MANAGING ORGANIZATIONAL INTERFACES IN THE CLADDING SUPPLY CHAIN: INITIAL RESULTS FROM EXPERT INTERVIEWS

Trevor C Pavitt and Alistair G F Gibb

Dept of Civil and Building Engineering, Loughborough University, Leicestershire, LE11 3TU UK

A key area for the improvement of construction efficiency lies in managing the interfaces between building elements and between the various construction organizations involved in the process.

This paper describes a 3 year research project sponsored by the DETR /IMI and industry, under the meeting clients needs through standardization theme. The aim of the research is to produce a generic management framework for the twelve most used cladding types in the UK. The majority of the research will concentrate on cladding types that are standard or that are readily available and not bespoke. The aim of the framework is to enable the user to solve the managerial interface problems that will occur at certain stages of design and construction and show ways of overcoming the problems.

Preliminary results are presented from forty semi-structured interviews with key experts involved in the cladding supply chain. A process framework is presented, describing various types of specialist contractor, discusses the cladding supply chain and the key decision-making process.

Keywords: interface, procurement, specialist cladding contractor, supply chain, tolerance.

INTRODUCTION

Typically the building envelope constitutes between 15-25% of the construction cost (CWCT 1999), which makes it one of the most expensive elements in a building. Also the lead in times for some cladding systems have been estimated to be as long as thirty-seven weeks, among the longest in construction (France 1993). With this in mind it is essential that the procurement of cladding systems is well managed from the design stage through to the installation on site, this includes managing the interfaces between parties involved in the process.

Organizational interface management concentrates on the interaction between the various parties; client, designer, contractor and specialist suppliers (Gibb 1994). Primarily it is about engineering the project before the client's money is fully committed, identifying risks, eliminating them as far as possible and generating contingency plans in instances where problems are likely to occur. In building, interface management is critical in a number of areas, including those of technical design detail, overall design, logistics, external influences and human relationships or organizational interfaces.

The author is currently engaged in a three year research programme funded by the DETR /IMI and industry entitled "a standardized strategy for cladding and window interfaces". The project covers technical and managerial issues. This paper

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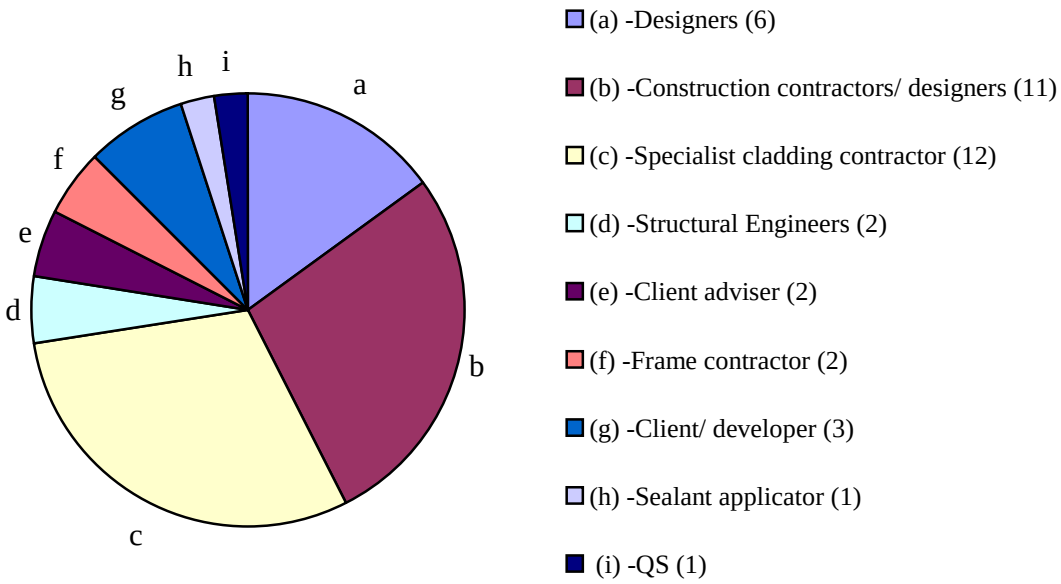


Figure 1: Breakdown of interviewees

concentrates on the management aspects, describing the aims and objectives of the research, providing an overview of the cladding supply chain and procurement methods, concentrating on the preliminary findings of key witness interviews.

AIMS AND OBJECTIVES

The aim of the research is to increase the knowledge and appreciation of the management and contractual issues regarding interfaces within the building envelope with particular emphasis on proprietary cladding systems and the cladding supply chain.

The objective of the research is to produce a strategy for benchmarking best practice for procurement routes, contractual arrangements, performance testing, design development, warranties, and managing tolerances. The main deliverable is to produce an interactive CD-ROM. The software will be available to any relevant parties connected with the design, manufacture, and installation of the building envelope. The research is intended to facilitate cultural change in the cladding industry by better management of the design development process particularly regarding construction interfaces.

METHODOLOGY

The methodology for this research is based upon requirements stipulated in the research proposal, namely:

- Literature search and review
- Interviews
- Questionnaires

This paper represents the research at present, which does not include the questionnaires, which will be completed later in the research. The literature review

was used to identify the fundamental issues for cladding types, the cladding supply chain, contractual and procurement issues in construction. Contemporary research into interface management, though limited, was also used to identify directions for the research. These findings formed the basis of the interview strategy.

The interviews were based upon a qualitative approach for data collection, at present the data has not been analysed in depth, only the broad findings have been included in this paper. In total forty key expert interviews were undertaken. As the research covers a wide spectrum of the construction industry (this is developed later in this paper) it was necessary to interview a cross section of the industry. It was decided that as designers, major contractors, and specialist cladding contractors are the major players in the process these would represent about 75% of the interviews. The remaining 25% would comprise consultants and other major interfacing trades such as frame contractors and sealant applicators. Figure 1 shows the organizational breakdown of the interviewees.

The interviewees were selected from contacts given by the research steering group. It was decided that the interviews should follow a set pattern, but also allow the interviewees to input information and their personal views over and above the set pattern, thus the semi-structured method. The premise of the interview questions was based on information gained from the earlier literature research (e.g. Brookes 1998, Latham 1994, Masterman 1992, and Shove 1994). It is intended that an expanded literature review will form the basis of another paper. Questions were then refined by the industrial steering group, also suggestions from the project manager for the research.

Before the interview process it was necessary to field-test the interview format, this was for numerous reasons; to ascertain the length of the interview, to evaluate whether the interview content was concise, and whether further points should be added. The interview pro-forma was pilot tested on five individuals involved with the project.

Part of the interview pro-forma was faxed to the interviewees prior to the interview. The rational behind this was to enable the interviewee time to consider their responses and to facilitate informed discussion during the interview. Set questions were asked relating to key interface management issues. This paper reflects the initial findings from the interviews. Further analysis of the interview data will be completed in due course.

PROCESS FRAMEWORK (GCPF)

From the literature review the author produced a generic frame, building upon the RIBA plan of works and the “process protocol” research from Salford University (Salford 1998). Figure 2 shows the generic cladding process frame (GCPF) which was used to structure the interview.

The generic frame provides a simplified process map, which was validated through the interviews. In reality, from inception through to the manufacture of the product parts, there will be overlaps and return loops in the process. All the steps will require extra information from elsewhere in the process for the design to be developed fully. Also, considering the long lead in times for cladding, the crucial stage in the GCPF is the product production drawings. It is essential that the design is finalized prior to completion of this stage. Fabricators need to agree their completed drawings before manufacture, which usually involves considerable co-ordination with other parties in the process.

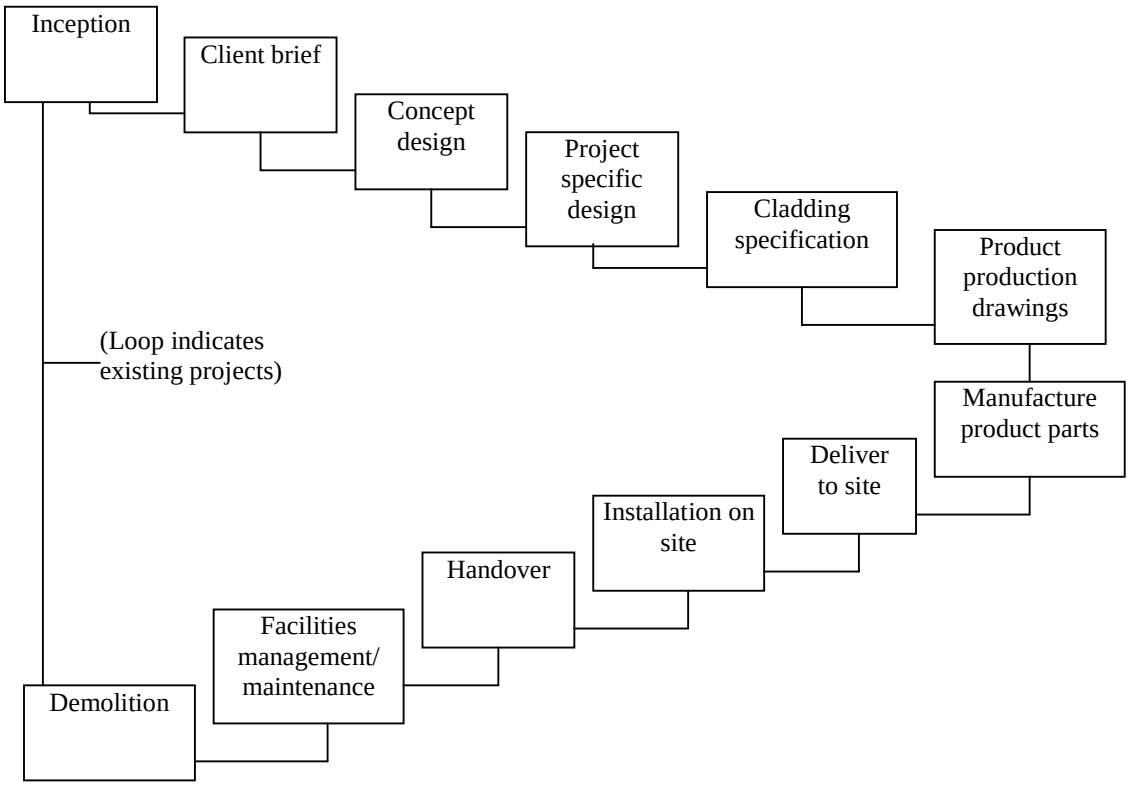


Figure 2: Generic Cladding Process Frame (GCPF)

The frame has intentionally omitted specific reference to tendering and the appointment of contractors and specialist contractors. This enables it to be used across all procurement routes.

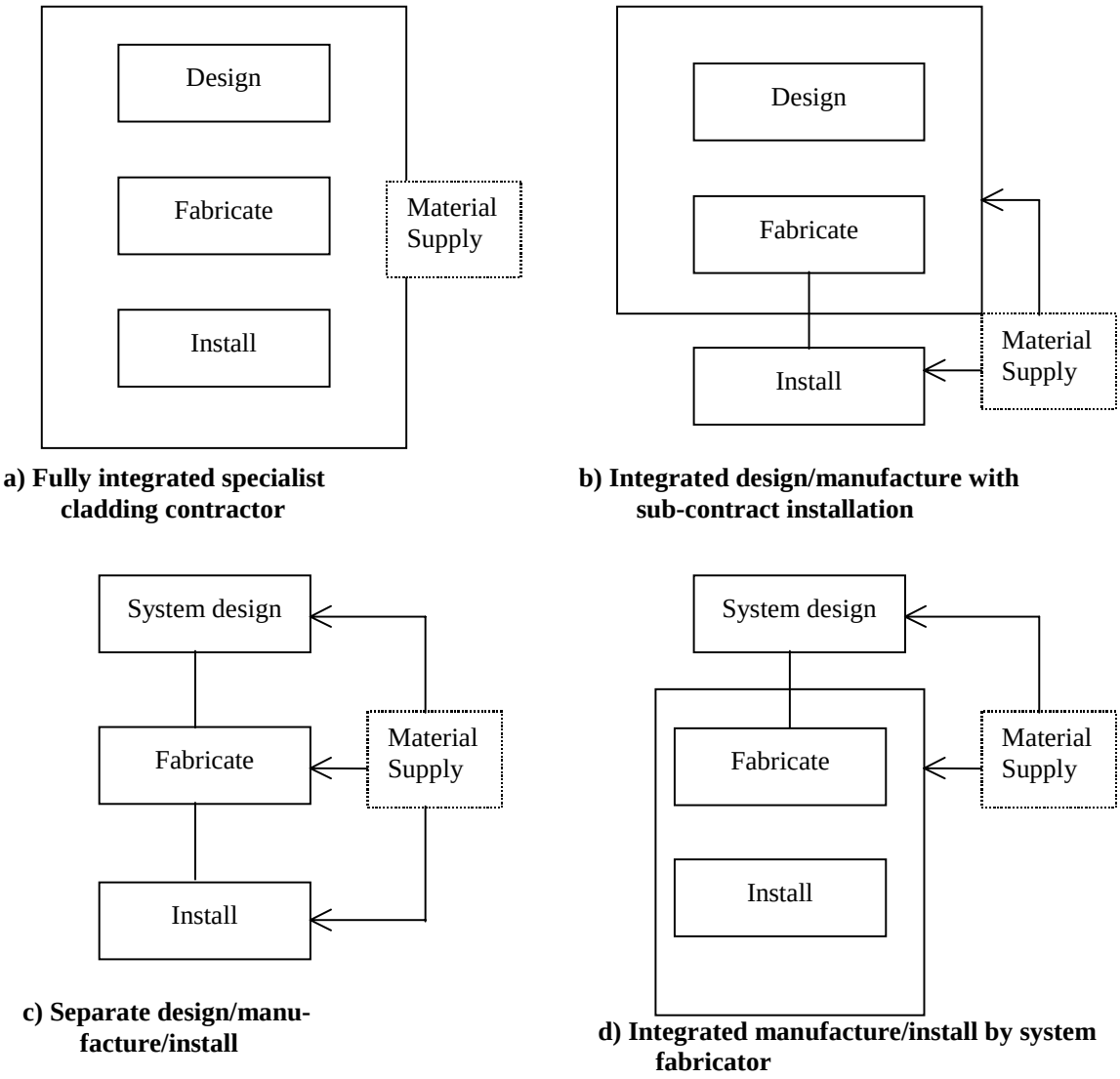
SPECIALIST CONTRACTOR

Typically the specialist cladding contractor is involved in many aspects of the delivery of a cladding system, this may include: system design, fabrication, installation, and component supply. A specialist cladding contractor may undertake all of the processes or be limited to just installation.

The different types of specialist cladding contractor are shown in Figure 3 and Figure 4 shows how the specialist contractor may be involved in the procurement of the cladding system. The type of specialist cladding contractor employed for a project will dictate the contractual arrangements for the cladding and the material supply. The examples given are for the procurement of aluminium and glass curtain wall cladding.

Fully integrated specialist cladding contractor (FISCC)
This is a company that manages the whole process including the extrusion of the aluminium and the finishing of the cladding sections. The only outside element will be the supply chain of raw materials such as glass and gasket components. The company will be responsible for all warranties and installation. There are few contractors who are capable of working this way.

Integrated design/manufacture with sub-contract installation
This is a company that manages the design of the system and fabrication of the sections and like the FISCC is dependant on an outside materials supply chain. The



a) Fully integrated specialist cladding contractor

b) Integrated design/manufacture with sub-contract installation

c) Separate design/manu-facture/install

d) Integrated manufacture/install by system fabricator

Figure 3: The different types of specialist cladding contractor (adapted from Ledbetter 1997)

installation will be sublet to an independent sub-contractor, who may be responsible for the supply of fixings. Nevertheless the design/fabricator retains the contractual responsibility for warranties, including installation. The sub-contractor will have a separate contract with the design/fabrication company.

Separate design/manufacture/install

In which the system designers design a system, extrude the raw aluminium to stock lengths then finish them. The fabricator purchases the extruded lengths and fabricates them to the required size for a particular project. sub-contractors then install them on site. The supply of the aluminium and gasket components is the same as the FISCC but the glass is supplied to the fabricator. Before tender, the design team or the client may approach the systems designer for technical input on their systems. This information will be very “broad brush” until the system is specified. Once the system has been specified the major contractor has two options; either to go out to tender to their known fabricators or to a list of fabricators provided by the specified systems designer. The latter is the most common method. The fabricator will be contractually bound for warranties and installation to the major contractor. The fabricator and the

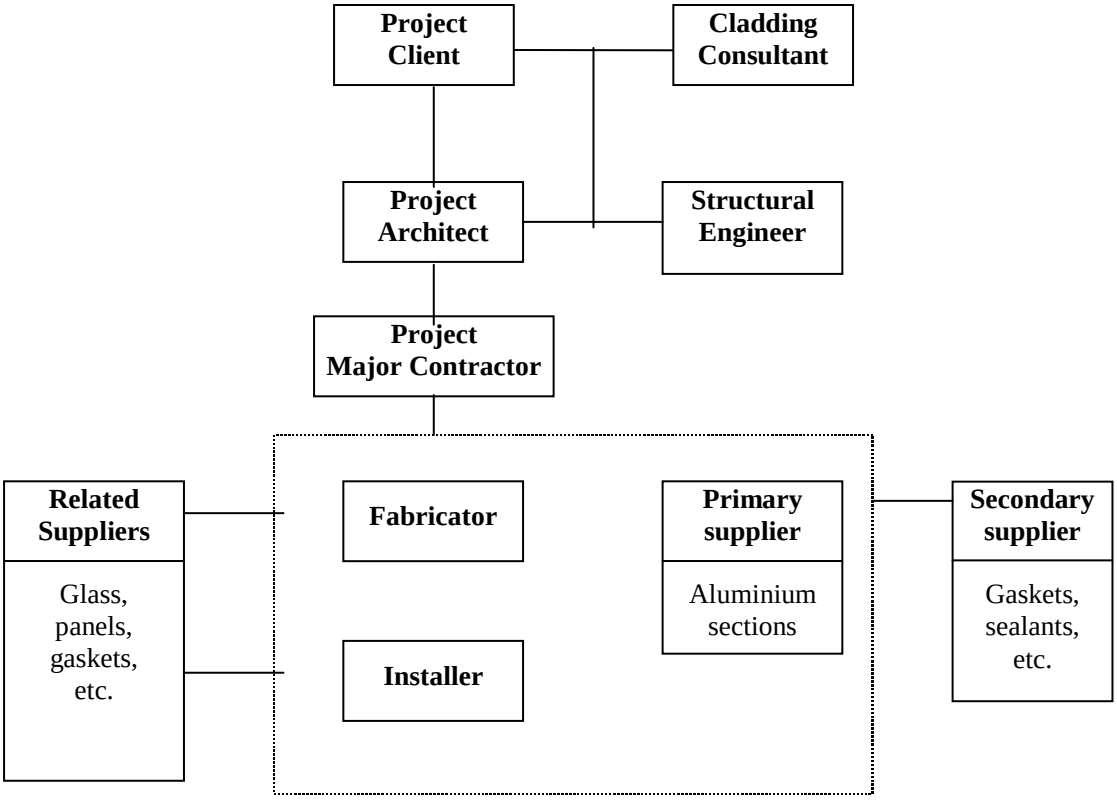


Figure 4: Shows a typical procurement process for a small-scale curtain wall cladding system (adopted from Layzell 1997).

systems designer will have a separate contract between them for the supply of the extruded aluminium and the actual system design. Also the fabricator and installer will have a contract between them for the installed work.

Integrated manufacture/install by system fabricator
This is virtually the same as the separate system except the fabricator will install the system without subletting. The fabricator is still contractually bound for the warranties and installation. This method gives the specialist contractor the greatest control for programming the project design and installation other than the fully integrated company.

THE CLADDING SUPPLY CHAIN

The cladding supply chain itself is a potential disaster area for management; this is due to the complexity of the cladding types and specialist contractors involved in their manufacture. Figure 3 emphasized the different types of specialists. It is possible for the supply chain of materials or components to become fragmented due to the type of specialist. Cladding is either sold as a standard system for fabrication and assembly to suit a building, or designed and manufactured specifically for a contract. Cladding types can comprise a large number of component parts, each with a varied range of types, available from a range of suppliers (Layzell 1997).

Figure 4 shows a typical project organization for a small-scale standard curtain wall system, which is very common in the UK cladding industry (Layzell 1997). The dotted box indicates the scope of the specialist cladding contractor as previously described. The client's choice of procurement route (e.g. traditional, design and build) will vary the role of the professionals and specialist contractors.

MANAGEMENT DECISION-MAKING PHASE

Figure 5 shows one of the completed matrices used in the interview. The matrices introduced key interface issues that effect the procurement of cladding systems. Its purpose was to identify when the interface issues were being resolved. It also aimed to establish whether the interfaces were being considered early enough to prevent management problems. It is necessary to explain the importance of the interfaces represented on the matrices.

CLADDING TYPE

This is an important issue that needs to be agreed early in the design process for outline planning approval to be obtained and the initial structural designs to be developed.

Frame/cladding
This is possibly the most complex interface. The cladding must be designed so that the frame can accommodate the cladding weight and differing panel sizes. This will vary immensely between cladding types.

Cladding/cladding
This is an interface that brings together two dissimilar cladding types, whereupon the junction must be designed so the cladding types can accommodate movement and tolerance of each other and still maintain the integrity of the building envelope.

Services/Cladding
This is an interface that details M&E works, such as flues and louvre which may pass through or be connected to the cladding panels.

Internals/cladding
This is an important interface, which concerns the internal design layout, especially the positioning of internal walls. It is possible that the cladding brackets will protrude into the building thus imposing a design restriction on the walls and floors.

Roof/cladding
This interface is one of hardest interfaces to design and manage. This is because the interface involves more than two elements; frame, cladding and roof. Site management and programming for this is crucial, as the building is often required to be made water-tight as soon as possible, thus three or four different trades have to work in a organized sequence.

Features/cladding
This is an interface that is sometimes considered late. This deals with the intricate features that are secured to the cladding, such as sun-shades, cleaning cradles, handrails, signs and flagpoles.

Sealants at interfaces
This is the interface that concerns the sealing of joints between two different cladding systems or differing trades, such as windows. It is important in the early design that the sealant is compatible with all of the interfaces.

		PLEASE RANK THE TIMING OF THE STAGES (Inception-Demolition) (1–6) FOR EACH OF THE KEY INTERFACE ISSUES	1 Not considered 2 Raised in general terms 3 Strategy considered 4 Strategy agreed 5 Details agreed 6 Situation resolved										
		1	2	3	4	5	6	7	8	9	10	11	12
	KEY INTERFACE ISSUES	Inception	Client brief	Concept design / performance specification	Project-specific design	Full specification	Product production drawings	Manufacture of product parts	Deliver to site	Installation on site	Handover	Facilities management / maintenance	Demolition
1	Cladding type	2	2	3	3	4	5	6					
2	Frame-cladding	1	1	2	3	4	5	5	5	6			
3	Cladding/cladding	1	1	2	3	4	5	5	5	6			
4	Services/cladding	1	1	1	2	2/3	4	5	5/6	6			
5	Roof/cladding	1	1	2	3	4	5	5	5	6			
6	Roof/cladding	1	1	2	3	4	5	6					
7	Features/cladding	1	1	2	3	4	4	5	5	6			
8	Sealants at interfaces	1	1	1	2	3	4	4	5	6			
9	Interface tolerances	1	1	2	3	4	5	5	5	6			
10	Interface warranties	1	1	1	2	2	3	4	5	5/6	6		
11	Interface construction sequences	1	1	2	2	3	3/4	4	5	6			
12	Maintenance of interfaces	1	1	1	2	2	3	4	4	5/6	6		
13	Work package contents	1	1	2	3	3	4	5	5	6			

Figure 5: The completed interview matrices

Interface tolerances

All materials have a manufacturing and installation tolerance. For an interface to be correctly designed it is important that the designers have a good understanding of the differing materials. If not, site installation will be effected by either undersized or oversized joints, or the worst case scenario, overlapping joints.

Interface warranties

All materials and cladding systems will carry a manufacturers' and installers' warranty, but when the differing cladding types or trades interface it is important that a warranty is given for that interface.

Interface construction sequences

This is a design aspect as much as a construction programming issue. Designers must be aware of the sequence of erection during design for the interfaces to be accurately programmed between interfacing trades.

Maintenance of interfaces
On completion of a building it is important that the maintenance of the interfaces has been considered in the design. It will be necessary for gaskets and seals to be maintained in accordance with the manufactures and installers' warranties.

Work package contents
It is necessary that the interfaces between the work packages has been considered especially if a building element has been broken down between different work packages.

PRELIMINARY INTERVIEW FINDINGS

It was made apparent to the author during the interviews the complexity of delivering cladding systems, irrespective of their type. Many of the interface issues and problems are caused by lack knowledge of cladding systems industry wide, in particular, designers and major contractors. The production of a cladding system can be divided into three equal sections; design, materials and assembly (Gibb 1999). The interview findings broadly highlighted the three areas. The major area findings from the interviews are included in Table 1. Asterisks indicate the categories.

Findings 1-8 have been previously mentioned in the paper or are self-explanatory. Finding 10 claims that performance specifications are too long and complicated. Generally, these are performance specifications and are not prescriptive. They are written by the architect or architect's specifier. Typically, a project team will take a specification used on a previous project and add to it to cover the new project parameters. This leads to lengthy and unwieldy documents, requiring considerable time and effort to interpret and apply. Also the application of generic standard specifications, often complied from a variety of sources, creates problems.

"By others" is a term used by many specialist contractors when responding to a tender (finding 9). To win a contract the specialist contractor must have a competitive price. To achieve this often the complicated and sometimes unspecified interfaces are omitted from the tender by using the term "by others". This can have a serious down stream effect on managing the interfaces on site, because on numerous occasions the interface gets left out because of this.

Table 1: Summarized interview findings

		Design	Materials	Assembly
1.	Longer lead times will bring benefits	*		
2.	Procurement routes should ensure early, effective involvement of manufacturers	*	*	
3.	Clients and designers must consider holistic costs	*	*	*
4.	Consultants can take design too far and out of their depth	*		
5.	Competitive tenders only achieve lowest initial cost and put quality at risk		*	*
6.	Project teams do not understand the supply chain		*	*
7.	Works packages contents are reduced for the sake of cost, putting quality at risk		*	*
8.	Contractors and suppliers must plan better		*	*
9.	"By others" should be avoided	*	*	*
10.	Performance specifications are too long and complicated	*	*	*

CONCLUSIONS

The management of organizational cladding interfaces should have a central objective, to make sure everybody knows what their role is in the process. The preliminary interview findings in this paper have introduced areas in which this can be improved. The research aims to further these preliminary findings and implement a framework for better interface management in the cladding industry.

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