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CONSTRUCTABILITY VERSUS COMMUNICATIONS

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ABSTRACT
This paper reports on how the constructability of buildings can be influenced by designers, particularly architects and structural engineers. Poor communication is identified as a major cause of cost increases in construction projects in Australia and the increased costs are usually borne by the client or builder and rarely by the originator of the problem. Major problem areas are identified along with their associated cost increases. Examples are taken from case studies.

KEYWORDS
Constructability, Communication Problems, Problem Areas, Costs, Liability.

1. INTRODUCTION

The current definitions of the term 'constructability' ('Buildability' in Australia) reflect its evolutionary development. It is now generally accepted that constructability is a holistic concept that takes all aspects of the procurement process into consideration (McGeorge et al,1996).

Good constructability demands that the design of a building inherently considers how the building is constructed with emphasis being given to the method of construction, the sequence of work, the overlapping and interruption of activities and consideration of how components are incorporated into the overall design. Constructability therefore, may be influenced by many organizational, technical, managerial and environmental considerations.

In the past constructability issues were under the control and influence of primarily one person – the Master Builder, but since the emergence of the separate professions of architect, engineer and builder in the 16th century, issues affecting constructability have become increasingly complex. This has been further exacerbated in recent years with subcontracting arrangements and IT systems.

A number of researchers have identified poor communications a major hindrance to good constructability. However while there has been considerable advances in communication techniques for the construction industry, the complex nature of the industry and the many communication links necessary between the different participants provides ample opportunity for mistakes to be made

2. BENEFITS AND BARRIERS

The benefits of good constructability are well documented. Likewise the impact of communication on constructability. However, these benefits, notes Russell et al, (1994), are often difficult to quantify or put a value to. Examples of the quantitative benefits obtained through good constructability he identifies are, reduced design and construction costs and reduced design and construction schedule time. The qualitative benefits, which Russell points out are harder to measure, include increased problem avoidance, improved site accessibility, reduced disruption to construction works, reduced amount of rework, improved communications, increased commitment from project members and increased construction flexibility to name a few. He notes that the documented benefits, not reflecting these qualitative benefits, will usually be under estimated.

3. THE ROLE OF COMMUNICATION

Also well documented is that fundamental to good constructability is the need for effective communication. Two distinct stages for effective designer / constructor communication can be identified:

Stage 1 is the design and pre-construction phases where, if full advantage, including cost savings etc are to be achieved from designer instigated constructability improvement initiatives, it is essential that the building contractors tendering or otherwise preparing a price for constructing a building are fully aware of the designers intentions.

The Dipstick Survey in 1989 suggested that the builders should be actively involved during the design stage so that their expertise can be tapped. Other recent researchers have made similar suggestions and it seems that this has been proposed as a solution to designers lack of technical skills rather than to enhance communication as such, which is a sad reflection on designers, of which more will be said later, Undoubtedly, closer designer/constructor links would improve constructability, but current building procurement methods, generally prevent their close involvement during the design/pre-construction stage.

Arguably the best method of communication for optimum constructability is direct dialogue between designers and constructors. Building procurement methods therefore require careful consideration for optimum constructability.

The increase in popularity of ‘design build’ package deals and of negotiated tenders, suggest an awareness of the advantages of good designer/constructor communications (Griffith and Sidwell, 1995), but these methods of building procurement are not always possible or desirable. However if constructability is to be optimized communication throughout the design stage requires careful consideration.

Stage 2 is the construction phase of the project where design intentions must often be conveyed to numerous personnel to achieve a finished built product.

Problems usually occur due to the inadequacy of the information passed from the design team in terms of detail required for assembly, or ambiguity in the interpretation of the details. In addition difficulties often occur due to inappropriate timing of information passed to the contractor which may cause delays to the work sequence. Or information may simply be omitted from the relevant drawings and/or be conveyed in an inappropriate manner. (Miller, 1993)

4. IMPROVING CONSTRUCTABILITY THROUGH BETTER COMMUNICATION

A number of researchers have identified poor communication as a major hindrance to good constructability

Griffith and Sidwell (1995) point out that the Emmerson Report of 1962, expressed concern at the division between the process of design and construction, and drew attention to the lack of communication and coordination between the respective members of the design and construction teams. They also mention that Emmerson identified a number of general problems, which still prevail to some extent, as contributing factors to potential inefficiencies throughout the construction industry. Of these there were three main items; (i) inadequate preparation of design procedures that are inefficient owing to their complexity; (ii) pre-contract design procedures that are inefficient

owing bto their complexity, and (iii) the lack of communication between the architect and contractor, consultant and subcontractor. They note that "…even if a project is designed with buildability (*constructability*) in mind, the impact will be minimal if good intent is not complemented by accurate and effective information that translates briefing and design concepts into subsequent phases of the construction process". They conclude that communication is paramount to achieving good constuctabilty and project success.

Russell et al (1994) notes that as a result of constructability principles being applied, better communication will improve the quality of the constructed facility through improvements in construction procedure. Good communication among the designers and constructors also, Russell points out, reduces the chance of project failure and other related performance problems.

Hon et al (1988) notes that efficient communication to the construction personnel of design information and constructabilty decisions taken at the early stages of the project is a crucial aspect of constructability. Hon also mentions that a flexible management structure and the creation of a direct communication system is also critical to the process of achieving good constructability.

It seems that most architects rely on their intuition and/or experience concerning constructability, rather than follow particular guidelines. Many even consider that constructability is 'the builder's problem'. (Miller, 1990).

From the above it is concluded that for efficient building construction it is essential that constructability implications are considered early in the design stage throughout the procurement and documentation stages.

5. TECHNOLOGY ADVANCEMENTS AND COMMUNICATION

Reinschmidt et al (1991), comments that it was not until the mid-nineteenth century that the current (USA) system of construction documentation, using working drawings and specifications to define precisely the desired construction project was implemented. He notes that "… prior to this, owner's intent was presented to the builder through sketches and models with personal attention from the architect or engineer". They point out that rapid advances in computer technology open up opportunities for innovations in communications that have potential to transform the profession through the integration of the functions of engineering, design, and construction.

O'Connor et al (1987) also recognizes the advantages of computer assisted design with site accessibility. He notes the "… development of CAD overlay techniques have proven useful for visually studying accessibility problems. For serious and costly problems, computer simulation models have been able to plan work flow and logistics to assist with buildabilty (*constructability)*".

Also STAR (1995) in relation computer generated construction documentation, note that "…due to the separated design and construction the needs of construction are poorly considered in the design phase". They also add that communication between design and construction is not adequate to carry the needs of every unique project into the drawings. "The design personnel do not know well enough the relationship between a design solution and time & cost". STAR notes that a primary objective is to establish a CAD system which enables constructability concepts to be incorporated.

6. RESEARCH FINDINGS

The following reports the findings of research carried out in Sydney, Australia. The research utilized two methods of data collection, namely, (i) a survey utilizing questionnaires and interviews of 32 senior personnel who have a direct involvement with construction and construction documents and (ii) a case study of a large community hostel. The community hostel utilized traditional construction techniques, and a lump sum tender.

6.1 Survey Results

It was found that poor communication by designers (architects and engineers) resulted in a significant increases in the cost of project cost. However, while the communication problems were created by the designers, the resulting increase in costs was generally borne by another party (Figure 1).

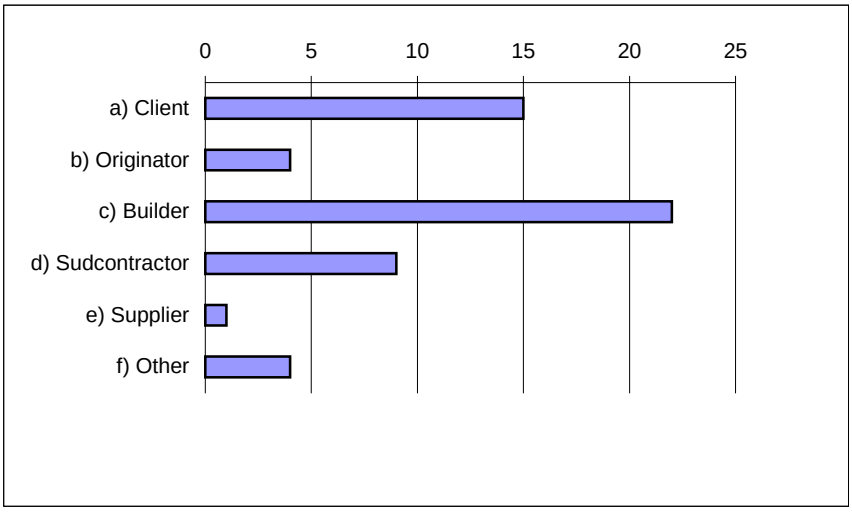

Figure 1: Who Paid to Rectify Problems

The typical percentage cost increases resulting from poor communication linked to constructability issues was found to vary depending on the size (value) of the project with larger projects recording a lower increase in cost (Figure 2). It is worth noting that the case study provided results consistent with the survey (see later).

It is tempting to suggest that the relatively better communication in the larger projects is possibly linked to the higher level of expertise / professionalism of the designers associated with these projects. However this has not been tested.

Table 1: Cost Increases Resulting from Construction Communication Problems for a Range of Project Sizes

Contract value ($)	Estimated extra cost incurred ($)	Percentage of Contract value
0.5 million	10,000	2.0%
0.75 million	300,000	40.0%
1 million	10,0000 – 30,000	2.0% - 3.0%
4 5million	22,500	0.5%
9 million	30,000	0.3%
12 million	180,000	1.5%
25 million	50,000	0.25

The survey also found that constructability communication problems can occur over the whole range of construction documents, (Figure 3) but mainly occur in the drawings produced by the architects and structural engineers. Problems are generally related to the communication of construction details; structural configurations and services installations. Figure 4 indicates where communication problems occurred. Generally the problems are overcome by the construction team, with only a small percentage requiring redesign by the originating designer. (Figure 5)

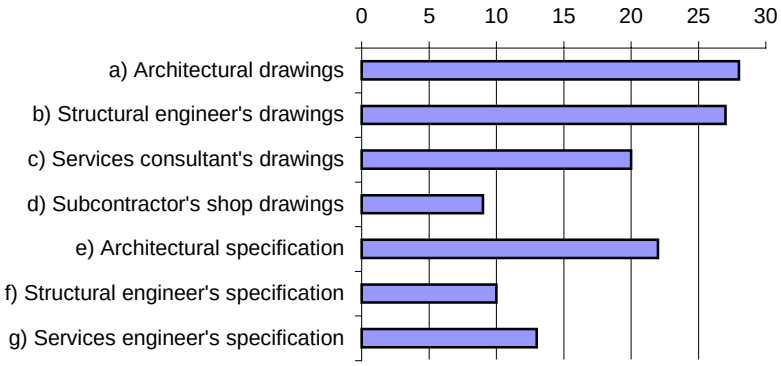

Figure 2: Occurance of communication problems

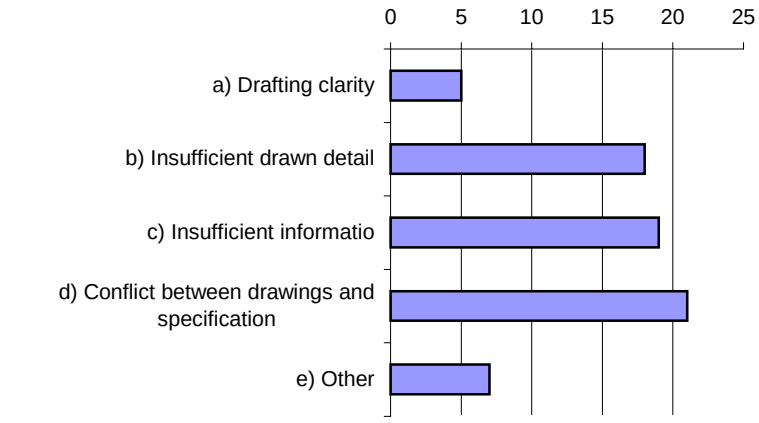

Figure 3: Area of Communication Problem

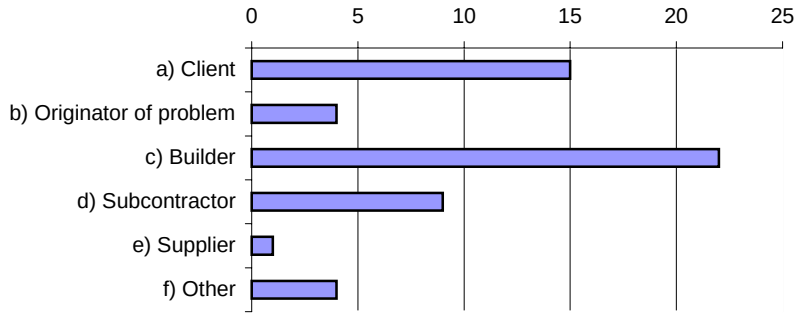

Figure 4: Indicates Who Pays for Constructability Communication Problems

Work involving refurbishment and new additions combined, was found to have significantly higher levels of communication problems. This is probably due to the added complexity involved in this type of work, which involves coordinating the design and construction with existing structures and finishes.

'Design and construct' projects were found to have less problems associated with communication in the construction documents. This is consistent with the findings of other researchers and it seems to confirm that, the involvement of

the builder early in the design decisions and in the selection of the design consultants is likely to enhance constructability.

6.2 Case study

The case study found that communication problems in construction documents occur for a variety of reasons including discrepancies between construction documents, poor structural configuration, poor services coordination, incorrect specification of materials. The increase in cost resulting from the communication problems and who paid are shown in Fig 6. Figure 7 indicates where the communication problems occurred.

Table 2: Cost Increases Resulting From Poor Communication Affecting Constructability

Item	Who paid	Cost incurred	% of contract value
Site layout & accessibility	Builder	$2,000	0.067
Materials non availability	Client	$1,500	0.050
Structural configuration	Client	$500	0.017
Structural configuration	Client	$1,500	0.050
Structural configuration	Client	$1,000	0.033
Document discrepancy	Builder	$900	0.030
Document discrepancy	Builder	$15,000	0.500
Document discrepancy	Builder	$7,500	0.250
Material specification	Builder	$950	0.032
Services	Client	$25,500	0.835
Services installation	Subcontractor	$500	0.017
Services specification	Client	$5,000	0.167
Materials specification	Client	$2,000	0.067
TOTAL		**$63,400**	**2.113%**

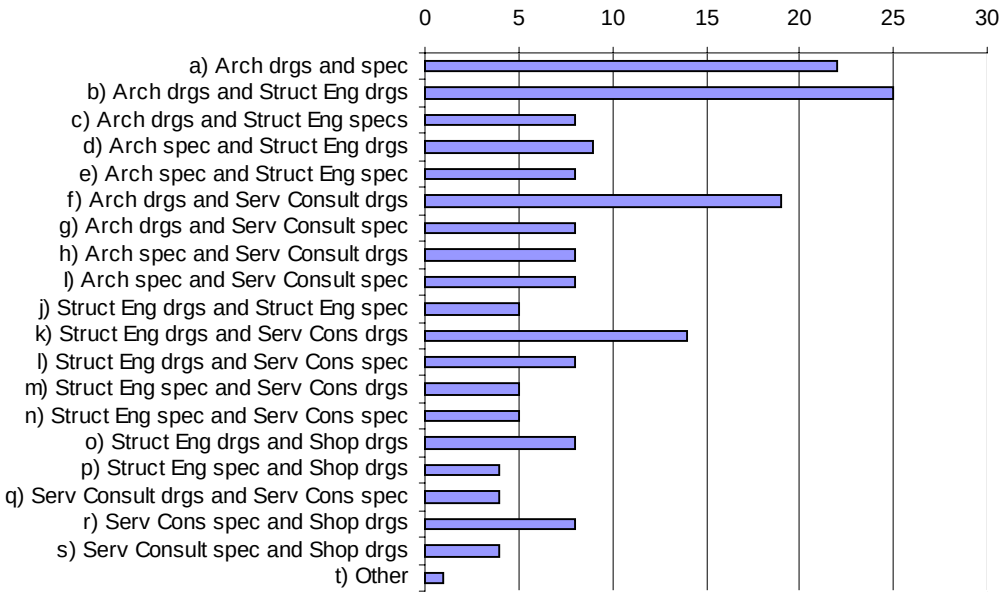

Figure 5: Areas of Communication Problems

7. CONCLUSIONS AND RECOMMENDATIONS

Findings from the survey and case study indicate that:

- Constructability problems caused by poor communication can occur within most types of construction documents, but mainly occur in the drawings produced by architects and structural engineers and are predominantly related to construction details, structural configuration and services installations.

- Most of the constructability communication problems are resolved by the construction team and the extra cost involved is normally borne by the client. The originator of the construction document communication problem, rarely pays to fix the problem.

- Construction projects combining additions and refurbishments are likely to have a higher percentage of constructability communications problems. Probably due to the increased level of complications associated with this type of work.

- Constructability communication problems rarely come to light before contracts are signed. Therefore the final cost of the project is likely to be higher than the contracted price. It is suggested that if the builder is involved early in the design process there is likely to be fewer constructability problems and therefore fewer claims for extra cost.

- 'Design and construct' contracts result in fewer construcatability communication problems. This is probably because of the builders early involvement in the project and their having more control of the project and the appointment of the design consultants.

- Communication problems in construction documents can occur for a range of different reasons and have quite different cost implications.

- The level of extra cost associated with constructability communication problems is roughly proportional to the contract value with larger the contracts having proportionately fewer problems. This is possibly because of the higher level of expertise in the design consultant team associated with larger projects.

Since most construction projects are generally unique, the findings from the studies mentioned in this paper should be considered as indicative only. However they are generally consistent with the findings of other researchers from westernised countries. This suggests that there is scope for significant reduction in the cost of construction projects by improving communication related to constructability.

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