TOOL C.3

COLLABORATING TO PLAN AND SEQUENCE DESIGN ACTIVITIES

1. PLANNING AND SEQUENCING DESIGN ACTIVITIES

In setting out Base Discipline 3 in Part II, we saw that the BDB approach sets great store on the effective management of decision-making during design, since designing well is the key to both maximising benefits to users and minimising costs. In practice, effective design management means above all directing and monitoring the ***sequencing*** of decision-making so that design can happen both quickly and effectively, with the right people involved in decision-making at each point, making their decisions on the basis of appropriate skills and information. The goal is to minimise "design loops" or iterations, and in particular late discovery of unresolved key interface issues, which generally add cost in the form of last minute design activities and extra work on site. Achieving a high level of participation

The experience of the BDB Pilot Projects suggests how the sequencing and management of the design process should take place through design development. In fact slightly different priorities need to be followed for each of the four stages of design development in the overall design phase. The table below summarises these shifting priorities.

Design Stage	Key Design Activities	Priority to guide sequencing
PROJECT BRIEF DEVELOPMENT	Develop the project brief	Follow **value planning** methodology
DESIGN STRATEGY	Produce Design Strategy, (RIBA Stage C/D), comprising overall spatial layouts, basic structural form and approach, and major services strategy	Identify where information needs to be shared amongst designers to resolve **strategic interdependencies**, convene designers involved in them and agree "points of fixity" as early as possible
SCHEME DESIGN	Produce Scheme Design (RIBA Stage D/E) including dimensions for all internal and external spaces on a common spatial grid, specification of all key components and materials and all key physical interfaces between building elements	Identify major **work interfaces** that occur between building elements stemming from the design strategy, and convene Cluster Leaders to resolve them as early as possible.
DETAILED DESIGN	Produce Detailed Design (RIBA Stage E/F), including precise dimensions for all key components and materials.	Once key work interfaces have been resolved, design can be driven to a considerable extent by the priorities of when information is needed to meet the **requirements of the construction programme**, including timely ordering and manufacture of components.

The Value Planning methodology used to manage project brief development is described elsewhere, in Tool A.2. In what follows, we explain in more detail why it makes sense to follow the three different priorities involved in the following design stages, and illustrate what it means to follow them.

1.1 Design Strategy stage: Agreeing Major Points of Fixity

The search for the optimal sequence of design activities at early stages in the project (which we call producing the design strategy, but which is called outline and concept design, up to stage C, in the RIBA plan of works) needs to be based on *identifying major design interdependencies* and *agreeing points of fixity*.

In design work it is normal for activities to depend on the result of previous design tasks or on estimated measurements and tolerances. However, especially in the early stages of design, there are often situations in which the information required for progressing an aspect of the design depends on a piece of design that might logically come later, because it in turn depends to a much greater extent on the outcome of the current task. In this way the process gets caught in design "loops. A typical example of problems of interdependence at the design strategy stage concerns the roof, structure, envelop and foundations. The type and size of the foundations and structure can often only be decided after the nature of the roof has been decided. However, the design strategy for the roof also depends on information on the layout and the nature of the walls. Further, it is difficult to decide finally on the type of walls until the nature of the structural frame has been agreed. A loop is therefore established.

Interdependencies of this kind in fact appear time and again in the design process each time the design moves to the next level of detail. Because they very often require cross-disciplinary information sharing as well as information from external sources, interdependencies need to be carefully managed for the success of the project. The aim of sequencing design activities in early stages of a project is to identify the key or strategic design interdependencies and resolve them as early as possible, on the basis of a truly multi-disciplinary discussion. This allows the design team, consisting of consultant designers and design staff from Cluster Leader organisations to minimise future design iterations. Once key parameters have been agreed, each Cluster can carry forward its own design development work with much greater security that interfaces have been taken care of. In other words, design activities cab be carried out concurrently.

One promising way of resolving interdependencies is to agree "points of fixity" for each of the phases of the design, either in terms of set design options or measurements or, when this is not possible, by identifying precise tolerances. Once agreed, "points of fixity" should not be changed unless some serious flaw is detected later on. The idea is to involve everyone who may be affected by the set of interdependent design issues in question in agreeing on key interfaces, in effect speeding up the iteration process so that people can then go away and design in parallel, rather than needing to come together repeatedly as the design goes through a number of iterative loops.

Each "point of fixity" is the result of a decision-making process carried out by the relevant section of the supply chain in collaboration with the project consultant designers and facilitated by the Prime Contractor. The criteria established in the Project Value Tree

should be used to establish early points of fixity and should guide any technical decisions thereafter. Design interdependencies signal the necessity of and opportunity for involving specialist suppliers in the decision-making process and can therefore be used as a guide for early and timely involvement of specialists.

Some "points of fixity" can most conveniently be agreed at "soft" project gates - occasions in which the project management ratifies and "fixes" major options and solutions.

(Between gates, others can be determined by the relevant stakeholders in the supply chain using a Value Management Process.)

The process for sequencing early design (figure 1) should therefore start with a brainstorming of major design interdependencies. Once they have been identified, they are given priority attention. It is best to involve all relevant stakeholders – those whose design and delivery work will be affected by what is going to be chosen as the point of fixity to resolve the design interdependency. Using decision making criteria emerging from value management activity involved in creating the Project Brief, the group can value-engineer the most plausible solutions, examining all the far-ranging implications. This may involve carrying out explorations as to the likely impact of certain design options.

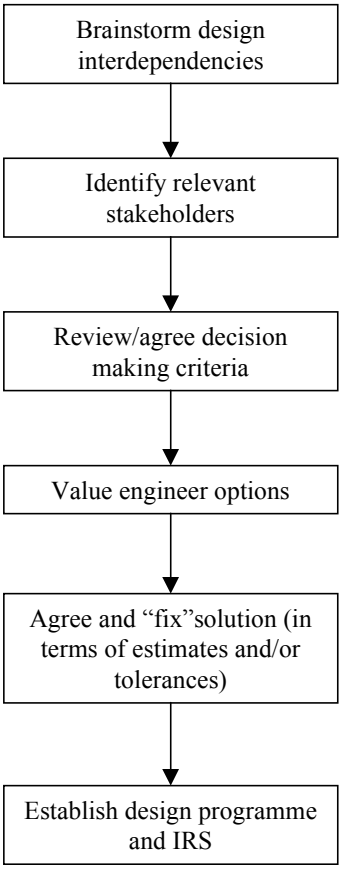


Figure 1

In one of the two BDB Pilots, for example, the process of identifying early "points of fixity" was carried out at the first high level Value Engineering workshop (see tool B.1 for further details).

Prior to the meeting, the project QS had been asked to cost some of the options emerging from the design development process carried out by the architect. At the same time, few selected suppliers were asked to provide alternative views on structural options for the building.

During the meeting participant were introduced to three spatial schemes prepared by the architect, brainstormed for improvements and agreed the criteria for comparing options. They also attended a presentation by the structural consultant and M&E engineer on the

technical solutions available in the project and two presentations by the timber and steel suppliers who were asked to argue in favour of the benefits of their solutions. At the end of the meeting, participants compared two revised design options and committed to some specific aspects, such as a height of the building (two stories), type of frame (steel portal), heating and lighting solutions. They also agreed on more specific aspects such as the basic "design grid" (to be made compatible with existing components). Other aspects that needed further investigation were explored in consultation between designers and key suppliers in the following two weeks, prior to the follow up meeting at which the Design Scheme was signed off.

Once this first round of points of fixity has been agreed, a conventional design programme with its "information required schedule" (IRS) can be agreed and the design development process started.

1.2 Scheme Design Stage : Sequencing development of the Scheme Design

While information interdependencies drive the sequence of early design activity, work interfaces should inform the sequencing of the next stage of design development.

Work interfaces are those areas of the building where elements belonging to different work packages interface. Typical examples are structure and cladding, structure and services, walls and finishes. When not properly identified and addressed interface issues can determine serious problems and consequent costly reworking. The sequencing of design activities during scheme development (RIBA stage D/E) should therefore be driven by the attempt to identify and resolve major work interfaces so that other aspects of the design can be carried out independently. The clustering process (Tool C.1) is in many ways an organisational mechanism to address interface issues. Clusters are set up so that most of the interfaces can be discussed and resolved among a limited number of specialists. At the same time, Cluster Leader Meetings constitute the natural forum where major interfaces between packages can be analysed and resolved.

To monitor critical interfaces and issues emerging at their boundaries the Cluster Leader Meeting should adopt, use and update an *Interface Register*. An example of an IR is provided in figure 2 below.

Figure 2: **Example of Interface Register**

N.	Interface Description	Cluster Involved	Responsible	Action Agreed	Status	Information reference
1	*Glass walls to squash courts/Floor slabs*	Finishes/ Substruct	Finishes	1/2 : Return information on solution within 3 weeks	Information received on 12/2	PROSPEC STD 1001
2	*Wall finishes /movement joins*	Finishes/ envelope	Frame	1/2 . Return information and deliberation as soon as possible	Information received on 9/2	See CL minutes 9/2
3						

The Interface Register is a recording device set up at an early Core Project Team meeting and developed during the process to take into account issues arising from the activity of the clusters. It consists of a list of work interfaces, their allocated owners and the solutions agreed. The Interface Register is managed by the Project Manager or Design Manager.

Items are identified through a brainstorming activity and entered in the first column of the form (see figure 2)

During the same meeting cluster members agree on responsibilities and actions necessary to manage the issues.

The Interface Register is thereafter mainly used as a log to monitor interface issues reported by Cluster leaders. Issues are added to the log during Cluster Leader meetings. Many of these issues are then resolved directly by Cluster Leaders, using a variety of formal and informal communication procedures (fax, phone, face to face). The log is regularly revised during Cluster Leader meetings.

The Interface Register is retained at the end of the design phase and used by the Project Management Team to monitor critical issues in the construction phase.

The Interface Register can be easily used as a device to sequence design during development of the Scheme. The process is very similar to that summarised in Figure 1. After establishing the interface register and allocating follow up activities and responsibilities, information requirements are prioritised and a design programme and an IRS is released. The sequence of this phase of the design is “work interface” driven.

1.3 Detailed Design Stage: Sequencing the later stages of design

The BDB approach recognises that design and construction activities obey different principles and set of priorities. Although the design should proceed from the roof down, construction, apart from some notable exceptions, proceeds from the foundations up.

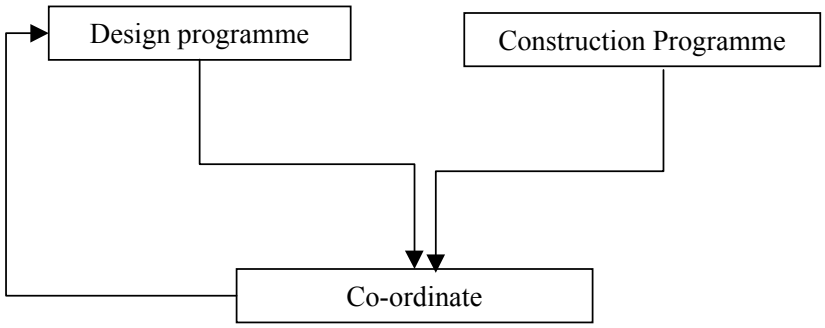


Figure 3

There are therefore two different sequences that need to be reconciled. While in the early stages of the project the design sequences need to govern the flow of activity, during detailed design (late RIBA stage E and F) the sequence and programme of design activities needs to be reconciled with the priorities established by the emerging construction programme (see figure 3). Design activities and items should therefore be sequenced according to the priorities set by the construction requirement schedule. In the BDB process this is facilitated by the fact that major interdependencies and interfaces have been identified early in the process, so that late stages of the design activity can be carried out concurrently. It should be emphasised, however, that the practice of starting construction before all critical design activities, i.e. the resolution of work interfaces have been completed and drawings are well under way should be avoided at all cost. Once mistakes and problems are "cast in stone" the cost of design or even construction rework grows disproportionately.

2. COLLABORATING TO DELIVER SUPERIOR DESIGN: ROLES AND RESPONSIBILITIES

One of the main characteristics of the BDB approach to design is that each deliverable is based on inputs from all key members of the supply chain. This includes, of course, architects and other design consultants, who still play a central role in the process. However, they work together with the construction specialists and the client as members of a team led and facilitated by the "Prime Contractor".
The result, in contrast to the established led process, is that each deliverable - and its associated cost implications - is endorsed by all parties. Architects, consultants and the

key buildings specialists (the Cluster Leaders – see Tool C.1) have to work in new ways and accept different responsibilities.

2.1 Design Strategy

At the end of this stage, the Prime Contractor must deliver to the client a Design Strategy (RIBA Stage C/D), comprising overall spatial layouts, basic structural form and approach, and the overall strategy for services, including the planning for principal ducts.

It is the responsibility of all members of the team - architect, consultants and Cluster Leaders - to contribute to the delivery of these outputs. However, it is for the architect to gather all the information necessary to produce the Project Brief (on behalf of the Prime Contractor) and, more obviously perhaps, take the lead in developing the spatial layout options.

But in neither task does the architect work in isolation from the representatives of the companies that may be involved in constructing the building or from any other design consultants that the Prime Contractor may want in the team. The client will also be represented, not by an agent acting on his behalf and trying to interpret the client's wishes, but by a member of the organisation able to take decisions on the organisation's behalf.

The issue for the design team, therefore, is to develop a collaborative working relationship with all the members of the team appointed by the Prime Contractor so that everyone's skills are exploited to the full. The Value Management process - with formal workshops facilitated in such a way that all participants can contribute based on their experience - will encourage the development of the collaborative style of working which ensures the development of the most appropriate solution for the client. The Value Management process will also firmly address the issue of aesthetics, of great importance to the architect, and allow a design approach that fully reflects the client's wishes.

Thus, even from this initial stage of the project, the consultant designers share responsibility for every aspect of the building with those who will construct it. In order to do so, they must accept that they do not have a monopoly on good ideas and, indeed, that they can always learn from others in the industry.

2.2 Scheme and Detailed Design

While these are separate stages in the RIBA Plan of Work, they form a continuum in the Building Down Barriers process marked by 'soft gates' only (i.e. internal structured reviews)

In The Building Down Barriers, this whole stage is best described therefore as the Pre-construction Phase and its objective is initially to produce a Scheme Design which:

- delivers the functionality requirements specified in the Project Brief, and
- incorporates design solutions which will enable the building to be completed at the lowest capital cost consistent with the requirement for lowest Through Life Cost

This demands a greater level of design input than would normally be incorporated at the Scheme Design stage. The reason for this is that the process aims to produce a design which, as it is developed through iterative reviews in which all parties contribute their expertise and ideas, will ensure the elimination of unnecessary cost in the materials chosen for its construction and labour in putting it together.

Just as the formal application of Value Management is crucial to achieving the optimal outputs from the initial design phase, the formal application of Value Engineering is essential to this phase. The issue for the designers is to become familiar with this technique and to use it collaboratively with Cluster Leaders so that the design can be clearly seen to incorporate the most appropriate materials - and in the most appropriate quantities - to meet the client's needs in terms of minimal Through Life Cost. Designers therefore also need to be familiar with Discounted Cash Flow modelling (the basis of Through Life Costing) and its implications for design solutions in Capital as well as Through-Life Cost terms.

A further issue for designers is that of "buildability", or ease and economy of construction so that labour on site is minimised. The issue for the designers is to ensure that they produce their drawings - even before the Detail Design stage is reached - to take into account the needs of the Cluster Leaders in terms of accurate dimensional grids and references so that they can proceed with their cost planning with increasing confidence at each iteration. Similarly, drawings need to be developed sufficiently to address all the interfaces between the Clusters so that design decisions can be taken which will eliminate the possibility of waste in labour and materials when construction starts. In this sense, the design develops according to disciplines more like those on an engineering project than a typical building project and the issue for the designers is to adopt those disciplines. The ultimate objective is that the drawings should contain all the information necessary to pre-fabricate as much as possible off-site - and for everyone to have the confidence that it will all go together on site..

When the Detail Design stage is reached, the process of design iteration and improvement continues. However, all fundamental aspects of the design should now be so firmly established that effort is restricted to final Value Engineering and seeking other value-for-money improvements in which the initiative may well come from the specialist suppliers rather than the designers.

There remains one fundamental issue for the designers at this stage and that is who should take responsibility for the production of final Detail Design drawings. It may be that the Cluster Leaders are in the best position to produce drawings that relate to their work packages - if they have the capability to do so, that is. But even where they can do

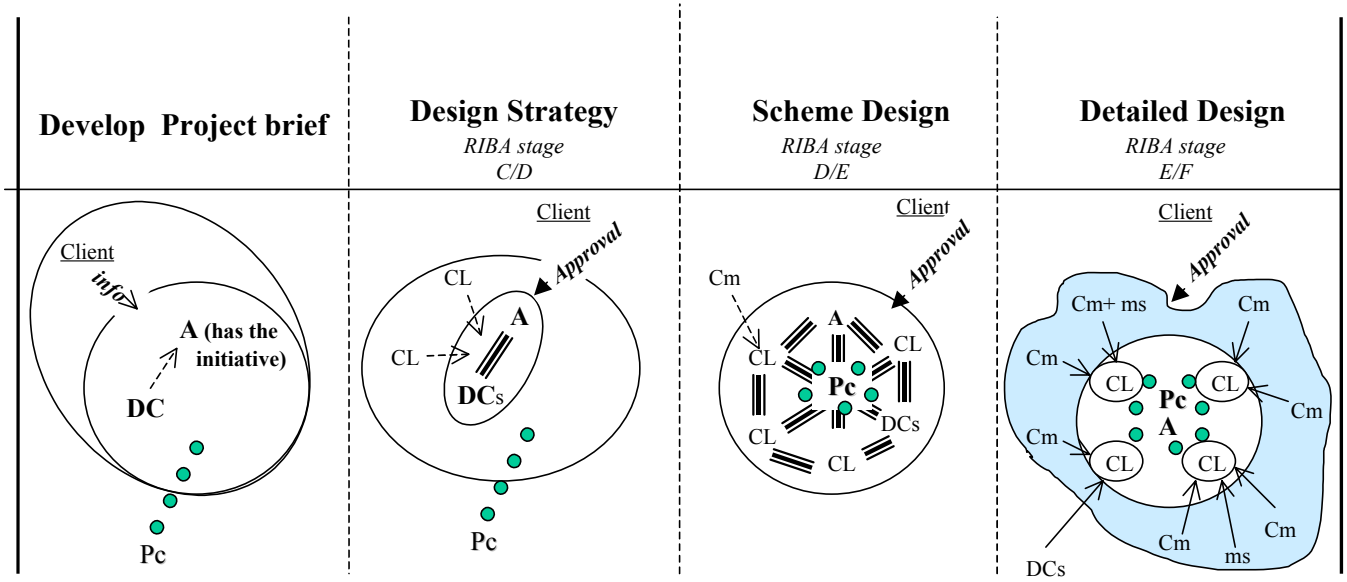
so, it remains a fundamental responsibility of the architect to take responsibility for the overall co-ordination of information and drawings produced by Cluster Leaders.

2.3 Designers' Responsibility.

None of the foregoing is meant to suggest that designers are in any way absolved of their professional responsibilities. Nevertheless, they exercise those responsibilities to the client through their responsibility to the Prime Contractor to deliver to the client a building with optimal functionality and lowest Through Life Cost. In doing so, they don't direct, control and "seize" the design process - rather, they work with everyone else in the team to ensure that the outcome is a design which meets the client's expectations of the construction industry. By the detailed design stage, the key interface issues between Clusters should have been clearly resolved, so that Cluster leaders can be in a position to take forward their own detailed design and drawing production schedule, all the time looking how to take further costs out of the design. The consultants, however, need t remain very much involved in reviewing what Cluster leaders produce, keeping in mind issues of design integrity and interfaces.

The shifting of roles and responsibilities during the BDB design process is summarised in figure 4 below.

SHIFTING ROLES IN THE DESIGN PROCESS



Provides input through consultation

Work together

Co-ordination

info → Provides information and input

Approval → Provides feed back and/or approval

A = Architect(s)

DCs = Design Consultant(s)

CL = Cluster Leader

PC = "Prime Contractor"

Cm = Cluster Member/specialist contractor

m = Cluster Member/ material supplier

Figure 4

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Collaborating for the Built Environment (Be) – www.beonline.co.uk

Be is an independent body formed from a merger of the Reading Construction Forum and the Design Build Foundation in 2002. Its 100 member organisations come from the demand and supply chains of the 'industry formerly known as construction', ranging from public sector and private sector clients and developers to contractors, designers, consultants, specialists and suppliers. It leads research and implementation activities in support of a vision of delivering integrated built environment solutions through collaborative working.

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Collaborative Working Centre – www.collaborativeworking.co.uk

The Collaborative Working Centre of Be is a not-for-profit organisation set up from members of the team that facilitated *Building Down Barriers* to provide consultancy, training and other continuous improvement services to support the development and implementation of collaborative working.

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