Maintain control or delegate responsibility? The design development dilemma at construction interfaces

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MAINTAIN CONTROL OR DELEGATE RESPONSIBILITY? THE DESIGN DEVELOPMENT DILEMMA AT CONSTRUCTION INTERFACES

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Summary
Whatever the form of contract, the detailed design of elements such as cladding, building services, for major projects, is developed by the specialist contractors from scope designs provided by the project design team. The manager faces a dilemma when considering the several available contractual arrangements, namely: whether to maintain control of a number of discrete packages or to delegate responsibility to one, or several specialist contractors.

Recommendations are made for successful management of the interfaces between different trades during design development. These are: to nominate an individual or organisation responsible for coordination; identify key areas where interface problems are likely to occur; agree a strategy for solving each of these key areas; mark up drawings showing interface responsibilities; develop a team approach; produce a fully coordinated interface drawing; instigate a flexible, all encompassing drawing distribution and tracking system; and, ensure that managers involved in design development are properly trained.

This paper is based on preliminary results of an EPSRC funded research project investigating the design development and performance testing of high performance, bespoke-designed cladding

Key Words Design development, interface management, project coordination, managing specialist contractors

Introduction
Irrespective of the form of contract, it is now normal for larger projects that the detailed design of elements such as cladding, building services, and even structural steelwork, is developed by the specialist contractors from scope designs provided by the project design team. Tucker (1986) found that in the USA project teams are typically composed of "specialists who have little familiarity with aspects other than their speciality." The client’s project manager or delegate must coordinate these specialists, and can only hope to have limited knowledge of their systems. Therefore the manager must concentrate on sorting out the interfaces. This is developed further by Gibb (1994a).

This paper evaluates the various contractual arrangements open to the client's project manager when considering work elements with a significant specialist design content. The paper derives its content from preliminary results of an EPSRC funded research project investigating the design development and performance testing of high performance, bespoke-designed cladding (Gibb 1995). The paper quotes the views of the interviewees, however, specific reference to individuals or projects is not made to ensure confidentiality. Where direct quotes are made they are indicated thus "xxx".

The paper provides the context of the overall research, describes the design development process and considers several contractual arrangements for managing this process for complex construction projects. The dilemma facing the manager is the choice between maintaining control of the various elements of the work and delegating the responsibility for coordination to one, or several, specialist contractors. This dilemma is discussed and a series of recommendations made for successful management of the interfaces between different trades.

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The case studies and base research

The EPSRC research investigated the design development and performance testing phases for the cladding elements of 15 major construction projects. The performance testing results have been published elsewhere (Gibb 1994b), and this paper concentrates on the management of design development.

The 13 UK cases were chosen to reflect the spectrum of complex cladding projects. The 2 non-UK cases represent the most common type of complex cladding projects in those localities. All 15 projects involved complex external cladding of bespoke design which required project-specific testing. The case study projects and dates are:

- Embankment Place 1990
- Stockley B8 1990
- Stockley B9-12 'Glaxo' 1991
- Stockley W3 1991
- 100 New Bridge Street 1992
- 10 Ludgate Place 1992
- 100 Ludgate Hill 1992
- Vintners Place 1992
- Heathrow COC 1994
- Edinburgh ICC 1995
- UOB Singapore 1995
- IFF New York 1995
- Camomile Street 1995
- Nottingham IRC 1995
- MAFF York 1996

The following parameters demonstrate the range of projects chosen:

**Client type:**
- Speculative (8)
- End User (3)
- Government (3)
- Insurance (1)

**Contract type:**
- Management Contract (4)
- Construction Management (8)
- Develop & Construct (1)
- Traditional Lump Sum (2)

59 key project personnel were interviewed from the following types of organisations:
- Client or Project Manager (5)
- Independent Test House (4)
- Major Contractor (12)
- Architect (17)
- Cladding Consultant (7)
- Specialist Contractor (14)

Each interview took between one and two hours, and covered the following areas:
- Project details such as cost, cladding description, specification and testing regime.
- Key construction interfaces for the building envelope.
- Opinions on a model for testing construction interfaces.
- Management methods for dealing with interfaces in design development, testing and construction phases.

How does specialist contractor's design development work?

What is design development?

"In most cases, the architect does not design the wall, as was the case 30 or so years ago when simpler walls required less technical expertise. The norm is for the major contractor to provide curtain wall bidders with a set of profiles, and materials and performance specifications from the concept architect." (Heitmann 1993)

Becker (1985) explains that "a typical division of responsibilities for cladding design in the USA, is where the architect selects the cladding materials for appearance, provides details for weatherproofing and specifies performance characteristics. The structural engineer designs the structure for the weight of the cladding, designates connection points and understands the effects of structural movement on the performance of the cladding. The supplier designs the cladding for the specified loads, details how it connects to the structure and provides for weatherproofing, performance and durability of the cladding itself."

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Why is design development important for the overall project?

It is generally accepted that it is cheaper to speed up the design process than it is to speed up construction (Anon 1991). Therefore effort expended at the design development phase will reap a reward later in the project. Concerning design development Becker (1985) states that "full cooperation between the Architect, Engineer and Supplier is absolutely necessary for success of the project, and that means communication".

Heitmann (1993) has found that "lots can go wrong down the line. The materials may not be consistent with the performance specification. The design loads may be wrong. The architect or structural engineer may not catch something during review."

Bell (1987) cites an interesting example of the structural failure of a roof, where failure of the design development process was apparent and contributed to the collapse. In this case it appeared that the detailed design drawings had not been vetted by the overall designer, and the individual specialist contractor had made some invalid assumptions.

What is the design development dilemma at construction interfaces?

What are interfaces?

In this context, the term interface defines the junction between two or more elements or components of a building, or between the work of two different specialist contractors. Some of these interfaces are inevitable physical interfaces, whereas others are influenced by the contractual arrangements and can be called management interfaces. There are, of course, relational and organisational interfaces that also need careful consideration, but these are outside the scope of this paper. Gray (1994) notes the importance of considering interfaces during design development.

How important is interface management?

Some preliminary findings of the EPSRC research are:

- Problems on complex construction projects become concentrated around the interfaces.
- Contractual arrangements sometimes exacerbate interface problems - either too many individual contractors or too much unfamiliar work managed by one specialist contractor.
- Different trades have different cultures - with different attitudes to tolerances, damage and interface responsibility.
- Failure to give adequate consideration to both physical and contractual interface will lead to poor coordination on site, contractual conflicts and potential future problems with the works.
- A positive, proactive and open attitude to interfaces from all parties should improve constructability and productivity on site (Gibb 1994a).

The interface dilemma

Irrespective of the contractual arrangements there is a need for the design development, manufacture and installation of work elements such as building services or high performance cladding, as explained previously. Having decided, or being forced, to sub-let this work, the manager faces a dilemma: "Do I ensure that the total responsibility for the whole package, including full coordination of interfaces with other trades, is novated to the specialist contractor?" OR "Do I retain control of as many aspects of the work as I can?" Put simply it is a choice between delegating responsibility or maintaining control of the key area of construction interfaces.
Heitmann (1993) lays the lion’s share of blame for problems with high performance cladding on the overall delivery system. The following sections consider options for the roles of parties involved in design development.

**What alternative contractual arrangements for the major contractor are available?**

Figure 1 shows the contractual arrangements for the case study projects. These arrangements reflect the nature of the projects which were all landmark buildings and all involved bespoke design, high performance cladding. Broadly speaking there are four types of contract for the major contractor, namely: traditional; management; design & build; and partnering. The management form includes both management contracting and construction management. The design & build form includes develop and construct, where the original concept architect is retained by the client to evaluate the design development. Partnering, in a formal sense, has not been used for this type of project to date. The term major contractor has been used to incorporate all these various contractual situations.

There are various advantages and disadvantages of each of these procurement routes, but these are outside the scope of this paper. The fact remains that, irrespective of the contractual arrangements with the major contractor the design development phase still exists for elements such as cladding, and the process must be managed to ensure maximum benefit to the project. The following section considers the alternatives for specialist contractors.

**What alternative contractual arrangements for the specialist contractor are available?**

**Contractual arrangements on the case study projects**

The contractual arrangements on the case study projects are described in Figure 1. As expected there were no projects where the major contractor was totally responsible for the cladding works. Also there were no examples of projects involving cladding contractors in partnering, special relationships or two-stage tendering.

**One-stop responsibility of the major contractor - 'Traditional builder' does it all**

This situation rarely occurs for work packages on complex projects that involve a significant amount of design responsibility. This is largely because the traditional builder does not have the expertise to do this specialised work.

However, there are a number of architect’s who express a wish to return to this situation, believing it to be the answer to all their problems, especially in the grey areas around interfaces. They see the traditional builder picking up all the pieces that are left behind in the architect’s design.

**Separate specialist trades packages with total coordination responsibility**

There are a number of advantages of this approach, including:
- use of the expertise of the various specialists; and,
- lack of duplication of management responsibilities;

The disadvantages include:
- overlapping and overdesign at the interface due to a lack of knowledge of the other specialist’s work;
- potential for inappropriate interface design due to lack of understanding of the overall design;
- increase in management resource for the major contractor, as there are more packages, and increase coordination requirements;
possible increase in project cost as both interfacing contractors price extra for accepting responsibility; and,
inability to apportion blame in the case of interface failure, as each party blames the other.

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<th>Contractual arrangements</th>
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<td>Lead S/C with domestic subs</td>
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<th>Parties in Design Development</th>
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<td>He Heathrow COC</td>
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<tr>
<td>LH 100 Ludgate Hill</td>
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<tr>
<td>B8 Stockley B8</td>
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<tr>
<td>UO UOB Plaza Singapore</td>
</tr>
<tr>
<td>Ed Edinburgh ICC</td>
</tr>
<tr>
<td>IFF IFF New York</td>
</tr>
<tr>
<td>NB 100 New Bridge Street</td>
</tr>
<tr>
<td>B9 Stockley B9-12 (Glazo)</td>
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<tr>
<td>Vn Vintners Place</td>
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<tr>
<td>EP Embankment Place</td>
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<tr>
<td>LP 10 Ludgate Place</td>
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<tr>
<td>IR Nottingham Inland Rev.</td>
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<tr>
<td>W3 Stockley W3</td>
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<td>YK MAFF York</td>
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**Figure 1**
Contractual arrangements and multi-disciplinary interfaces on case study projects

In support of this approach an interviewee explained that "the curtain wall contractor was made responsible for sealing the interface with the whole world - but so was everyone else." He justified this 'scatter gun' approach because at the design stage, they were not aware who would be awarded the various cladding packages - "We might get a really good precaster and a poor curtain waller. If this had happened then the precast contractor may have been better at the interface than the curtain wall, so we kept our options open." He admits that it is not very precise, but claims that when dealing with a number of package contractors tendering and not being sure who you will be successful it seems to be the safest route to go in. It then means that the decision can be made when there are more facts.

US research (Anon 1991) investigating major engineering construction projects has found that "there is frequently a lack of 'balance' among components of a process line or segments within a building project. The designer of each element of the plant or facility wants to make sure that his particular part meets the overall requirements of the project. Some will put in extra capacity to ensure that his particular part meets the overall stated project performance criteria. The additional capacity takes time to
build and costs more. In all probability the overall plant performance is still held to
the lowest output of a particular part of a plant. The owner does not get additional
capacity but has to pay more." Nicastro (1993) supports this view claiming that "the
problem appears to lie not in the separation of the building components but in the
separation of responsibility."

An interviewee provided an anecdotal illustration of typical attitude at interfaces:
"Two men are cutting their back lawns. They are both scared about trespassing onto
their neighbour's land. Therefore they only cut up to within 6 inches of their
boundary. The end result is that there is a 12 inch strip of 2 foot high grass that never
gets cut." He went on to say that "someone is needed to co-ordinate this. It is
something that we focus on when we are employed by clients to look at shop
drawings. We focus on the interfaces - that is where problems are - the joint between
the precast and the curtain wall, or the window and the masonry opening."

Notwithstanding the above 12 of the 15 case studies had individual specialist
contractors with coordination responsibility. The extent of this delegated
responsibility varied according to the contract, but also on the ability and inclination
of the major contractor.

**Lead specialist contractor coordinating numerous domestic sub-contractors**

There are a number of advantages of this approach, including:
- reduction in management resource for the major contractor - an easy ride;
- one point of contact for future redress due to default, or defective work; and,
- reduction in the perceived hassle and delay claims etc. at the interfaces
  between trades - the lead contractor takes the pressure.

The disadvantages include:
- duplication of management responsibilities;
- questionable ability of the management skills of the lead specialist;
- unwillingness of other specialist contractors to go into contract with the lead
  contractor - fears over insolvency etc.
- inability to get close to the people actually doing the work - they are protected
  by the lead contractor; and,
- some would claim an abrogation of the major contractor's duty to control the
  works.

Some of the larger specialist contractors are used to being given the coordination
responsibility, by being nominated as the lead contractor. They are not concerned
about this extra responsibility (which is included in their price), except where "others
walk away from the problem, and will not work at resolving the interface details."

Discussing the use of a lead specialist one major contractor said that in terms of
liability, it is a good idea, it takes away all that responsibility from the major
contractor. But he sees it as "a bit of an abrogation of duty, and if you are really
doing the job properly then you would still be checking that the prime contractor was
doing it right. Also, he thinks that you would probably spend more time sorting it out
contractually than if you kept the responsibility in the first place.

A senior management interviewee admitted that "for personal satisfaction, if they had
the right people, they would prefer to have the knowledge that they had checked it out
themselves. But if restricted on the fee as a major contractor and not having the staff
to do it then the soft way out would be to nominate a prime package contractor."

However, there may be a compromise where the several contractors are still retained
as employees of the major contractor, but one is given the responsibility to produce
the design solutions to demonstrate that they have correctly delegated the work. In
this way the major contractor would see copies of what is done, and would be able to
comment on them, but has also got a way out if it goes wrong - Several interviewees
saw this approach as the best compromise.
Nominated specialist with direct relationship with the Architect and Client

Nominated subcontractors are not preferred unless absolutely necessary. Despite the practice of novating the contract to the major contractor, there remains an awkward relationship between all parties, and the lines of control and responsibility often become blurred. However, this would be the preferred route for some architects who consider that the major contractors often do not understand what they are trying to achieve, and this special relationship with the specialist contractor is seen to offer them a greater opportunity to achieve an end result to their satisfaction.

Two of the case studies had nominated cladding contractors, but both involved special circumstances. The first was a recladding contract and the contractor was the original cladding supplier, so the appointment for replacement was logical. The second was the successful tenderer from an earlier phase of the project and the client insisted that the cladding appearance was identical on all the phases.

Partnering, 'joint ventures', 'special' relationships and two-stage tendering

Partnering and joint ventures with cladding firms have not occurred to date in high profile buildings such as the case studies in this research. It may be that partnering between clients and major contractors will grow, but there is no indication that such partnering relationships will extend to incorporate the specialist trades contractors.

There are, however, a number of special relationships between architects and preferred suppliers, and these suppliers are sometimes used to give advice at an early stage of the project. Nevertheless, unless a formal nominated sub-contractor route is chosen (and this is rare for cladding) these are usually negated upon the appointment of the major contractor. One architect admitted that he does "try to affect tender lists, but this rarely happens. If he had more control over who would be selected then he says that they could be more precise about the specification. If not, then the specifications are written without knowing who was going to be responsible for what, and so have to cover everything, and could be seen as slightly onerous."

The practice of two-stage tendering is a preferred future option of some project managers. With this approach, a select number of competing contractors would be invited to work up the architect's scope drawings to an initial detailed scheme. At this stage the contract for the full development would be awarded and the losing contractors would be reimbursed for their costs in developing the design. This system looks promising, but relies on the integrity of all the parties to ensure that value for money is achieved and fair recompense is given for work done.

Somebody must take overall responsibility - Who should it be?

Figure 1 shows the parties involved in design development on the case study projects. Irrespective of the precise nature of the contractual arrangements, there is a need for someone to have the overall responsibility of the design. This view is supported by Heitmann (1993) who states that most agree that the parties involved should join together during design development to work out a system of shared responsibility based on a clear set of rules, written into contracts. He has found that without this agreement "important numbers may never get passed to the curtain wall designer-contractor. For example structural information on the frame's lateral displacement, beam deflection, column shortening and long-term creep is often not provided to the curtain wall designer, unless it is asked for." "Whether an owner retains in-house construction management responsibility, or gives it to the designer or constructor rather than to a separate construction management organisation, the functions still need to be done." (Anon 1991)

There are other reasons for being careful about delegating design responsibility. Korman (1991) explains restrictions on the delegation of design for parts of buildings, emanating from the New York Education Dept. "The practice of delegating design
responsibility to unauthorised firms constitutes unprofessional conduct under New York State Education Law. Delegating design leads to a structure with parts designed by several parties and an absence of responsibility on the part of the principle design firm or firms to ensure that the entire structure will function properly and safely as an integrated system."

In the US most curtain wall contractors, which usually design the walls, tend to want the architect or curtain wall consultant to take on more responsibility. Some architect's disagree: 'It doesn't work for the curtain wall designer to turn around and expect the architect to be responsible.' (Heitmann 1993)

The case study research has shown that many specialist contractors prefer to deal directly with the architect/designer rather than through the major contractor. Also, on recent contracts the major contractor has started to put one cladding 'expert' in charge. Again, the specialists like this approach, since the cladding industry is fairly contained and "you know who you are dealing with - It can be a pain at first, but it is worth it - I think its a good idea."

Where there are several cladding contractors involved on one elevation the need for coordination is even greater. "With walls with precast or stone, you get a less coordinated response from the industry because there are generally more parties involved. If there are going to be problems, it tends to be from a lack of focus, because no single party owns the wall. Often it is the major contractor's job to coordinate while maintaining schedule and budget." (Flynn 1993) One senior management interviewee agrees stating that "whether it is management contracting, or main contracting with package contractors, then the responsibility of ensuring that the interface is going to work is with the major contractor - If you leave it to both parties and say that 'It is your problem, sort it out!' it does not work. To a large extent, it is the package contractors working with the major contractor that have to get that detail, with their experience, to work. They have to bring the architect along with them into that decision making process." He is not convinced that this is the architect's responsibility.

**Summary of the contractual arrangements**

The usual route for cladding procurement is the appointment of individual specialist contractors with a certain amount of responsibility for coordination. The extent of this responsibility will differ between projects and is often a point of contention throughout the duration. Complex cladding projects are not retained by major contractors as their own work, and partnering or joint ventures are not prevalent. There is a desire to move towards a two-stage tender approach providing this can avoid the need to nominate and subsequently novate the contract to the major contractor.

Fundamentally, it is essential that all parties are fully committed to the successful completion of the project. "Most contracts define responsibility clearly to resolve questions of who has jurisdiction in each phase of a project, such as design, inspection and construction. However, this does not provide a high quality project. A high quality project is provided by owners, engineers, contractors and inspectors who take responsibility for and pride in completing the job." (Moorman 1989)

**How can interface coordination be made more effective during design development?**

- **Clearly nominate an individual or organisation responsible for coordination.**

Exactly who fulfils this role is less important than the fact that it must be done. O'Conner (1986) states that the person chosen should be intimately familiar with the design.
• Identify key areas where interface problems are likely to occur
This must be done at an early stage

• Agree a strategy for solving each of these key areas
This may not involve a detailed design at this early stage, but will lay down the priorities and establish the criteria for future design development. It is essential to define a list of actions for resolution at this time. If at all possible the number of interfaces should be reduced, or simplified, minimising one element's dependency on others (France 1993, O'Conner 1987). Many believe that most interface problems can be designed out if addressed in this way at an early stage.

• Mark up the architect's drawings clearly showing interface responsibilities
There is no ultimate advantage in slipping something through at tender stage hoping to get it done for nothing. Prior to the tender for the cladding work on several of the case studies, the major contractor marked up the architect's drawings, clearly stating the extent of each package contractors work. As a result the precise interface responsibility was very clearly defined in the project documents. It was acknowledged that this was a tedious task involving up to 50 architect's details, but it ensured compatibility with the interfacing trades and the project teams claimed that the project ran a lot smoother.

• Develop a team approach throughout design development
Several project teams claimed that considerable effort was made to develop a team approach to resolving problems through interface meetings, full and free issue of information and some social events at key project milestones. This emphasis was to ensure that the specialist contractors owned the problems as a team. Communication is key (Gibb 1995b).

• Ensure that a fully coordinated drawing is produced showing the whole interface
It was agreed that someone must produce a fully coordinated drawing showing the whole interface, although there was some disagreement amongst the interviewees about who should produce it. The practice of drawing and building only one half of the connection will lead to problems during installation and in the life of the building. "It is highly desirable that the cladding shop drawings include all of the forces used at connection points of the cladding for the structure. This is rarely done, but allows another opportunity for the structural engineer to confirm his design and his understanding of such forces." (Becker 1985)

• Instigate a flexible but all encompassing drawing distribution and tracking system
Most complex projects will require information to pass between the various specialist contractors. It is essential that each party is aware of the status of the drawings upon which they are basing their design. The practice of a blanket issue of all drawings to all parties does not appear to be successful, although it has its supporters.

• Ensure that managers involved in design development are properly trained
The lack of suitably trained and experienced managers was a recurrent theme during the interviews. Tatum (1987) explains that "managers of projects which successfully used constructability techniques insisted on the early involvement of experienced and team-playing construction personnel, not just field persons between jobs." There is evidence of a lack of willingness to address this issue properly, for example a proposed MSc in Facade Technology at Bath University has not been able to start
because firms will not release their managers and designers to attend. The ability to control work outside the area of personal expertise will remain an essential skill for aspiring managers of complex construction projects (Sher 1995).

References


