

LEAN DESIGN MANAGEMENT—A NEW PARADIGM FOR MANAGING THE DESIGN AND DOCUMENTATION PROCESS TO IMPROVE QUALITY?

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ABSTRACT

Poor design and documentation quality has been identified as being a major factor in reducing the overall performance and efficiency of construction projects as well as being directly responsible for many projects running over budget, over time and being plagued with rework, variations and disputation. Recent studies show that this problem is not only widespread, but continues to get worse in spite of the negative impact it's having on the construction industry.

In a similar way, project management deficiencies have also been shown to have a negative impact on construction process efficiency. However, by adapting Lean Production principles and viewing construction in terms of “production” as opposed to “transformation”, the concept of Lean Construction has been promoted as being successful in improving overall construction process efficiency, by improving the management of construction project operations.

Whilst recent studies into design and documentation quality problems have focused on a variety of external factors (ie. design fees, design time, procurement methodology, ICT, etc.), as being the key to improving overall quality, this paper investigates whether the way in which the design process is managed, may provide more immediate and easily measurable results.

Lean Design Management (LDM)—the introduction of “lean production” principles to the process of design—has been promoted as a new paradigm by which the design process can be made more efficient and better quality outcomes achieved. As part of an ongoing study into “theory-based lean project and production management”, this paper reviews the LDM approach to determine how new it really is and whether its implementation has the potential to achieve the design and documentation quality improvements required.

KEYWORDS

Lean Design Management, Design and Documentation Quality

INTRODUCTION

Poor design and documentation quality has been identified as being a major factor in reducing the overall performance and efficiency of construction projects and as such, has been directly responsible for many projects running over budget, over time and plagued with rework, variations and disputation (Love & Li 2000; Tilley & McFallan 2000a, b & c; Gallo et al. 2002; Tilley, et al. 2002; Andi & Minato 2003; Barrett & Barrett 2004; Love & Edwards 2004). Recent studies show that this problem is not only wide-

spread, but continues to get worse in spite of the negative impact it's having on the construction industry (Tilley et al. 2002; Andi and Minato 2003).

Studies into the construction industry over many years have identified poor management processes and poor relationships between project participants as being major factors leading to poor industry performance in relation to time, cost and quality (Simon 1944; Banwell 1964; Ireland 1985; NPWC 1990; Latham 1994; Egan 1998). According to Koskela and Howell (2002), poor project performance has a lot to do with deficien-

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cies in the way projects are managed and that these deficiencies are caused by traditional project management practices being based on an implicit theoretical foundation that is both inadequate and counter-productive. They suggest however, that by adapting lean production principles and viewing construction in terms of “production” as opposed to the currently accepted “transformation” view, the concept of “Lean Construction” (LC) can successfully improve overall construction process efficiency, by improving the way in which construction project operations are managed.

With the design process generally being managed by traditional project management methods (Lahdenperä & Tanhuanpää, 2000), there is an obvious link between the way design and documentation is managed and the poor level of performance being achieved. As part of an ongoing project looking into “theory-based lean project and production management”, research is currently being carried out in relation to “Lean Design Management”, a methodology which is being promoted as a new paradigm by which the design process can be made more efficient and better quality outcomes achieved.

The aim of this paper therefore is to consider the issues and main factors affecting design and documentation quality and determine not only whether a lean approach really is a new paradigm for managing the design process, but also whether it can help to achieve the quality improvements required. Based on this aim, the paper will firstly look at recent research to determine both the extent and perceived causes of design and documentation problems within construction. Traditional management and project management issues will then be reviewed, along with a look at design management from a project management approach. Following a look at the factors that seemingly underpin a lean approach to design management, a number of conclusions will be made as well as some recommendations for future research.

DESIGN AND DOCUMENTATION DEFICIENCY

EXTENT OF THE PROBLEM

As indicated above, inadequate and deficient design and documentation, impacts directly on the efficiency of the construction process. Unfortunately, contractors are often supplied with project designs and documentation that are considered to be substandard or deficient due to incomplete, conflicting or erroneous information. According to Barrett & Barrett (2004) “...projects that run

over time and budget are often underpinned by faulty documentation that looks professional (CAD and WP), but in fact does not properly specify or describe the built solution.” Is it any wonder then that the perception of what constitutes good quality documentation has started to decline (Egan 2002).

Over the years, various case studies into the causes of contract variations have identified design and documentation deficiency as the major contributor. According to Hibberd (1980), 60% of variations were directly design and documentation related, whilst Kirby et al. (1988), found that design deficiencies were responsible for 56% of all contract modifications. However, Burati et al. (1992) found that on average, that 78% of the total number of contract deviations identified were design related and that these deviations made up 79% of the total deviation costs. Similarly, a national survey of Australian contractors by Tilley & McFallan (2000a, b & c) found that design and documentation deficiencies were directly responsible for approximately 50% of all variations, contract disputes and cost overruns.

According to Love et al. (1997), a large proportion of rework and non-conformance costs are also directly due to deficiencies in design and documentation and in the transfer of information during the design process. These findings were supported by John Holland Construction and Engineering Pty Ltd and WorkCover New South Wales (1997) who also found that problems with design and documentation quality were major contributors to rework and variations, with the overall cost of rework (including delay and disruption) going well beyond just the direct physical cost of rectification.

When considering the cost of rework, Crosby (1979) considered the impact of rework at different stages of a project with the “1/10/100” Rule. In construction, this rule would mean that changes made during the pre-design phase would have a proportional impact of \$1 to the project. However, if not identified early enough, the cost would increase to \$10 during the design phase and up to \$100, if left until construction had begun. Extending this concept to post occupancy, then the cost of rework to implement changes not picked up previously, could be as high as \$1000.

MAIN PROBLEM AREAS AND PERCEIVED CAUSES

When considering the main design and documentation problem areas, Tilley et al. (2002) identified briefing, detail design and constructability as being the major problem areas within design, whilst information deficiencies and poor coordi-

nation between design disciplines were seen as the major issues affecting project documentation. According to many within the construction industry, an overall decline in design fee levels and a reduction in the amount of time being made available to carry out design—combined with an increase in the overall complexity of construction projects—are the major contributing factors to poor design and documentation performance (Tilley and McFallan 2000a, b & c; Andi & Minato 2003).

According to DeFraités (1989), overall project quality is greatly determined by the level of professional services provided and that the quality of these services is generally determined by how the services are selected and how the fees are negotiated. Where designers are selected on the basis of low design fees, then the level and quality of the service and expertise provided is likely to be limited and generally translates into additional project costs to the owner.

A study of the relationship between fee structure and design deficiency, showed that design deficiency had a non-linear inverse relationship with project design fees (Abolnour 1994) and that project costs due to design deficiency increase sharply when design fees are reduced below their optimal level (McGeorge 1988; Abolnour 1994). This was also confirmed by an Australian study which showed that there was a causal link between an overall reduction in design fees over a 12 to 15 year period and a corresponding decline in both design and documentation quality and construction process efficiency (Tilley and McFallan 2000a, b & c).

Unfortunately however, there is a worrying perception by some sectors of the client population that low price or “cheapness” relates to good value (Pasquire & Collins 1996). When investigating the decline in fee recovery for professional services, Lowry (1996) concluded that the decline in fees was not the result of efficiency or productivity gains in the provision of professional services, but was due to: “...simple cost-cutting measures undertaken for organisational survival.” Thankfully, over the last few years, there have been a number of reports highlighting this problem (Latham 1994; Egan 1998; Construction Queensland 2001; Barrett & Barrett 2004; Hampson & Brandon 2004) and whilst a growing number of clients are recognizing the differences between ‘cost’ and ‘value’, it would appear that further education is still necessary.

But whilst insufficient design fees is considered to be the main problem by a large proportion of the industry, insufficient time to properly carry out the design process, runs a very close second (Tilley and McFallan, 2000a, b & c; Tilley et al.

2002; Andi and Minato 2003). In a recent survey (Tilley et al. 2002), it had been found that not only had the availability of design time declined by 37% over the previous 12–15 year period, but that designers generally spend around 20% more time on a project, than was budgeted for initially. Results from these surveys also indicated industry’s perception that if more time was allowed for the design and documentation process, then quality would improve.

These findings would appear to be backed up by an American case study (Ballard 1999 & 2000), which identified ‘waiting for prerequisite work’, ‘insufficient time’ and ‘conflicting work demands’ as being the most common causes identified by designers for the non-completion of planned project design tasks. However further analysis of these causes indicated that the failure to complete assigned tasks on time was more to do with a “... failure to apply quality criteria to assignments and a failure to learn from plan failures through analysis and action on reasons.”

It would appear therefore that although time might be tight, much time is also wasted within the design process and that improving the management and planning practices within design, could help to minimize that waste.

POTENTIAL MEANS FOR QUALITY IMPROVEMENT

When considering factors that have shown a positive impact on design and documentation quality, both value management studies and relationship style procurement methodologies have been considered to be effective.

Value Management

The concept of increasing overall project value as well as reducing total project costs through the principles of Value Engineering (VE) (Green and Popper 1990) and Value Management (VM) (Green 1994 & 1997; Barton 1996; Tilley and Barton 2000) have been well documented.

According to Green (1994),

“...the purpose of value management is to develop a common understanding of the design problem and to identify explicitly an agreed statement of design objectives by the project stakeholders.”

It is also through the use of these ‘value’ principles that the traditional project delivery objectives of time, cost and quality, can be expanded to meet the ecological sustainability and total life cycle requirements being increasingly demanded by the global community (Barton 1996).

According to the study by Tilley et al. (2002), VM studies have a positive overall effect on the levels of design and documentation quality. It was also noted however, that this improvement was achieved in conjunction with improvements in the communication amongst project stakeholders, the adequacy and certainty of both the project and design briefs and greater design innovation. All these benefits were also seen as having a significant impact on improving overall project value, with the benefits noted as being far greater than the costs involved.

Relationship Contracting

Research has also indicated the potential for substantial gains in industry productivity and performance if relationships between project participants can be improved and confrontation reduced (NPWC 1990; Latham 1994; Crow 1998; Egan 1998; Walker, et al. 2000; Construction Queensland 2001; Crow and Barda 2001, Tilley 2001). Over the years, a wide range of solutions to achieve those gains have been proposed, but unfortunately their impact to date has been limited. Relationship Contracting (RC) approaches and the principles of Equitable Asset Delivery (EAD), have been shown to have a positive impact on overall project outcomes, through improved project stakeholder relationships and communication as well as focusing on project value and end user requirements (Walker, et al. 2000; Construction Queensland 2001; Crow and Barda 2001, Tilley 2001 & 2005).

According to Tilley (2005), one of the benefits of RC procurement approaches, is an improvement in the perceived overall quality of design and documentation produced and corresponds with similar improvements in the level of service quality achieved. Interestingly, the adequacy of the actual time available to carry out the design and documentation function was also considered to be greater under a RC approach when compared to more traditional contract forms. Again, it would appear that good relationships and high levels of communication between project stakeholders, may hold the key to improving design and documentation quality.

CURRENT DESIGN AND PROJECT MANAGEMENT

According to (Lahdenperä & Tanhuanpää 2000), the design process is generally being managed by traditional project management methods and that this is why poor levels of performance are being achieved. Therefore, to consider the problems with current design management, its probably

worthwhile briefly looking at traditional management principles, how project management is different and whether here is an obvious link to the deficiencies in the way the design process is managed.

MANAGEMENT PRINCIPLES

Traditionally, management has been loosely defined as *the process of getting things done through other people* (Dessler, 1982; Organ & Hamner, 1982). According to Dessler (1982) managers get things done through the performance of the following traditional functional elements:

- planning—setting goals and targets, developing plans and forecasting for the future;
- organising—determining what work needs to be performed, allocating tasks to staff, delegating authority and coordinating the work between staff;
- staffing—determining the type of staff required, recruiting and selecting staff, setting performance standards, and providing staff training and development;
- controlling—setting performance and quality standards, monitoring actual performance against the standards and instigating corrective action where required; and
- leading—getting others to get the job done, maintaining morale and motivating staff.

Not dissimilar are the thoughts of Chapman (1984), who felt that management is primarily concerned with the achievement of ‘organisational objectives’—achieved through a process of communicating, planning, organising, controlling and evaluating—and Kotter (1990a) who described management in terms of planning and budgeting, organising and staffing and determining and problem solving.

However, according to Deming (1986), “*The job of management is not supervision, but leadership*” and so for managers to be effective, they also need to be leaders—working with their teams to remove barriers and create an environment of innovation and creativity. When considering the issue of leadership from a project management perspective, Howell et al. (2004) identify two distinct styles of leadership. The first, which is said to be the most common style found in project management, follows the typical chain of command or “*command and control*” model—where work is directed and motivation is expected to be achieved through external incentives or punishments. The second and preferred option however, considers the work of Flores (1982), which uses an approach aimed at developing the relationships between management and workers, based on the

making and keeping of commitments to generate trust and maintain motivation to achieve agreed goals.

This second approach is also consistent with the work of Kotter (1990b), who indicated that leadership involves carrying out the following:

- establishing direction—developing both a vision of the future and strategies for producing the changes needed to achieve that vision;
- aligning people—communicating the vision by words and deeds to all those whose cooperation may be needed to achieve the vision; and
- motivating and inspiring—helping people energise themselves to overcome political, bureaucratic and resource barriers to change.

In addition, issues such as setting the corporate identity (organisational culture), generating commitment, managing power processes and managing cultural transformation are also considered an important aspect of leadership (Zairi 1991).

From the above it can be seen that whilst management is about the process of getting things done *through* others, leadership is about getting things done *with* other people. For management to be effective, it needs to consider not just the process, but also the people who carry out the process. Only through a high level of social interaction at all levels in the corporate hierarchy can management provide the direction necessary to elicit the commitment and motivation needed to enable the vision to be realised.

PROJECT MANAGEMENT AND THE ROLE OF THE PROJECT MANAGER

One would expect therefore, that the principles of successful management would also apply to project management. However, project management and the role of the project manager are considered to be different from traditional management (Sayles & Chandler 1971), due to the temporary nature of the endeavour being undertaken. With project teams seldom outliving the project for which they were created, this creates a unique set of organisational problems for the project manager to overcome.

Although the role of the project manager is defined as "... *the individual responsible for managing a project.*" (PMI 1996), this does not tell us what a project manager does. According to PMI (1996), project management is "... *the application of knowledge, skills, tools and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project.*" Whilst this implies the application of the traditional functional elements of traditional management—i.e. planning, organising, staffing and

controlling, it does not appear to take into account the unique organisational problems associated with projects.

The major challenge that project managers face, is that they are largely dependent on people outside their own organisation and direct control, to get work done. This means that the normal leadership functions—necessary for effective management—are compromised by inter-organisational barriers and conflicting loyalties between the project and the employing organisation. Project managers therefore, must constantly seek to penetrate these outside organisations and provide pressure and influence from within to ensure that project goals are being met (Sayles & Chandler 1971). Done successfully, project managers are like a metronome—a device designed to keep a number of diverse elements responsive to a central beat, or common rhythm—ensuring that all parties involved respond to the needs or 'beat' of the project (Sayles and Chandler 1971). The project manager does this by providing the leadership needed to establish and communicate the project direction, motivate and inspire the people involved and maintain commitment to the project, right through to completion.

However, the project manager's influence to get things done is always going to be limited if the environment within which the project is being carried out, is not conducive to a complete management approach. It is the author's opinion therefore, that the adversarial and litigious nature of the construction industry over the past few decades, has likely limited the development of project management practices to just the traditional management's functional elements.

PROBLEMS WITH DESIGN MANAGEMENT FROM A PROJECT MANAGEMENT APPROACH

According to Rounce (1998), a lot of the quality and efficiency problems experienced during the design process, are due to inadequate design management and poor quality control of the end product. Whilst modern construction projects range in their level of complexity, they all still require the skills of many diverse individuals to be brought together, coordinated and effectively managed as a team, to ensure the realization of the client's objective.

According to Tzortzopoulos and Formoso (1999), poor design management contributes significantly to poor design process performance, with the following being the main problem areas:

- Poor communication
- Unbalanced resource allocation
- Lack of adequate documentation
- Lack of coordination between disciplines

- Deficient or missing input information
- Erratic decision making

Design from a construction perspective, is a complex process and therefore difficult to manage at the best of times. From identifying and determining customer and end user needs to visualising and developing construction solutions that meet those needs, design requires the input and collaboration from a large and diverse group of individuals and organisations. Managing the design process therefore has as much to do with managing people and the flow of information between the various project participants as it has to do with managing specific activities and tasks.

Probably due to its complexity, the effort applied to planning and controlling the design process is generally either inadequate or inappropriate. Failure to effectively plan and control the process, eventually leads to chaos and a lack of a common direction for the design team, ensuring that information does not flow efficiently between the parties to enable the design solutions to develop properly.

According to Ballard & Koskela (1998), the traditional project management approach is unable to provide an effective solution to the difficulties of managing the design process. This is due to the fundamental principles of project management being based solely on the transformation (T) model/theory of production—an implicit theoretical model that considers production only in terms of inputs being converted into outputs (Koskela & Howell, 2002). Under this model, the total transformation is broken down (de-composed) into smaller transformations or tasks; with each task being considered and managed independently of other tasks. Management techniques such as work breakdown structures (WBS) and Critical Path Method (CPM) are based on this model (Ballard & Koskela 1998).

Although this approach has some obvious benefits from a contractual perspective, the problem with this model being used in isolation is that it fails to consider the issues of material and information flows (F) as well as value generation (V) for the customer and end users at the same time (Koskela 2000; Koskela & Howell 2002) and does nothing to assist with the production of design, which requires an allowance for the inter-dependant nature of tasks, the interactions of individuals carrying them out, or the flow of information needed to enable design solutions to progress. This lack of appreciation of the inter-relatedness of tasks is what leads to tasks being planned with insufficient consideration for the information needs of the designers, causing poor productivity, project delays and decreased value of the final solution (Koskela et al. 1997).

Although traditional project management is able to identify specific design tasks within a project plan, there is often insufficient consideration given to the information required from others to enable these tasks to actually be completed as and when required to minimize waste. By failing to plan the information flows in relation to the various tasks, delays in obtaining the information often occur, which can either lead to delays in completing design tasks, or having designs and design documents issued with missing information. Unfortunately these design management problems often don't show up until much later in the construction process and as indicated previously, the latter situation is a common cause of rework in both the design and construction processes (Rounce 1998; Lahdenperä and Tanhuanpää 2000).

Another problem relates to change—and if there is one constant in construction projects, it is change. Standard project management practice is to try to avoid change—considering it to only be a negative influence—and manage the project as if the project initiators and planners could foretell the future with a large degree of certainty, which is obviously not the case. As projects are constantly changing to meet the challenges of a dynamic and variable system, thus the management approach also needs to be flexible enough to adapt to those changes (Highsmith 2004). A project or design manager who tries to adhere slavishly to a fixed plan, will miss opportunities to meet or exceed project objectives through flexible activity definitions and schedules. However, due to the iterative and developing nature of design, such flexibility needs to not only be an integral part of its management process—requiring a different management approach—but also be reflected in the nature of the project environment, with contractual arrangements that embrace and manage change as a part of the value generation process (Sakal 2005).

LEAN CONSTRUCTION

SUPPORT FOR A LEAN THINKING APPROACH

Over the last few years, support for a “Lean Thinking” approach to construction has been growing steadily and been provided at fairly high levels. In his report entitled ‘Rethinking Construction’, Egan (1998), recommend that the UK construction industry should adopt ‘Lean Thinking’ as a means of sustaining performance improvement. According to Kagioglou et al. (2000), the successful implementation of lean production philosophies within the design and construction process, provides opportunities for

optimising material and information flows and processes, as well as improvements in internal and external supply chain integration—through more effective partnerships—leading to reductions in project time-scales and waste.

More recently, in their Construction 2020 document, Hampson and Brandon (2004) identified the need to move to “a lean production environment” as part of its “Improved Process of Manufacture of Constructed Products” vision for the future. Generally, this vision sees the industry developing new production processes to enable it to work more efficiently and effectively. The report also goes on to say that a lean production environment—in association with the adoption of ICT improvements—will enable the supply chain to become more integrated and collaborative, leading to a considerable reduction in time and cost over-runs on construction projects.

However, are these all these benefits solely the result of the implementation of lean production philosophies, or are other factors relating to the way projects are carried out and managed, of equal importance? Is a “Lean” approach really anything really new... or is it just about re-identifying the elements of how things should always have been done and communicating and re-implementing that information. According to Howell et al. (2004),

“The difference between lean and current practice is so profound that adopting lean requires and produces a new paradigm.”... where paradigm here means “common sense”.

However, is this lean “*common sense*” actually new, or just old common sense that has been lost, forgotten or just conveniently put aside, due to the financial pressures of a modern commercially orientated society?

IS LEAN CONSTRUCTION REALLY NEW?

Whilst such developments as the Last Planner System (LPS) of production planning and the TFV model of production are acknowledged as major components of the lean approach to construction, this author does not consider either, or the successes attributed to them, to be based on any fundamentally new development. On the contrary, it is the author’s belief that the success of lean as a concept has more to do with the fundamentals of good human relationships and that lean is just the repackaging of basic management and production practices with the relationship fundamentals we all know are necessary for project success. According to Howell et al. (2004), people are at the “*beginning, end and centre*” of construction projects and as such, are likely to be the major

factor in poor project performance. With these thoughts, I agree, however while Howell et al. (2004) also indicated that “... *people are THE problem...*” I feel that it is the environment in which people have to operate where the problems lie and that resolving people relationship issues, is likely to be the source of the solution to better project performance.

When considering the LPS, a major component is effective and reliable planning. Under traditional project management, planning is the predominant component (Koskela & Howell, 2002) and with the old adage “*If you fail to plan... you plan to fail!!!*” almost being the PMI’s mantra. However the problem traditionally lies in the extent (or lack there of) of actual planning carried out at the various levels in the design and construction process in addition to how those plans are actually used in practice. Planning things properly requires involving all the project stakeholders at all the various levels, throughout the project’s timeline. Project plans at all levels are meant to be tools to aid in identifying what needs to be done, when it needs to be done, how it could best be done and who needs to be involved to do it. Plans however, need to be flexible enough to adapt to inevitable change, but also be structured well enough so that you do not lose sight of the end objectives.

Last Planner System

A major part of the LPS, is the making of promises—or commitments—by individuals to do something within a specified amount of time. According to Macomber & Howell (2003), the LPS “*articulates and activates*” conversations, to enable planning and commitments to occur. These promises are required to enable others to plan ahead, but can only be made following a proper assessment of the tasks to be undertaken, taking into account what information and resources are required to enable all the various and interrelated tasks to be carried out (including promises from others) and how they should be done (process). It is suggested however, that these types of conversations are a normal part of construction coordination and that promises are only likely to remain reliable as long as the conditions and details relating to that promise don’t change sufficiently to affect the meeting of that promise. As change is an inevitable part of construction projects, the reliability of commitments will have more to do with the motivational factors of the parties involved and which are likely to be influenced by the nature of the project environment.

The need to plan and have flexibility in those plans, is nothing new. The need to coordinate

action to achieve plans, monitor progress and adapt plans to suit a dynamic process, again is nothing new. It would appear therefore, that the LPS is a method that simply formalises the coordination process within a planning context, to help focus the attention of the individuals actually involved in getting the work done, as to what the project objectives are and how they can best be achieved through teamwork and cooperation. And whilst this is something that has been sadly lacking in construction of recent times, the principles of planning and coordinating effort to achieve a common goal, have been around since before civilisation.

Importance of Relationships

Work is carried out by people and in most construction projects, there are lots of people involved, each responsible for carrying out a variety of tasks that generally require either the successful completion of prerequisite work by others or the direct involvement of others. Whilst planning helps to organise how all these tasks fit together, the inclusion of other factors is necessary if project objectives are to be achieved efficiently. As indicated above, resolving people issues is considered to be the key to project success and so it is the opinion of this author, that for lean processes to be successful, the following attributes are necessary:

- Collaboration
- Cooperation
- Commitment
- Coordination
- Certainty
- Communication
- Trust

Whilst *collaboration* involves people working jointly together on a common enterprise or project, *cooperation* is also necessary to ensure that the work is carried out willingly to achieve the common goal or purpose. Although agreements and promises to do something in the future are considered to be *commitments* within a lean context, much has been said about the need for these promises to be honoured. For the promise to be achieved, a degree of motivation or dedication (*commitment*) is also needed to actually see it get done.

Another essential component to this mix is *coordination*, where all the people involved negotiate with each other to determine how all the various work elements fit together to achieve efficiency in the process and harmony in the finished product. However for this to be successful, there needs to be a high degree of *certainty* in the

understanding of the project goals and objectives to be achieved.

Obviously, the process of *communication*—the two-way exchange of thoughts, messages, or information, via speech, signals, writing, or behaviour—enables all the above to occur, but its the efficiency and openness of that *communication* that determines how effective it really is. But the glue that holds it all together, is *trust*—the firm belief in the integrity, reliability, truth, ability, character or strength of someone or something, which influences one's ability to rely on stated performance in the future. Without *trust*, the willingness to collaborate and cooperate is significantly diminished and commitments will lack validity—as they are unlikely to be relied on—ultimately affecting workflow.

And whilst successful teams are considered to be based on the foundation of trust, (Howell et al., 2004), only within a suitable project environment is it possible to develop a shared project vision, necessary to generate greater commitment among the project participants as well as assist with improved communication, co-operation, collaboration and co-ordination... all needed for successful project delivery.

As indicated above, relationships between people are considered to be the key to the success of lean and in this respect, the Golden Rule—“*Do unto others as you would have others do unto you.*” is probably central to the maintenance of good relationships. It is only when we violate the golden rule, that the spirit of fairness and concern that lie at the heart of morality and ethics, start to become compromised. As 5 of the 10 commandments are based on the principles of the golden rule, we are obviously talking about a principle that is not only very old, but is also fundamental to the way human interactions work best. It is therefore this authors opinion, that this very old saying—and the principles underlying it—could also be said to underpin lean's new paradigm and that the success of lean is totally dependent on the project environment and the relationships developed within the project team. Research which has shown that the procurement methodology under which the project operates, has a bearing on the success or failure of an attempt to apply a lean design management approach Tzortzopoulos and Formoso (1999), would also seem to support this premise.

LEAN DESIGN MANAGEMENT

When considering the issue of lean design management, one has to consider the nature of design and whether design development can be considered as production?

THE NATURE OF DESIGN

Design initiation and development is a mental activity, with ideas put either to paper or in an electronic medium, to allow communication of these ideas with others as well as maintaining a record of the author's thoughts and ideas!!! What is eventually produced, is a set of documents (either physical or electronic), within which the elements and details of the design are described and given visual form.

According to Lawson (1997), the process of design involves the finding as well as solving of problems, based on the designer's subjective interpretation of the client's needs and objectives. However, there are an infinite number of design solutions and no one solution is likely to be optimal to all stakeholders. And although the design process is considered to be endless, the practicalities of project timeframes requires that the time for a design to be developed is limited.

In order for designers to develop specific solutions, the process is iterative by nature and includes the following three elementary activities (Zeisel, 1984):

- Imaging—the creative thinking process, using imagination to create mental pictures and models based on the conceptualization of ideas being considered;
- Presenting—creating a physical image (through drawings or sketches) of those mental pictures and concepts to clarify the thought processes;
- Testing—assessing the concept sketches in the cold light of reason, either separately or in consultation with others.

However, the quality of any design solution and its ability to meet client requirements and maximise value, is dependant on the level of interaction with the client and others involved in the design process.

LEAN DESIGN MANAGEMENT OBJECTIVES

When we consider managing this process, one school of thought is that we are really managing the development & production of documents, which move towards a greater and greater level of detail, until they get to a stage where they are suitable to be used for planning, budgeting, estimating and eventually construction. Based on this perception, design management would simply apply to the managing of people and the flow of information between the various project participants from an internal process perspective.

Previous research has indicated that a lean design management approach considers not only the transformations (T) of inputs to outputs, but

also the material and information flows (F) and the generation of value (V) for the customers and end users involved within the design process (Koskela, 2000; Koskela & Howell, 2002). And whilst improving design process efficiency is important from an internal design team perspective, the ultimate aim of any lean design management strategy should be to maximise overall client and end user value from the project.

Project success is highly dependent on the decisions made during the very earliest stages of the project's development (Smith & Wyatt, 1998), however at the project conception stages, there are numerous uncertainties which need to be resolved for the design and the project to proceed properly and failure to maximise overall project value can occur by making major design decisions too early in the development process due to insufficient information (Othman, et al. 2004). However, according to Ford et al. (2002), "...many construction project conditions evolve over time, and the conditions, times, and managerial choices for effective decision making cannot be determined completely and accurately during pre-project planning." This is particularly so when considering the project/design brief and making the wrong choices at these early stages of design, has the potential to limit overall project value and be very costly to all involved in the project. This is often due in part to the contractual arrangements used for the procurement of design services as well as the way brief development is managed.

It is therefore proposed that the only way to achieve this is for the project brief to be a dynamic and evolving document that acknowledges change as an inevitable part of the design development process in order to maximise client and end user value. However, for this strategy to be truly effective, there also needs to be a collaborative and cooperative project environment from in which to work—one that emphasises the people issues and highlight the importance of the relationships between *all* project participants within the design process.

LEAN DESIGN MANAGEMENT APPROACH TO BRIEFING

Under traditional procurement methodologies, change is considered something to be avoided due to the contractual and cost implications that it represents. Therefore, the general approach to project briefs is to try to nail it down right at the start of the project, and therefore avoid changes which may impact on project time, cost and quality. However, changing circumstances may require changes to the project to maximise value for the client and so changes to the brief are needed to

accommodate those changes. Unfortunately, due to the inflexible nature of traditional construction processes and management, this is generally only achieved at significant cost to the project, thereby limiting the additional value of the change gained by the client. The following provides a briefing option considered suitable to a lean design management approach.

Dynamic Brief Development

Otham et al. (2004) suggest a process known as Dynamic Brief Development (DBD) as a way to not only help clients maximise project value, but also reduce the impact of changes to the project brief. This approach of continuous brief development is similar to the concept used in Agile project management for the software industry (Highsmith, 2004). In traditional procurement, the brief is used as a contract document, which needs to be frozen early in the design process to provide a benchmark from which changes can be costed and claimed for. This is often seen as necessary by designers, due to the pressures exerted by clients on initial fees to minimise up-front costs. However, this approach is obviously not working, when one considers the extent of problems being caused by project briefs being either ill-defined or constantly changing to reflect a client's changing requirements.

The DBD approach on the other hand, considers the development of the brief to be a project long process rather than an event and is specifically managed to evolve over time, as more and better information comes to hand during design process. A continuously developing brief also provides a learning opportunity for the project participants, by detailing why changes needed to be made, what changes were developed and the benefits these changes achieved for the client. Such a flexible approach to managing the design process (including briefing) obviously has the potential to significantly contribute to the achievement of client goals and objectives.

However, vital to the success of this process of continuous brief development and refinement, is a high level of involvement from not just the client, but the whole project team throughout the whole design process. This level of collaboration would however most likely require a relationship based procurement methodology to provide the right project environment to maximise value generating opportunities.

CONCLUSIONS AND RECOMMENDATIONS

Problems with the quality of design and documentation in the construction industry continue to have a significant impact on the efficiency of the construction industry and are a major contributor to design and construction rework. Research has identified a variety of industry-wide and project specific issues that have an impact on the quality of design and documentation produced. Whilst industry surveys have indicated issues such as low design fees, short design time allowances and poor design briefs are major contributors to these problems, other research suggests that poor project relationships and the traditional way in which the design process is managed is also contributing to these problems.

The adoption of 'lean production' philosophies to the construction industry, is seen by many as a new way of helping to improve its efficiency and that by adopting a lean approach to the management of design, the deficiencies of the traditional management approach can be alleviated to help make the design process more efficient, optimise the use of limited resources and help to improve design and documentation quality. Lean design management has therefore been promoted in literature as a "new paradigm" in the way the design process should be managed and that this approach is likely to provide the improvements needed by industry.

This paper has set out to consider the issues relating to LDM, how it differs from traditional management practices and whether or not it really should be acknowledged as a "new paradigm" for managing the design process. Based on the information provided in this paper, it is felt that the principles underlying a lean design management approach are not new, but are based on old core values necessary for the success of any human endeavour.

However, even though LDM is not considered to be a "new paradigm", by helping to focus people's attention on those old core values, a LDM approach definitely has the potential to significantly improve the way the design process is managed, increase client and end user value and minimize waste in the construction process through better quality design and documentation.

However, for a LDM approach to become common practice, proof of the benefits it can provide will be required by industry. Further research into the human relationship issues relating to lean in construction is therefore required, with case studies showing the links between the relationship issues, construction process efficiency and increased client value. With a large proportion of

the industry still failing to perform to requirements, one would hope that opportunities to showcase an approach that offers to provide significant advantages for all parties involved, will be readily available.

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