

IMPROVING THE EFFECTIVENESS OF THE BUILDING DESIGN MANAGEMENT PROCESS IN THE UK

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Managing the design process has become an issue of prominence in the UK Construction industry in recent years. Experience of practitioners as well as research and industry analysis have suggested that the process is not under control and there is a lack of understanding of how it works in practice. In order to consider how to improve the effectiveness and efficiency of the process an investigation was carried out by obtaining data from senior practitioners in the local Architecture Engineering and Construction professions in the North East of England. The analysis suggests that, in order to improve, the most significant concepts which need attention are; the Design time available, the quality of briefing, the involvement of a team approach, that a clearly identified competent manager controls the process and that the process and particularly task dependencies are understood.

Key words: design control, design management, design process constraints.

INTRODUCTION

This work was initiated from the concerns of one of the authors when he carried out the design co-ordination for a new hospital that at the time was the largest project in the North East region of the UK. The UK's Rethinking Construction report (Egan 1998) said the UK industry should not just aim to improve construction but to change completely the way it works. This report supported the author's concerns when it said that one of the areas that needed improvement and change was the management of the design process. Improvements have been made, but there are still few examples of success. What is missing is a total understanding of the design process and the way information flows between people and organizations. Successful integration of the design process with the procurement and construction of a project is of utmost importance. UK construction is an industry, which has always had low profit margins and the subsequent pressure to be effective and efficient. There has been a growing recent demand for faster construction, which has increased the pressure on effective management and co-ordination of information transfer between Architects, Engineers and Constructors. The concept of the Design Manager as a specific job role is relatively new but modern building projects have begun to place greater emphasis on the management and coordination of specialist designers and works contractors as well as traditional Architects, Engineers and Constructors. This paper evaluates the

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problems of managing design in relation to the separation of design from construction i.e. lack of integration, poor communication, increasing project complexity and lack of preplanning. A review of the literature identified the key issues for design management. These were discussed with industry practitioners in structured interviews. The aim was to identify key success factors for effective design management as perceived by those involved in delivering projects.

DESIGN MANAGEMENT

The key issues for design management can be classified under the following headings:

DESIGN IS A COMPLEX PROCESS

Gray and Hughes (2000) indicate that two issues should always be addressed in design; the provision of accurate, fully coordinated, complete information and the timely provision of that information. The first is the responsibility of the lead designer and the second is management. Findings from research indicate that, for design, planning and control are substituted by chaos and improvising in design, (Koskela *et al.* 1997). Poor communication, lack of adequate documentation, deficient or missing input information, unbalanced resource allocation, lack of co-ordination between disciplines and erratic decision making have been pointed out as the main problems in design management (Ballard and Koskela (1998). Coles (1990) found that the most significant causes of design problems were poor briefing and communication, inadequacies in the technical knowledge of designers and lack of preplanning for design work. Common consequences included slow approvals from clients, late appointments of consultants and inadequate time to complete design documents carefully. Koskela *et al.* (1997) explains that, to some extent the situation is understandable. The design effort is complex, with numerous interdependencies, singularly uncertain, with erratic decision-making by lay clients and authorities, and often carried out under time pressure.

IMPACT ON PRODUCTION

Alarcon and Mardones (1998) concluded that the problems that affect the design construction interface are poor design quality, lack of design standards and lack of constructability. They also suggested that construction personnel should be involved in the design stage to prevent the deficiencies of lack of information and wrong information and continuous changes and modifications of the design. Hyett (2000) claims, the growing trend to litigation has encouraged the design professions to accept exclusion from areas where their competence may be limited. For example, many architects have withdrawn from supervising work on site and, as a consequence, they have less opportunity to learn about the real problems that are encountered by builders using design information.

THE DESIGN PROCESS

Ashworth (1999) believes that excellence in building and construction is attained only where appearances, soundness of construction and usefulness have been developed together in a fully integrated manner. The design approach will also vary depending on the nature of the designer.

Coles and Barritt (2000) suggest that during design development, everyone involved in the process has different ideas and many models will be created to represent parts or

aspects of the building. The Architect will model solids and spaces, while the structural engineer will investigate the ground and suggest how to support the weight and the forces that may act upon the building. Services engineers model routes of pipes, ducts and cables, and equipment sizes and types needed. Cost consultants model the likely cost of the designers' proposals. The client may model what should happen in the completed building and how this activity will be financed and operated. Since these models include different interests and viewpoints, they are never perfectly compatible at the beginning. Design development is largely the process of reconciling these different models, so that the builders will be given design documentation for one complete and coordinated model. This process is often made more complicated by the growth of the project organization over a period of time. Ideally, a full team of designers their specialist knowledge would be assembled at the outset. In practice, the various members of the design team join at different times and the process of developing and all the models, to make one integrated design for the building, can be long and unpredictable.

MANAGEMENT OF THE DESIGN PROCESS

Design management concerns itself with the design content of project outcomes and the effective management of the design process. Like design itself, design management is a multi-faceted subject. There are different and equally valid ways of approaching it, all of which are concerned with realizing potential and avoiding risks (Allinson 1997). Dumas and Mintzberg (1992) proposed four management models for design management. The 'cooperative design: Interactive functions' is the model most effective with the growing level of complexity that exists in the process today. This model encourages interaction between the different contributors. Co-operative design is based on teamwork and reflects the ad hoc structure of most creative organizations. Gray and Hughes (2001) suggest we view the task of managing the design as the responsibility of everyone on the project. Various professional institutions have published a formalised view of the main stages of design work, in an attempt to make it more controllable. The RIBA Plan of Work (RIBA 1991), for example, gives an impression that the work can be neatly wrapped up into stages, however Coles and Barritt (2000) claim, in many projects after construction starts, specialist contractors generate the majority of the production information which indicates overlaps in the process which are not seen in the professional model. The principles of lean construction are proposed in Koskela *et al.* (1997) where the following hypotheses are presented and justified through results from case studies: 1) There is an optimal sequence of design tasks. 2) Internal and external uncertainties tend to push the design process away from the optimal sequence. 3) Out of sequence design leads to low productivity, prolonged duration and decreased value of the design solution. 4) It is possible and worthwhile to enforce the realization of the optimal or near optimal sequence. They also observed the following as problems:

- The iteration needed from incomplete information
- Lacking or delayed input from the client
- Changes in design objectives
- Unbalanced design resources
- Late engagement of a design party
- Earlier intentions not being taken into account in a later task

These deteriorate the design and construction performance and eventually decrease the value provided for the customer.

INTERDEPENDENCIES BETWEEN DESIGN ACTIVITIES

Specific tools have been developed to assist in the understanding of the interdependencies between design activities and to deal with the iteration necessary to produce quality co-ordinated information. The Dependency Structure Matrix (DSM) has been included as a part of a multi stage approach called analytical design planning tool (ADePT) developed by Austin *et al.* (1999). It is aimed at the detail design stages where, in the analysis of four typical building designs the number of design tasks averages around 350 – 400, yet the number of information dependencies is over 2400. On larger projects, with over 750 design activities the design dependencies are over 2400. Clearly not only is it important to identify the design activities, but also the information interdependencies. The advantage of this approach seems to be the clear emphasis on the design stages order to meet the requirements of information interchange thereby the dependencies of one task on work done in another task can be anticipated. Subsequently there is an attempt to minimize the iterations commonly seen in design processes.

DESIGN PROBLEM SOLVING

An efficient decision making process is the backbone to an effective problem solving strategy. Providing information and decisions at the last responsible moment will reduce quick and imperfect decisions being made. Users and clients tend to keep their options open for as long as possible to enable them to react to change, whereas designers and contractors want decisions frozen at the earliest opportunity. Blyth and Worthington (2001) suggest “A project programme should include a strategy for fixing decisions progressively through the project, but enable clients to keep options open on matters which cannot be decided early. If there are no clear decision points then there is confusion about what decisions might change.”

Designing for construction projects is virtually always a wicked problem (Conklin and Weil 1997). The requirement documents are the supposedly definitive statement of the problem and to insist that they are specified up front and frozen until the project is complete is to ignore the fundamental nature of the design process. Because of the number of stakeholders, the dynamic nature of the problem formulation and changing constraints, it is not possible to reach an ideal solution for a wicked problem. “Design is not like solving a puzzle, where there are only a few possible solutions. Instead, there may be no limit to the alternative acceptable outcomes”, (Coles and Barritt 2000). To solve wicked problems it is necessary to confront a complex mass of information while unleashing creativity and opportunity driven thinking. Decisions, partial solutions and disagreement will flush out new aspects of the problem. Either time or money will run out, at that point, there will be a solution that is operationally optimal with respect to the resources provided and the approval of the stakeholders.

PLANNING AND MONITORING OF DESIGN TASKS

According to Coles and Barritt (2000) several factors contribute to the difficulty of planning and monitoring building design work. One is a kind of ‘entropy’ principle, whereby it is not possible to create order in one place without creating at least as much disorder somewhere else! The process of preparing a design should remove the majority of uncertainties from the construction operations by eliminating bad aspects of the design before work begins on site. Allinson (1997) pointed out that planning has traditionally adopted a ‘relay’ concept presuming one task is complete before

another is started. However, it has become increasingly common to go for forms of 'concurrent' planning which run team efforts in parallel. Coles and Barritt (2000) confirm that time is a critical input to design work, which can have direct effects on the quality of design work produced. Design practices should not be too generous with the allocation of designers at any stage of the work, because commissions must realize a profit if they are to remain in business. The skill and productivity of the designers condition the value of that time. It is therefore imperative to monitor progress to ensure that sufficient resources remain to complete the design. In the monitoring of progress, designers and managers must pay close attention to the degree of co-ordination between the various forms of design information. In collating progress reports, it is often necessary to compensate for views of progress that may be too optimistic. It is easy to overlook shortfalls in productivity that can become impossible to rectify. Small shortfalls should be recoverable. However, slow input may make it very difficult for other disciplines, at work on the same project, to meet their production targets and to make a profit on their commission.

COMMUNICATION OF DESIGN INFORMATION

Communication problems are a fundamental cause of poor performance in the design process. According to Gray and Hughes (2001), technologically intensive work requires the input of specialist knowledge that must be communicated by people working at the same level and within a collaborative environment. The need to express designs through solutions and to communicate these clearly to others means that the process of drawing is inextricably integrated with the design process. Design is impossible without some representational medium.

"In an ideal world, the design and documentation provided for construction products would be complete, precise and unambiguous. Unfortunately, this is rarely the case and quite often contractors are supplied with project documentation that is incomplete, conflicting or erroneous, thereby requiring revisions and clarifications regarding the contract documents supplied", (Tilley et al. 1997).

Evidence suggests that many 'quality related events' in the construction process are the result of poor communication in the design process. This has been supported by a small survey that points to the fact that errors leading to defects are mostly a result of failing to clearly communicate design requirements to the construction process, (Cornick 1991).

THE ROLES AND STAGES OF DESIGN

It is generally thought that the head of the design team is the natural leader throughout the life of the project. However, an examination into the pattern of work shows that different roles need to dominate during the design process at different times, this has been termed 'The Wheel of Dominance' (Gray and Hughes 2001). They state that there are three distinct types of knowledge controlling the progress of the design. At the beginning, the client dominates the briefing stage, the design team becomes the dominating influence at the concept stage and once the production needs are paramount, the management will dominate. At any time, one will naturally lead in decision-making and problem resolving.

DESIGN AND DOCUMENTATION QUALITY

Designers provide the graphic and written representations that allow contractors and subcontractors to transform concepts and ideas into physical reality. How effectively and efficiently this transformation occurs, depends largely on the quality of the design and documentation provided (Tilley and Barton 1997). Unfortunately, contractors are quite often supplied with project information that is incomplete, conflicting or erroneous. (Tilley *et al.* 1997). According to Tilley *et al.* 1997, when documentation quality is considered the level of quality is determined by: Timeliness [being supplied when required to avoid delays]; Accuracy [free of errors, conflicts and inconsistencies]: Completeness – providing all the information require; Coordination - through coordination between design disciplines; Conformance - meeting the performance standards and statutory regulations.

ANALYSIS

The research was carried out by a combination of in depth interviews and written responses to key questions from thirteen senior professionals within the North East region of the UK. Approximately half were from a major construction contractor and half were designers from architectural, civil engineering and services companies. The key issues for design management from the literature survey formed the basis of for the study. The subjects were asked to discuss their experiences, opinions and any proposed solutions to these issues. The aim of the study was to consider how to improve the efficiency and quality of the design management process on building projects. The findings from the data analysis were used to formulate possible improvements. The data analysis indicates that the most significant areas of operational weakness are: Design time available; Quality of information received particularly at briefing stage; Lack of a team approach; Clearly identified competent management and Understanding of the process and its tasks and dependencies. Successful integration of the design process with the procurement and construction of a project is of utmost importance. This is because the demands of team management and information co-ordination have intensified as the modern building industry operates to faster programmes against seemingly tighter profit margins. The following five areas are considered to be achievable in terms of improvements that can be made in the design management process.

ADEQUATE DESIGN TIME

The time afforded to the designers to carry out their work was the most significant issue to be raised in the research. There is a realization from both designers and contractors that a lack of adequate time affects the design quality and subsequently the contractors' performance on site. Adequate design time, budget and resources to carry out the design properly prior to construction starting on site would ensure more certainty. This appears to be an industry wide problem and change can come from clients recognizing the philosophy that good design pays. Design teams will tend to accept the time available rather than fight for the adequate amount of time to do design work. If the industry were to look at allowing more time to produce the design before commencing construction it would allow; good critical design reviews to be carried out; design teams to take time out from producing drawings and reappraise whether the project objectives are being met; completion of design documents with care for the user and completed and coordinated design The time available for design should of course be used effectively. At the start of design all the design team

members should be assembled, including any specialists and the known design workload should be planned to form a 'base plan' with the high-risk design activities emphasized. This period is a busy time for designers, which means it requires managing correctly. Planning the design to enhance coordination and to reduce or control iteration is an important factor and must be done at this early stage. Linked to the planning of the design activities is the philosophy that design should be solely produced on its own internal logic. There are other factors that influence the order of design, such as, order of construction, lead in times, authority approvals. However the basis for scheduling and organizing the design should be that of how design is effectively produced. There is evidence that the process of design is not fully understood and knowledge of tools and theories such as ADePT, Activity Definition Modeling, Transformation, Flow Value or QFD is low. The counterargument for adding more time and resources to the 'front end' stage is that construction companies may be reluctant to pay the additional costs on better front-end preparation. There is of course a value judgment to be made against the cost associated with not finishing on time and potentially losing future business prospects from a dissatisfied client.

BRIEFING AND THE BRIEF

When Egan's rethinking construction challenged the industry to improve its performance, he identified the parts of the business cycle that are missing in construction, namely the testing of the brief and feedback after occupation. The production of the brief is a key point of the design process. If the client's brief is not fully understood by all parties then a clear understanding of what is required is not mapped out. Included in this would be the transformation of 'Employers Requirements' into 'Contractors Proposals' on design and build type projects. The brief is both the plan and mechanism of understanding what has to be done before going to design. What is required is more awareness and knowledge of the process of 'briefing' and what is entailed in the compilation of a suitable brief. A lack of appreciation of the clients business needs and operation and not achieving a proper brief leads to designs with poor functionality and high maintenance bills. A better understanding of the clients' requirements would mean that they receive the right design advice leading to the construction of a facility that meets their needs. More often than not clients have had to alter their business operations to suit the building. All too frequently, aesthetics take priority over the practicalities of operation and maintenance. Evaluation of the brief after post-occupancy is rarely carried out. This is important to facilitate continual improvement by the build up of knowledge as to how to carry out the design of such projects in the future. Importantly there may be a direct link between building performance and business success of the client.

WORKING IN TEAMS

Primarily the design process is about the successful integration of different organizations and disciplines into one team. This is not possible without the correct people. It is common in design processes that the interplay between members and their knowledge is not fully considered and structured. This is also threatened by the attempts of others to compromise design objectives in order to satisfy their own agendas. Attention should turn to the concept of project partnering as a means of encouraging participants to work together rather than concentrating solely on their own specialism or agenda. Contractor, designers, clients and subcontractors must contribute positively, pull together and understand they all have a margin to make.

Currently most project teams have to start from scratch and thus design team workshops and team-building sessions should be utilized to short cut team development. Once teams have been established attempts should be made to keep teams together. If this is not possible then at least contractors should develop elite groups who can operate design and build contracts and keep those together. These teams will then be able to act as the focal point and bring such contracts to a successful conclusion. The very nature of some project procurement methods deter team working, over 50% of all contracts are now tendered with novation of the architect/engineer as a pre condition of appointment. This prevents the contractor from making a design contribution within their tenders because they are denied access to the architect until post tender stage. By then the opportunity to benefit from close collaboration in design development between architect and contractor has usually been lost. A means of improving communication between design teams and the construction team could be that each designer is given certain work packages to lead, whilst working alongside 'element co-coordinators' assigned by the contractor to coordinate and check the interfaces and buildability of the design produced. Along with this is the consideration of co-locating in an on-site office the different members of the design team. Whilst designing on site might be considered contra to the design process, the design team will have first hand appreciation of construction problems associated with the design.

COMPETENT DESIGN MANAGERS

The essence of a professional service is the application of knowledge, skill and judgment that is primarily in a client's best interest. Professionals should not be expected to perform without appropriate support, preparation and adequate time. Conversely designers working arrangements seem to be frequently adjusted or interrupted, often without consultation, in ways that can damage the capacity to exercise professional competence. According to this research the Architect is still considered the most influential person involved with the design process. Design and build emerged in its present form when architects and quantity surveyors began to 'parcel up' elements of modern building construction and pass the task of detailed design on to specialist subcontractors. Design and build has taken away much of the authority from the architect leading to the development of design managers from contractors. This can suggest that on such contracts construction is more important than design. This leaves the architect as head of the design team but not the whole process. The emergence of design managers has not solved all the problems, the 'contractors don't understand the design process' and 'the designer does not know how to manage' arguments continue. What is required however, is the right training to have the authority and competence in the role of managing the design. There is nothing to suggest that a designer or a contractor could not perform this role. Managing the design process requires pulling together diverse teams of people into coherent units to produce solutions to difficult and challenging construction problems. This requires good technical grounding, good grasp of the technical aspects of most types of buildings, good communication skills, drive and determination and a decision-making ability. This is clearly a role for a competent and experienced person.

DESIGN TASKS AND INFORMATION INTERDEPENDENCIES

It is clear from the data collected that no real consideration is given to determining the optimum sequence of design tasks and the interdependencies to produce the required

co-coordinated information in many projects. Therein lies one of the main problems of managing design. Even if at least the main design development stages were considered and the optimal sequence of those tasks together with the information interdependencies was determined the whole design process would be greatly improved. If those tasks and interdependencies were then planned and scheduled as 'deliverables' then monitoring of progress would be simpler. This goes some way of reducing the complexity of the process. A clear understanding the design process is of course required and specific software tools have been developed to assist in the understanding of the independencies between design activities. However, these are new and, as yet, have not penetrated far into the mainstream of construction in the UK. It is feasible to consider that the better companies in 5 years time will not only be those who have understood how to integrate and apply design management software to their operations, but also have fully understood the design process.

CONCLUSION

The research has highlighted that many factors contribute to the design management process and to the quality of design and documentation. These factors in the main do not add value to the process and therefore impinge on a contractor's performance to build to safety, time, cost and quality criteria. It is also apparent that even if excellent site management exists, without control over the design process difficulties will still arise in the construction process. Effective management of both the physical works and design are essential. The management of the design process is undoubtedly a complex problem. The understanding of the task has grown to a point where most people recognize the need for competent management. The analysis here suggests that, in order to improve, the most significant concepts which need attention are; the Design time available, the quality of briefing, the need for a team approach, that a clearly identified competent manager controls the process and that the task dependencies are understood. It is acknowledged that there are enormous difficulties associated with generalizing the design process to the extent in this paper and it is realized that there is no single prescription that will suit every project. However the findings are intended to provide a starting point for helping project teams to consider how to improve management of the design process and to lead them to some of the research, which is available to assist them in the process.

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