings, specifications and parametric and data models. These documents recommend the use of other conventions particularly:

- CIC Scope of Services [4];
- Outline Scope of Services for the Role of Information Management [3];
- COBie UK 2012 [12];
- CIC BIM Protocol, First Edition, 2013 [2];
- Employer's Information Requirements (EIR) [13];
- CPIx Protocol [10].

24 Pre-commission review

Before a commitment is made to proceed with a project, each Task Team Manager, should confirm that the commission is suitable for acceptance by establishing the following:

a) the proposed commission is financially acceptable;

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

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

d) all perceived risks can be contained within acceptable limits by carrying out a risk analysis and applying effective risk management techniques.

A checklist should be available requiring a judgement to be made concerning the features most likely to cause concern. These features might fall into categories such as:

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 with an investigation of past problems and opportunities.

After completing these investigations, Task Team Managers should decide whether to recommend acceptance (with conditional internal or external changes if necessary), or rejection of the commission at the appropriate management level within the organization. It might need to take account of the wider strategic and commercial issues outside the scope of the Task Team Manager's investigation, for example, whether to accept marginal commissions to secure a future stream of profitable work.

25 Design brief

25.1 Interpretation of the project brief

A client/employer project brief is rarely sufficiently detailed to meet design requirements and a design brief should therefore 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 for the works. Guidance on project and design brief development is given in **7.3**.

It is usually the responsibility of the Design Leader, through the coordination of contributions from design task units, to develop a design brief and to ensure that design is carried out accordingly, within cost and programme constraints.

25.2 Managing brief development

The development of the brief requires the project team and/or individual design task units to undertake activities such as:

a) assembling all relevant information;

b) initiating studies, if appropriate;

c) testing alternative solutions;

d) preparing an outline scheme; and

e) preparing an outline life cycle cost plan covering design, construction and operational costs.

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

1) legislation;

2) standards;

3) good practice; and

4) needs of subsequent processes.

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

25.3 Consolidated brief

When the brief has been developed to the point where it can be used for detailed design it should be presented to the client/employer as a consolidated brief. Once accepted, it is owned by the client/employer and further changes should be avoided if possible. If changes are essential they should be approved by the client/employer. The consolidated brief generally takes the form of a client/employer report giving sufficient information about the design intentions so that both the client/employer and the design task teams are clear about what is to be designed.

A client/employer report should, as a minimum, contain the following information:

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

b) list of principal participants (client/employer, task teams such as architect, engineer, specialists etc.);

c) identification of design personnel and other significant resources;

d) research undertaken and outcomes;

e) discussion of options, constraints, recommendations and conclusions;

f) description of proposed design solution including:

   1) meeting/interpreting the client's/employer's functional/operational and any other specific requirements;

   2) assumptions and objectives for environmental and other conditions such as Building Research Establishment Environmental Assessment Method (BREEAM) target data;

   3) assumptions and objectives for operational durability/reliability/maintenance requirements;

g) special requirements and provisions;

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

i) limitations (aspects that might fall short of the client's expectations);

j) technical risk (site conditions, use of materials, selection of building services solutions etc.);

k) construction issues;

l) cost plan, including:

m) capital cost;

n) operating cost/cost in use;

   1) on going design programme;

   2) drawings, models and other illustrative material; and

o) supporting calculations.

The client report should be submitted to the client/employer at the agreed date for comment within an agreed period and approval by an agreed date.

25.4 Brief change control

Changes in client/employer requirements after approval of the consolidated brief are likely to render some previously completed work as abortive. The client/employer should be advised when this transition occurs and that such changes are likely to incur a time and/or cost penalty, and in some cases could even compromise other aspects of design.

All subsequent brief changes should be recorded and formally reported to the client/employer and Task Team Managers with a comprehensive assessment of the likely consequences. Where a change could have a significant effect on health, safety, cost, time or reliability, the implications should be assessed by referring 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.

26 Design stages

26.1 General

The construction industry has developed a number of process plans (see Clause **9** and Figure 4), each appropriate for a particular discipline, project type or construction sector, with differences in terminology and the level of refinement of information at stage boundaries. There are also differences in emphasis between the actions to be taken and the outcomes to be achieved.

26.2 Process plans and data exchanges

The development of processes for use with BIM and particularly its use in government procurement has brought about the notion of tightly defined information exchanges that punctuate the virtually continuous exchange between project participants as in the Common Data Environment (CDE) first published in BS 1192. In the government procurement protocols these generally coincide with client decision points and become strict client requirements. Typical information exchange points and client/employer decision points are shown in in Figure 5 in relation to the process plan (in this case the CIC Scope of services [4]). For BIM projects both government and private procurement are expected to follow a similar model and in practice all of these processes are expected to be subject to specific project definition and degrees of iteration that involve specific and discrete information exchanges collected at the key stages.

Use of the system also benefits non BIM projects and the use of the term model in Figure 5 can be taken to mean the collected project information that when brought together (as in the CDE mentioned above) describes every aspect of the project.

26.3 Process integration

The CDE process is relatively strategic in that it addresses the need for a single source of all data that can be collected, managed and disseminated and embody an approval process. Having a single source is a great improvement when compared to disciplines working in relative isolation. Active participation in various techniques, such as Analytical Design Planning Technique (ADePT) [4], LEAN [5], other proprietary or bespoke systems allows a single source to be used to its full potential.

For example, ADePT prioritises the activities and has learning routines from feedback so that known solutions can be reused and greatly enhance and benefit efficiency and reliability. Similarly, in some ways the CDE is a LEAN process but at a more detailed level. LEAN techniques such as workflow control, work structuring and learning from feedback also support the detailed work. There are other systems and techniques that may be applied. The detailed work includes in particular the design work of the various disciplines generally led by functional spatial design and its coordination and the deployment of computational and other, often discipline specific, tools to arrive at solutions to functional, environmental, visual and other matters.

27 Progress validation

Progress validation should be planned into the system. Actions such as the following should be taken at the end of each process plan stage and at other significant points in the project as necessary:

a) check that the stage or overall objectives are being/have been met;

b) prepare for the next stage by re-assessing resources and the programme. This could mean keeping a stage open and overlapping with following stages or carrying over some specific items to the next stage so that the existing stage can be closed-out. Formal records of any such changes should be kept; and

c) check 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, recorded, and completed.

The exchange of drawings, documents and other design information and data should be consistently monitored through the CDE.

28 Design data control

A Common Data Environment (CDE) should be prepared in accordance with BS 1192 and, for BIM projects, PAS 1192-2.

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[4] Developed at the Department of Civil and Building Engineering, University of Loughborough.

[5] LEAN is a generic term under which a variety of techniques (e.g. Just in Time) are collected and used primarily to remove waste from processes without affecting the product.

Design change control procedures should be agreed between design task units, so that one design task unit's work is not unilaterally modified by another and that no design changes can short circuit the CDE procedures set out in BS 1192 and PAS 1192-2.

In some cases design changes are necessary. These should be flagged up as soon as possible through an early warning system of notification and addressed with the same rigour, and processes, as original design. Changes should be undertaken only when the appropriate approvals have been received. The cost accounting of changes and recording the changes should be accurate to add to the feedback mechanisms for the particular project and generally to inform learning. The Design Lead is responsible for undertaking the change control reporting to the client/employer using formal reports from the relevant Design Team Managers including costings (initially cost estimates but as soon as possible refined to fully costed status).

29 Design during construction

The degree of involvement of members of the design team during construction varies considerably from one project to another and depends upon the extent of the duties defined in the commissions.

Members of the design team might be required to undertake actions such as:

a) approve samples (for example, brickwork, finishes) which could involve factory visits;

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

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

At the start of construction projects ground conditions are established generally from geotechnical surveys which can take a considerable amount of time to undertake, analyse, test where required and provide input to foundation or other subterranean (e.g. tunnelling) design and construction. Ideally the correct design sequence should follow comprehensive resolution of these issues but sometimes a decision might be taken to overlap a certain amount of superstructure (or other) design based on assumptions. The degree of risk involved in this approach is related to a number of factors, including experience of adjacent and nearby constructions or other sources of feedback. The level of risk should be analysed, including in the risk register along with costed scenarios so that the impact of delayed project completion can be weighed against unconventional process scheduling.

The Design Leader should be responsible for reporting to the client/employer with input from Task Team Managers and specialists. Some client organizations might have in-house specialists who also have an input (e.g. some tunnel operators).

30 Monitoring during construction

Members of the design team who are responsible for monitoring should ensure that these duties are sufficient to cover their obligations to the client/employer and other parties involved.

Designers might need to visit the site or reside on-site to resolve design problems. This is particularly relevant when certain conditions cannot be established conclusively before the start of construction for example, ground conditions or the details of existing structures.

31 Testing

Testing should include inspection and witnessing of testing during manufacture and assembly of components, materials and machinery, and plant for incorporation into the construction. Tests on soils, bituminous material, concrete and similar materials might be required. Acceptance tests should be witnessed during commissioning and reports should be made on all such tests.

Testing requirements for the project should be set by the Design Lead, possibly in consultation with Task Team Managers. Test methods should be specified by the relevant Task Team Manager and, where available and appropriate, should be taken from a standard, code of practice or similar reliable source.

*COMMENTARY ON Clause **31***

Where choice is not unreasonably restricted or cost unreasonably increased, the use of products and materials certified under recognized schemes might be desirable.

Certification is a regulatory requirement for some elements of construction.

Potential property insurers might have particular requirements.

The validity of certification schemes of some products is sometimes contingent on the use also of certified or licensed installers.

Where certified products are used, Task Team Managers are responsible for the place of products within the scope of their task designs and the Design Lead are responsible for collecting, coordinating and retaining the various scheme certificates to handover to the client upon completion as a part of a handover report. Some might also be relevant to the health and safety file.

32 Completion

Upon completion, which can be phased, the design team should inspect the work with construction team and record any deviations from the brief or EIR and agree corrective action including timescales and effect on payments (e.g. retentions).

On completion of the work, the Design Lead's duties should include assembling the following.

a) As constructed data (e.g. drawings and specifications; as constructed models and data etc.). From concept through construction to completion and handover, data moves from being generic and perhaps performance based to being specific (e.g. describing particular products) and prescriptive. The handover data should contain the specific and retain enough of the performance requirements such that future reselection/replacement (due to maintenance, failure etc.) ca, be based upon the original performance requirements as well as, or instead of like for like. Any point cloud, LiDAR or other survey data should also be included.

b) Audit record of changes during construction. Changes can be of significant design features at one extreme to minor component substitutions at the other. All such changes should be recorded and this information might be useful in informing reselection/ replacement decisions.

c) operation and maintenance information in accordance with the contract requirements and the EIR;

d) health and safety information (CDM related and other project specific); and

e) asset data in a form required in the contract/EIR. For BIM projects data requirements are quite specific and the process is to turn BIM information into Asset Information Model (AIM) information. The contract is likely to require neutral data formats.

The design team might be involved in providing or organizing training for the client's personnel who could be required to operate complex equipment or novel systems. Audio visual components to the handover data, possibly accessed via a quick response (QR) code or other link to the internet, might also assist.

33 Post occupancy

The capital cost of a new construction is normally less than the cost to operate it over its lifetime and several orders of magnitude smaller than the value it is likely to contribute to its purpose over its lifetime in operation. These facts are the main driving factors behind the introduction of BIM and the data sets that are a part of it.

There has also been a steady increase in the application of various forms of post occupancy evaluation of projects with some, such as Soft Landings (including a mandated government version [6]), requiring an extension of the design team's commission into the occupancy period to ease the user/occupier client into their new building and provide valuable feedback to the design teams. The introduction of BIM is likely to see an increase of these methods as data from BIM becomes increasingly useable and useful to users/operators. The Design Lead should establish the form and extent of any post occupancy evaluation and the service/information implications at the earliest stage in the project as possible and where a particular published system is to be used build in and implement the appropriate processes and protocols.

34 Design management appraisal

On completion of a project, an appraisal of the process and design management should be undertaken by each design unit. Ideally the integrated team protocols should also allow for the performance of the whole team to be appraised. A design unit appraisal that reports on where changes in policy, procedure or resources would be beneficial on future projects should be prepared by the Design Task Team Managers and should include recommendations for making such changes. Where the integrated team protocols permit, a team appraisal report should be compiled by the Design Team Leader from the input of the various design unit leaders for the benefit of generic feedback on matters of principle and specific feedback for use when the various design units work together in the future.

[6] Government soft landings (GSL)

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