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# The handbook of supply chain management

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sharing knowledge
building best practice

The Construction Clients' Forum has consistently supported moves towards developing true partnering arrangements between construction clients and their suppliers. The approach to effective management and proper treatment of the supply chain set out in this Handbook is therefore welcomed by the CCF. The joint approach to risk, and the recognition that the construction solutions provided by suppliers should add value to the clients' business, accord with the policies advocated in the CCF publications *Constructing improvement* and *Clients' guide to whole life costing*, to both of which Defence Estates made significant contributions, reflecting the development of their procurement policy. Now that this fully developed and refined generic version of the Handbook has been published by CIRIA, the CCF is happy to recommend its adoption by clients, both large and small, where they have chosen the prime contracting route to support their drive for better value.

Terry Rochester CB
Chairman
Construction Clients' Forum

**The handbook of supply chain management: the essentials**

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*Construction Industry Research and Information Association*

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# Foreword

The watchword of this Government is modernisation. A key facet of this is innovation led by Government in public-private partnerships. The Building Down Barriers project has been an outstanding example and has demonstrated the high level of innovation that can be achieved. The new thinking behind the project was embraced with enthusiasm and determination by the MOD with support from the DETR and encouragement from HM Treasury. It led to the development of the Building Down Barriers Handbook of supply chain management, so that the valuable lessons learnt from this project could be shared more widely.

Having invested heavily in the Handbook toolset, the Government looks to industry to take up and use it to support the drive to deliver better value and better designed buildings and, as the Deputy Prime Minister has emphasised, as a means to deliver the Government's strategy for investing in the modernisation of Britain and of our social infrastructure.

Nick Raynsford
Construction Minister
DETR

Lewis Moonie
Under Secretary of State
Ministry of Defence

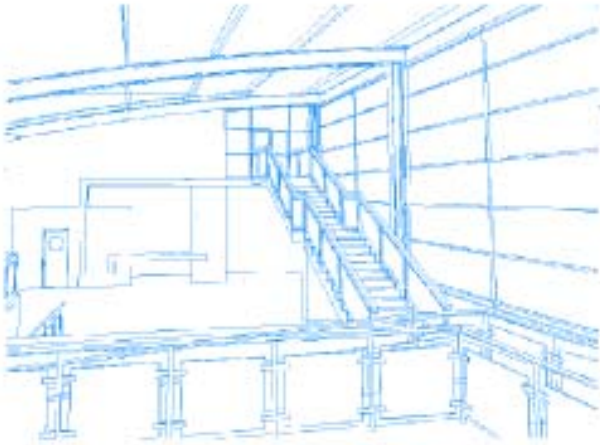
Andrew Smith
Chief Secretary
HM Treasury

# The Building Down Barriers initiative

In 1997, Defence Estates (DE) within the Ministry of Defence (MoD) combined with the Department of the Environment, Transport and the Regions (DETR) to set up and sponsor “Building Down Barriers” (BDB). They wished to create a learning mechanism for establishing the working principles of supply chain integration in construction. The first phase of the initiative, which is also sponsored by AMEC and Laing from the private sector, concludes late in the year 2000.

BDB has created a process for integrating the supply chain within a construction project, then tested it out and refined it on two live pilot projects for Army Land Command. AMEC and Laing have each acted as “prime contractor” in the provision of an indoor sports and training centre, including a swimming pool, for the garrisons at Aldershot and Wattisham respectively.

A research and development group has developed and evaluated the supply chain process with its supporting tools and techniques. The Tavistock Institute has led this aspect, working in close collaboration with Warwick Manufacturing Group, British Aerospace Systems, and Building Performance Group, as well as staff from Defence Estates, AMEC and Laing. Symonds Group and White Young Green have provided additional support to the Land Command Sponsors responsible for each project, in the role of works advisor.



Entrance area, Aldershot facility *Faulkner Brown*

# About this book

This book provides an overview of the approach and an introduction to the toolset as whole. It is intended for anyone within a client organisation, an established contracting, design or project management organisation, or within a materials or component manufacturer who wishes to understand the implications of supply chain integration and single point responsibility procurement models. It is particularly relevant in determining how to act on recent Office of Government Commerce guidance for the public sector. This guidance strongly emphasises single point procurement methods that promote integrated ways of working. A statement from the Office of Government Commerce of 22nd May 2000 specifies that, as part of the Achieving Excellence programme for public procurement launched by the Chief Secretary of Treasury in 1999, "From 1st June 2000 all Central Government clients should ... limit their procurement strategies for the delivery of new building to PFI, Design and Build and Prime Contracting." The statement made clear that all three procurement strategies can only achieve best value for money if they are based on the integration and management of the supply chain.

Chapter 1 describes the BDB approach. Chapter 2 sets out the underlying principles, whilst Chapter 3 provides an overview of the process for managing a project in an integrated way. Chapter 4 describes the main benefits that the parties concerned can expect from adopting the approach, and the key issues they will need to confront. A postscript reflects on the place of single-point responsibility models in the future development of integrated ways of working in construction.

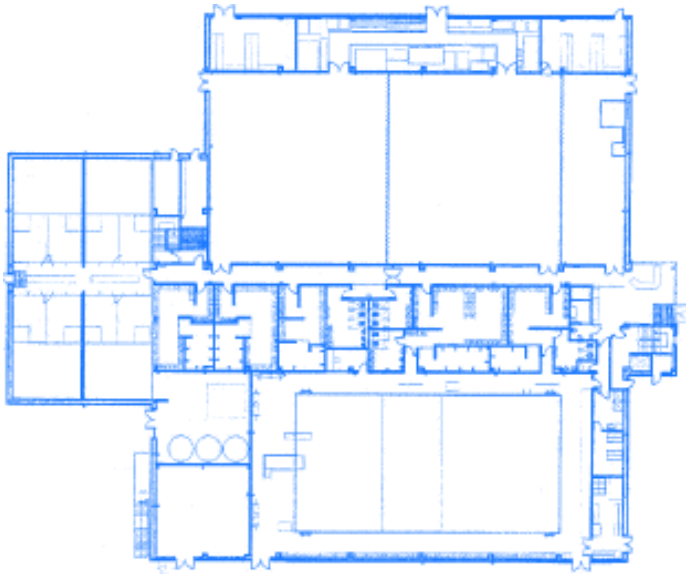
Appendix I offers a brief description of the two pilot projects and lists the key personnel involved in various roles within the Building Down Barriers initiative as a whole. Appendix II lists the panel of architects which was convened to review issues of design quality and design leadership for future development of the BDB toolset, in the light of experience of the pilot projects and other initiatives. Useful publications and contacts are also listed at the back of the book, along with a glossary of terms.

The BDB toolset's basic disciplines, a detailed account of the project process, and the detailed tools will be set out in further volumes of the Handbook. These topics are subject to continual updating in the light of learning through experience, which has characterised BDB from the outset. Current information on the content of additional volumes in the BDB Handbook series and how to obtain them appears inside the back cover of this volume.

# Acknowledgements

The learning distilled within this Handbook has resulted from collaboration between the authors and all the members of the Building Down Barriers community listed in Appendix 1. Nothing that appears here would have been possible without the committed and energetic participation of this set of people. Each member of the community has played a vital role, but a number of special mentions are also necessary.

Above all, Clive Cain, the Defence Estates Quality Director, has been a tireless champion throughout the journey since the initiative began in 1996. He has led, provoked and supported all that has been achieved in terms of this Handbook and everything else that Building Down Barriers has produced. Malcolm Dodds, then of the Department of the Environment, Transport and the Regions, John Hall, then of the Defence Estates, Simon Flint of AMEC and Geoffrey Wort of Laing also played key roles in formulating the initial idea for Building Down Barriers, and worked out how to make the initiative a reality. The pilot project teams, at Wattisham led by John Thorn of Land Command and Peter Whitmore of Laing, and at Aldershot led by Bob Crawley of Land Command and Ian Farrell of AMEC, repeatedly and unselfishly took time out from their pressing day-to-day concerns to help create the Building Down Barriers toolset and evaluate its practical application.



Plan of Wattisham facility *The Charter Partnership*

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# 1 The Building Down Barriers approach

Building Down Barriers (BDB) offers a systematic and managed approach to the procurement and maintenance of facilities, based on integrating all the activities of a preassembled **supply chain** under the control of a single point of responsibility, known as a **prime contractor**. The overall goal is to harness the full potential of the chain to deliver optimal value to the client in terms of the through-life performance of a facility, whilst maintaining or improving the margins earned by all concerned. This involves designing for efficient construction, operation and maintenance as well as for functional effectiveness and other design characteristics valued by the client. The approach draws together a number of available tools, techniques and practices – including **value management**, **value engineering**, **through-life costing**, **risk management** and **continuous improvement** – to achieve significant gains for the completed facility.

## 1.1 Aims and elements of the toolset

The overall aim in developing this model of supply chain integration, with a single organisation taking overall responsibility for delivering value to the client, has been to explore and identify at a detailed practical level

- the benefits to participants
- the challenges and difficulties involved.

The exploration has been undertaken recognising that single point responsibility is not the only way to achieve integrated working and improved value for money. Much of what has been learned will be relevant to other approaches such as **strategic partnering**; and it is hoped that analysis of other forms of supply chain integration will soon become available.

The BDB toolset consists of four elements. The first two are arguably relevant to achieving supply chain integration in general, whether there is a formal single point of responsibility or not. They are:

- a set of underlying principles to be followed
- a set of basic disciplines that need to be applied. .

The remaining two are more specific to the single point responsibility model:

- An outline project process or flow of activities
- A set of detailed tools and techniques for applying the principles and disciplines at various junctures during a project.

## 1.2 The need for BDB

For at least the last 70 years, reviews of the construction industry have relentlessly criticised its fragmentation and adversarial attitudes. Commentators have spoken of lack of integration between design and construction expertise, and the way that problems are tackled in a "contractual" manner by and between clients, designers, main contractors and their suppliers.

The overall result is seen as chronic poor performance from several different perspectives: inefficient use of labour, wastage of materials, high costs of construction, functional inefficiency of many buildings including high operational and maintenance costs, and design concepts poorly implemented – and last but not least, low and uncertain profitability for the supply chain.

Because the construction industry's projects are geographically dispersed and unique in their detailed design, it has developed fragmented supply relationships that respond mainly to local and short term needs. Most clients engage designers and main contractors for a single project at a time, and main contractors in turn assemble a project-specific set of subcontractors and materials suppliers.

In recent years some major UK clients with extended programmes of construction work have begun to assemble their own standing supply chains based on **preferred supplier** arrangements, and to manage projects in a more integrated way. There has however been little development of long-term relationships between main contractors and potential preferred suppliers, even though in some supply areas, such as roofing and cladding materials, manufacturers are generally large companies supplying the whole of the country. There is little evidence of sustained performance improvement based on continual reinvestment of operational surpluses; and a great deal of evidence of continued low levels of trust and collaboration.

The benefits that a carefully nurtured, financially secure and efficient supply chain can bring to improving the overall competitiveness and technological development of the construction sector are largely unrealised; and its clients – most of whom are "one-off" procurers – are left with the disadvantages of high prices and low quality. On occasion, particular enlightened and determined firms and individuals find a way to achieve genuine, productive collaboration on a construction project. But all too often this occurs in spite of the system of procurement, rather than because of it, and so is unlikely to be re-established once the particular project team has been disbanded.

Recent years have seen a number of attempts to find ways of improving the situation. Notably, in the UK the Reading Construction Forum has gathered evidence on the effectiveness of strategic partnering arrangements, where clients, lead designers and major construction firms work together over a series of projects to fulfil common objectives. Now, the BDB initiative sets out to offer an approach to managing the supply chain that naturally supports and encourages collaboration on each and every project, based on a single firm taking responsibility for integrating the work of the supply chain.

## 1.3 Integrating the supply chain to deliver value

Encouraged by ample evidence from other industries of the technical and commercial effectiveness of supply chain management techniques and strategic supply chain partnerships, the BDB approach replaces short-term single project relationships with long-term, multiple project relationships based on trust and co-operation. These standing supply chains focus on delivering value as defined by their clients. The contrast is clear with the familiar pattern where each organisation uses the terms of its contract on a project to optimise its own commercial position with little regard for the consequences for others, effectively preventing consideration of how the same parties might work better together on the next project.

Long-term strategic supply chain alliances can incorporate continuous improvement targets to reduce costs and enhance quality, and focus on the through-life cost and functional performance of buildings. The idea of continuous improvement, based on a systematic analysis of the weaknesses and strengths in existing design and construction processes, underpins every aspect of the BDB approach. Without this discipline, it would be impossible to reduce through-life costs significantly, or enhance quality, deliver superior functionality or any other design benefits, or improve levels and certainty of profits for the supply chain.

Supply chain integration is the cornerstone of the BDB approach. It is important to realise that the supply chain needs to be integrated in two complementary senses:

- those who design and those who construct and deliver need to be brought together
- the supply chain needs to be kept together over time, from project to project.

First, during a particular project the typically fragmented accountabilities of the participants need to come under a single frame of reference. The supply chain needs to function so that a facility is designed in order to be economical to build, maintain and operate from the first, plus meet the client's functional needs and other design aspirations. Subsequent delivery of the facility should focus on those aspects of quality that really matter to client and users. The BDB toolset provides a blueprint for achieving integrated working between all the organisations that make up a supply team within a construction project, including representatives of the client organisation.

Second, as the experience of other sectors shows, the full benefits of this integrated approach will come only from its repeated application by a supply team working together on successive projects. Long-term relationships between designers, constructors and facilities managers developed over several examples of a particular class of building offer the opportunity to develop in-depth understanding of how to integrate various aspects of design excellence, buildability and maintainability. Such relationships may also provide the right conditions for collaboration in taking waste out of design, construction and maintenance work, and implementing innovations such as off-site fabrication and assembly, and re-use of standard design components or details. Action in all these areas should in turn contribute to achieving further significant improvements in industry performance – improving the value delivered to clients, whilst maintaining or increasing margins throughout the supply chain.

There is no need for successive projects to be for the same client, although this does provide favourable conditions for improvement from project to project. In the case of both of the BDB pilot projects, working together in an integrated way has led organically to collaborative bids for further work on a range of different construction projects for different clients and under different formal procurement routes. The efficiency and effectiveness gains of the BDB approach are already providing standing supply teams with a competitive edge – the only sound basis for successful long term relationships.

Supply chain integration and continuous improvement pose profound challenges for established patterns of responsibility in UK construction. In particular, these concepts fly in the face of norms whereby consultant designers undertake design work that is then priced by specialist subcontractors who have not been significantly involved in developing the design. Designers typically spend a lot of time gathering advice from specialist suppliers they know, then find themselves actually working with different

suppliers or specialist contractors chosen by the main contractor, who have contrasting opinions and judgements. Too often, poor communication and strained relationships result, decreasing trust all round and adding to the cynicism that the parties carry into their next project. Integrating the supply chain involves rethinking relationships between design consultants and specialist sub-contractors or materials suppliers, to make them much more consistently collaborative.

## 1.4 Commercial and contractual implications

Clearly, supply chain integration in design, construction and facilities management has major implications for commercial arrangements. The BDB toolset addresses in detail costing and pricing practices, as well as setting criteria for selecting prime contractors and outlining the general features of commercial agreements compatible with an integrated way of working and long-term continuous improvement. That said, the BDB philosophy is that the specifics of commercial arrangements should be devised for particular public or private sector circumstances. The details of contractual forms or long-term commercial agreements that achieve this are beyond the scope of this book. Relevant guidance is however available from the Office of Government Commerce, Defence Estates and the Reading Construction Forum.

The two pilot projects were undertaken with particular project-specific commercial arrangements and forms of contract between the MoD and the two prime contractors, and between Laing and AMEC and their suppliers. These involved the prime contractors taking responsibility for facilities management during a proving period following handover. Once the through-life performance of the facilities has been demonstrated over an agreed period, the formal contract between MoD and prime contractor will in each case end, and facilities management will be taken over by Land Command.

The toolset and project process described in this handbook take a generic form. Commercial issues to be resolved will include:

- at which point, and in what form, a client agrees a price with a prime contractor, and under which form of contract
- in what respects and for how long the prime contractor takes responsibility for facilities management after handover
- how such project-specific arrangements are linked to longer-term commercial agreements.

## 1.5 Leading an integrated supply chain

Leadership of a supply chain, both at project level and over time across projects, must be established. The BDB approach builds on the basic tenet that integrating the supply chain can be achieved through some version of a single point of responsibility to the client, providing overall leadership in achieving value for money. Beyond this, it is vital that there is genuine teamwork among participants with the different perspectives and sets of skills that most construction involves. It is essential to avoid the parody of co-operation that has often occurred under the banner of "single point responsibility", which fuels continued distrust between industry sectors.

The term "prime contractor" as it appears throughout this handbook should not be confused with references to existing contracting organisations. By prime contractor we mean any agency that leads an integrated, long-term supply chain. There are a number of different organisational forms with the potential to provide this leadership, although at present its discharge poses a significant challenge to the capability of virtually all existing construction sector players. In the coming years we expect that a variety of organisations hitherto known as architects, design consultancies, project management consultancies or contractors, as well as different kinds of alliance and partnership, will come forward to provide it.

One of the key tasks of this book is to convey what the function of being a prime contractor involves, regardless of who or what is doing it. The experience of the BDB pilot projects, and subsequent discussions with a panel of leading UK architects (see Appendix II), have provided valuable insights into what is required of organisations taking on this role. There are strong arguments that many organisations other than conventional large contracting firms have as much, if not greater, capability for meeting its considerable demands. At project level, leading an integrated supply chain requires a productive balance of leadership of both the design and the construction or delivery processes, each of which needs to take place within appropriate systems of management.

**Design leadership** involves:

stimulating and co-ordinating discussions with the client and user representatives so as to elicit and clarify a set of project values – the functional requirements of the building, other key design characteristics or architectural aspirations, and the specific capital and through-life cost constraints which need to be observed;

developing an overall design strategy or concept consistent with these values;

ensuring that design development and detailing remain true to the design concept or strategy as a whole, and do not compromise agreed project values.

Successful design leadership requires effective **design management**, in the form of systems for scheduling, monitoring and integrating the interrelated streams of design activities involved in most construction projects.

**Construction** or **delivery leadership** involves:

developing an overall construction strategy consistent with the project values;

co-ordinating the development of detailed manufacturing, construction, operational and maintenance methods and techniques to deliver the design within a target through-life cost.

Successful construction leadership requires effective **construction management**, in the form of planning and monitoring of construction activities, so that every participant has the materials, resources and access they need to do their assigned tasks when they need them, taking account of the interfaces between work packages of different organisations and trades.

At present in the UK, clients generally entrust design and construction leadership to two separate organisations, with separate contracts. This can be effective in balancing the need for innovation and attention to the client's needs, on the part of the design organisation, with the need to manage risk effectively, on the part of the construction organisation. There are however tensions inherent in this kind of arrangement. If managed well, and with mutual understanding, these tensions can be very productive. The downside, well documented, is that such tensions can and often do degenerate into destructive conflict between organisations separately accountable for two sets of priorities.

The BDB approach seeks to bring these two aspects of leadership into effective dialogue with one another, on an equal footing and on a dependable and systematic basis, under the overall control of a prime contractor. The experience of BDB shows that a single prime contractor organisation can take overall responsibility, provide both design and construction management, and promote an integrated approach to design and construction leadership.

This collaborative model of management and leadership needs however to avoid relapse into some dangerous misconceptions of integrated working. Two distortions present in the minds of many construction sector players need to be guarded against. The first finds expression in many contractors' views of architects and design leadership. They cite examples of working on construction projects under a traditional procurement route, where an architect has been in the position of leading the client's design team, with effective authority over the ultimate shape of the project. Their perception is that on these occasions the architect has advanced the design concept with too little consideration of its impact on buildability, and crucially with too little regard for whether it is really meeting client needs in terms of the utility of what is being constructed. The conclusion they draw is that there is always a danger that architects or other design consultants will provide a form of design leadership not properly focused on client value, but rather driven too strongly by standards and aspirations internal to the designers' professional community.

The second distortion is found in some architects' and design consultants' fears of what happens when a contractor is given design and build responsibility. These designers similarly generalise from examples of design and build where a contractor has taken over a design concept, and substituted cheaper components and materials, compromising the original concept beyond recognition – and of contractor-led design processes that do not allow the client to hear designers put their case for the value that can stem from a broadly-based conception of "good design". In their case, formal single point responsibility for a contractor is seen as effectively disenfranchising consultant designers from their appropriate design leadership role.

The BDB approach draws on two key strengths in order to avoid falling prey to either of these distortions:

- a rigorous and structured project process
- a collaborative model of leadership.

The first ensures that all key design and delivery parties agree with the client at the outset what the values of the project are, and subsequently compare design and delivery plans with them at regular intervals. The second enables a prime contractor to draw on the expertise of key supply chain members to provide aspects of design and construction leadership, as well as design and construction management. In both the BDB pilot projects, organisations that have hitherto operated mostly as contractors took responsibility for both

design and delivery management, but each worked in close co-operation with an architectural practice as part of the integrated supply team to provide key aspects of design leadership appropriate to the project.

The role of the prime contractor is then to take ultimate responsibility for the integration of design and construction or delivery leadership, ensuring that all members of the supply team are able to contribute to the full in ensuring that the client's needs are fulfilled. Any prime contractor who does not take full advantage of the vision and skills of professional designers is unlikely to be able to deliver superior value for money to the client. A structured project process provides a number of anchor points at which developing design and delivery ideas can be compared explicitly against what value means to the client. The overall ethos is that all key supply chain partners make contributions as team members, with no one discipline claiming a privileged view as to the nature of value.

At present, any organisation that seeks to assemble and lead an integrated supply chain is likely to look to some other organisation to provide key complementary elements of leadership during a project. In reality, most current construction sector organisations have a greater capability in either design leadership or delivery leadership. The predominant pattern is likely to be that established contracting or project management organisations with the financial backing to manage the risk inherent in a "prime contract" will team up with design firms as strategic partners. It is however also possible for design firms to form strategic alliances with firms that have both a successful track record as construction managers and the requisite financial strength, and in effect become part of the prime contractor role. There is no reason why such an alliance cannot provide a client with the full benefits of an integrated service, acting in effect as a single point of responsibility.

## 1.6 BDB and other supply chain initiatives

The BDB approach can deliver the range of benefits described later (in Chapter 4) because it pulls together a range of existing collaborative techniques within the framework of an integrated supply chain. Its distinctive element is a systematic approach to encouraging collaboration, led by a prime contractor. It adopts and assimilates a range of practices developed by other initiatives in the UK industry and abroad, developing some of them further to overcome a number of limitations.

The BDB approach bears some resemblance to strategic partnering. It shares the aim of establishing long-term relations in order to exploit the potential of continuous improvement. Under strategic partnering, a client, design firm and contractor work together to achieve common objectives over successive projects, but the design firm retains formal responsibility for designing and the constructor for delivery. The BDB approach differs in that there is a single point of responsibility for design and delivery.

Arguably, many of the detailed tools and techniques in the BDB approach, as well as the seven underlying principles set out in Chapter 2, have considerable relevance to strategic partnering. The BDB toolset spells out the principles of effective collaboration in practice, as well as offering detailed processes and techniques that may be used at project level to implement these principles. Overall, it provides guidance on precise mechanisms that allow strategic partners to make a difference by contributing at the appropriate stage of the project. Moreover, it emphasises extending partnering throughout the supply chain.

The BDB approach at individual project level also has considerable relevance to what needs to happen in projects run under a **construction management** procurement method. Here, the client hires a construction manager, as in effect an additional fee-remunerated consultant, to manage early input from delivery specialists and integrate it with the design development work carried out by design and cost consultants. The construction manager oversees the subsequent letting of delivery packages to “works contractors”, each of whom contracts directly with the client. Although the construction manager carries no formal risk or liability for delivery, the integrative function is in many respects similar to that of a prime contractor, particularly during the early stages of a project.

In terms of other single point procurement systems, the BDB approach builds upon the strengths of the most refined and successful versions of “design and build” or “design and construct”. BDB differs substantially however in that it is based on intensive early involvement and collaboration of all members of the supply chain including designers, suppliers and material manufacturers.

Several of the features of the BDB approach have strong similarities to what is being implemented in a number of client-led supply chain integration initiatives, where particular large clients are seeking to integrate the work of their various supply organisations. Examples include BAA’s extensive experience of running projects using framework suppliers, as well as high

profile large-scale developments run by Lend-Lease and the Canary Wharf Co. In these cases, continuous improvement and supply chain development are greatly enhanced in the presence of guaranteed streams of work which are conditional on the achievement of negotiated improvement targets.

Client-led supply chain integration is however mainly appropriate for large repeat clients, for whom the development of the specialised expertise necessary to act as supply chain integrators is justified by a substantial amount of construction and maintenance activity. In contrast, the BDB approach addresses the needs of a broader section of the industry. It is suitable for a wide range of situations where prime contractors are attempting to meet the needs of smaller or more occasional clients, who do not have the in-house expertise to integrate the work of their supply chain.

The BDB approach also bears striking resemblance to processes developed by some consortia to address the requirements of **private finance initiative (PFI)** projects. PFI projects and BDB share the aims of promoting in-depth supply chain integration to achieve maximum functionality at the lowest possible through-life cost. The BDB toolset offers a number of features and techniques of considerable relevance to PFI projects. Something very similar to the BDB approach could be applied in many PFI projects to greatly strengthen the level of integration of the supply chain and improve the value delivered to end users, as well as the returns made by the providing entity. In a sense, BDB seeks to attain the advantages of supply chain integration for the construction industry without the burden of the financial commitment inherent in the PFI route.

Finally, the underlying philosophy of BDB has a great deal of overlap with the recommendations of the Construction Task Force chaired by Sir John Egan. The task force report *Rethinking Construction* advances the goal of achieving "lean" supply in construction, where the work of supply chains is integrated to focus on delivering value to the end customer and eliminating waste at all points during the supply process. In many respects, the BDB process and toolset represent a first attempt at implementing **lean construction**.

To summarise, the BDB approach is suited to situations where a client with a substantial programme of construction work decides not to make an investment in the in-house expertise needed to integrate the network of suppliers required to design and deliver facilities. This kind of client can look to prime contractors to perform this kind of integration in order to achieve superior value for money. The BDB approach is similarly suited to situations where smaller or occasional clients do not have the capability of integrating

the network of suppliers themselves. The Postscript reflects on the kinds of situation where the BDB approach is likely to be more or less appropriate.

> Many of the principles, tools, and techniques from the BDB toolset are also relevant to other ways of integrating the supply chain, for example when undertaken by a sophisticated client, by a construction manager, or within a strategic partnering arrangement. Implementing the learning from BDB does not require a procurement route called “prime contracting” for all new building projects. The benefits of BDB can be applied to projects procured other than through prime contracting.

This applies even to projects run through the traditional procurement method. For example, where a client desires a building project strongly led by architectural aspirations, they may feel most comfortable engaging a creative architect to lead a design team and then supervise construction. The challenge in such cases will be how to use some elements of the BDB approach and what has been learned in developing it, to ensure that buildability and maintainability are tackled throughout the design process, through early involvement of key constructors and facilities managers. The architect may find considerable advantages in taking on many of the functions and behaviours of a prime contractor, as described in these pages.

# 2 The underlying principles

Seven underlying principles have emerged from the experience of the BDB pilot projects as necessary to guide the combination of design and delivery leadership for the integrated supply chain. Each principle represents a significant point of departure from attitudes and behaviours that have characterised UK construction in recent years. Figure 1 shows how the first principle depends on prime contractors, their clients and supply chain embracing the other six, as a mutually reinforcing set.


Figure 1 The seven underlying principles

## 2.1 Compete through superior underlying value

Mobilisation of key members of the supply chain by the prime contractor aims to achieve mutual benefit in the arrangement for all parties. The benefit for the client is better value - in principle a combination of a lower price and better quality, in whatever terms matter most to the client. If the prime contractor and key suppliers work together to offer lower prices or better solutions to meet the client's needs, this may provide the basis for increasing market share. It should also mean the routine achievement of better and more predictable profit margins. Supply chain integration has nothing to do with putting in bids at negative margins, and then extracting a profit by squeezing suppliers.

The commercial core of supply chain integration is setting up long term relationships based on improving the value of what the supply chain delivers, improving quality and reducing underlying costs through taking out waste and inefficiency and over time. Profit and overhead recovery margins need not merely remain intact but can even be increased, while at the same time improving the underlying benefit to the clients. As Figure 2 illustrates, any price is made up of underlying costs and margins. With supply chain integration it is possible to shift effort into attacking underlying costs whilst protecting margins. Reasonable profits and overhead recovery levels can be negotiated between the clients and prime contractor and then at all points up the supply chain, on the basis that all will use their capabilities to "take cost out" in order to achieve competitive prices. Everyone has the security and investment that is needed to undertake the continuous improvement or innovation required.

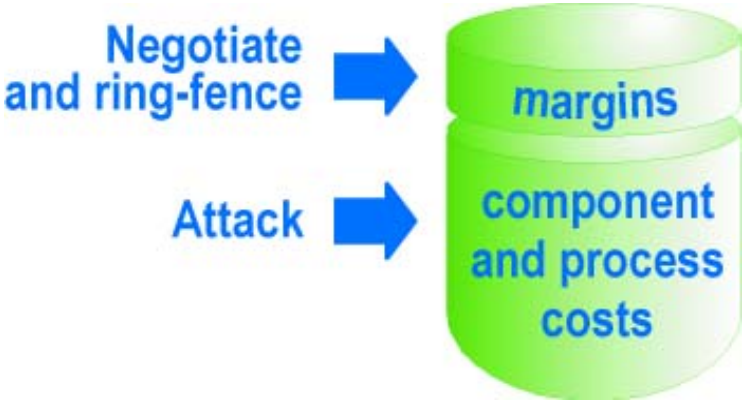


Figure 2 Focus on improving both margins and value

This is the opposite of "business as usual" in the construction sector, where people do things on project after project in the same old inefficient ways, forcing each other to give up profits and overhead recovery in order to deliver at what seems to be the market price. What results is a fight over who keeps any of the meagre margins that result from each project, or attempts to recoup "negative margins" through "claims". The last thing that receives time or energy in this desperate, project-by-project, gladiatorial battle for survival is consideration of how to reduce underlying costs or improve quality.

## 2.2 Define client values

The Building Down Barriers approach makes a deliberate break with the single main criterion used to assess most construction products in the UK: the capital price. Most clients and contractors prioritise this measure of a facility's value to the detriment of all else – particularly whether the facility really meets the needs of its users and whether it represents good value for money in terms of how much it costs to run and maintain. Typically, facilities procured through a design and build route, for example, are constructed using the cheapest possible components and materials and have undesirably high maintenance costs. They may be inefficient in terms of energy costs and downtime required for maintenance, and may also fail to meet users' needs at a detailed level. A building may offer roughly the right amount of space, but not arranged in a way that permits employees to work in the most efficient way.

The BDB process makes the standard for gauging the value of what is being delivered more rigorous in two ways. It makes the functional requirements explicit, and involves a more sophisticated way of measuring the cost of providing them. Together, these two make up a meaningful way of assessing value:

- define client need in output terms
- design for through-life cost performance.

First, a BDB project starts from a statement of the client's need in functional or output terms, rather than design or engineering terms. The statement of requirements says what the facility is there to do or contain – house x number of people engaged on activities a, b and c; provide facilities for training y number of people in activities p, q, and r; or store up to v tonnes of water, with a maximum outflow rate of w cubic meters per second. It does not need to say how big the facility should be, what shape it should be, or how heavy a load the floor should be able to bear. Such design and engineering issues are best judged by a combination of members of the supply chain, each one having some specialist knowledge which the client does not normally possess, in collaborative discussion with the client's key representatives. The statement of requirements can also say in what way aesthetic or environmental requirements are important to the building's or facility's function, as well as what kind of more general design character or architectural aspiration is really relevant to the client and the building or facility's setting.

As a design is being developed, it can then be judged against the functional specification – does the facility really do what the client wants? – as well as the required design or architectural character. Such steady attention given to issues of functional performance in principle avoids the common danger that a design, when developed from an outline brief couched in design terms, becomes something that simply does not work for the client once it is built.

Second, the BDB approach uses the through-life cost (TLC) of a building or facility as the most meaningful measure, rather than capital price alone. The client is again involved in making the decisions necessary to balance the capital and operational costs of the building. The TLC is the combination of these two elements, expressed as a **net present value (NPV)**, and also as a target through-life cost profile over time. This profile allows the client to express for example how far they are willing to invest in initial capital expenditure in order to drive down operational and maintenance costs and obtain the lowest possible NPV, or whether there are in fact constraints on the level of capital expenditure they can contemplate.

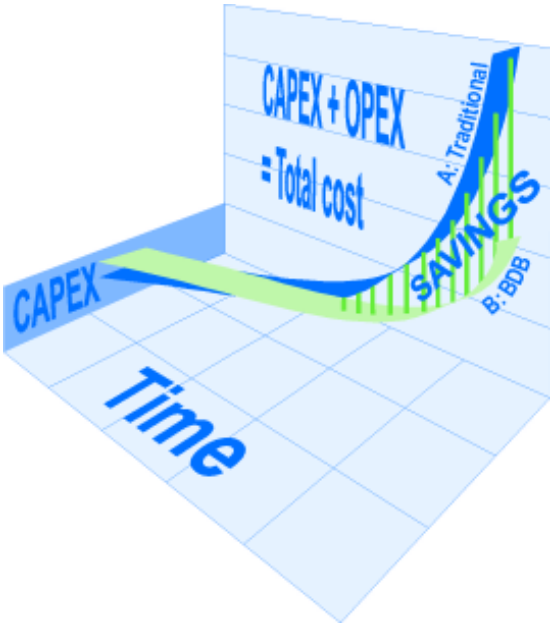


Figure 3 TLC savings

The BDB process is predicated on the argument, illustrated in Figure 3, that it is possible to deliver facilities with through-life costs showing significant savings compared to similar facilities procured through traditional routes. Moving up curve A from left to right illustrates how, in existing forms of procurement, savings in capital price (CAPEX) are often achieved only through using cheaper materials and components which then lead to increased operational and maintenance costs (OPEX). The result is generally an unpredictable and rising TLC.

Curve B indicates how in the BDB approach savings in OPEX can arise through selection of materials, electrical and mechanical equipment, finishes, and construction methods so that they are appropriate to the design life of the facility, and also provide ease of maintenance and replacement. There will be a tendency for materials and components in particular to be more expensive compared to those selected without consideration of how to reduce TLC, and so CAPEX tends to rise. This tendency to increase capital spend should however be more than offset by savings in construction costs from the application of effort through the supply chain to drive out waste of materials and labour. This provides a basis for substantial savings in through-life costs.

Through-life costing demands the further discipline of understanding – and then sticking by – the operational and maintenance requirements of all the constituent parts of a facility. Hitherto, this level of functional analysis of facilities management needs has rarely been achieved during design, and so presents a challenge to all parts of the construction industry.

Together, clarification of the functional requirements, the design character and the target through-life cost profile for the desired building amount to setting out the client values. In debating then deciding these values with the client, it is important to remind them that they need not set out with a prejudice that to achieve a totally functional building for the lowest through-life cost they should give up the aspiration to produce an award-winning piece of architecture. There is no reason why a building should not achieve both. The question is what functionality and architectural aspiration both mean to the particular client and user community. Arguably, supply chain integration and the BDB approach offer immense potential to UK clients to increase both the architectural merit and the functionality of the facilities they procure.

## 2.3 Establish supplier relationships

The products and services provided by the companies in the supply chain typically account for over 80% of the total cost of a construction project. The way in which those products and services are procured – and the way in which their delivery is managed – have a profound effect on the outcome of the project. The performance of the whole supply chain impacts not only contract profitability for all parties, but also how the completed building meets the client's justifiable expectations of cost, quality and functionality.

One of the fundamental requirements of the BDB approach is that prime contractors must demonstrate their commitment to forming long-term relationships with those companies which will be the major suppliers of products and services to the kinds of construction project they see as making up their business. It is important to emphasise that long-term relationships are unlikely to benefit anyone unless the prime contractor has clearly identified at the outset what the business goals of the overall supply chain are to be. What kinds of facilities is it seeking to provide to which range of clients? What is the intended source of competitive advantage, in terms of the balance of knowledge of client requirements, design excellence, and technical capability?

Once a prime contractor has achieved sufficient business focus to allow it to identify a set of key suppliers, long-term relationships can drive up quality and drive down both capital and through-life costs for clients. At the same time, they can increase profitability for the supply chain. These long-term relationships are likely to be with only a small number of suppliers in each key supply category, because it is not possible to invest in the kind of relationship required with a large number of organisations.

As in other industries, the development of long-term supply relationships in construction is quite compatible with maintaining variety and flexibility in putting together teams for particular projects. In sectors such as aerospace or electronics, end suppliers usually develop strategic partnerships with a number of organisations in each key supplier category. This is in order to avoid becoming dependent on any one organisation, to encourage a degree of competition between supply partners, and also to be able to call on the different capabilities of each partner as circumstances dictate. In construction, prime contractors may chose to set up distinct networks of preferred suppliers on a regional basis, taking advantage of the distinctive capabilities of smaller enterprises operating within a particular region.

However long-term relations are organised, they offer the possibility of performance improvement through:

- the gradual establishment of better and more collaborative ways of working together, so that skills throughout the supply chain can be harnessed and integrated to minimise waste of labour and materials
- the prime contractor working with preferred suppliers to exploit the latest innovations in equipment, materials and building processes, in order to enhance performance and develop collective expertise in particular building systems or approaches.

At the project level this makes it possible to:

- ensure the supply chain is fully involved in the development of through-life cost calculations and the associated management of risk
- improve the quality and functionality of the final building through early – and constant – involvement of the supply chain partners in the design of the project and in planning the method of execution.

Though long-term supply chain arrangements are still rare in construction, they are increasingly common in other industries, where the benefits they can deliver are achieved regularly – indeed, have become the norm. These industries provide good examples of the way in which long-term supply chain arrangements can be successfully implemented. Long-term supply chain relationships of the kind that the Building Down Barriers procurement process calls for will only come about – and deliver real benefit – if prime contractors develop a sound process for the development of strategic relationships with the major organisations in the supply chain which deliver that 80% of the value of any project.

## 2.4 Integrate project activities

So far, we have set out the importance of long-term relationships that go well beyond the demands of any one project. But what does this mean for how the prime contractor manages a particular construction project?

Just as it is not practicable for a prime contractor to have a long-term relationship with all suppliers on all projects, it is not possible to *manage* them all directly during any one project. There have to be mechanisms to decide which suppliers are seen as strategic long-term partners and through which effective management of the suppliers on a project can be achieved.

A key consideration in developing BDB was the need to break with the established pattern for managing construction projects, where a client relates first to one set of what might be called “design suppliers” ie an architect and/or other design consultants, and then to a set of “construction suppliers”, usually led by a “main contractor”. The main contractor and a set of sub-contractors price what others have designed, usually as a competitive tender, and then have to work out how to deliver to that price whilst still making a viable margin. This largely sequential approach typically results in a lack of integration between design, construction and maintenance methods, leading to a host of inefficiencies and inferior value, as well as poor margins.

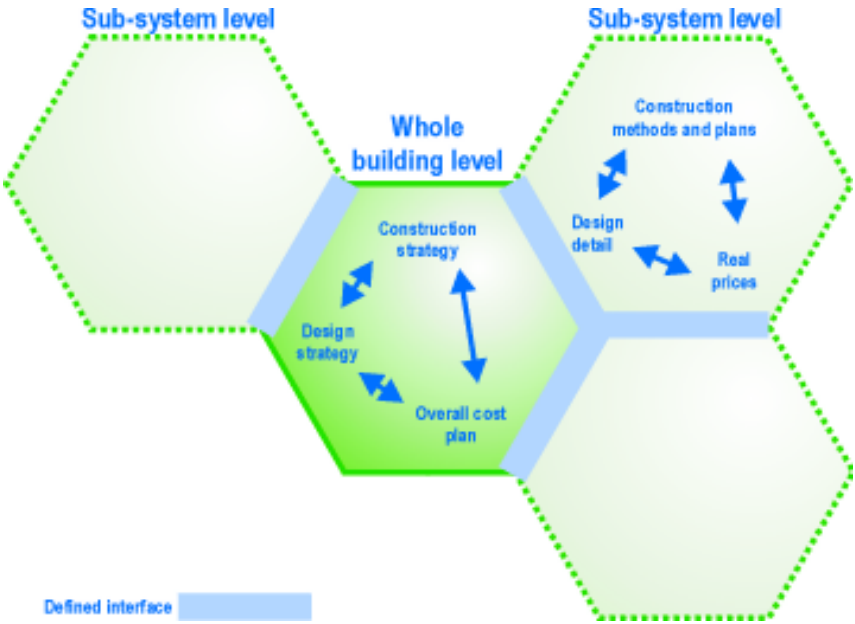


Figure 4 Simultaneous engineering at whole facility and sub-system levels

The BDB approach sets out to integrate project activities on a different basis. Designs for the facility, for the construction and subsequent maintenance methods, and costs of construction and operation are all developed in parallel in a process of **simultaneous engineering**. Figure 4 illustrates a general model for achieving this in practice, by working at two contrasted levels of detail over time. Looking at all the design, construction and cost decisions in a facility or building all at once would simply not be manageable. The idea is therefore first to achieve simultaneous engineering of the overall concept for the facility and how to construct it, and then to look separately at its main sub-systems in a similarly integrated way. This allows manageable areas of project decision-making to be tackled in an integrated way at any one time.

In the early stages of a project, key design suppliers, constructors and material or components suppliers collaborate with the client to decide on overall concepts for the design of the facility and a construction strategy, to meet the requirements of the project values, including capital and through-life cost plans. Key supply chain members in addition to the usual consultant designers are closely involved at this stage, and the idea is to develop construction ideas and realistic cost plans in dialogue with the designers right from the first. According to the BDB way of thinking, everyone involved at this stage is a “supplier” of expertise, regardless of which kind of organisation they work for, and has something to contribute in making decisions about the nature of what is to be constructed.

Once an overall design strategy has been agreed, the details of the design, construction methods and cost implications can then be worked up, again in parallel, within a number of sub-system or **cluster** areas. For a facility or building, these need to concern relatively independent elements of the whole project, such as groundworks, frame and envelope, mechanical and electrical services or internal finishes. For each sub-system or cluster, design interfaces, constraints on construction methods and cost parameters can be specified within the overall design strategy. Within each cluster, a sub-group of design, construction, materials and component suppliers can then work in close collaboration to develop detailed designs, construction methods and actual prices for delivery. These aspects should always be developed in parallel, so as to deliver best value in the cluster product to the client, rather than focus on their traditional fragmented parts of the overall process.

The next stage is for the cluster team to take responsibility for delivering the work. Delivery can be now much more predictable in terms of time and cost

than is common in construction, because those responsible for producing prices and construction methods have been closely involved from the earliest stages.

Figure 5 depicts a particular way of organising this general approach to integrating project activities that has been developed within the BDB pilot projects. According to this, the term “cluster” refers to both the group of suppliers who work together (each of them being a **cluster member**) and the scope of work that they performed. The job of a cluster is to design and then deliver an integrated part or element of the building. The prime contractor allocates overall responsibility for the work of each cluster to a lead supplier – known as the **cluster leader**. Cluster leaders are generally strategic long-term supply partners, although it is quite possible to have strategic long-term partners working within a cluster and responsible to another partner who acts as cluster leader (rather than the prime contractor) for their work within a project.

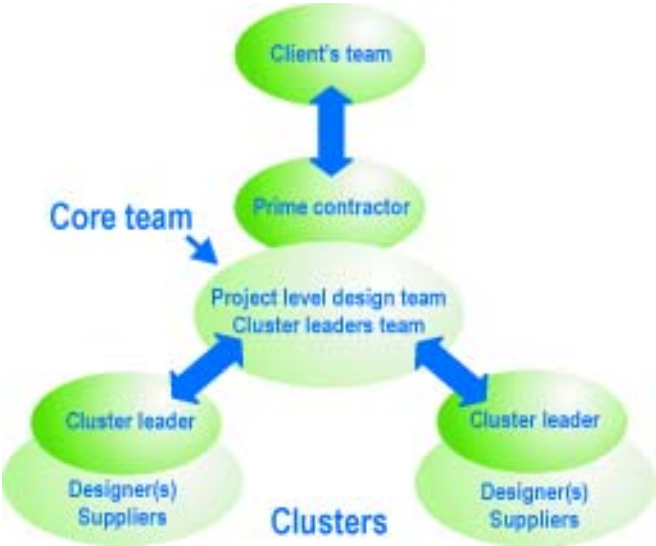


Figure 5 Cluster model of project organisation

Generally, the cluster leaders will be appointed to their roles because they will have the greatest opportunity to influence favourably the effective execution of the work of the cluster. There is no reason why prime contractors may not themselves choose to take up the role of leader for one or two clusters, on the basis that they have staff with particular expertise relevant to developing detailed designs and construction plans for that cluster.

The decisions as to what should constitute a cluster, and how many there should be, will be project specific. These decisions are made with reference to the capabilities of long-term strategic supply partners available to work on the particular project, as well as the emerging view as to the project's technical nature.

Cluster leaders are appointed to a project in its earliest stages so that they can work with prime contractor staff and a set of project level design or cost consultants appointed by the prime contractor, notably the architect, together with the client. Together, these make up the "core team" for the project. Through the use of value management and value engineering, a design strategy is produced which:

- optimises functionality
- achieves other design values important to the client
- optimises buildability to keep capital cost down
- optimises through-life costs through effective specification of materials and equipment.

The goal is to resolve all the key cross-cluster interface design issues at an early stage, leaving each cluster with maximum scope and autonomy to optimise the area of design it is responsible for. Inevitably, some cross-cluster issues will still need revisiting at a later stage, but the design process can be made significantly more efficient by keeping this to a minimum.

Once the design is complete, the cluster leaders take responsibility for putting together the price for the completion of the work of their cluster which will be agreed, after any negotiation thought necessary by the prime contractor, and form part of the final price of the whole job to the client. This entails the cluster leaders agreeing prices with each of their cluster members, and doing so in a structured and methodical way which reflects the requirements of the BDB process. All the participants are committed to driving out unnecessary cost, ensuring that quality is never jeopardised and on the basis that all parties should make a fair and predictable profit. In

keeping with the first underlying principle, the object of these negotiations is not to squeeze the profit and overhead element for the cluster members below what is reasonable. Rather it is to see where underlying costs can be reduced, for example by removing duplications in “prelims” and managing the site more efficiently.

The BDB pilot projects have shown that a variety of arrangements are possible in terms of precisely how and at what point the initiative for design work is handed from core team design consultants, who take the lead in developing the design strategy, to design staff working for a cluster leader. Table I shows the arrangements actually used on the two pilot projects.

Table 1 Clustering arrangements in the two BDB pilot projects

| Wattisham pilot | | Aldershot pilot | |
|---|---|---|---|
| **Cluster** | **Who did the design** | **Cluster** | **Who did the design** |
| Groundwork<br><br>*Led by civil engineering contractor* | Scheme design undertaken by core team consultant in constant consultation with groundwork and frame and envelop cluster leaders; detail design by core team consultant advised by cluster leader | Civils and groundwork<br><br>*Led by civil engineering contractor* | Scheme design undertaken by core team consultant in constant consultation with cluster leader; detail design by core team consultant advised by cluster leader |
| Frame and envelope<br><br>*Led by steelwork fabricator* | Scheme design undertaken by core team consultant in consultation with cluster leader; detail design by core team consultant advised by cluster leader | Dry envelope<br><br>*Jointly led by steelwork fabricator and roofing and cladding contractor* | Scheme design undertaken by core team consultant in consultation with cluster leader; detail design led by cluster leaders |
| Swimming pool (including water treatment)<br><br>*Led by specialist pool contractor* | In-house designers of cluster leader | Water treatment<br><br>*Led by pool water treatment systems supplier* | In-house designers of cluster leader |
| Internal finishes<br><br>*Led by core team architect* | Core team member (architect) undertook scheme and detailed design, in consultation with specialist cluster members | Building and construction (block work and finishes)<br><br>*Led by specialist contractor* | Core team member (architect) undertook scheme and detailed design, in consultation with cluster leader |
| Mechanical and electrical services<br><br>*Led by specialist contractor* | Scheme design undertaken by core team consultant in consultation with cluster leader; detail design led by cluster leader | Mechanical and electrical services<br><br>*Led by specialist contractor* | Scheme design undertaken by core team consultant in consultation with cluster leader; detail design led by cluster leader |
| | | Sports equipment<br>*Led by specialist equipment contractor* | Core team (architect) undertook scheme and detailed design, in consultation with cluster leader |

## 2.5 Manage costs collaboratively

The BDB process focuses on bringing together the knowledge and skills located in various parts of the supply chain in order to develop a design solution that optimises value. The knowledge and skills to be brought together include the specialist knowledge of key suppliers – designers, specialist sub-contractors and materials suppliers – the client's knowledge of their requirements, and of course the prime contractor's own knowledge of how to integrate the entire picture. The basic principle is to involve anyone from any point in the supply chain if they have knowledge and skills relevant to a particular decision.

The traditional practice of developing designs that then prove to be too expensive for the client frequently results in profit margins and build quality being eroded, to nobody's advantage. Key to optimising value under BDB is a rigorous approach to managing costs during design development. This approach is called **target costing**, and has been used to great effect in many areas of manufacturing.

> In its essence, target costing is a simple idea: the supplier works backwards from the client's functional requirements and the maximum market price for the item. The supplier sets out to design a product that both matches the required level of quality and functionality and provides a viable level of profit at that target price. Costs are to be managed before they are incurred, so that margins can be protected, providing the security to look at underlying costs. Suppliers identify the impact of any design option on both the level of functionality and the cost. Design options are generated and evaluated until a combination of options is found that meets the functionality and cost requirements.

This evaluation involves looking very broadly at the ramifications and possibilities of a range of design options, including how cost savings can be achieved by simplifying them or the way they are manufactured and installed. This is the essence of the simultaneous engineering of products and processes, so that problems can be solved earlier and costs "designed out". Early involvement of the supply chain is of course fundamental. While the logic of target costing is simple, it has two formidable implications in practice for construction:

- how to determine a market price and hence a target cost for a given project
- how to convert to target costing from established costing approaches.

In construction, different facilities even in the same general class – retail sheds, general hospitals, water treatment works – may have very different requirements; and it can be difficult to determine unequivocally a market price, based on what the client should normally expect to pay, without first developing a design to quite a high level of detail. Target costing in construction will sometimes involve some element of to-and-fro at the outset between client and supply chain as to what a viable target price and cost are. The prime contractor leading a supply chain may need to convince the client to change their ideas of what they can viably receive for their budget, or else to recognise the need for a budget increase. The basic principles are to resolve these discussions as early as possible, ideally as part of defining project values at the outset, and to base these discussions on objective estimates or costs of design options, so that they do not degenerate into bargaining over margins.

A second major challenge in applying target costing in construction stems from the extent to which it differs from established costing approaches. In much of the industry, a version of the contrasted cost-plus or **price-plus** approach prevails. Table 2 summarises the differences between these two approaches to costing and pricing.

Table 2 Traditional construction costing and target costing compared

| Traditional construction costing | Target costing |
|---|---|
| Costs determine price | Price determines costs |
| Performance, quality and profit (and more rarely waste and inefficiency) are the focus of cost reduction | Design is key to cost reduction, with costs managed out before they are incurred |
| Cost reduction is not customer driven,nor project/design team driven. It is driven by separate“commercial” people | Customer input guides identification of cost reduction areas |
| Quantity surveyors advise on cost reductions | Cross-functional teams manage costs |
| Suppliers involved late in design process | Early involvement of suppliers |
| No focus on through-life cost | Minimises cost of ownership for client and producer |
| Supply chain only required to cut costs – regardless of how it is done | Involves supply chain in cost planning |

"Cost-plus" starts by estimating the costs of production, adds a profit margin and so derives a market price. If the client is unwilling to pay this price then some sort of cost reduction activity has to start. In the construction industry, a variant which we might call "target pricing" commonly exists. A main contractor follows the usual cost-plus pattern, save for starting to cut costs before a bid is submitted, through lowering specifications, reducing quality, and trimming profit levels for themselves and their suppliers. This undercuts any motivation on the part of these suppliers to lower their underlying costs. They experience cost reduction activity as "squeezing the subbies", and "open book costing" as a crude attempt by main contractors to lift the veil on the way their price quotes have been built up.


Figure 6 Value management and risk management

Whilst target costing provides an overall approach for attacking underlying processes costs, Figure 6 shows how it needs to be supported by two other mutually reinforcing techniques: value management (VM) and risk management (RM).

Value management enables a client to collaborate with the prime contractor and the supply chain in defining what value is attached to different aspects of the performance specification, and then offers a structured way for pooling information on the cost and functionality impact of design options, so that collective decisions can be made. It allows everyone involved in the project – and especially the client – to achieve optimal functionality while being fully aware of the cost implications, so that the lowest cost options compatible with project values can be selected. Its use ensures that the client is brought into the design process so that no one has to interpret his or her wishes. The design can be agreed by all the parties who will be involved in its construction and use, and the possibility of changes being imposed after construction has started can be all but eliminated. Value engineering (VE) is the term that usually refers to detailed refinement of design options in the same way, in order to reduce their costs, without undermining their contribution to functionality or other project values, and without eating into margins.

Such use of VM and VE in design development requires rigorous cost management systems on the part of both the prime contractor and the cluster leaders. For example, clusters and core team designers need at all times to have an updated cost plan, indicating the target cost for the scope of work to be undertaken by each cluster, to guide their decision-making during design development.

Risk management is generally used in conjunction with VM and VE. It offers techniques for the entire supply chain, including the client, to assess the risks associated with design options, their possible cost implications, how these can be best managed, and by whom. It offers enormous potential for reducing overall cost, because it allows all members of the supply chain to identify components in their initial price estimates which are there to cover “risks”, such as unproductive delays due to poor co-ordination on site or another sub-contractor failing to complete work on time and delaying access to a workface. Collaborative planning within clusters allows many of these risks and their associated costs to be managed out. Once suppliers know that their reasonable margins are secure, they can afford to be more open about how much of their initial estimate is based on allowing for problems arising elsewhere on the project. They can use RM together to reduce these allowances, and even make sure that they are not needed at all.

RM gives greater certainty to the client of the out-turn cost of the building, and greater certainty to the members of the supply chain, including the prime contractor, that they will make the profit they intend from the project.

## 2.6 Develop continuous improvement

So far we have been looking at how to improve value significantly through better design and costing approaches. We now turn to the central role of continuous improvement (CI) in delivering processes, to achieve an even lower price for the current project and ever lower prices for future projects.

While the concept – and, indeed, the practice – of CI are well established in manufacturing and many other industries, it is still relatively unfamiliar to the construction industry. CI is the vehicle for achieving long-term performance improvement, in terms both of what is delivered to the client and of profitability of the whole supply chain. It is the theme that underpins the philosophy of **total quality management (TQM)**:

> *"A company-wide, management-led style of running an enterprise in which everyone is involved in ensuring that all actions and processes are done right first time, thus ensuring the elimination of waste in materials and labour."*

Two facets of the management style of a company that implements CI in this way are:

- preventing things from going wrong rather than identifying subsequently that they were not done properly to begin with;
- a determination to utilise the contributions of everyone in the business continually to seek better ways of doing things.

In practice this means paying far greater attention to planning how to do things in advance, and seeing how problems can be anticipated and avoided. This contrasts with normal practice in much of UK construction, where contractors and clients set themselves ambitious delivery programmes without clear ideas of how exactly the work will be done. The emphasis of CI is on planning in the sense of mapping out the detailed work processes or methods, and then improving them so that they are compatible with whatever genuine client priorities are driving the overall project programme. CI amounts to the adage "less haste, more speed" developed into a system of participative project management, and thus requires a far more rigorous approach to planning than is to be found in most of UK construction. There are initial costs in terms of the management and employee input that is needed from all supply chain members in planning and improving their work processes. As Figure 7 suggests, there are however potentially far greater savings in underlying process and material costs across the supply chain through reducing waste of materials and labour.


Figure 7 Using CI to reduce underlying component and process costs

In both BDB pilot projects a variety of improvement teams, composed of staff from cluster leader and cluster member organisations as well as from the prime contractor, met intensively during the preconstruction and construction phases, to improve construction processes in particular. Their work focused for example on improving the sequencing of different elements of work in order to reduce overall programme time. In both cases rethinking the sequence for erecting steelwork allowed cladding and roofing to start earlier in certain parts of the site, and teams made sure that hard standing and access were always available at required times to make it simpler for cranes to lift concrete beams into place. Improvement teams also focused on a variety of aspects of site logistics, making sure that materials were available when needed and delivered to the right place, so that they could be used without wasteful extra handling and carrying.

Process mapping and process improvement techniques were also applied to earlier design work. Both project teams recognised that the application of rigorous CI to design processes is a demanding discipline which they could only begin to explore on a single project. The continual and methodical

seeking of better ways of doing things must inevitably involve the principal companies that work together in the design and execution of a project, but the full potential of CI cannot be achieved over the life of one project – it has to be achieved over a period of time. For that to happen it will be necessary for the prime contractor to capitalise on long-term relationships with key providers of professional services and advice, materials, equipment, and labour. To be really effective, CI requires some form of agreed long-term relationship between prime contractor and supplier. This may well mean that the prime contractor has to help suppliers of both materials and labour – particularly the smaller ones – with their improvement plans. That help may take the form of investment in problem solving training for the supplier's staff, or making experts and expertise available to suppliers.

In many branches of manufacturing, such as aerospace, electronics, or pharmaceuticals, this kind of investment in supplier development by the principal manufacturer has become the norm, further cementing the long-term relationships that support CI activities. Companies such as British Aerospace and Shorts identify a small number of suppliers for each key component or sub-assembly. These preferred suppliers are heavily involved in the design of new products, and then agree demanding performance improvement targets in terms of cost, quality and delivery to time, to be met in stages over a number of years. The manufacturer provides specific kinds of expertise to its suppliers to help them achieve these targets.

It follows that this approach encourages the principal manufacturer to become much more discerning in their choice of suppliers in the first place, particularly since they will – or should be – looking for benefits from the suppliers in addition to doing everything better. For example, the principal manufacturer should be seeking opportunities to exploit new technologies or new working methods that the suppliers develop as part of their own effort to improve their competitiveness.

A similar pattern may emerge in the construction sector, with the demise of suppliers not prepared to invest in the future, as has happened in manufacturing. At the same time, the companies that do invest in the future will be actively informing the supply chain leaders and integrators, the prime contractors, of the benefits which can be made available to clients as a result of their CI activities.

## 2.7 Mobilise and develop people

Developing long-term supply relations in an environment of continuous improvement and carrying out individual projects using the BDB approach are extremely challenging undertakings for anyone in UK construction. Adopting the first six principles above means breaking with much of what most UK firms operating in construction have seen as important in recent years. A handful of players have already set off down the road of implementing something similar to these principles, but they are generally the first to admit that the journey is a difficult one, requiring a great deal of commitment in order to make progress and achieve the considerable potential rewards.

Prime contractors who set out on the new road need to be aware that they will be managing a comprehensive programme of organisational change within their own company, based on the idea of collaborating with key suppliers and clients rather than fighting with them. Their staff will need to learn new ways of thinking, acting, and reacting. This involves unlearning old ones. A key task in leading supply chains is therefore to mobilise and motivate people wherever they are working to learn the benefits of the new approach, whilst recognising there are challenges to be met, and that some level of resistance and difficulty is to be expected.

What is involved in achieving this kind of mobilisation? Four key mechanisms are likely to be central to promoting change successfully within prime contractor organisations and the wider supply chain:

- visible, systematic commitment from the top
- facilitation for project teams
- training in new skills
- economic incentives.

It is a truism that such programmes of change are utterly dependent on leadership from the top. Senior managers must routinely demonstrate, in everything they do, that they believe in the new processes and the changes that need to happen. They need to demonstrate this not only to their own staff, but also to their supply partners. Whilst prime contractors will be relieved to find some key suppliers who are ready and waiting to embark on long-term relationships and who thoroughly understand what continuous improvement and value management are all about, there will be others who are just starting, as most prime contractors are. Such suppliers will be all too ready to lapse back into suspicious ways of relating, and it is up to the

prime contractor to maintain the processes and to keep asserting the value of long-term collaboration.

Next, prime contractors will need to offer facilitation to project teams and CI problem-solving teams. People will need help in understanding new processes and making them their own. Facilitators are people who work with groups to help them understand and customise new techniques and ways of working, without having managerial responsibility for the team or group concerned. Separating the roles of introducing the new process (the role of the facilitator) and being responsible for making it deliver (the role of the project manager or team leader) generally makes it easier for the people concerned to accept and learn a new way of working. The prime contractor needs to make trained facilitators available to project teams, and over time to help its key suppliers identify and fill their own facilitation needs.

One of the issues here is overcoming the notion that employing a facilitator is “just adding an unnecessary overhead”. The business benefits of facilitation are well established in many leading sectors of manufacturing, such as chemicals and food. When companies in these sectors make major investments in new manufacturing plants, they have learned the value of also investing in the design of new ways of working to get the best out of the technology, employing teams of facilitators to help employees at all levels understand and develop their new roles.

Thirdly, prime contractors need to take training provision very seriously, because many of the essential principles we have described involve skills that are new to the construction industry. Training is a necessary investment for getting the BDB approach to work, but it needs to be targeted on the particular needs of a project team.

Finally, setting up and sustaining a collaborative approach to supply chain management requires economic incentives. One fundamental incentive is that improved supply chain performance can offer everyone involved improved security of future business. In reality however, and particularly at the outset, there need to be incentives to encourage collaborative problem solving and cost savings at project level. These might take the form of arrangements for sharing savings through the supply chain, once the target cost for a facility as a whole or a particular cluster area has been achieved.

# 3 The BDB project process

This chapter summarises the implications for running construction projects of the seven underlying principles set out in the last chapter. The essence of the BDB approach is improving supply chain integration over time across projects, but this cannot be achieved without re-examining the way supply partners work together within individual projects.

## 3.1 Structuring the involvement of the supply network

Application of the seven principles requires a coherent and structured process for conducting construction projects. This process has to be capable of supporting the integration of the whole of the supply network – not only the prime contractor and the supply chain but also the main representatives of the commissioning client, representatives of the users of the facility that is going to be provided and any other relevant stakeholders.

The experience of the BDB pilot projects indicates that the direct involvement of client representatives and end users, combined with the early involvement of suppliers, reduces the scope within the supply chain for distorted understanding of what is being designed and built and why. In many construction projects, clients and users are often at arm's length once detailed design and construction begin. Project team members have to interpret concept designs without being able to check their understanding directly with the client or users. Such layers of interpretation can result in diminished value.

Eliciting contributions both from suppliers and client representatives and from end users has to be carefully managed and structured. Members of the wider supply chain should be brought into the project early compared to most UK construction practice, but only as early as their contribution can actually make a difference. There is little point in bringing a specialist tile manufacturer into discussions about the concept design for a building when the basic structural and finishes strategy has not been decided. There is however every reason for involving at this point potential "frame and envelope" cluster leaders such as firms with expertise in the design and delivery of steel and concrete frames, roofing and cladding systems. Likewise, end users should be involved only when their voice will really make a difference. They will have views on overall appearance, spatial layouts, finishes, lighting and air conditioning requirements, but not much to say on structural design

issues. Like suppliers, they need to be involved from the earliest stages, but not in each and every deliberation.

The kind of project process described in the following section can only be achieved in practice once the client organisation and the supply chain, led by the prime contractor, have both invested in understanding its requirements. Chapter 4 gives an overview of the key issues that various parties will need to address before they can participate effectively in this more integrated and collaborative way of working.

## 3.2 The phases of the BDB project process

Figure 8 at the end of this section summarises the BDB approach to structuring design and delivery of a construction project. The sequence of four broad phases we set out here offers guidance as to how some form of prime contractor can take on the role of integrating the activities of the supply chain and providing a single point of responsibility to a commissioning client. Lead responsibility for shaping the project shifts from a client team to the prime contractor's supply team at the end of the first pre-project phase. The supply network then becomes actively involved in identifying client value and delivering the appropriate product at the lowest appropriate cost.

These are the four phases and their subsidiary stages:

- pre-project
  - inception
  - selection and appointment
- design and construction
  - project brief development
  - design strategy development
  - scheme design development
  - detailed design and production information
- construction
- proving

The process model differs from many others in that it does not attempt to provide a detailed set of procedures encompassing all project activities.

Although it has been derived from the experience of two pilot projects, it is generic. Within the single point of responsibility framework, it offers considerable scope for customisation to suit particular circumstances, and can be supported by a range of detailed commercial arrangements. The general features of this process model could also be productively applied within projects where long-term supply partners work together under some other procurement form, for example where there is a strategic partnership between a client, a lead design firm and a lead construction firm.

### 3.2.1 Pre-project

The pre-project phase begins at the point where the requirement for a new facility is initially considered by a client and ends with the appointment of a prime contractor to deliver it. This may on occasions be a straightforward and rapid process, but for many clients and projects it is likely to require a considerable amount of analysis and consideration. In general there are two distinct stages.

#### Inception

The purpose of this stage is to establish the client business case for a construction project, summarising the underlying need and economic justification over a defined life-cycle. The client needs to collate business and technical requirements to be met by its facilities over this life-cycle period (35 years was specified for the BDB pilot projects in establishing their business cases). There then usually needs to be some form of option analysis, which might typically compare in broad terms the costs and benefits of refurbishing existing facilities with providing new facilities. The option analysis should include deriving indicative through-life costs for each broad option, as well as capital expenditure estimates. At this point, the client should also determine any major budgetary constraints which may affect how much initial capital investment is actually viable. This may have a bearing on the conclusions derived from the option analysis. For example, a new facility may potentially offer a lower NPV for the TLC, but require an unrealistic level of capital investment. Alternatively, a new facility may be viable, but the client will still need to specify a limit on the capital budget.

Larger clients may have the technical and commercial expertise in house to undertake these activities, but will need to appoint an in-house project co-ordinator to pull together information and analysis from a number of different places within the wider client organisation. For clients without sufficient

expertise, there are two basic options for obtaining this external assistance. They can appoint an external professional advisor, whose main role is to help in the production of the business case. If this advisor retains a role beyond the inception stage, it is important that they continue to act as an advisor and not as a shadow project manager. They will need to adopt an "eyes on – hands off" approach and above all a collaborative attitude. Alternatively, a client can even at this very early stage appoint a prime contractor to advise them in the development of the business case.

The client then – with the help of their advisor if appropriate – summarises the business need, the capital budget and indicative TLC estimate, and the conclusions of the option analysis in the form of a **strategic brief** document. This document provides the basis for subsequent phases to be led by a prime contractor. The brief needs to be written as an output or functional specification which encourages innovative contributions from the prime contractor's team rather than prescribes design or engineering solutions. This specification can in principle cover a wide range of aspects of function that may be relevant to the client. These may include the kind of activities to be housed, the kind of physical environment required in terms of temperature and lighting, the economic benefits to be delivered, and the kind of design character or cultural function to be provided by the facility.

## Selection and appointment

During this second stage the client team selects and appoints a prime contractor in a way compatible with the BDB principles. Above all, selection cannot be based simply on asking potential prime contractors to price a design, because there is still at this stage no design that can be meaningfully priced, just a set of functional requirements. The whole point of the BDB approach is to develop real and dependable prices in parallel with development of the design. However price is taken into account, it will probably be secondary to a number of other more relevant selection criteria.

One approach to price issues is to ask prospective prime contractors for an initial response to the strategic brief in terms of a target price, made up of a target cost and an agreed margin, together with some form of arrangement for sharing risk and savings on the target cost. An alternative is for the client to set a target price and ask potential prime contractors to propose a margin they would expect for the job, with arrangements for sharing risk and savings. Yet another option is to ask bidders to indicate rates for a "basket" of construction elements, to be used to select the most efficient supply chain so that the job can then be priced during the design process.

More generally, the client needs to seek evidence of the prime contractor's capability to work with their supply chain to deliver value in terms that matter to the project under consideration. A great deal of work has been done in recent years on how to assess both contractors and consultants for their capability and contribution to delivering value under established procurement methods. This work is highly relevant to evaluating potential prime contractors and their supply partners. In particular, guidance has been produced by the Construction Industry Board (1996) on selecting consultants, and by CIRIA (1998) on selecting contractors.

The client will need to assess the prime contractor's and their key supply partners' capabilities in a number of areas:

- Business focus and financial strength
- Relating to client value
- Design excellence
- Design management
- Construction technology expertise
- Construction management expertise
- Planning
- Delivery to time and cost
- Quality assurance
- Continuous improvement
- Cost management
- Health and safety
- Environmental management
- Human resources management.

Critically, the client needs to have a potential prime contractor effectively demonstrate the existence of established supply chain relationships as well as the mechanisms through which this supply chain will be actively involved in delivering value during design and construction. The client should be looking for evidence, such as records of process improvement meetings, that the supply chain has been learning, project by project, from cumulative past experience.

During selection, the appointed prime contractor will gain an initial understanding of the project and then negotiate all aspects of the contract with the commissioning client. Negotiations need to address:

- budget constraints and any targets in terms of capital and through-life costs
- the scope of the prime contractor's services, including whether they will take responsibility for managing the facility after handover, and at what point the length of this **proving period** will be agreed
- commercial terms, including prices or margins for providing these services, and how savings or losses compared to any target cost will be shared
- collaboration structure, including roles and responsibilities for the client and prime contractor; phases of the project, control gates and deliverables
- an outline programme and strategy that links payments to project progress, covering design and other pre-construction activities as well as construction itself.

This agreement provides the basis for the prime contractor to enter into similar agreements with key supply chain partners, including potential cluster leaders and design consultants. Above all, there needs to be an agreed basis for all relevant parties to be involved in the design activities from an early stage.

### 3.2.2 Design and pre-construction

The prime contractor can now lead their supply team through the all-important design and pre-build phase. This is subdivided into four stages, marked by control gates. As indicated, these are closely related to the stages of design development in the Royal Institution of British Architects (RIBA) plan of works.

#### Project brief development (RIBA stage B)

Having entered into a formal relationship with the client, the prime contractor and their core team, consisting of design consultants and potential cluster leaders, work with the commissioning client and relevant user stakeholders to clarify and interrogate the strategic brief. **Value planning** plays a key

role in this in-depth review of user needs. The review must incorporate all the client's and end user's functional requirements, taking into account the activities to be housed by the facility and the internal and external environmental requirements, as well as economic and cultural or design character issues. It should also cover planning issues and any consultations with the local community concerning the appearance and possible impact of the facility. This leads to agreement between the commissioning client and the prime contractor on a more detailed **project brief**.

The prime contractor, core team designers and potential cluster leaders then define and optimise the design development process ahead.

### Design strategy development (RIBA stage C)

In order to meet the requirements spelled out in the project brief, the prime contractor's team develops and appraises a range of potential design concepts. These are likely to include a spatial layout, a basic structural form and approach, and major services strategy. This involves collaborating with the commissioning client and user representatives on high-level value engineering, risk analysis and through-life costing activities. The result is a design concept that will provide the best value on the through-life costing of the building. The agreed solution – the design strategy – must be signed off by the client.

### Scheme design development (RIBA stage D plus 25% of RIBA stage E)

At the start of this stage the design is sufficiently developed for cluster areas to be identified within the overall facility and for cluster leaders to be formally appointed. Under overall prime contractor management, the core team design consultants work with cluster leaders to develop the design strategy into a scheme design with the collaboration of key supply chain partners (cluster team leaders). According to the RIBA plan of works, scheme design (stage D) corresponds to a fleshing out of the overall identity of the design, including precise spatial layouts, structural forms, construction technologies, and building services plans and specifications, as well as obtaining planning and any other regulatory permissions. It is then possible to achieve further refinement in capital and through-life cost predictions.

BDB experience indicates the advisability of resolving key physical interfaces between building elements before taking the design and its associated cost through the scheme design control gate. Consideration of these at scheme design stage adds considerably to cost certainty, and so becomes

necessary when undertaking value engineering to decide which scheme design options will optimise the functional performance of the design, its buildability and its cost. In the RIBA plan of works, key interface issues are resolved at stage E. Hence the BDB approach advocates bringing some elements of stage E forward to the scheme design stage.

All this involves the prime contractor, core team design consultants and cluster leaders looking at the sequencing of both design and construction. The team must decide which are the key interfaces that need to be attended to first in the design process, in order to improve cost certainty and minimise design iteration. They can then use value engineering and risk management to optimise the design and devise the most efficient construction methods.

### Detailed design and production information (75% of RIBA stage E and stage F)

The design is developed and completed in all critical aspects with the full and proactive involvement of the supply chain. The cluster leaders and core team design consultants first resolve all remaining interfaces, material and component choices. They then work with the core team design consultants to develop the design to the level of production and construction drawings. Here a key role for the architect and other design consultants is ensuring that cluster design work remains consistent with the agreed overall design concept and project values.

At the same point, cluster leaders and their own suppliers will be able to provide refined figures for capital and through-life costs. This allows the prime contractor to provide a much firmer delivery price and through-life cost prediction to the client. This price, with a refinement of arrangements for sharing remaining risks and apportioning savings, must be signed off by all the parties and constitutes the basis for further project actions. The detailed design is also accompanied by an outline proof of compliance plan, to enable the client to validate the predicted through-life cost, covering both capital and running costs.

At this stage the supply chain also undertakes necessary pre-build activities, including the collaborative definition of the construction process and programme, prelims and site logistics as part of the project level continuous improvement activities.

### 3.2.3 Construction

Once a project moves to site, the prime contractor aims to preside over a management system that ensures construction activities are “right first time” and that labour, plant and materials are used to the maximum efficiency. Fundamental to the system is collaborative planning and monitoring of construction activities.

Cluster leaders take a high level of responsibility for planning, co-ordinating and monitoring activities within their own scope, on the basis of their understanding of the construction method and costs that they have developed alongside their design. Their responsibilities extend to procuring and ordering many of their own materials and components, and to assuring not only the quality of their own work but also that of the second tier suppliers within their cluster. Once they have established that cluster leaders have their own mechanisms for controlling quality, the prime contractor and client need only carry out periodic back-up inspections. The prime contractor provides assistance when unexpected quality problems arise, so that they can be tackled before they cause serious disruption to the programme.

The key role of the prime contractor is to provide site level facilities and plant, and also to co-ordinate the detailed planning of construction activities across clusters. First of all, prime contractor and cluster leader staff examine the overall construction method and programme, and work out how to optimise the sequencing of the main phases of construction. They also identify areas or topics that are likely to be problematic during the course of work on site, such as storage and access to materials, or availability of skilled labour when it is needed, and set up improvement teams to work out how to minimise or avoid these pitfalls. This high-level continuous improvement activity can then feed into monthly, weekly and daily cycles of detailed planning, reporting, and continuous improvement. Representatives of all clusters meet to examine the detailed interfaces between their activities and work out how best to make progress. The aim is to ensure that each day all site operatives can proceed with clearly defined tasks, with all preparatory work completed, the required materials and plant readily to hand, and with clear access to the workface. The completion of this phase is the handover of the facility to the client for occupation.

The core of the BDB approach is to maximise understanding of client and user requirements before site work begins in order to minimise the chance of design changes being required once construction work begins. The nature of some clients’ businesses mean however that they have to refine their

understanding of their requirements even during construction. The prime contractor needs therefore to operate a tightly controlled procedure, with the same rigour as during early design development, for evaluating changes in requirements, the design options relevant to them and their implications for through-life costs. This analysis can then form the basis for collaborative discussions between client and prime contractor as to the price implications of the few genuine changes in requirements that simply could not have been foreseen during the design and pre-build phase.

### 3.2.4 Proving

The prime contractor will monitor the operation of the completed building and maintain the facility until the proving of the predicted through-life cost. This can be expected to take a minimum of 15 months from handover (ie at least a complete annual cycle to build up a picture of energy costs), depending on the nature of the compliance plan and the actual performance of the building in use. At the end of a successful proving period the building is handed over to the client. If performance differs significantly from the prediction, the client and prime contractor will need to develop a shared understanding of why this is and agree a way forward. One possibility is that the proving period is extended following certain modifications. A key outcome of the proving period is a further refinement of the predicted through-life cost profile of the facility, based on the experience of operating and maintaining it for the agreed initial period.

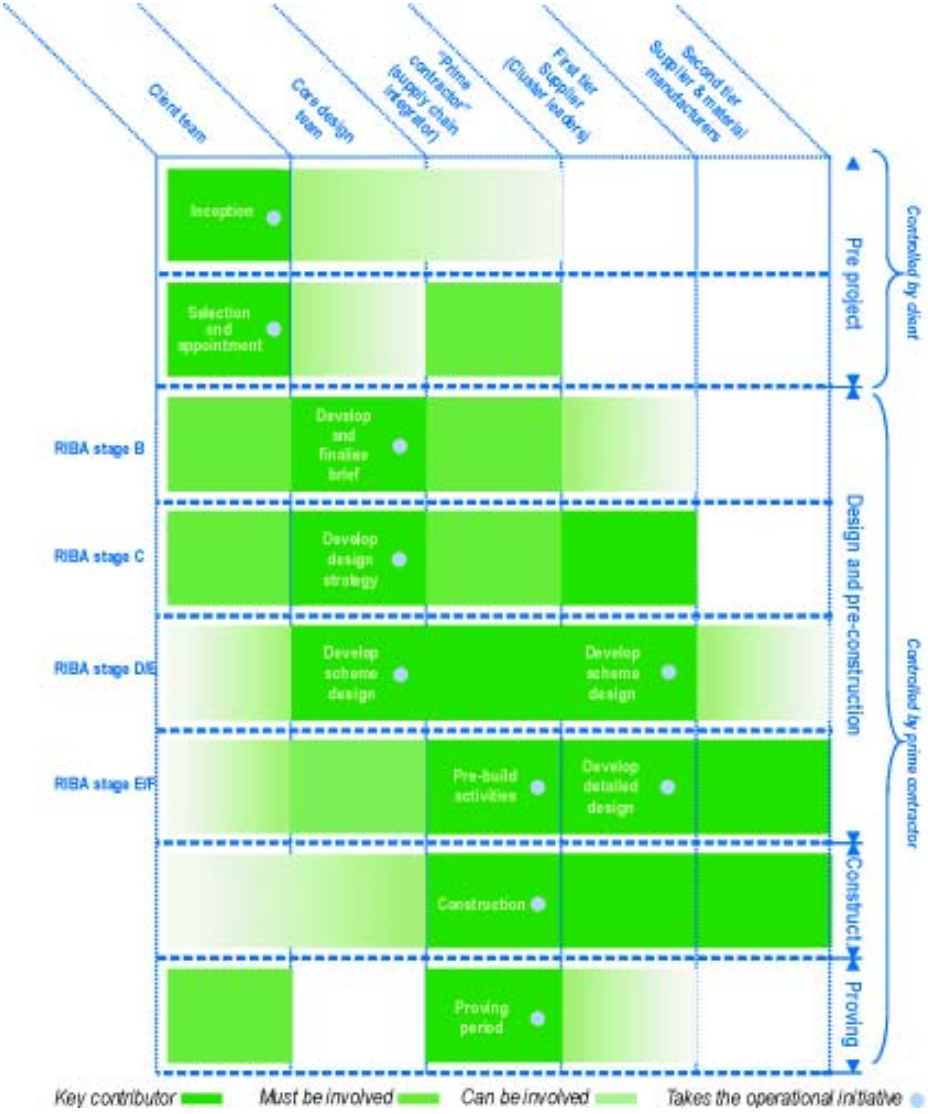


Figure 8 Overview of the BDB generic process

## 3.3 Customising the BDB process: key issues

In adapting the generic process to particular circumstances, as well as being guided by the seven underlying principles of Chapter 2, it is important for a client, prime contractor and supply chain to ensure that the process:

- is as seamless as possible
- is controlled through a combination of “soft” and “hard” gates
- incorporates continuous improvement within all activities
- brings in established value enhancing techniques.

### Seamless process

Once a project has begun, as little as possible should interrupt the collaborative process by which the contractor and supply chain strive to achieve the best balance between quality of design, enhanced buildability and lowest TLC for the client. Two kinds of disruption in particular need to be minimised.

First, contractual and commercial arrangements should not require any member of the project community to commit contractually to the outcome of future activities in the absence of all the necessary information. Requests to provide firm prices should ideally be made only when all the critical information is available to the players concerned. People tend to react defensively when faced with a need to provide a firm price at a point where there are still uncertainties about what they will be providing, putting a premium on the risk, and introducing **contingency allowances** into their prices. Commercial arrangements should avoid disruption, as far as possible, by respecting the logical flow of development of the design and understanding of what it will cost.

Second, even within the same organisation, a collaborative project process can be seriously disrupted when one team, for example the bidding team of senior commercial and design staff, hands over to another, for example the contracts or site team. The second team tends to impose its own interpretation on key decisions made by the first, because they do not fully understand why those decisions were made. Each handover from one team to the next introduces an interface and hence a risk of poor communication and misunderstanding, resulting in loss of appreciation of the overall sense of the project.

The key goal should be to keep the same core multi-disciplinary team membership involved in the project throughout most if its life, and certainly

during the various design stages. There will need to be some new faces arriving as the project moves into construction, and then again as the facilities management and proving stages approach. It is vital to ensure a level of team continuity as well as providing in-depth induction to new members of the project community.

## "Soft" and "hard" gates

A basic requirement of any form of project management and control is a series of gates or stage reviews, clearly identifiable decision points which divide the total effort into a sequence of distinct stages. As we have seen, each of the four broad phases and stages within them represents a number of activities to be performed and information that needs to be gathered. The gate at the end of a phase or stage takes the form of a meeting at which a management decision is made to allow the project to proceed to the next stage, or else to cycle back to the current stage to improve on some of its products. A third option available is of course to terminate the project, if available information suggests there is insufficient likelihood of a viable outcome. Gates need to be defined at the outset of the project and specify a set of deliverables – a list of criteria, both "must-have" and "should-have".

There are two kinds of gates in the BDB process. "Hard" gates are points during the process at which all the work and deliverables associated with one stage must be complete before the next can commence. Hard gates usually have contractual implications, involve a broader number of decision makers, and imply an increased level of financial commitment. They are therefore highly sensitive decision points that may even require the temporary holding up of the project until a decision to proceed can be made. "Soft" gates are internal review points at which critical activities are evaluated and endorsed by all the relevant players. In order to speed up the process soft gates can be rendered "permissive". A permissive gate is one where the next stage is authorised although some work in the almost-completed stage has not yet been finished. Gates should be made permissive only when there is enough certainty that the work still to be carried out will have no unexpected knock-on effects for other activities.

The key characteristic of this **stage-gate process** is that each signing off of the agreed deliverables constitutes a mutual commitment and an authorisation to proceed. In this way, the results of each successive stage are frozen, and subsequent activities can confidently build upon the results of previous work. Any subsequent variation to the signed off agreement needs to be specifically negotiated and tracked within an agreed late change process.

The positioning of the gates in the process needs to be negotiated on an ad-hoc basis in view of specific characteristics and constraints affecting the project. It is generally an essential component of agreeing the commercial framework during the pre-project phase. Client-specific procurement rules or special environmental or safety requirements may require gates at specific points. Moreover, the process of negotiation of gates, phases, deliverables and evaluation criteria constitutes a critical step in the establishment of a transparent and honest collaborative relationship between the prime contractor and the client team.

Figure 9 summarises experience accumulated in the BDB and other innovative projects (see for example the work carried out at Salford University) as to how gates should be positioned. The main characteristic is that hard gates are positioned so that they do not introduce unnecessary interruptions into the flow of design development, facilitating the achievement of a seamless process.

The principal difficulty is where precisely to locate the hard gate after the development of the scheme design, at which some form of firm price or guaranteed maximum price and incentive arrangement is agreed between client and prime contractor. Many clients and prime contractors will prefer to have this hard gate as close to the completion of scheme design as possible – everyone then has confirmation of what is to be built and how much the client will be paying, before more detailed design development takes place. The problem with this is that the prime contractor and supply chain generally need to develop the design further, ideally to the end of RIBA Stage E (detailed design) and even including some elements of Stage F (production information), before being able to provide truly reliable costs.

If the client is able to wait until this later stage for the hard gate, much more accurate prices can be agreed. The later hard gate arrangement will generally depend on having commercial arrangements in place for funding the prime contractor and supply chain in carrying out design development work. Even when the hard gate is placed at the later point, the soft gate at the end of scheme design still requires a thorough examination of the design and its through-life cost, because changes made after that point add considerable cost to the design process.

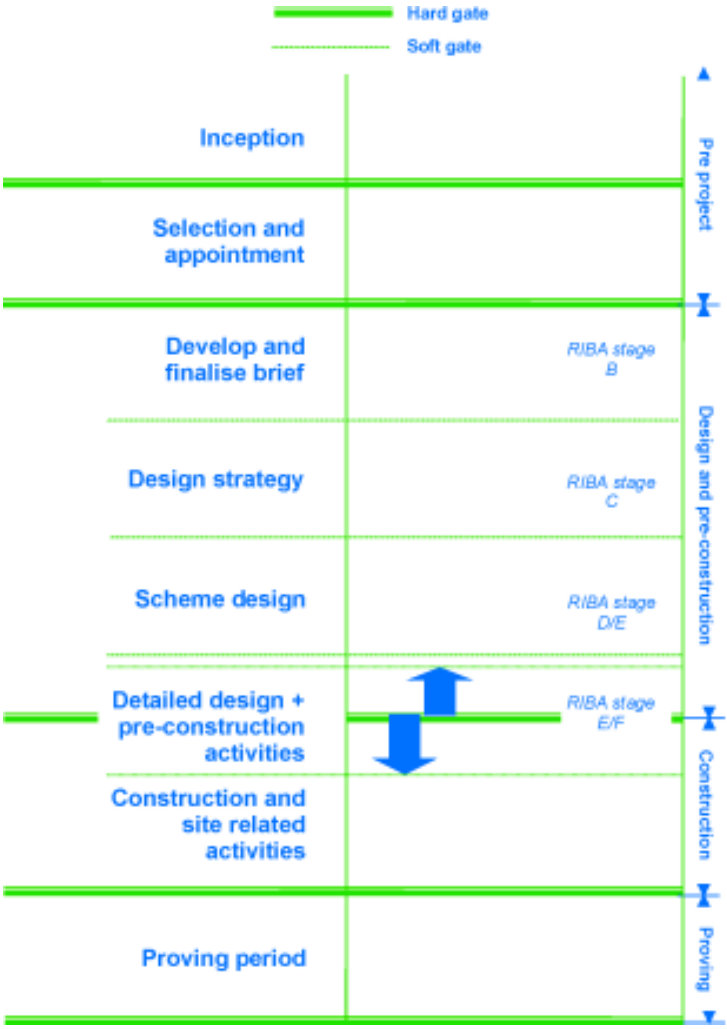


Figure 9 Soft and hard gates

## Continuous improvement

The stage-gate approach lends itself to incorporating continuous improvement as a way of doing everything. Each of the project phases can begin with a review by the team of the results of previous work, leading to forward-looking process mapping and planning activity. A workshop can be convened in which participants:

- review the outputs and processes of the previous phase
- review the nature of what is required for the various gates in the phase ahead, particularly the final gate
- map, analyse and agree the detailed processes for the phase ahead
- develop or agree the programme
- clarify roles and responsibilities
- agree a meetings schedule and attendance for managing progress
- introduce new techniques and methods to be used in the specific phase they are beginning
- identify training needs.

In a similar way each phase concludes with review and consolidation of the work carried out, which becomes the basis for the next set of activities. Figure 10 opposite summarises this CI-based pattern of activity.

## Value enhancing techniques

The BDB approach incorporates several value enhancing and cost reduction activities. These include aspects of value management, risk management, collaborative planning, and site process improvement and waste minimisation. Each will be appropriate for certain parts of the project. Although all are interrelated in their contribution to improving value, BDB experience indicates that they should be introduced and managed as distinct activities, so that they are easier to comprehend, and so that their impact on the project is maximised. Any implementation of the BDB project process will need to identify specific points in time for the formal start-up and conclusion of each of these initiatives. Figure 11 overleaf shows where the main value enhancing techniques are used to best advantage in the overall process.


Figure 10 Continuous improvement

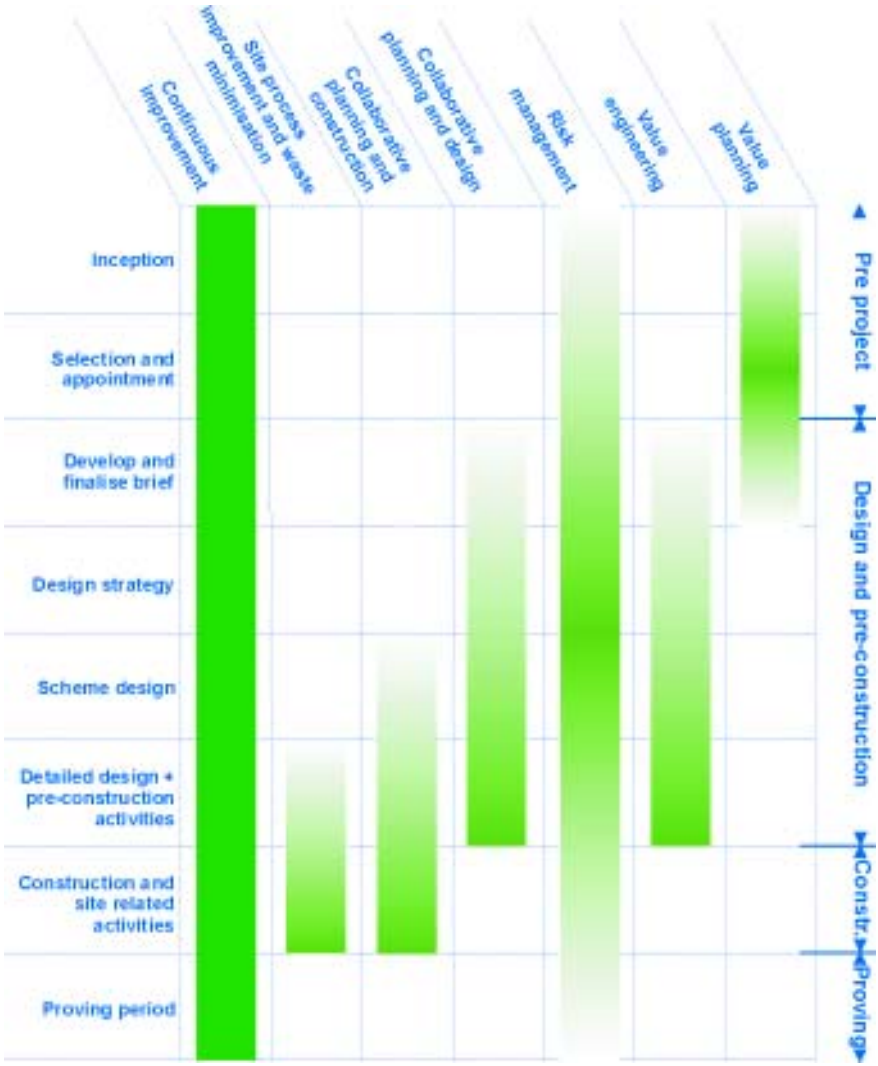


Figure 11 Value enhancing techniques

# 4 The benefits and key challenges

Applying the Building Down Barriers approach has the potential to reward clients with buildings that really meet their needs, are delivered faster and have a lower through-life cost. The prime contractor and all members of the supply chain can simultaneously benefit from far greater certainty of commercial outcome and with justifiable margins agreed and protected.

However logical, this process is very different from the way in which both construction clients and their suppliers behave currently on most projects. In this chapter we draw on the experience of the BDB pilot projects to look not only at the benefits but also at the key issues and barriers which each party will have to confront if they wish to participate in the successful application of the BDB model.

## 4.1 Clients

### 4.1.1 Benefits for the client as an end user

The pilot projects demonstrate that the BDB approach is capable of delivering facilities that achieve better than normal functionality and user friendliness. This brings tangible as well as less tangible benefits.

> In both projects the prime contractor worked from an early stage with their architect, client sponsor and works advisor, together with key user representatives, in developing the project brief. End users were further involved at a number of points during design development, together with the supply chain. This collaborative process has been enormously successful. The resulting sports halls and swimming pools are usable exactly as the garrison trainers wish them to be. For the MoD, this means the achievement of unprecedented levels of functionality and usability, compared to facilities built by more conventional routes, where significant operational snags generally emerge as trainers get to know the facility after handover. The tangible benefits take the form of a rapid and smooth transition to full operational effectiveness following handover, and a minimum of expenditure on putting shortcomings right.

Less tangible, but still of great significance, are the benefits that stem from the familiarity that key users have with the facility and their confidence in its appropriateness even before it has been handed over. For the BDB pilot projects, the trainers were already familiar months before handover with both the facility and the reasons behind all the key decisions.

### 4.1.2 Benefits for the client as a budget holder

The pilot projects have delivered considerable financial and business benefits for the commissioning client. These include achieving:

- savings in through-life costs
- delivery ahead of programme
- improved predictability of cash flow both during the construction phase and over the entire life of the building
- collaborative and non-adversarial relationships.

Table 3 below shows figures on actual capital and predicted through life-costs for the two facilities, compared with demanding benchmarks set for them by the MoD at the outset. These benchmarks represented the best that could be expected had the facilities been procured in the established "design and construct" manner, without any particular emphasis on integrating the work of the supply chain. They were calculated using data from previously completed physical and recreational training centres. These were in the main acknowledged by the MoD as being in some respects functionally inadequate and of questionable quality in terms of durability of materials and components. All project participants, including client representatives, have acknowledged that these benchmarks were set using very stringent standards. Aldershot costs are as predicted one month prior to handover, and Wattisham's are final outturn costs.

Table 3 Benchmark and predicted costs

| | **Capital cost (£M)** | | **Through-life cost (£M)** (Expressed as net present value) | |
|---|---|---|---|---|
| | Benchmark | Predicted | Benchmark | Predicted |
| Aldershot | 9.779 | 10.318 (+5.51%) | 16.708 | 14.311(-14.3%) |
| Wattisham | 3.773 | 4,000 (+6.02%) | 7.191 | 6.675 (-7.18%) |

Such savings against demanding through-life cost targets represent a major achievement, particularly given the inevitable difficulties involved in implementing a radically new approach to project integration for the first time. The main successes in improving value through reducing cost have been in the use of value management and value engineering in design development to optimise TLC rather than capital cost alone. This has however tended to push capital cost above the benchmark capital figure. It has led to the identification of materials and components that require less maintenance or cleaning effort, or which have lower running or replacement costs, and so reduce operating expenditure and TLC, whilst pushing capital expenditure up. In both facilities, a capital investment in a combined heat and power installation has lead to significant TLC gains.

There are good reasons to believe that the BDB process will lead to lower capital costs in the future, as the approach is developed further. There is a clear prospect for the future of facilities that are cheaper in both TLC and capital terms, whilst meeting all functional requirements and delivering good margins to the supply chain. It is possible to identify where the pilot project prime contractors have been able to drive out cost so far, and where they will rapidly learn to drive out further capital costs. In particular, there is scope for even greater application of detailed process planning to construction activities, and the use of continuous improvement or problem solving groups of site personnel in working out how to take waste and inefficiency out of site activities.

The application of a Continuous Improvement philosophy throughout each project and use of “smart” sequencing of work through involvement of cluster leaders and cluster members in planning has borne substantial benefits in terms of delivery compared to the contract programmes. Table 4 overleaf shows how the overall time taken to construct each facility compares with the programme agreed at the end of scheme design. Both projects compare favourably with the annual “construction time” improvement target of 10% set for the industry by Sir John Egan’s Construction Task Force report *Rethinking Construction*. The comparison with normal industry practice of late delivery is of course more telling. For both pilots, the issue has been not “Can we deliver to time?” but rather “How early will we manage to deliver?”

Table 4 Construction times

| | Contract programme (weeks) | Actual construction time (weeks) | % Improvement | Client changes post construction contract |
|---|---|---|---|---|
| Aldershot | 75 | 73 | 2.6% | 3 |
| Wattisham | 54 | 43 | 20% | 1 |

A further financial and management benefit comes from the sheer predictability of quality and functionality, as well as construction time and cost. The client, key users and suppliers had been so thoroughly involved in developing the design that once construction was underway exceptionally few client changes and even design queries had to be considered. On both projects, the very small number of client changes that had to be acted upon resulted either from circumstances that could not have been predicted during design development – for example a change in site drainage due to a development on an adjacent site – or from a minor change of mind on a detailed design option by a key user.

Time and cost predictability have been achieved through involving the supply chain in detailed planning, so that problems and interface issues are anticipated and planned out, rather than discovered on site. According to the two Land Command sponsors, the absence of the delays typical in most construction projects has led to absolute predictability of expenditure against planned milestones during construction. This has greatly simplified financial management and control.

Similarly, the open approach to risk management and the early involvement of the supply chain has allowed drastic reductions in the size of the risk contingency "pot" put aside by the client, with obvious financial advantages from the release of considerable amounts of money. In one pilot project the risk contingency was eliminated altogether, and in the other reduced from an expected £400K to £120K.

Finally, the BDB approach appears to foster a team ethos and a collaborative attitude that has a number of valuable consequences for the client. It promotes good working relations and a high quality of workmanship. In the long-term these diminish the client team's requirement for legal and technical support.

### 4.1.3 Benefits to the client as a facilities or estate manager

The development of a through-life cost model as an integral part of the design and construction process in fact extends predictability well beyond the end of the construction process itself. The through-life cost model, refined and corroborated during the proving period, enables the client to plan and budget maintenance activities for the entire life of the building. It provides the basis for a far more thorough approach to planning and budgeting in estate management than has previously been possible. This predictability in itself offers enormous scope for saving money and delivering better value year by year. Resources deployed on a planned basis are generally cheaper and more effective than resources obtained at short notice.

The use of value planning and participative decision making, involving end users and other stakeholders in developing the brief, raises further possibilities for adding new dimensions to facilities or estate management. Although the BDB pilot projects focused on functionality and cost as key elements of the strategic brief, a number of other headings can be added as future priorities for joint consideration. These include aspects of environmental impact, like visual appearance and impact on the surroundings, and ecological impact or the achievement of what has become known as sustainable construction. Structured consideration of these topics provides a basis for genuine involvement of the local community and other stakeholders in the development and management of facilities.

### 4.1.4 Challenges for clients

The first challenge for the client is to understand the logic of the BDB process and the nature of the relationship with a prime contractor. There are no intermediaries between the client and the firm delivering the facility in the same sense there are in a traditionally procured contract. Many clients are more used to going first to design and other consultants for professional services based on an impartial understanding of their needs. They then engage a distinct construction firm to manage the risk in delivering a design which has been conceived, if not fully developed, elsewhere. The consultants play an important role in mediating the relationship between client and contractor. In contrast, the integrated supply chain brings together under one umbrella of responsibility those who consider needs, produce design ideas, and consider how to manage risk in order to make delivery economic.

Once a client embarks on the route of working with prime contractors within a BDB framework, a set of further challenges comes into focus:

- Selecting prime contractors based on their capability to deliver value
- Producing output based strategic briefs
- Setting through-life cost benchmarks
- Committing time of staff to take part in brief development and design development
- Appointing a credible internal project manager
- Appointing and defining the role of any external advisors to the inter nal project manager
- Developing appropriate commercial arrangements with the prime contractors.

The client faces the challenge of applying a rigorous selection process to ensure that the most appropriate prime contractor is chosen to undertake the project. This involves evaluating potential prime contractors and their supply chain members in terms of their capability to deliver forms of value relevant to the client. Section 3.2.1 in Chapter 3 provides examples of the areas of capability likely to be relevant to most clients. Above all, clients need to gather evidence that the prime contractor and supply chain have established detailed processes and techniques for working together to improve value. This will include integrating and managing design inputs from a number of different sources, and managing costs during design and construction in a systematic way.

The ideal is to have documented evidence from prospective prime contractors of how they have applied something like the BDB approach on previous projects, and the resulting benefits. Since integrated working is still very rare in construction, a more realistic expectation is that potential prime contractors can show how they and their key suppliers have invested in considering how they will work together. This can be demonstrated by process maps and other outputs of a series of joint workshops. The validity of this kind of preparation can perhaps most tellingly be judged by interviewing members of the supply chain separately to establish whether there is indeed a common view of how they are all going to work together.

The client must also tackle the question of how to develop a strategic brief for a BDB project. Particularly for one-off projects where a prime contractor is brought in once a business case has been approved, the client needs to have the capability to think from the beginning in terms of functional or output-based definitions of need, rather than design or engineering ideas. The objective of such a brief is to allow the prime contractor and their team the opportunity to contribute their joint expertise to the development of the solution which best meets the client's needs.

The strategic brief needs to be accompanied by some form of realistic through-life cost target, to set constraints for the development of designs and prices for delivering them by the supply chain. This poses a particular challenge for the client, in terms of clarifying whether targets for through-life cost apply regardless of the impact on initial outlay, or whether there are also important constraints on capital expenditure. Many clients are not used to carrying out this kind of strategic analysis of the expenditure profile that will best suit the nature of their business.

This leads to the next challenge for the client - the requirement to contribute the time of the most appropriate people in the organisation to work with the prime contractor's team to interrogate the strategic brief in order to devise the best business solution for the client organisation. Client representatives must be prepared to listen to the prime contractor as to the time needed to develop the design to the right level of detail before real prices can be considered. Time spent in getting the design right can be more than made up through a more efficient construction phase.

Leading the client's input to the whole process must be someone of sufficient stature within the organisation to take decisions when they are needed (or get those decisions taken fast where he or she may not have sufficient knowledge) and to ensure that the organisation's user community is properly involved. There will be a need for this internal project manager – from time to time – to balance what the users say they would ideally like to see in the new facility with what fits within the budget or is simply common-sense. The person filling this role needs two strengths. First, the appropriate seniority within the organisation and personal maturity to gain the confidence of all the members of staff asked for their inputs. Second, the ability to instil confidence in the prime contractor that he or she is dealing with the authoritative voice of the client and that there will be a consistent approach to decision-taking.

The client thus becomes a part of the whole team, working extensively with the prime contractor and being a party to making fundamental decisions, in particular as the design phase is underway. Although the client's commercial relationship is with the prime contractor, with no intermediaries, it is likely that, given the participation that he will have in design-led decision making, they will seek the support of a professional advisor. A further challenge is defining the role of this advisor so that they contribute value to the process along with everyone else.

That advisor's role is not to second-guess the prime contractor. Rather it is to adopt an "eyes on, hands off" role to help the client understand fully the implications of some of the decisions that they will be asked to endorse and for which they do not have the necessary expertise. If roles and responsibilities are not clearly considered and spelled out at the outset, there is a danger of the advisor moving into a *de facto* project manager role, which can seriously disrupt the work of the prime contractor.

The development of effective forms of commercial arrangements with prime contractors to support the general collaborative ethos is a key issue for clients. These arrangements need to protect the client's interests while not prejudicing the delivery of the benefits from Building Down Barriers. The basic need is for forms of commercial agreement and contracts which support the collaborative development of designs and costs, with reasonable margins protected. This is likely to mean moving away from lump-sum prices agreed on the basis of inadequate design information, towards some form of guaranteed maximum price and shared savings regime, probably with capped risk exposure for the client. At the time or writing, guidance on appropriate terms of engagement and forms of contract is available from the Office of Government Commerce and Defence Estates. Further work on commercial arrangements for the integrated supply chain is being undertaken by the Reading Construction Forum.

In order to address these challenges, clients need to embark on a process of systematic change and education within the ranks of their own staff. The new approach requires management commitment and willingness at all levels to explore the implications and find solutions to unexpected problems.

## 4.2 Prime contractors and key specialist suppliers

### 4.2.1 Benefits for prime contractors and their cluster leaders

The benefits for the client are all the more impressive when considered alongside the fact that members of the two supply chains on the pilot projects have made fair and predictable margins. Margins (profits plus overheads) for suppliers who generally operate as contractors have been maintained within the range of 8% to 14%. Considerably higher margins have been made by some specialist contractors and design consultants, who operate on the basis that significant margins are necessary to finance various forms of research and development. Both pilot projects have demonstrated the reality of achieving financial gains simultaneously for the client and for the supply chain, through using processes that design cost out and eliminate waste.

This is illustrated by the use of value engineering to take cost and time out of the construction of the foundations, without compromising quality of the finished product or supplier margins. On both projects, consideration of the initial design approach and programme of work for the foundations by the cluster leader, supported by the design consultant, led to identification of significant improvements in design and method. On the Wattisham site, approximately 50% of the cost of various elements of the foundations were taken out. At Aldershot, omission of sheet piling and any need for a reduced level excavation gave rise to savings of over £80,000.

Other immediate benefits for the supply chain include:

- greater confidence in design information once construction begins
- a more efficient site, with enhanced predictability of workforce utilisation, increased productivity, and reduced site waste and rework
- a safer site
- a positive atmosphere on site and an absence of claims or any other “contractual” activity.

The structured and disciplined collaboration between designers, manufacturers and constructors throughout the design process not only minimises iteration in design activities; it has the potential to eliminate “designing by

fax" at the last moment once site activities begin. At Wattisham, the management of the dimensional grid by the architect was so accurate and the design development work undertaken by the whole team so thorough that building services components fitted first time when installed. There was no need for additional site input or support from the project level design team. This has led the services cluster leader to contemplate much greater prefabrication off-site on future jobs run under the BDB system, with further considerable cost saving opportunities.

> The thoroughness of detailed construction planning and interface management made possible by the clustering process allows operatives on site to tackle their work uninterrupted, with easy access to work faces, plant and materials. The BDB approach helps sites run smoothly. The delays and false starts accepted on most construction sites have been prevented, with a consequent increase in productivity.

At Aldershot, for example, use of the Building Research Establishment's CALIBRE monitoring system has demonstrated week by week that the proportion of labour-time spent overall on adding value to the building is in the region of 65%. This compares to a BRE benchmark of 54%, based on averaging other sites to which CALIBRE has been applied. According to BRE's database, this level of performance, achieved within a single project, equals what has been achieved elsewhere only within long-term partnerships, where a stable construction team has undertaken repeat projects of the same type of building. Although formal measurements of labour utlisation have not been taken at Wattisham, the dramatic savings in construction time achieved, of the order of 20%, would not have been possible without comparable or even superior levels of labour efficiency.

Data from both pilot projects demonstrate that the BDB approach reduces materials wastage and rework levels. CALIBRE reports from Aldershot showed wastage and rework levels consistently below 2%, compared to an industry "best practice" benchmark of 10%. Less rigorous benchmarking of Wattisham activities suggests that rework was down by 90-95% compared with a comparable construction project.

The improved site organisation created by the BDB approach is also reflected in the safety record of both pilots – there were in fact no reportable accidents for the entire duration of the project at Wattisham. This health and safety statistic is of the utmost significance. In an industry that regularly maims and kills, often as a result of lack of attention to detailed planning of working methods and conditions, two well run sites have indicated what is

possible. The BDB approach has the potential to move well beyond Sir John Egan's *Rethinking Construction* target of a 20% reduction in reportable accidents per annum.

The experience of the two pilot projects eloquently supports the claim that the BDB process generates high site morale and an atmosphere of willing collaboration, which underpins the hard performance gains. The participative approach to decision-making and planning, and the underpinning continuous improvement philosophy produced a collaborative, non-confrontational working ethos during both design and construction. Designers and deliverers at all levels worked as a cohesive team. Problems were identified early and mostly solved within a framework of fostering the success of the project as a whole. On both projects, this has laid the foundation for the establishment of more formalised strategic supply chain partnerships.

An absence of significant commercial or contractual conflict on either project starkly demonstrates this ethos. In neither case has "the contract" been referred to at any point once signed. No member of either supply chain has felt the need to make any claims. Nor have they been subject to any payment retentions after completion, or had to put up any bonds.

### 4.2.2 Challenges for prime contractors

A first set of challenges for any organisation seeking to establish themselves as a prime contractor concern establishing themselves in the emerging markets for integrated design, construction and facilities management services. Three main issues must in fact be addressed:

- Achieving clarity of business focus
- Selecting appropriate supply partners and setting up long-term relationships with them
- Establishing credibility with potential clients and key suppliers as a responsible and capable supply chain integrator.

Many construction sector organisations have a very reactive and broad notion of what business they are in. They will need to develop greater strategic focus in terms of the types of client they wish to do business with and the types of facilities they seek to deliver for them. Only then can they identify which supply partners they most crucially need to help them deliver.

This involves a prime contractor clarifying the kind of competitive advantage they aspire to relative to potential competitors in their chosen markets. Should the prime contractor aim to supply simple but flexible buildings that offer low capital and running costs, but which do not involve an extremely detailed consideration of the client's business processes? Or should designs seek to add value by being highly tailored to the client's business processes? Is innovative architecture or engineering likely to be important in the chosen markets? Which aspects of facilities management will be most crucial to client businesses or activities? Such questions have an important bearing on the kinds of supply partners who will be needed and the capabilities they should have.

The prime contractor then needs to select a number of specific suppliers within each key supply category that has been identified. In general these will include design, construction and facilities management specialists. Just as clients need to select prime contractors for the value they can deliver, so prime contractors need to gather evidence from potential preferred suppliers on a broad range of capability indicators. The list of capability areas and sources of further information set out in Chapter 3, section 3.2.1 are just as relevant here. Once suppliers have been selected, prime contractors need to develop a form of agreement with them that indicates the level of business they can expect and the kind of joint working and continuous improvement that will be expected.

Aspiring prime contractors face the hurdle of establishing their credibility to both clients and suppliers in what is a new role for the UK construction industry. In recent years, clients have not for the most part turned to a single organisation for co-ordinating the entire project lifecycle right at the inception of a project. Rather, they go first to architects or other consultants, even if they later go down a design and construct route once they have a design concept. Prime contractors need to persuade clients that they can provide a broadly-based and professional approach to managing the early stages of concept development as well as the later construction stages.

To sell a Building Down Barriers solution requires the ability to help a client understand:

- the benefits of the process, not least price certainty
- the relevance of the experience brought by the prime and supply chain team, both at design consultant and specialist supplier levels
- the role of the prime contractor in the process and the need to invest in working together to get the design right before construction starts
- the importance of agreeing and protecting margins and concentrating effort on reducing cost
- the importance of non-adversarial forms of contract.

It is not easy for an organisation without quite sophisticated new business development capabilities to convince a client to change from the traditional procurement processes with which he or she is familiar. So there is a requirement for the prime contractor to learn to sell business benefit. This amounts to a significant departure for many established contracting organisations. Most have typically had a view of new business development as a reactive process – waiting for tenders to drop through the letterbox and responding with a lump-sum price, regardless of the inadequacy of either time or design information.

The challenge of selling business benefit is closely related to establishing an image as a truly professional organisation in the sense of making impartial assessments of what a client will actually benefit from, and working with them to deliver it in a way they can afford. Whoever establishes themselves as prime contractors in the future will need to gain a reputation for meeting real needs, not merely selling something and then extracting payment for it according to the terms of a contract.

A related barrier is that of the cynicism of suppliers within the industry towards any form of “main contractor”, even when approached to develop ostensibly collaborative relationships as part of a supply team. This cynicism stems from the adversarial commercial practices that suppliers have experienced in the past. It is likely to be more intense when an established contracting organisation sets up as a prime contractor, less so with a project management organisation or some form of alliance between a design organisation and a construction management firm. Experience on the Building Down Barriers pilots shows that such suspicions cannot be ignored, but that they can also be overcome, given time and a determination

on the part of the prime contractor to practise the principles of competent supply chain management. Above all, fair margins have to be protected for all participants.

A second set of challenges for the prime contractor concern establishing the required integrated ways of working with the client and supply chain at project level. The key issues emerging from the pilot projects are:

- managing collaborative design
- understanding and managing underlying costs
- leading and facilitating the supply chain in developing the new ways of working.

Management of design involves addressing a number of inter-related issues. Whoever they are, prime contractors need to find a productive relationship between design leadership and construction or delivery expertise and leadership. The prime contractor needs to provide conditions that encourage designers to listen to and respect constructors and vice versa.

This in turn requires operating a systematic approach to the planning and sequencing of design. Undertaking design on a more collaborative basis, involving input from a broader range of sources, requires considerable co-ordination. Above all, key interface issues need to be resolved early, so that the various cluster teams can develop detailed designs secure in the knowledge of how their work fits within the scheme as a whole. Roles and responsibilities of project-level designers and cluster-level designers need to be clarified with great care, to avoid misunderstandings and disruption. The pilots firmly suggest that the use of some form of interface register is crucial not only for design co-ordination but for the management of costs within clusters. Clusters need to know at an early stage what design interfaces and cost constraints they need to observe.

The challenge of understanding and managing costs in a rigorous way also has a number of facets. At a general level, the BDB approach requires disciplined analysis of design options in terms of their costs and contribution to functionality before a decision is taken. Prime contractors need to manage design development using the disciplines of value planning and value engineering. Not least, they need to use discounted cash-flow modelling when producing through-life cost estimates for design options.

This standard of rigour challenges many established ways of operating within the UK industry. The individual techniques needed are not new to the

industry, but they appear rarely to have been applied consistently. People often seem to prefer to work on intuition rather than fact in making design decisions and to get their job satisfaction from fighting the fires that they themselves cause through inadequate attention to detail. Other industries manage to apply systematic cost management techniques during design development and the BDB pilots show that construction firms can as well – although not without some shock to the system.

Beyond this general need for rigour, there is a crucial specific requirement for effective cost management with an integrated supply chain. Prime contractors and their cluster leaders need to understand what their construction, manufacturing and facilities management processes actually are and how their costs are built up.

Very few firms either in construction or facilities management appear currently to have the data needed to estimate the various categories of underlying costs, ie labour, plant, materials, and subcontracts. Some organisations employ the vast proportion of their labour on sub-contracts based on lump sums for completing specified tasks. They have very little idea of how much labour time is actually involved in their operations, or how it could be reduced. Throughout the supply chain, most organisations determine price based on previous lump sums they have achieved, coupled with lump-sum quotations from their own suppliers. Many organisations have only a limited sense of the balance of underlying costs, margins and risk allowances in the prices they offer.

> Prime contractors and their cluster leader need to be able to produce delivery prices and through-life cost projections for the facilities they design on the basis of understanding what these facilities will actually cost to build and maintain. They need to build up underlying costs in terms of meaningful categories. They must also be able to propose margins that are reasonable for the needs of their business, as a basis for agreeing margins to be protected. Only then is it possible to work on reducing underlying costs and improving value. Continuous improvement requires an understanding of processes and their cost drivers.

Managing an integrated supply team requires a very different approach to project management from that which predominates in construction. In terms of commercial relations, the prime contractor needs to ensure that their own business needs – and margins – and those of key suppliers are recognised and supported throughout the project, alongside meeting the needs of the client. In terms of day-to-day operations, instead of merely controlling

suppliers, the prime contractor needs to ensure that the expertise of each supplier is really being contributed and exploited to the benefit of the project. This involves delegating tasks whilst facilitating and supporting the members of the supply chain who take responsibility for them.

Such participative management still requires clear leadership. Leadership in this environment means ensuring that everyone is crystal clear about their deliverables, about their responsibilities to all other members of the team, and – most importantly – where those responsibilities begin and end. At the same time, the project manager will be the prime contractor's single point of interaction – and decision making – with the client's representative. That requires commercial skills – and the appropriate delegation of authority – which may require a different kind of person from many who currently hold project management roles in the industry.

### 4.2.3 Challenges for specialist contractors

The BDB process demands that the specialist contractors contribute to the considerable investment that is made from the first value management workshops to the completion of scheme design. A barrier for some specialist contractors will be too few people within the company with the right skills to take part in this vital stage of the Building Down Barriers approach – or an unwillingness to become involved.

A second issue could be the expectation that all supply chain members have an open book relationship with the Prime Contractor. There can be no secrets in this process if margins are to be protected whilst cost is ruthlessly minimised on each project and from one project to the next. Although many specialist contractors may well accept the principle of open books, there are reasons why apparently open books may contain inadequate or even misleading information. Just like prime contractors, specialist contractors are on the whole not used to keeping precise data on the actual costs of their processes. In addition, there is still sufficient lack of trust in the industry for specialist contractors to protect their position. For many years they may have experienced themselves as under attack by all main contractors. This behaviour is understandable but not helpful for implementng the BDB principles. Open books must contain accurate figures.

Another issue identified on the pilots was the lack of design capability on the part of some of the specialist suppliers. This is required particularly at the detail design stage. The lack of design capability in house need not be a

problem if the specialist supplier has a well-established relationship with a design consultancy. But whether in-house or bought-in, a lack of design capability will be a major barrier to entering a prime contractor's supply chain and fulfilling the responsibilities that the process requires.

A further challenge concerns the ability to manage sub-contractors and suppliers. The BDB approach requires that specialists take a high level of responsibility for assuring and controlling the quality of workmanship of their own operatives and of those of any subcontractors. Site supervisors must be able to control quality in a proactive way, and also liaise with other clusters to anticipate and solve site problems in the participative style that the process encourages. Inability to undertake either of these creates problems on site for the other members of the team who are able to work in these ways and generate the benefits. Similarly, any failures in the specialist contractor's procurement function can cause delays due to materials not being on site when required. This can cause knock-on problems not just for the prime contractor but the entire team.

### 4.2.4 Challenges for manufacturers and materials suppliers

Component manufacturers and materials suppliers face new challenges from the Building Down Barriers approach. They will be asked to deliver their products in a particular sequence on particular days to ensure that the build schedule is optimised and that no material is stored on site until it is needed. Few construction sites are currently so closely under control that they make such demands. So manufacturers have to provide new levels of service to play their role in the BDB approach. Again, the pilots showed that it can be done – but it would not have been done without the project managers making suppliers realise that they were serious about this new way of working. Component and materials suppliers to a project are key supply chain members too.

This new disciplined way of working means that when products are delivered to site (when stipulated) they are what was asked for in every particular. In the current UK construction industry it is not possible to take that for granted. Certainly the BDB pilots suffered when manufacturers failed to deliver precisely what had been asked for. Those suppliers who continue to deliver orders late and incomplete may soon find themselves in the same position as those suppliers in other industries who failed to keep up with increasingly demanding customers – out of business.

A further challenge for UK manufacturers and materials suppliers to overcome is their apparent reluctance to warrant, or confirm in writing at all, the life expectancy of their products. Building Down Barriers is predicated on minimal through-life costs. For this, prime contractors have to know – or estimate – the likely replacement and maintenance schedules for the materials, components and service equipment in the building. The pilots showed that, while some manufacturers made claims for the likely life of their products, they were on the whole stopped short of confirming the claims in writing. Manufacturers of products for the construction industry will need to emulate their colleagues from other sectors, who readily accept that they must tell their buyers what life can be expected from their products, with warranties where appropriate.

## 4.3 Design consultants

### 4.3.1 Benefits for design practices

The change in role for the design consultant in the BDB system is as radical as that for the client and prime contractor. Design consultants become service providers to a client through a prime contractor. Designers are trained to offer design leadership and have a professional commitment to understand and meet the needs of the commissioning client, of users of the facility and of those who will be impacted by its external appearance. This capability and professional stance can be fully brought to bear and even enhanced.

In the two BDB pilot projects, both architects in particular have found their ability to design enhanced by having clear statements of what value means to the client, in terms of a detailed project brief. This clarity of what the design is trying to achieve, alongside early involvement of the firms who are actually going to deliver the facility means that design ideas can be developed with much greater clarity of purpose and certainty of cost than is often the case. The opportunity to design for through-life value is also an important benefit that arguably allows greater scope for high professional standards than is common in many areas of construction.

Being a part of a supply chain will not suit all consulting design firms and the way that they work. However, there is a strong argument that for those who chose to work in this way the reward may be the chance of making viable design ideas that might otherwise be rejected by a client as too expensive or risky to contemplate. The supply chain can be integrated to

deliver design innovation through managing risk, rather than limiting innovation in order to minimise construction risk as some designers fear, based on past experience of design and build projects where there has been no real collaborative working up the supply chain.

It is also worth making explicit that the general principle of protecting margins in the BDB approach applies as much to consultant designers as to any other supplier. Given current stiff competition over design fees, this offers security to design practices just as it does to specialist contractors.

### 4.3.2 Challenges for design consultants

There may be a perceived barrier for consultants in what is a new relationship between them and prime contractors. Typically they have the final word in design decisions. In Building Down Barriers projects, design decisions are reached by the team. Obviously, the consultants will have a major impact on the final decision and the other members of the Prime Contractor's team will respect the expertise and leadership that the consultants bring. But the consultants must also respect the expertise that the rest of the team brings and in Building Down Barriers no one has a monopoly of good ideas. So a possible barrier is the lack of acceptance by the consultant that he or she is a team member and not the person to whom everyone turns for all design decisions. A challenge for the consultant is to exploit the unprecedented knowledge available in the group at the pre-design stage in developing the design solution within the team.

A further issue – and a potential barrier to the successful involvement of the consultants in the team – is that of **professional indemnity (PI)** insurance. Consultants must ensure the structural integrity of the building and are responsible for applying "due skill and care" in all aspects of design. If not, claims can be made successfully against their PI cover. So there is some level of pressure to produce an over-engineered design, in order to meet standards of due skill and care. But that does not meet the objective of ensuring that the building can be delivered to the client at the lowest possible through-life cost. The consultants are therefore required to ensure that both the PI requirements and the client's objectives are met through the most appropriate balance between these two potentially conflicting aims. It can be done, as the Building Down Barriers pilots have demonstrated – but not without having to overcome traditional ways of working on the part of both consultants and other members of the supply chain.

Although it is possible to operate the BDB model successfully using current models of insurance, its fuller development will almost certainly require the development of new forms. If designs are developed collaboratively by the whole supply chain, one possible model is that of project insurance, which all parties contribute to and are protected by. This offers considerable benefits over established models which in effect insure each party against claims being made by another party. The issue of forms of insurance can only really be tackled at the level of the whole industry, however.

A final issue concerns architects in particular. It involves achieving a productive relationship between functionality and other design values, such as quality of form and space, overall impact and other elements of architectural interest. Building Down Barriers allows this relationship to be worked out through the participation of the client in value management workshops, along with the prime contractor and the key supply chain partners, including of course the design consultants. A key role for the architect is to provide design leadership, showing how good design can contribute to meeting tangible functional requirements as well as providing "uplift to the spirit".

The ultimate decision on the balance and relationship between functionality and other design considerations of course rests with the client. It may be that functionality and cost outweigh other considerations, and the building need only be a rainproof container with no obvious architectural merit.

Even in such a case, the architect still has a major role to play. An individual practitioner or practice will however need to consider in advance the kind of building likely to be valued by the present client and the kinds of future clients likely to engage the same supply chain. It is important that the architect identifies with the kind of project values the supply chain is addressing. Any limitations on what good design means however ultimately come from clients, rather than from the BDB approach per se.

To summarise, the challenges of adopting the BDB approach wholeheartedly are profound for all members of the supply chain. Taking them on requires a considerable investment of time, energy and thought. The BDB pilot projects have shown that it is possible to achieve considerable progress with a first stage of implementation, leading to immediate and tangible benefits all round. The pilot projects have also given rise to a fuller toolset for tackling the challenges (set out in Parts II and III of this Handbook). These will be developed over time as the experience of the BDB approach itself deepens and broadens.

# Postscript

## Future developments

The Building Down Barriers model has set out to demonstrate how single point responsibility in construction projects can be made more effective through integrating all key supply chain members. It is based on the assumption, drawn from the experience of capital goods industries other than construction, that the benefits of supply chain integration become much stronger when supply chain integration moves beyond the project level to include continuous improvement activity carried out within the context of longer term supply relationships. A great deal has been learned through developing the approach and piloting it. As with any productive research and development exercise, however, this endeavour has also brought into focus a number of needs for further exploration and development. Three are of particular note:

- applicability and limitations of the single point responsibility model for supply chain integration
- long-term supply relations in construction
- design leadership and the design process.

### Applicability and limitations

The experience of two pilot projects can only provide the basis for informed speculation as to where the BDB prime contracting model is most likely to be effective and where some other mechanism for achieving integrated supply may be more effective. The key assumption behind the BDB model is that a prime contractor pulling together an established network of suppliers can achieve continuous improvement in design, products and processes related to a particular class of facilities and client needs. The pilot projects give ample evidence as to what this kind of continuous improvement looks like at project level, and how it can be continued from project to project. However, the underlying assumption is that there are basically stable bodies of knowledge about client needs, design approaches, construction technologies and approaches to facilities management that can be mastered and improved from project to project, to deliver improved functionality and reduced through-life cost from project to project.

All this implies that the BDB approach is most appropriate for the kinds of facility where there are established models, technologies and bodies of

knowledge. It is then meaningful to identify a focused network of suppliers and embark on a programme of “modular” innovation in the nature of the facility and the means of delivering it. Modular innovation refers to making improvements in the way that parts of the facility are designed and built within existing conceptions of the facility as a whole. It can involve a great deal of creativity and step changes in performance and value delivered to the client.

This contrasts with kinds of facilities that are innovative at an overall systems level, involving radically new approaches to conceptualising client need, new design approaches, and innovative construction technologies. Precisely because the basic technologies being applied are new, supply networks may need to be pulled together on an ad-hoc basis. On occasions, it may be advantageous to involve in a key role an organisation that has never worked in construction before, because they have a great deal of experience with a particular design approach or technology in a different sector altogether.

Under these circumstances a different approach to managing the integration of the supply chain is required, such as a one-off alliance or partnership between a number of design consultancies and a construction management organisation. Many of the detailed techniques developed for the BDB approach at project level will still be appropriate. An important issue for future exploration is to establish how the overall principles of BDB and some of the tool-set can be transferred to procurement routes and models of project integration such as these.

Thinking of the limits of applicability of the single point model in terms of the level of innovation being attempted in successive projects is probably more useful than trying to set a size limit on the kind of project where the BDB approach is appropriate. For smaller, repetitive projects, a much-simplified version of the project process may be required, but it is possible to see the benefits of a single player offering an integrated service even for very small projects. A garden landscape design and construction firm operating on a regional basis might deliver individual projects in the region of only £10,000 to £20,000, but could still offer superior value by working over time with long-term design and delivery partners, and working out how to integrate in a structured way the different areas of expertise in the light of client needs.

## Long-term supply relations in construction

A key focus for future development of the single point responsibility model is to explore the nature of the required long-term relationships and supply partnerships that will work best in different sectors of construction. Precisely because they were individual projects, the Building Down Barriers pilots were able to confirm the benefits of long-term partnerships only indirectly. The two prime contractors and their key suppliers involved have both submitted a variety of bids for further work using the BDB principles. Both supply chains have learned enormously from the pilot experience and have identified how they will be able to work more effectively, with still greater integration and ability to deliver client value "next time". Two of the issues to explore for the future are the following:

- Effective configuration of long-term supply chains for different kinds of construction
- Models of supplier development and commercial agreement.

In some areas of work, prime contractors may choose to set up quite narrow supply chains, where there are only one or two suppliers in each supply category, for example architecture or steelwork. This might be the case where a prime contractor has identified a stream of business with relatively high volumes of a tightly defined building type, and feels that a specialised rather than a flexible supply chain will be most effective. In contrast, a prime contractor may have identified a business stream requiring a much greater variety of facilities, and so choose to set up long-term relations with a broader range of suppliers, so that there is a range of different capabilities to draw on when deciding on the team for a particular project.

Another aspect for exploration concerns understanding the circumstances under which national supply networks, involving larger organisations, are effective, compared with establishing regional networks, probably involving smaller design and delivery specialists.

Prime contractors need to develop ways of encouraging performance improvement from different kinds of first-tier supplier, both in terms of setting performance improvement targets and providing "supplier development". Supplier development is in its infancy in construction, but in other industries it refers to helping suppliers assess their strengths and weaknesses, and providing tools and techniques for making improvements to products and processes.

Closely related are a number of issues concerning the nature of commercial agreements between prime contractors and key suppliers that will work best under different circumstances. In general, commercial agreements need on the one hand to provide security and motivation for working together over time in improving products and processes, but at the same time need to avoid too much "cosiness". They need to convey the pressures of commercial realities up the supply chain, and allow for termination of long-term arrangements when clearly specified performance standards are persistently not being met.

The development of appropriate commercial arrangements will need to include forms of contract and approaches to providing insurance cover that support collaborative working, rather than merely protect individual parties' interests regardless of the consequences for what is delivered to the client.

## Design leadership and the design process

A third key set of issues for future exploration concerns the promotion of design quality within models of integrated supply, in order to support the overall goal of delivering improved value to the client. A number of interrelated facets will need to be tackled.

It will be important to think of design quality as multi-dimensional, rather than a single continuum between "good" and "bad". Different kinds of clients have complex preferences in terms of what good design means for them. They have distinct views about how far they prioritise the straightforward utility of a facility, as compared to its environmental impact, or its architectural and cultural character. Good design generally means bringing together a number of diverse requirements, but it is difficult to deepen knowledge about how to do this without acknowledging the variety of values held by different kinds of client.

This leads to a need for exploration of innovative approaches to briefing. These should allow prime contractors and their designers to gain deeper understanding of the "client" as a system of activities to be accommodated and enabled. Designers can then take a lead in structuring dialogue with client representatives about how to express the range of requirements – from the strictly utilitarian to the creation of a particular kind of atmosphere or character – which the integrated supply chain will work to deliver.

Once the balance of project values, including financial constraints, has been clarified, there is a need to explore further what is involved in achieving integrated working between designers and those who will construct, deliver, maintain and manage a facility. This will involve:

- improving inter-disciplinary working between different design disci plines on more complex projects
- achieving an efficient design process with a minimum of unnecessary iterations
- developing an effective division of labour between project level design consultants and design staff working within cluster leader delivery organisations.

Finally, these issues of what is involved in practice in providing design leadership and achieving productive teamworking will need to be explored within different procurement routes. In addition to single-point models and PFI, strategic partnering, construction management, and even traditional forms of procurement all have their contribution to make in achieving integrated construction supply. No single procurement route can be held up as providing the perfect solution. As knowledge and experience develop, however, it may be possible to set out practical guidance as to the procurement routes most likely to be effective in addressing different kinds of client values and emphases in design quality.

# Appendix I

## The Building Down Barriers community

The Building Down Barriers community consisted of three elements with some overlapping membership:

- the Aldershot pilot project team
- the Wattisham pilot project team
- the research and development team which devised the BDB process, and then facilitated and evaluated its use on the two pilot projects.

### The Aldershot pilot project

The Aldershot Garrison Sports Centre was handed over by AMEC in June 2000, with the proving period scheduled to finish in June 2002. The total capital budget was £10.8m (including all fees but excluding VAT), of which £2.4m was provided from the Army Central Fund, and £8.4m from Army Land Command.

The facility forms part of the Army's Centre of Sporting Excellence at Aldershot. The building contains a 50m competition standard swimming pool with 5m, 3m and 1m diving boards, a boom and floating floor. There are two back-to-back sports halls, providing facilities and equipment for a wide range of sports. There are six squash courts and a fitness and weights suite.

After completion of scheme design, in February 1999, Land Command agreed a guaranteed maximum price with AMEC for delivery and facilities management during the proving period. There was a scheme for sharing savings resulting from value engineering and continuous improvement.

| | |
|---|---|
| ***Project sponsor*** | Col (Ret'd) Bob Crawley, HQ Land PST(A) |
| ***Works advisor*** | Symonds Group |
| ***Prime contracting team*** | AMEC:<br>Ian Farrell (Project Manager)<br>Nigel Miller (Senior Commercial Manager)<br>Roger Francis (Design Manager) |
| ***Architect*** | Faulkner Brown |
| ***Structural engineer*** | Ove Arup & Partners |
| ***Mechanical and electrical services engineer*** | AMEC Design |

| | |
|---|---|
| ***Cluster leaders*** | |
| *Dry envelope* | Briggs Roofing & Cladding, Conder Structures |
| *Building and construction (blockwork and finishes)* | BR Hodgson |
| *Civils and groundwork* | Hiretest |
| *Water treatment* | Thermelek |
| *M & E services* | Mathew Hall |
| *Sports equipment* | Watson Brook |
| *Site services* | AMEC Civils |
| ***Facilities management*** | AMEC FM |

## The Wattisham pilot project

The Wattisham Physical and Recreational Training Centre was handed over by Laing in February 2000, with a subsequent proving period of 15 months. The total capital budget was £4.2m (including all fees but excluding VAT), provided by Land Command.

The facility is located at the Wattisham Garrison in Suffolk and will be used for survival training by army helicopter crews as well as for more general physical training and recreational use by the base. It contains a 25m swimming pool with 3m and 1m diving boards.The sports hall provides facilities and equipment for a wide range of sports, including an indoor climbing wall. There are four squash courts, a fitness and weights suite and a sauna room.

After completion of scheme design, in February 1999, Land Command agreed a fixed price with Laing for delivery and facilities management during the proving period.

| | |
|---|---|
| ***Project sponsor*** | Lt Col (Ret'd) John Thorn, OBE HQ Land PST(A) |
| ***Works advisor*** | White Young Green |
| ***Prime contracting team*** | Laing, Peter Whitmore (Project Manager) |
| ***Architect*** | The Charter Partnership |
| ***Structural engineer*** | Richard Jackson Partnership |
| ***Mechanical and electrical services engineer*** | Roger Preston Partnership |
| ***Cluster leaders*** | |
| *Frame and envelope* | DGT Fabrication |
| *Mechanical and electrical services* | Acqua |
| *Swimming pool* | Ardep |
| *Groundwork* | Jacksons Civil Engineering |

## The BDB Research and Development Group

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Phil Brown
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Geoffrey Wort
Laing

Ray Would
White Young Green

Richard Holti (R & D Project Manager)
The Tavistock Institute

Davide Nicolini
The Tavistock Institute

# Appendix II

## The BDB Architects' Panel

Clive Cain
Defence Estates

Stefanie Fischer
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Andrew Kane
Faulkner Browns

Andrew Morris
Richard Rogers Partnership

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Building Design Partnership

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The Charter Partnership

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# Glossary

### Cluster
A group of suppliers – designers, specialist contractors and suppliers of materials and components – who take the responsibility for the design and delivery of a major element of a facility, working to reduce costs, improve value and minimise waste within a defined scope

### Cluster leader
A lead specialist contractor or designer who takes responsibility for and co-ordinates the work of the others in a cluster. Cluster leaders are selected on their ability to carry the main risks, including their capability and credibility in managing the work of others

### Cluster member
A specialist contractor, manufacturer or supplier appointed by the cluster leader to carry out work within the remit of the cluster

### Continuous Improvement
The continual search for better ways of carrying out all projects and business activities. This involves multifunctional teams who understand, map and measure existing work processes, then apply problem solving techniques to reduce waste of material and labour

### Contingency allowance
A sum included in the estimated cost of a project to cover unforeseen circumstances

### Lean construction
A production-management-based project delivery system based on extension of the manufacturing principles developed by Toyota. These emphasise delivering value to customers whilst consuming the minimum of all forms of resource

### Net Present Value (NPV)
The net present value of a sum of money due in the future is the amount of money you would have to invest today at some interest rate to achieve this future sum of money. The interest rate is called the discount factor. The NPV of the through-life cost (qv) of a facility is the total amount of money that must be invested today to build, maintain and operate the facility throughout its projected life.

## Preferred supplier

Preferred suppliers (or strategic supply chain partners) are selected for their abilities to support the prime contractor in achieving the objectives of an overall business strategy in terms of type of work and type of client

## Professional Indemnity (PI)

A form of liability insurance for designers against claims which may arise out of any defects or performance failures in what they design

## Price-plus

Common approach in UK construction in which the main contractor needs competitive prices from all the trades and then adds its own mark up to derive the price for the contract

## Prime contractor

The organisation awarded overall responsibility for delivery of a project, through co-ordinating and integrating the activities of the entire supply chain, to meet the overall specification efficiently, economically and to time.

## Private Finance Initiative (PFI)

Procurement method through which the public sector secures the use of an asset which is designed, built, paid for and possibly operated by a private trust or organisation. The public sector client pays only on delivery of the services to specified quality standards. The private sector, often acting in consortia, typically seekssynergies across design, build, finance and operation

## Proving period

The period following the handover of the facility during which the assumptions built into the through-life cost model are tested and validated

## Project brief

Sets out, in construction industry terminology, the detailed functional or business requirements for a specific facility. It is derived from the strategic brief (qv). The purpose of the brief is to encapsulate all key requirements so that the client is fully aware of what they will get. The prime contractor and key supply chain partners can then proceed with the scheme design confident that each will be working towards the completion of a consistent whole.

### Risk management
The systematic attempt to evaluate the probable cost to the project of factors outside the control of either the client or the supply chain, and identify actions that will minimise these costs

### Simultaneous engineering
A systematic approach to the integrated design of products and their related production processes, including manufacturing and support. The aim is to minimise the total product development and delivery time, by designing the product to be easy to manufacture and assemble.

### Stage-gate process
A widely employed approach for managing product development that breaks the project into discrete and identifiable stages marked by clearly identifiable decision points (gates or phase reviews). Each stage represents a number of activities that need to be performed and information that needs to be gathered to progress the project to the next gate

### Strategic brief
The document which conveys to the prime contractor the purpose and functional requirements of the new building.

### Strategic partnering
An agreement between client and contractor and/or design organisation that recognises mutual responsibility in ensuring successful project outcomes for all parties, usually over a stream of successive projects

### Supply chain
Strictly, the entire sequence of processes and activities involved in the specification, design, manufacture, construction, commissioning, management and operation of a facility. Used by extension to refer to all organisations involved in this entire cycle. In the BDB approach the term is used simply to refer to all the specialist sub-contractors, trade contractors and design consultants who contribute to a project

### Target costing
An approach to the development of new products aimed at reducing their life-cycle costs while ensuring quality, reliability, and other consumer requirements within a specified cost threshold. Target costing is based on the

adoption of a market-driven attitude combined with a disciplined effort to involve the whole supply chain in developing products which offer the best achievable balance between through life cost and functionality

### Through-Life Cost (TLC)
Through-life cost includes all capital and running costs associated with the development, implementation and operation of a project over its lifetime. Also known as “whole-life cost”

### Through-life cost model
A cost model in spreadsheet form in which the capital cost appears together with the estimates of maintenance and operation costs throughout the planned life of the building. A discount factor is applied to the latter, which are then added to the capital cost to obtain the Net Present Value (qv). The model serves to compare through-life costs of design options and subsequently to evaluate changes brought about as a result of value engineering.

### Total Quality Management (TQM)
A company-wide, management-led style of running an enterprise in which everyone is involved in ensuring that all actions and processes are done right first time, thus ensuring the elimination of waste in materials and labour

### Value engineering
The second state of value management, i.e. the activities that take place once the major value drivers for the project have been identified and agreed upon through value planning (q.v.). Value engineering is a reiterative activity aimed at ensuring that all the cost drivers are minimised.

### Value management
The systematic, workshop based, multidisciplinary effort directed toward analysing the costs incurred and benefits delivered by a construction project for the purpose of improving value to the client.

### Value planning
The first stage of value management, i.e. the structured and facilitated process in the early phases of a project aimed to define, clarify, and agree a clear hierarchy of client objectives, i.e., the functions and other values that really matter to the particular client, as well as cost limitations that must be observed.