3 Perceptions in the Australian building industry of deficiencies in architects' design documentation and the effects on project procurement

Rochelle Slater and Antony Radford (The University of Adelaide, School of Architecture, Landscape Architecture and Urban Design, Adelaide, South Australia)

ABSTRACT

This paper explores the Australian building industry's perceptions of the relationships between architects' provision of design documentation and the constructability, programming and cost control of major projects. Previous recommendations aimed at improving communications in the industry have not achieved widespread endorsement and implementation. Consequences of current problems are discussed, with additional costs to participants and lengthening of the project program seen as common outcomes. Some initiatives are proposed that aim to improve the professional understanding of these issues through integration within the everyday practices of architects and contractors and through a higher profile in tertiary education programs.

Keywords architecture, documentation, quality, programming, cost control, constructability

INTRODUCTION

There is a longstanding perception in the Australian building and construction industry that architectural design decisions and related documentation standards are "substandard or deficient due to incomplete, conflicting or erroneous information" (Tilley, McFallan and Tucker 2000). Misunderstanding, miscommunication and shifting of blame are rife, with an "adversarial relationship often existing between parties to a building contract frequently fiercely exacerbating the problems" (Wilson, 2000). The aim of the research reported in this paper is to investigate this perception and to propose practical and achievable strategies for its improvement.

Architects provide most of the information required to build a project (RICS 2000, in Lam, Wong, Chan 2005). Despite research that suggests the quantity of produced drawings for each building project, regardless of scale, has progressively increased over the last 12-15 years (Gallo, Lucas, et al 2002), there is concern in many parts of the world about a perceived reduction in design and documentation quality (Syam, 1995). Recent surveys have found that 68% of designers and 88% of constructors within the industry feel that the standard of design documentation and specifications has declined over the past 12 – 15 years (Tilley 2005). This perception was held by 90% of the constructors who responded to the survey in the research reported below in this paper. Poor design and documentation has "led to significant financial losses to consultants, constructors, clients, the State and its taxpayers; an overall loss of quality in the end product; and an increase in disputes and variations" (Engineers Australia Queensland Division Task Force 2005). Design deficiencies account for almost half of all documented variation orders, rework, cost overruns, extensions of time, program delays, contractual disputes and requests for information (Tilley, McFallan and Tucker 2000). These impressions are supported by data on the principal causes of claims against architectural professionals recorded by the Royal Australian Institute of Architects (RAIA), which are (in order) design errors, incomplete documentation, negligent inspections, and cost control (Poulton 2006). Nevertheless, the architectural profession does not appear to recognise these concerns to the extent expressed by constructors (see Table 1, Design Quality Attributes, in Tilley, McFallan and Tucker 2000, p.9).

Rank	Implications experienced within the industry compiled from survey and interview responses	
1	Additional costs to all stakeholders	
	1.1	Increased submission of variation orders.
	1.2	Decrease of available preliminaries.
	1.3	Potential project budget overrun experienced.
2	Delays and prolongation of project program	
	2.1	Minor documentation or specification changes can lead to a domino effect on site. Lead times of "off the shelf" items can result in long delays.
	2.2	Time is perceived to be more valuable than design by some clients, so additional pressure is placed on all site personnel to re-establish or accelerate the program.
	2.3	Misapprehension by many consultants that the constructor achieves profitability from these circumstances is unfounded. Under a majority of established contractual arrangements profit is dependant upon realising the agreed construction programme.
3	Numerous instances of rework by all parties	
	3.1	Resulting in a slowing of work rates.
	3.2	Reduced productivity and momentum on site.
	3.3	Production of out of sequence work.
4	Frustration and aggravation experienced on site	
	4.1	Trades losing confidence in the architect.
	4.2	More time spent by all parties managing discrepancies and seeking resolution.
	4.3	Solutions to errors and omissions sought on site placing additional strain on resources and increased staffing costs.
5	Increased need for requests for information (RFI)	
	5.1	Clarification of all inefficiencies, errors and omissions placing strain on site management time and resources.
	5.2	Significant programme delays due to lack of response or deferral of issue.
6	Decreased coordination of documentation	
	6.1	Documentation clashes between architectural intent and intended services and structure.
	6.2	Resolution sought on site, placing additional drain on site personnel and trade contractor services.
7	Decreased coordination with shop drawings	
	7.1	Frustration felt by shop drafting technician due to lost time and late addenda notices.
	7.2	Approvals and discrepancies experienced placing further strain on construction programme.
8	Fluctuating trade contractor pricing of tender documentation	
	8.1	Prices submitted are higher, or alternatively no allowances are made for items cited as omitted within design documentation.
	8.2	Trade contractors make extra claims/ variations and extensions of time. This equates to a reduction of project contingencies and margins available to the constructor.
9	Inefficiencies in details submitted	
	9.1	Common reliance on standard details that bear no reference to the resolution of project specific issues.
	9.2	Complexity of design not adequately depicted, or relying on resolution by structural engineer.
	9.3	Time and resources utilised on site to ensure details are workable.
	9.4	Increase in risk allocation to constructor and trade contractors.
10	Constructability issues experienced	
	10.1	Decreased construction knowledge of architectural professionals, demonstrated for example by a material application not appropriate for the project specific utilisation.
	10.2	Inefficiencies and strain on site resources and administration to manage discrepancies.
	10.3	Poorer project outcome.

Table 1: Top 10 implications experienced in major building projects, from surveys and interviews of construction industry member carried out in this research

RESEARCH METHODOLOGY

A qualitative multi-method approach was adopted for this research, incorporating direct participant observation, questionnaire survey, unstructured interviews and conversations with participants. It embraced a constructivist approach (Guba and Lincoln 1989, who build on the work of Goodman 1984). In constructivist research, outcomes are not presented as "facts" – single independent realities in the positivist tradition – but as constructions (understandings) of, and as the basis for making further constructions of, a situation. These different constructions are documented and made available to the stakeholders in a reflexive process. Instead of claiming objectivity, the positions of the researchers are made clear in the documentation of the work so that readers can understand the positions taken, and criteria of trustworthiness and authenticity used to sustain the credibility of the results.

For the research reported in this paper, the research team was a new graduate from an Australian architecture program (the principal researcher) and an experienced architect-academic (providing research support and advice). The constructions reported are the principal researcher's understandings of the constructions of interviewed and surveyed members of the building industry, backed up by an extensive literature review. The constructions of other stakeholders in the project procurement process, most importantly architects, were not sought or reported in this research. It is solely focused on the building industry's view of the situation.

The core of the study has been participant observation achieved through a prolonged engagement of the principal researcher within a nationally operating construction company. This enabled the observation of work on several projects with different building types and consultants. Twenty-five people working in the industry were interviewed, each contributing their own values, beliefs and experiences. Thirteen of these participants had a background in general building and construction, the others including professionals with backgrounds in the fields of estimating, cost planning, engineering, and one in architecture. Twenty-one of them had more than ten years experience in the industry. In addition, a limited questionnaire survey was undertaken to seek perceptions from a broader group of stakeholders. Each survey participant received identical questions, regardless of background, experience or role held. Triangulation and clarification was achieved by subsequent interviews with most participants. Following the undertaking in the agreement for participation, in this paper all identifying anecdotal and contextual information has been obscured.

CONSTRUCTABILITY

Constructability is a "system for achieving optimum integration of construction knowledge in the building process and balancing the various projects and environmental constraints to achieve maximisation of project goals and building performance" obtained through the integration of construction expertise and personnel during design development, thus enabling the systematic establishment of construction procedures and sequencing techniques (see the Case Studies in the Constructability Implementation Report in Construction Industry Institute Australia 1996). It is affirmed that constructability can result in "tangible financial benefits to the client, more straightforward design and lower development costs for the designer" (Griffith and Sidwell 1995). However, the industry is not embracing these processes. The impression from participant observation in this research is that constructability advice offered by the constructor is not readily accepted by the design team. Alternative buildability approaches and sequencing, with potential for considerable cost savings, have been seemingly overlooked. Marked up drawings returned to the architect by the site team have been reissued omitting all suggested alterations. This lack of response could be a reflection of a process in which the information offered was not effectively workshopped in an open, non-accusatory, environment. It may also be a result of insufficient funding of design development in the competitive market for architectural design services. Whatever the reasons, in the experiences observed in this research, the new constructability models are not yet resulting in the anticipated reduction in documentation problems.

In the last two decades the industry has experimented with new styles of contract, labelled "relationship contracting" (Martin 2004), aiming "to remove barriers; encourage maximum contribution; and allow all parties to achieve success" (Martin 2004). The new approaches encompass Design and Construct, Guaranteed Maximum Price, Partnering and Alliancing. For example, the C21 Construction Contract Conditions of the New South Wales Department of Public Utilities and Services were developed in response to "the

government's reform process to reduce adversarial and destructive attitudes prevalent in the construction industry, and to encourage the industry to adopt co-operative principles" (Griffin 1997). So far these new contracts have been mainly used in large infrastructure projects. Martin contends that when a guaranteed minimum profit on direct costs and overheads is established through Partnering and Alliance contracts it "is seen as likely to foster a co-operative non-adversarial relationship" (Martin 2004) between the parties.

IMPROVING DOCUMENTATION STANDARDS

Design documentation should be fit for purpose (Engineers Australia Queensland Division Task Force, 2005, p. 7); unambiguous and coherent; timely, accurate and complete; easily communicated and constructed; and coordinated with external consultant documentation as appropriate (Tilley and Barton 1997). Nevertheless, the questionnaire responses and interviews conducted in this research make it abundantly clear that published recommendations and research initiatives have not been promoted effectively within the industry. Amongst the surveyed or interviewed members of the Master Builders Association of Australia (MBA), Society of Engineers Australia, or Australian Institute of Building (AIB), only 1% of respondents referred to experience or knowledge of any recommendation outlining documentation deficiency management. From these responses and interviews, the six main factors listed below appear from a building industry perspective to be leading to inadequate architectural documentation.

1. External time pressures, placed on the designer by the constructor, client, and other consultants to complete documentation and cross checking procedures by a pre-determined time.
2. Disregard of required documentation standards, through inadequate and ineffective use of technology. This includes poor application of CAD techniques, inappropriate use of technical detailing and lack of clarity.
3. Increasing pressure on architectural services to become leaner "in order to adapt to today's increasingly volatile and competitive environment" (Richardson, 1996, in Jaggar, Love, et al 1999). This has caused a loss of experienced staff and a "reduction of the quality of service provided… causing an overload on those available" (Tilley, McFallan, and Tucker, 2000).
4. Reduced consultancy fees.
5. Extensive use of CAD and direct information transferral, removing opportunities for cross-checking during redrawing.
6. Coordination of architectural documentation with structural, civil, landscape architecture, interior design, mechanical, electrical, technology and security representatives (Rydeen, 2004) is inadequate.

A series of additional factors were also cited.

- Advanced construction methodologies and materials, which have enabled more sophisticated and complex designs to be proposed. The specification or application of materials relying on "the term 'to manufacturers specifications' is leading to the selection of inappropriate products and design error" (Poulton, 2006).
- Incomplete and inadequate development of the project brief, based on unrealistic expectations regarding time required and cost limitations (Rydeen, 2004).
- Inclusion of "catch all" clauses. Contractual clauses (Tilley, McFallan and Tucker 2000) which transfer risk from consultants to builders in an increasingly litigious society (Poulten, 2006) cause builders to include allowances for items not designed or specified.
- Devaluing of the architectural profession through "lowest tender" selection in which, by definition, the winning tender has the least money to do the design. Further, Griffin suggests that "the element of competition in an active market may mean that submitted tender figures are deliberately reduced in order to secure employment, in the knowledge that additional costs will be recovered once work commenced" (Griffin 1995, p. 270).
- Tendering pursued based on sketch plan design documentation or partially completed documentation (routinely adopted by client organisations) in a bid to transfer any potential design risk to the Managing Contractor. There is a consequent excessive production of addendas through the tender process, resulting in a working environment of frustration and distrust.
- Traditionally the constructor has been expected to "provide a certain level of expertise and design license depending on the level of quality required" (Wilson 2000). However within today's arbitral environment there are fewer persons with

the qualifications and experience to provide this service within the building process. Additional restrictions are placed on these activities by specified professional liability insurance.

- Reluctance throughout the industry to actively embrace Quality Assurance (QA) techniques leads to "missing, conflicting, erroneous information within contract documentation, [which] are major sources of rework and customer dissatisfaction" (Jaggar, Love, et al 1999).
- Contractual arrangements, with a lack of appreciation of the benefits of Partnering and Alliancing.

During the tender process the industry currently evaluates the perceived quality of design documentation to assess inconsistencies. A CSIRO survey found that generally "the quality of the design and documentation did influence the price submitted for tender…it also had an influence on the time allowed for a project" (Tilley 2001). In a construction management arrangement, where the architect has been pre-selected and the design documentation is thought by the tenderer to be of a poor standard, the constructor would submit an increased price. Additionally, the constructor would seek opportunities to secure compensating variations, as permitted by contract conditions. This trend is confirmed in Engineering Documentation Standards of Australia (2000), where an increase of submitted prices was recorded by 93% of constructors with an increase in time allowed for projects submitted by 75% of constructors. Inevitably the process has extended the time, taken on average, for building estimators and planners to assess tender documentation. This has placed strain on the capacity of individuals to ensure that, in the words of one construction company, "construction documents will be free from buildability problems to the extent that they will not: be obviously erroneous; be too complex for construction; be unable to be constructed within the programmed time available; be likely to result in serviceability or maintenance problems during their operational life". As a result, some architectural offices which are seen as commonly producing inaccurate and deficient documentation are in essence 'black marked' within the industry. With each tender submission assessed on an individual basis, the constructor places assessment priority on projects with architects who have a proven track record.

The quality of design documentation is generally determined by how the professional services are selected and how the fees are negotiated (DeFraites 1989). Although the RAIA Risk Management Procedures warn all professional members that "charging cut price fees won't justify providing cut price services" (Poulton 2006), where architects are selected on the basis of lowest tender bid, then the building industry experience is that the level and quality of the service provided is likely to be limited and generally translates into additional project costs to the owner (McGeorge 1988). Engineers Australia (2005) contends that "an additional $1 spent in design optimisation has the potential to save $10 in construction and $100 in operating costs".

Does this simply confirm the adage that "you get what you pay for"? It has been argued that architects "have compromised the quality of their work to make their fees achievable. Either the architect pays when fees are too low or else the built environment – and therefore, the image of the entire profession – suffers" (Kubany and Linn 1999). This perception was reiterated by the research questionnaire with 77% of the responses supporting a proposition that the architectural profession has de-valued itself through the acceptance of lowest fee submissions for professional services. Indeed, architects have themselves accepted that "the reduced levels of design fees have detrimentally affected documentation completeness, certainty, co-ordination and final checking" (Tilley, McFallan and Tucker 2000). All professionals are representatives of their profession's core values (Beach 2003), yet it has been claimed that fees submitted are "substantially lower than the required fees recommended to provide a comprehensive and professional service" (Hudson 2002). Tilley (2005) contends that architects spend, on average, 20% more time on a project than their budgets allow.

CONSTRUCTABILITY IMPLICATIONS

This research suggests that documentation inconsistencies between building fabric, structure and services are the most frequent constructability problem experienced on site. A typical example is an instance of ductwork and maintenance catwalks allocated within the same area, observed by the principal researcher. More generally, maximising floor areas within set building heights has lead to restrictive ceiling cavities, providing inadequate room for mechanical ductwork and affecting the ability to install required electrical and fire services. Buildability issues that arose on site during this research appeared to the builder to be due to a lack of in-house design

review within architectural companies. These have included:

- A fabricated steel staircase delivered to the site without the mandatory handrail, due to lack of coordination with the engineering consultant. The contract program was prolonged to facilitate secondary fabrication and resulting trade variations.
- An entire secondary wall omitted from drawing revisions, then later replaced without confirmation.
- Door schedules not updated to match drawing revisions. Consequently, items were tendered and ordered incorrectly.
- Materials selected which were deemed unsuitable for the purpose by their supplier.
- Floor plans provided without allocated set out points, with floating dimensions or inaccurate radii – consequently more building surveyor's and site manager's time required to resolve the inconsistencies.
- Provision of documentation details containing inaccurate material referencing, indicative of reuse from previous unrelated projects.
- Incomplete information or insufficient detail to construct what is required.

It is discoveries of issues at the "eleventh hour" that have posed the most dramatic construction problems on site. For instance, all new contracted works within a large refurbishment project were indicated within a bordered/shaded area of the documentation. As the building works progressed it became apparent that additional items (external to the shaded area) were required within the demolition trade package. The trade contractor deemed the items as additional work, submitting a variation. The architect deemed the items as "obvious work", with a small note appearing on the plan defining "all other works not depicted will be the contractor's responsibility". This assumption had programming, planning and cost control implications. Table 1 indicates the ten most significant implications experienced within major projects of the building and construction industry of Australia at present, from the builder's perspective, based on the participant observation and survey responses in this research.

Variations and extensions of time were the main areas of dispute within construction and building projects as a result of contractual arrangements, with 60 – 90% of all variations attributed to poor project design documentation (Engineers Australia Queensland Division Task Force 2005, p.4. This has led parties to adopt an adversarial position to achieve dispute resolution. Meanwhile rework, cited as the third most prevalent implication, "can have an adverse effect on a firm's morale, profit and productivity. It can also adversely affect, both in monetary and non-monetary terms, other participants" (Jaggar, Love et al 1999). It has been argued that "it is impossible to create a perfectly error free design" (Chappell and Willis 1996, quoted in Arain, Assaf and Pheng 2005), but documentation deficiencies and related problems appear to be more prevalent within construction and building projects compared with oil, gas, resource or heavy engineering projects (Engineers Australia Queensland Division Task Force 2005). This perception was affirmed those individuals surveyed who had previous experience in these other fields.

RECOMMENDATIONS & DISCUSSION

The following recommendations seek to address the problems from the industry's point of view.

Prompt on-site decisions: Active decision making on site, including quick exploratory sketches of a detail resolution or compromise with the constructor/ trade contractor, was highlighted as a positive attribute of the experienced architect. The site instruction would subsequently be formalised within the office and submitted to the site for referencing. Unfortunately, due to the adversarial nature of the project environment an inexperienced architect will not commit to such proceedings. In many projects instructions will only be made formally in writing upon direction from senior partners and are often withheld for a period of time. This process of "hold off – I'll check and get back to you" affects the site's momentum. The trade contractor is given the opportunity to pursue Extension of Time claims or discontinue work on site. Direct information access systems, such as ACONEX, an international documentation and management system utilising the internet to manage the storage and flow of information for projects in the construction, engineering, and facilities management industries (ACONEX 2007) do enable data transfer between the architectural office and the site location.

From the constructor's perspective, it is important to have regular site visits by architects. Site staff, trade contractors and suppliers then have the opportunity to clarify issues or discrepancies upon discovery.

Compromise and resolution is sought in minimal time, reaping benefits for the client and ultimately the achievement of the contract program.

3D documentation: The ability to visualise detailing in three dimensions, and working through buildability issues as they arise, would see a marked decrease in the amount of rework currently experienced. Although a major undertaking, more use should be made of 3D detailing and digital modelling.

Builder engagement during the design and documentation process: Architects should strive to include constructors within the design development process, in some capacity, as early as possible. Incorporation from feasibility, as optimally suggested (Construction Industry Institute Australia 1996), is not commercially practical within most contractual arrangements. It is suggested, therefore, that the constructor should be consulted at the attainment of 40-75% of conceptual design development to provide a measurable risk analysis. If the constructor has not been finalised by this stage, an independent (perhaps semi-retired) site manager could be employed on a casual basis as advisor. Direct employment through the architect would enable subjective and unbiased assistance for all issues raised. Alternatively, a representative of the prospective constructor may be engaged by way of a service agreement to advise on buildability, programming, cost effectiveness and comprehensiveness of documentation. Suppliers should also be consulted earlier within the development of documentation "so as to acquire their expertise about design and procurement issues" (Pearson 1999).

Collaborative approach to contracting: Respondents commented that poorly performing architectural consultants would frequently seek to place the onus on dealing with any discrepancy on the constructor. Architects who sought resolution through compromise, regardless of contractual restrictions, were respected in the industry. A collaborative approach to contracting, regardless of contract format, should be strongly promoted. One means to do this is "start-up workshops" in which the client, consultants and constructor are brought together to define and agree relationship frameworks, roles and responsibilities, methodologies and risk management procedures through open communication.

Documentation management protocols: Consistent following of some straightforward practices would reduce documentation deficiencies and their impact on site operations:

- Mark each set of alterations made to documentation as a new revision number.
- Cloud each alteration individually regardless of vicinity to any other alteration.
- Attach and submit a comprehensive listing of all alterations to accompany documentation transmittal. Simple reliance on the task/ revision bar does not provide the detail required to convey the design intention to all parties and can lead to misunderstandings, reworking or variation claims.
- Physically print off each CAD drawing at the completion of each design phase or revision before transmittal to any external sources. In-house review to be completed by the person/s producing the drawing, a nominated checker and senior staff.
- Include and complete mandatory sign off procedure for each drawing produced prior to transmittal, with signatures under "Drawn By:", "Checked/ Reviewed By:" and "Approved By".
- Accept all marked up drawings from the constructor, trade contractor, service and engineering consultants and implement alterations immediately upon transmittal, with confirmation back to source.

Education: Questionnaire responses show a strong majority view (73%) that architectural graduates are unprepared when entering the workforce, and that practical knowledge of construction technologies is lacking. Specific areas highlighted include:

- Buildability principles and promotion of constructability procedures;
- Interfacing with service / other consultants- with particular emphasis on electrical and mechanical;
- Interfacing with superstructure trades, including timber and structural steel;
- Costing and lead times for materials;
- Safety and access requirements during construction.

Most respondents advocated direct interfacing with the worksite as a part of professional development or required for registration as an architect. It was thought that the decline of standards of design documentation would be curbed if practising architects were aware of the effects of their work, not only on project outcomes but also on the personal stress imposed on the people in the project team. Educators observe that an architectural graduate has only completed a maximum of

5/7ths of the time expected for registration as a professional architect in any state of Australia. Upon leaving university, they should be regarded as apprentices within the industry. Commencing salaries reflect this status. It remains the role of the architectural employer to ensure practical experience is obtained during the remaining 2/7ths of their education towards registration, an education in the aspects of architecture that are impossible to cover with the large classes and enforced isolation from the realities of building that exists in the academy. Unfortunately, as a result of the pressure on the architectural services to become leaner, it has become increasingly difficult for companies to consider graduates as apprentices and learners. They are expected to perform as full professionals, often to an unrealistic degree.

CONCLUSIONS

The relations between design decisions and processes in the constructability, programming and cost control of major projects within the building and construction industry of Australia have been explored. Participant observation during this research supports the assertion by those surveyed and interviewed that some problems experienced on site can be traced to architectural design decisions, inaccurate documentation, deficient specifications or ineffective knowledge of construction technologies. Increased constructability, resulting in more efficient, lower cost construction, can be achieved within the construction industry without compromising architectural standards and values, if communication and collaboration are enhanced.

This research has sought to understand the constructions of people within the building industry of the effectiveness of design documentation processes. We are well aware that the construction of the situation by architects may well be different. At the smaller scale of building construction, particularly, architects complain that builders and their subcontractors do not appear to read drawings and specifications and do not appear to maintain adequate quality control.

No single recommendation presented within this paper has the capacity to individually change design and documentation deficiencies. However, we are confident that the situation can be improved. Confidence in the architect, in architecture and in good design must be regained within the industry.

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