A SOCIO-TECHNICAL STUDY OF DESIGN MANAGEMENT PERFORMANCE IN A CONSTRUCTION COMPANY

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INTRODUCTION
Traditional methods of project delivery are being challenged by Design and Construct (D&C) and alliance contracting (similar to Partnering in the USA or PFI in the UK) (Lazar, 2000; Crane et al., 1999). In D&C projects, the design management function often rests with the prime contractor or with an alliance partnership, rather than with the specialist designers or consultants. As a consequence, construction companies, which traditionally were not directly concerned with design management, are now taking a proactive role in the design management function, within a total project management process. Project delivery and design management practice is also being transformed by the utilisation of information technology that supports distributed collaboration.

These changes to project delivery have the potential to dramatically increase the value added to clients, to the D&C participants and to the wider community. However, in order to be able to realise this potential we need to have the most insightful means of measuring the success of projects, one that recognises the needs of each of these stakeholders. Design management plays a pivotal role in this and how it is practiced would seem to be crucial to project success. Therefore understanding how design management contributes to project success and how best to measure the performance of the design management function in the context of D&C projects using new technology should be studied.

A survey of contractors by the CSIRO found a steady rise in deficiencies in design and documentation supplied by consultants over a 15 period (Tilley, 1998). These resulted in a corresponding increase in inefficiency within the construction process. Two industry workshops provided some approaches to measuring and improving the design and documentation performance (Tilley, 1997). There are significant potential benefits available for the construction industry through improving the management of design. It has been estimated that better project delivery strategies can yield up to 20% more wealth to the stakeholders (Crow and Barda, 2000).

Traditional metrics used to track the performance of design management include measurement of the number of documents versus time taken, time taken per document and/or hours per day. These are sometimes related back to a cost function, which usually determines
how the design firm is paid. Arguably these metrics do not get to the fundamental drivers of performance, as they do not explicitly acknowledge the influence of the underlying organisational culture on performance and how it is measured.

This paper presents early results from a research project that aims to identify key aspects of design management culture in a major construction company and to measure its impact on project performance. The paper outlines the conceptual framework for this project and the socio-technical research methods being used and it offers some preliminary findings.

CONCEPTUAL FRAMEWORK

Marshall (1994) defines organisational culture as “the values, norms, and patterns of action that characterise social relationships within a formal organisation”. Values are ideas about what in life is important and norms are expectations of how people will behave in different situations.

The following more general description of culture indicates the relationships between the values, norms and patterns and also introduces the key concept of artefacts as embodiments.

“Culture consists of patterns, explicit and implicit, of and for behaviour acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiments in artefacts; the essential core of culture consists of traditional ideas and especially their attached values; culture systems may, on the one hand, be considered as products of action, on the other hand, as conditioning influences upon further action” (Kroeber & Kluckhohn, 1952).

When it comes to measuring design management performance, this broader description of culture highlights the need to acknowledge the importance of values (what is seen as important) in shaping actions and hence performance. However, core values are often hidden from view and cannot be measured directly. They can only be inferred from things that are observable such as behaviours and artefacts or systems.

Based on these and related literature on organisational culture it is possible to construct a simple framework that describes the relationship between core values, behaviours and artefacts (or systems or performance). Put simply, core values give rise to behaviour which in turn gives rise to artefacts and systems in the organisation. Conversely, core values can be inferred by observing behaviour and artefacts and systems can be analysed to gain deeper insights into these behaviours. This forms the conceptual basis for the socio-technical study of design management reported in this paper.

RESEARCH PROJECT AND METHODS

The research project involves Thiess and the University of Queensland and the members of the research team are drawn from both engineering and the social and behavioural science disciplines. This combination provides a unique and diverse combination of perspectives from which to interpret the work of design managers. The social science researchers are not just using the engineers to give them a greater insight into the work of design managers. They are in fact working together, each using and drawing from the research traditions, techniques and language of each other.
The research project commenced in 2003 and will run for 3 years. It involves a series of studies which each produce incremental results over the time. Thus far two case studies have been conducted on completed projects and two case studies are being conducted on live projects.

In keeping with the conceptual framework above, data for this project has been gathered using ethnographic and related social science techniques including participation, observation, document analysis, interviews, surveys and workshops. Brewer (2000:10) defines ethnography as “the study of people in naturally occurring settings or ‘fields’ by means of methods which capture their social meanings and ordinary activities, involving the researcher participating directly in the setting, if not also the activities, in order to collect data in a systematic manner but without meaning being imposed on them externally.”

An ethnographic approach means studying people in a specific place in order to understand their local culture through direct observation. The main components of ethnography are:

1. Participant Observation: The researcher observes actual practice of the group and individuals under study on their site and records details.

2. Actual Participation in Work or Social Life of the Site: The researcher may perform some tasks associated with the running of the site or organize and participate in social or work functions, such as attending meetings.

For over a decade, ethnography has been used to study workplace and professional cultures within industrial settings (e.g. Luff et al., 2000) including that of designers (e.g. Bucciarelli, 1994; Cluff, 1991) but not that of design managers. In order to cope with some of the time pressures on ethnographers to undertake efficient but effective studies especially in industrial settings, Handwerker (2001) developed the concept and practice of “quick ethnography”. He describes quick ethnography as “package that integrates conventional means of collecting cultural data, analysing cultural data, and project management with more novel forms of data collection and analysis” where “each individual tool for collecting or analysing cultural data achieves specific, complementary and overlapping project goals; their integration yields findings with high reliability and construct validity”.

In this industry based R&D project, we have adopted a quick ethnographic approach and are developing specific tools and combinations for data collection and analysis to suit our particular research setting. We have recorded the behaviours, systems and artifacts common to design managers in the context of D&C projects. Historical information about the organization and immersion in the company has helped in capturing instances of the organizational behaviours, its systems and artifacts.

CASE STUDIES ON COMPLETED PROJECTS

An initial set of case studies was conducted based on several completed D&C projects. This involved carrying out document analysis, interviews with the relevant design and project managers and general observation of the systems and processes used in the company. As part of the document analysis a simple timeline of important events was made in order to gain insights into the projects studied. This helped determine why certain decisions were made and what influenced them.
Two such case studies have been completed. One case study was done in the building discipline comparing two different hospital design and construct projects and the other was done in the civil discipline on a dam design that used an alliance contract. The different disciplines were used in order to see if there were discipline specific issues in design management performance.

**Building Case Study**

The main findings from the first case study were:
- Managers were sure that one project was a success and the other project was not so successful. The relationships between the client and constructor were the main influence on this determination, not cost, nor time, nor quality, nor risk management.
- Meetings seemed to be unstructured and the difference of the significance between formal and informal meetings as well as informal communication needed review.
- The role and responsibilities of the design manager function needs further investigation with a tool such as a time line to determine what they actually did on the project.
- There was trouble with document sharing software that never worked properly.
- Cost savings were not a major influence on the view of the project success.
- The performance of the projects after construction completion was not considered when viewing the project as successful.

**Civil Case Study**

The main findings from the second case study were:
- Alliance contracts have the potential to motivate people and help them work together towards the same goals.
- Key Performance Indicators, apart from the traditional cost and time, were used throughout the project to evaluate performance.
- Having a designer on site contributed significantly to the success of the project.
- The design and construction team were in the same office at the beginning of the project. Construction personnel had direct communication about design issues.
- An unexpected delay early in the project allowed further planning before construction which led to improved outcomes.
- Rather than have a Design Manager, there were two Design and Construction Coordinators, who communicated between the two design firms and the construction firm and document control, was done by construction services.
- Traditional performance methods using production rates such as work done per hour was well documented for the construction teams but what was used for design was unclear.
- Extra spending on Design contributed to savings in construction.
- Favorable weather conditions helped the project to be completed on time. Good and bad luck versus good planning needs further investigation.
- The success of the project for the client post-construction was not considered in assessing the success of the project.
- The project was seen having good workplace health and safety even though there were accidents. Safety in design needed further investigation.
- The client did most of the work on environmental management, community liaison and obtaining government approvals not the designers or design management function.
- There were training schemes for construction personnel, but none for designers or design management.
The results of these initial case studies led us to consider a number of further issues including the needs for training for design managers, those factors which impact upon the ability of design managers to influence safety, environment, community and conceptual design, why the performance of a project is not usually considered beyond the time of practical completion, the issues of “good luck” versus “good management” in project success, how safety can be better integrated into the design management function, the influence and impact of document control, including document control software in design management performance and the relative importance of the early involvement of construction personnel in the design.

**LIVE CASE STUDIES**

The first live case study is set in the discipline of Process Engineering. Data gathering in this case study involves a combination of participation, observation, document analysis, and interviews.

The researcher acts as an assistant or shadow to the Design Manager, to find out what design managers are actually doing. They began with unobtrusive observation techniques and built up trust to enable them to undertake some practical work in order to actually experience the design management function first hand.

Notes and summaries are made about what the Design Manager does and how people act towards each other. The researcher participates in meetings and engages with other people in the D&C team. Collecting and reviewing relevant documentation is made easier by being within the project. The researcher has also conducted interviews with people on the project. This case study started at the end of 2003 and is due for completion late 2004.

**Process Engineering Case Study**

Some preliminary observations and questions for further investigation:

- Different people with different skills in Design Management are utilized in different stages of the project. People with different role descriptions fulfil some of the functions of Design Management.
- Document management. Who is responsible for document management and document management software? What is the best way to track documents?
- How is design performance measured?
- How are disputes between experienced designers and construction personnel resolved?
- Traditional measures of DM performance such as percentage of drawing complete, can be misleading due to practices in the processes used to change and reissue drawings.
- The payment system used to determine work progress can distort performance measures.
- Requests For Information and meetings used to determine the weekly work schedule
- Information exchange and knowledge sharing between people
- Contractual issues
- The changing organizational structure
- Personnel following the jobs, not the company
- Incidents not being investigated to determine root cause
DISCUSSION

As the project evolves, we are discovering more about the design management culture. For instance, there appears to be clear differences in core values (the things that are seen as fundamentally important) or drivers between a construction person and a design manager. They seem to operate from two different paradigms often lacking an understanding of each other’s viewpoint and the import of their function in a project. This has a potential impact on the design of reward systems, financial and otherwise, which can determine the level of respect a person has within the organization.

The context model of design and production (Hales, 1993) has been adapted to help interpret some of the organisational issues raised in the case studies. This model has helped put design management function within construction projects into context and it suggests some of the reasons for limited influence of the design management function in areas such as environment and community and conceptual design and to explain why the performance of the project after project completion is not considered.

Project Performance

Project performance refers to the aspects that make a project a success. One of the aims of this research is to identify project performance measures appropriate for design managers in order to improve design management. There are numerous performance measurements and metrics in project management (e.g. PMI, 2003) and engineering design literature (e.g. Moody et al., 1997). The literature suggests performance measures should reflect the objectives of the company or the current project and should be strategically created in order to get people to do the things, which will place the company in a better strategic position (Meyer, 1994). If people create performance measures about things they deem important and conversely if people are evaluated on their performance measures, then they will endeavour to achieve them. Thus performance measures would have the ability to reflect company culture and also to change that culture. In other words they have the ability to change behaviour and consequentially values and beliefs.

For instance, performance measurement used to evaluate design managers is the schedule performance of documentation. If a new performance measurement is added or replaces this, such as the amount of rework done by the construction team, design managers may examine the designs in a different way and make sure the construction team can do the work before issuing the design for construction. Initially they may still value schedule performance, but over time after being consistently evaluated on rework they may value construction team input over good schedule performance of their documentation. This is however the real world and the uptake and influence of such a measure will be subject to many intangibles, some concerning traditional practices within the company and some brought from outside.

There is a growing interest in measures of performance and success other than the traditional short-term financial measures. The Balanced Scorecard (Kaplan and Norton, 1992) is one method, which tries to align the objectives of the company with four aspects, finance, customer, internal business and learning and growth. Another method, the triple bottom line, is an expanded baseline for measuring performance, adding social and environmental dimensions to the traditional monetary yardstick. Sustainable development, development that meets the needs of the present without compromising the ability of future generations to meet their own needs, and the human development theory (Sen, 2001) are other philosophies which can be used in favour of having more responsible measures.
These practices are particularly relevant in Design and Construct projects, because they are often infrastructure projects for the society at large. When a project is being commissioned and the concept design drawn, it’s the design manager who is responsible for putting these ideas to use and presenting them in an appealing way to the client. Using performance measurements, which go beyond short-term financial gain and time, and which perhaps include quality, safety, social and environmental dimensions may alter the perception of a successful project.

**Key Performance Indicators**

In a design consultancy, a design manager governs the work that the designers do and ensures document control. However a design manager in a construction firm has a quite different responsibility. For example, they don’t directly determine what the designers do, they are responsible for incorporating construction methodology into the design, they are responsible for keeping relevant parties informed, they have to ensure the design intent is maintained during construction and they are often responsible for the design of temporary works.

There is fundamental difference in the responsibilities of the two types of design manager in terms of document control. Design managers in a construction organisation must ensure the right documents get to the right people at the right time with the right approvals in order to construct and often have documents coming in from several sources including design consultancies, vendors, manufacturers and the construction team. Design Managers from design consultancies ensure that they develop the documents at the right time and give them to the right people. They may extend their function to include some of the responsibilities of the construction design manager, but the projects we have studied thus far don’t indicate this.

In our case studies design managers have had different titles including design manager, design engineer, design construction coordinator and design integrity officer. There are one or two people or a team of people in the construction company that take on the functions of the design manager and we are thus determining who takes on the Design Management functions as well as Design Managers.

From these findings, a preliminary set of Key Performance Indicators were developed and used for re-analysis of the first case study and for the second case study. In developing this list the following questions or issues regarding the definition of success were considered by our research team; Is it a perception by senior management? Is it about profit or time objectives? Is it about project quality (however that is defined)? Is it about the ability of the project to sustain society?

The headings, given below, ‘for a comprehensive list of performance measures’ (Chan *et al*., 2002) were adapted to fit the 4 classic performance measures.

- Cost and Profitability
- Time
- Quality (Technical performance; Satisfaction; Functionality; Productivity)
- Risk Management (Risk and Opportunity; Health and Safety; Sustainable Development)

Each indicator under the headings was set up as a goal. For example under the heading Time one goal was ‘the program was completed on the target date’ and under Quality ‘no part of
the project failed inspection’. The goals are aggressive but achievable. Most of the goals are company specific and come from current literature about projects and design management. These goals reflected overall project goals and also concentrated on specific problem areas of design management within total project management.

No specific indicator or group of indicators can prove a project was successful or not. How each project addressed each indicator was used to determine the importance of that goal. Projects can be viewed, by individuals or by the company, as successful or unsuccessful from the completion or failings of one or more goals. The Key Performance Indicators addressed which goals they are. Specific issues from each case study addressed by the pro-forma can also be identified. These can be taken as is or further researched in order to get to the root cause or core values. It is not each individual indicator, but what is the overall pattern relative to various goals and how they compare to other projects within and outside Thiess that are being examined.

In addition, a performance review task list was developed, which lists the tasks a Design Manager should or could do. It is intended to have Design Managers fill this out, so we could determine what they were actually doing and when they were doing it. A number of iterations of the survey were made before coming up with the final survey. This survey is designed to determine what a Design Manager actually does. Another of our aims is to determine the priorities of Design Managers in order to observe how their priorities influence what they do. Thus we are developing another survey, which will follow on from this survey.

FURTHER RESEARCH
Further live case studies are planned for 2004 and 2005 in the civil, process engineering and possibly the building disciplines. It is planned that the researcher move to the location where the project is being conducted and spend several periods of immersion of between several weeks and a month with the project as it is designed and delivered. The same combination of participation, observation, document analysis, and interviews is planned. The expected outcomes include an improved understanding of how design management performs best across different project types taking into account the traditions of the different disciplines (civil, building, process engineering) with a database of good and bad design management practices with cross-discipline comparisons.

Another prime focus of this research project is to determine the occupation and identity of design managers in a broader organisational, industry and societal sense. Preliminary findings from the building case study, company literature review, workshops and work done by Crawley (1985) show that Design Managers need cross-disciplinary knowledge and skills in areas such as the economy, project management, engineering, architecture, construction, and leadership. We are gathering data on the tasks design managers are performing and the skills they are using. Currently there seems to be no tertiary courses offered which focus specifically on design management, beyond elements in architecture programs. We plan to determine the training and skills required to become an effective design manager.

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