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THE MANAGEMENT OF CONSTRUCTION INTERFACES

Preliminary Results From An Industry Sponsored Research Project Concentrating On High Performance Cladding In The UK.

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ABSTRACT

This paper provides preliminary results from current UK research into the management of construction interfaces, which has been jointly sponsored by a UK research committee and industry.

The paper includes the following:

• Definition of construction interfaces
• Why interfaces are important
• Why contemporary contracting must address interface management
• Construction interfaces and the building envelope
• Recommendations to improve interface management

DEFINITION OF CONSTRUCTION INTERFACES

In this context, the term 'interface' is used to define the junction between two or more elements, components or parties involved in the construction process. Interfaces may be classified as follows:\(^1\):

• **Physical interfaces**, which are physical joints and connections between elements or components. These may be unavoidable or may be brought about by the intricacies of the detailed design.
• **Management or contractual interfaces**, where the parcelling of work into discrete packages to suit logistics or design information availability creates interfaces between work by several specialist contractors.
• **Organisational interfaces**, which are the interactions between the various parties involved in a construction project.

Physical Interfaces

Research and development in the area of building technology has ensured that, generally, individual elements and components are well designed, detailed and constructed. However, commonly the interfaces between them are left to be detailed on site, often between specialist contractors who may have little knowledge of the constraints on their neighbours and probably no organisational or contractual relationship to resolve the inevitable conflicts.

Management Interfaces

Some physical interfaces result from the process of packaging the works into separate sub contracts. The success of the project will be affected by this process and by the effort employed in managing these interfaces. Referring to cladding failures, Nicastro states that "the problem appears to lie not in the separation of the building components but in the separation of responsibility."\(^2\)

Organisational Interfaces

The term interface can be broadened to include the relationships between the individuals and parties involved in the construction process. Contemporary buildings are considerably more complex than was previously the case. One individual, or organisation, can no longer conceive, design and control the construction process. Projects involve many different organisations at all phases of the design and construction process. Efficient interaction between these parties is essential for the successful completion of the project. This is clearly more far reaching.
than just defining responsibilities and setting up systems. Moorman found that "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."

**Iterative And Subsequent Interfaces**

In both the physical and management case the nature of the interface is important: namely, whether it is iterative or subsequent. These terms are best explained using an example: Toilets and washrooms constructed traditionally, on-site, are one of the areas where several trades must work in cramped conditions. First-fix items are then followed by second fix, with most trades dependent on the work of others to enable them to continue. We can describe this process as a series of iterative interfaces. The co-ordination of such works often becomes an excessive burden on the 'major contractor'. Management and supervision costs can spiral upwards in an attempt to resolve disputes, adjust to unforeseen delays by one trade etc. One solution is to use fully finished, factory-made units in place of insitu construction. Thus the iterative interfaces can be changed into subsequent interfaces. The units are delivered and installed, and, with careful planning, the following trades can all 'follow', without the need to wait for small sections of work by others. Services connections were made from outside the unit, and, typically the units were then clad with drylining. These interfaces obviously require close co-ordination during the design stage, and it is essential that the interfacing contractors clearly understand the extent of their responsibilities.

France, of Construction Manager Mace, states that "interface management is about engineering the project before the client's money is committed, identifying risks, eliminating them as far as possible and generating contingency plans in instances where problems are likely to occur. It can also mean designing out interfaces and minimising one element's dependence on others."

**SIGNIFICANCE OF CONSTRUCTION INTERFACES**

Abundant anecdotal evidence from the author's industrial experience has lead him to a belief that one of the keys to increasing efficiency in construction is effective management of construction interfaces. This view has been reinforced by preliminary results from a research project into performance testing of the building envelope, particularly from interviews with managers involved in the larger, more complex projects. For example, France states that "in building, interface management is critical in a number of areas, including technical design detailing, overall design, procurement, programming, logistics, external influences and human relationships." Yet despite this positive affirmation little serious research has been done to investigate how interface management is done, and more importantly, how it can be improved.

Since little has been published on the subject, the author has been recording and evaluating the expertise that exists within the construction industry. Some preliminary findings are listed below:

- 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 of both physical and contractual interfaces will lead to poor co-ordination on site, contractual conflicts and potential future problems with the works.
- A positive, proactive and open attitude to interfaces from designers and specialist contractors, lead by the major contractor, should improve constructability and productivity on site. (In this case the term major contractor defines the organisation that controls the construction phase of the project, with the specific title varying depending on the type of contract).
IMPLICATIONS OF INTERFACE MANAGEMENT ON CONTEMPORARY CONTRACTING

Movement Away From Direct Employment of Labour

In the UK, since the late 1970s there has been a distinct move away from the direct employment of operatives and tradesmen by the major contractors. Hence, the role of the major contractor changes from a labour master to a construction co-ordinator. Much of the planning and management effort concentrates on the management of interfaces between the works of the various package contractors. Discussion on the reasons for, and effects of this shift are outside the scope of this paper, but there is no doubt that it has increased the need to consider interface management.

Management Forms of Contract

Certain forms of procurement have brought interface management into sharp focus. In particular the management forms, namely Construction Management and Management Contracting. With these forms the 'major contractor' does not do any of the work, its responsibility is purely for the management of the project. If the construction manager does not effectively manage the interfaces then he, or she, has nothing left to manage.

Works Packaging

Both of the above factors result in the need to divide the contract works into a series of works packages. The process of deciding on the package split is crucial to the quality and time aspects of a project. Following some extensive research in the USA, particularly in the engineering construction sector, O'Conner 6 states that "poor works packaging can result in an excessive amount of interdependency among work packages, thus increasing the likelihood of delays."

Prefabrication

The use of off-site fabrication of building elements has changed the way that buildings are constructed 7. The prefabrication may be the building frame, the cladding, the building services, or, volumetric units such as fully off-site finished plantrooms or washrooms. Each of these will alter the inter-relationship between the trades on site, often combining together several trades in the off-site works which may remove the need for some of them to be involved on site at all.

In New York off-site fabrication is very rarely used, despite the acknowledged benefits. The main reason for this is the powerful New York Unions who appear reluctant to remove the opportunity for the trades to benefit from the iterative interfaces, with all the attendant extra opportunities to claim delay and disruption, or additional pay for out of sequence working in congested areas.

Advanced Technology And Complex Buildings

Interface issues have become more acute with the development of increasingly technically complex buildings and advanced technologies. Until recently, managers were able to fully understand the technology behind the buildings that they were constructing. Many of them took considerable comfort in knowing more than the workers. However, it is now common that managers controlling the construction process do not have detailed knowledge of the components which are being assembled. This requires a considerably different management philosophy and skills to be successful.

Specialist Contractor's Design Development

Irrespective of the form of contract it is now normal for larger projects that the design of elements such as cladding, building services, and even structural steelwork, is developed by the specialist works contractors from scope designs provided by the design team. Tucker 8 found that in the USA project teams are typically composed of "specialists who have little familiarity with aspects of a project other than their speciality." The major contractor's manager must co-ordinate these specialists, and can only hope to have limited knowledge of their systems. Therefore, the manager must concentrate on sorting out the interfaces.
CONSTRUCTION INTERFACES AND THE BUILDING ENVELOPE

The building envelope is one of the areas where effective interface management is especially important. The UK’s Standard and Guide to Good Practice for Curtain Walling was published in 1993. In a related article, Hodkinson of independent test organisation Taywood Engineering states that joints and junctions are trouble spots. One of the check points given in the report is: Look very carefully at the detailing of interfaces within the wall (for example, windows set in precast concrete) or between different forms of construction. In a paper for the UK’s Chartered Institute of Building, Endean emphasises the importance of examining the perimeter details of a glazing system, to establish the boundary relationship with adjacent building elements.

Summary Of EPSRC Funded Research - Testing Methods For Construction Interfaces

The author is about to complete a two-year research programme, benchmarking best practice in the area of interface management in the context of high performance cladding systems. This research is sponsored by several UK construction organisations and the Engineering and Physical Sciences Research Committee (EPSRC). Industrial collaborators in the research comprise architects, cladding consultants, design engineers, contractors and cladding suppliers including: John Laing; Bovis; Taylor Woodrow; Lehrer McGovern Bovis, Gartner; Crittall; Harman; Briggs Amasco; Cirt; Permasteelisa; Construction Research Laboratory; Israel Craig Berger; Ove Arup; Terry Farrell; SOM; and, Nicholas Grimshaw.

The hypothesis of the interface research project is that the key to improvements in the efficiency of building design and construction lies in the area of interface management. By concentrating performance testing on interfaces, weaknesses in design and construction should be identified, leading to improved standards of detailing and workmanship.

This research is investigating the extent and effectiveness of interface testing for the building envelope. It forms part of the author's broader investigation into interface management. The project is developing a theoretical model for interface testing. The model is being field-tested on fourteen contemporary construction projects, by means of a semi-structured questionnaire supported by interviews with members of the project teams and by obtaining project documentation relating to testing.

Preliminary results have indicated that there is benefit in concentrating test regimes on interfaces as they are often areas where problems are likely to occur. However, this benefit must be weighed against the extra costs involved in testing and the complexity of test rigs, linked with the difficulty of representing complex interfaces in a test sample.

The interface project has also examined the broader aspects of interface management in the UK construction industry. The author has found that many of the more efficient organisations are practising good interface management, whilst not recognising it specifically under that name. O’Conner found a similar problem in the USA when he was studying constructability: "Many companies have been addressing constructability, but do not refer to it by name. To these organisations, constructability is simply good project management." However, there are still some organisations, or types of organisations that appear to ignore the significance of interface management. For instance, where the normal contract type is fixed-price, lump sum, some managers still view their subcontractors as though they were direct employees. This has some benefits, but can also result in the manager taking an inappropriate interest in the detail of the subcontract work, at the expense of careful consideration of how the particular subcontractor must co-ordinate with others.

RECOMMENDATIONS TO IMPROVE THE MANAGEMENT OF CONSTRUCTION INTERFACES

Preliminary results of the interface research indicate the following recommendations for improvement in current practice and culture regarding the management of construction interfaces:

Industry-wide Recommendations

- Ensure that trainee managers are educated and trained in appropriate skills to identify, understand and control construction interfaces. The following should be given serious consideration:
  - Shift the educational bias away from its current emphasis on technology for technology's sake, towards a more integrated technology management approach; and,
- Develop partnerships with industry to ensure that the education and training are meeting the real needs of the construction industry, for today and, more importantly, the future.  

- Ensure that managers involved in more traditional sectors of the industry are aware of the similarities between their work and that of say, the construction management sector. The abilities and techniques are there, but often not adequately communicated, even within the same organisation.

**Project Specific Recommendations**

- Ensure that at the start of a contract the project manager identifies the key organisational, management and physical interfaces, and agrees a strategy to manage them with the whole project team.

- Ensure that all parties involved are aware of their specific responsibilities.

**CONCLUSIONS**

- The management of construction interfaces is an important facet of contemporary construction management.
- Some sectors of the construction industry are practising effective interface management but may not identifying it as such.
- The best practice principles and methods of interface management need to be communicated to all sectors of the construction industry.
- The interfaces between organisations, buildings elements and components require a specific management strategy, agreed at an early stage in a project, to ensure that they are managed efficiently.
- All parties must be aware of their responsibilities, particularly at the interface.
- The education and training of construction managers must reflect the best of contemporary industrial culture. For example, technology should not be separated from management.

**REFERENCES**