Solving design problems to add value

SOLVING DESIGN PROBLEMS TO ADD VALUE

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ABSTRACT

Value management is well established in construction to structure early project briefing and to agree satisficing project values and objectives among project stakeholders. Current practice concentrates on the consideration of value during project definition. This paper proposes Integral Value Engineering as a design management practice that considers value in design throughout project resolution and delivery.

An expansion of value management principles is proposed to include the adoption of a problem-solving approach and value-adding tools. These can help assemble value-adding frameworks in which design activity is more explicitly focused on project values. The use of problem solving frameworks to relate design method and outcome to project values is described and the notion of documenting these relationships to create a value-adding audit trail introduced. Integral Value Engineering is defined as the consideration of value when solving design problems, irrespective of the project stage in which they occur or their technical nature.

The adaptability of the problem solving approach is discussed, together with its ability to accommodate the extensive variability in problem scope and concurrency in construction projects. The role of individual design engineers as practitioners of Integral Value Engineering is also described; this focuses on collaborative forums to incorporate the expertise of specialised suppliers. A web-based Value-Adding Toolbox is described to disseminate value-adding tool descriptions, methods and examples within a single organisation or managed value chain.

The paper concludes that, for integral value engineering to be effective, suitable metrics must be identified to monitor the extent to which technical design solutions satisfy overall project values. This would allow responsive mechanisms to be defined so that design development can be managed throughout project duration to ensure that the satisficing values initially defined by value management at project outset will be delivered.

KEYWORDS:

Value Management; Value Engineering; Design Management; Problem Solving; Value-Adding Tools

1. INTRODUCTION

Industry clients demand the demonstration of value for money, but in most construction responses value management and value engineering are limited to project conception. These established techniques have become common and relate whole project solutions to end user requirements and stakeholder expectations. They are considered sufficient to format entire construction projects to ensure that their procuring clients will consider them to provide value. However, during the project stages where most design occurs the relationship of technical design solutions to project values is not explicitly considered. The industry must develop means of systematically relating individual technical design solutions to project values. This will provide a rigorous approach to the demonstration of value for money that spans the full extent of design activity within construction projects.

This paper examines problem solving in design management. Integral value engineering (IVE) is proposed as the consideration of value within individual design problems. The practice will therefore complement established value management practices by extending the scope of consideration of value to include all project stages where design takes place. The findings presented are derived from the Integrated Collaborative Design (ICD) research project, a collaboration of AMEC Capital Projects – Construction, Loughborough University and eleven supply organisations, supported by the EPSRC and DETR through the IDAC Link programme.

2. DESIGN PROBLEMS AND DESIGN MANAGEMENT

The Integrated Collaborative Design project provides designers with tools and techniques to manage their design activity to ensure that end users consider value to have been provided in their solutions. To achieve this, the research established a premise to extend the scope of explicit value consideration within projects from its current restriction to conceptual design to encompass all design activity, irrespective of the project stage in which it takes place. This section describes the development of this premise.

2.1 THE ROLE OF VALUE MANAGEMENT

In construction, the individuals responsible for defining physical and functional project characteristics (i.e. designers) tend to be isolated from those whose view of those characteristics determines them be of value in use. Designers must therefore anticipate how users will perceive value, using the functional requirements of the project client to define expectations. Physical and functional project characteristics are defined to satisfy these requirements.

To achieve this, current practice uses value management to agree the basic format, objectives and characteristics among the client, stakeholders and providers of the construction service (McGeorge and Palmer, 1997; Neasby, M., Barton, R., et. al., 1999). Value management complements client briefing by initiating a project solution anticipated to deliver value to its end users. Periodic workshops create forums in which the mutual buy-in and understanding required to make satisficing decisions is developed (Austin and Thomson, 1999). The process of doing this, however, is complicated by two characteristics of construction:

1. the numerous parties who will either use or be influenced by a project. Because these stakeholders are not directly involved in projects, their relationship with the project after handover must be predicted; and

2. the need for a multitude of organisations to be involved in projects to provide the range of specialised skills required. Each organisation has internal business objectives that influence the manner of its involvement in projects. Each project solution must therefore be satisficing: responding to diverse client and stakeholder needs to a sufficient extent to ensure their buy-in to it, while also satisfying the business objectives of all project parties.

Current value management practice addresses the first characteristic. A response to the second characteristic is not typically provided, as value is not systematically addressed in the later project stages where most technical design occurs. To overcome this, integral value engineering will provide the continuous appraisal of the relationship between technical design task solutions and the project value expectations they must satisfy.

2.2 DESIGNERS AND DESIGN PROBLEMS

Integral value engineering (IVE) uses a problem solving approach to create frameworks in which design tasks can be completed using established methods and related to the project values. IVE defines a problem as a difficulty that must be overcome (following Hawkins, 1986, for example). This definition accommodates substantial variation in the scope of the activity it may encompass. For example, the completion of an entire construction project could be managed in this way, as could the design of a mechanical system within it, down to the selection of paint colours and ironmongery.

Problems arise when a set of objectives must be fulfilled and the manner of doing so is not well understood or routine. Given that objectives are specific to project circumstance and can not therefore be generalised, the management of problems must be concerned with controlling the progress of their solution. Numerous problem-solving process definitions exist. A representative selection of these was compared to derive a generic process (Figure 1).

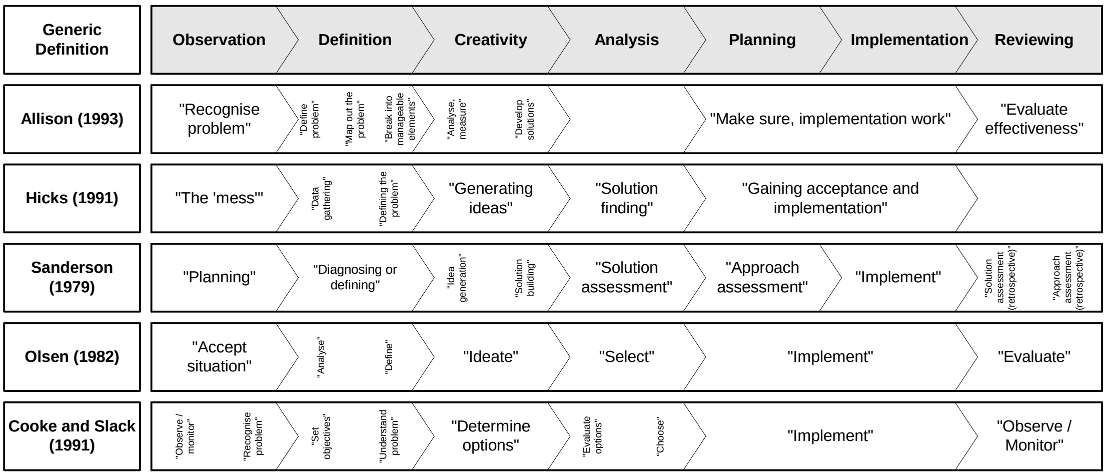

FIGURE 1: Management Problem Solving Processes Compared

By progressing individual technical design tasks within the generic problem solving process in Figure 1, emerging technical design solutions can be related to project values and, if necessary, modified as they are produced to ensure they will contribute to the satisfaction of project values.

Figure 2 illustrates the effect of varying the scope of the problem solving process considered. Irrespective of the scale of the problem solving activity, an emerging solution can continue to be revised until a stage in its progression at which the cost of revising the emerging design (to better align it with project values, for example) exceeds the benefit of doing so. When a whole construction project is managed as a problem solving process, this cut-off point tends to arise at the boundary between problem definition and resolution activities. This restricts value management to the conception project stages (Figure 2A). If problem solving structures the completion of individual design tasks, the problem solving approach will commence with the start of that design task at a time in the overall project programme determined by traditional methods (Figure 2B). This extends value consideration into the project stages where most design occurs and the greatest opportunity to add value therefore lies.

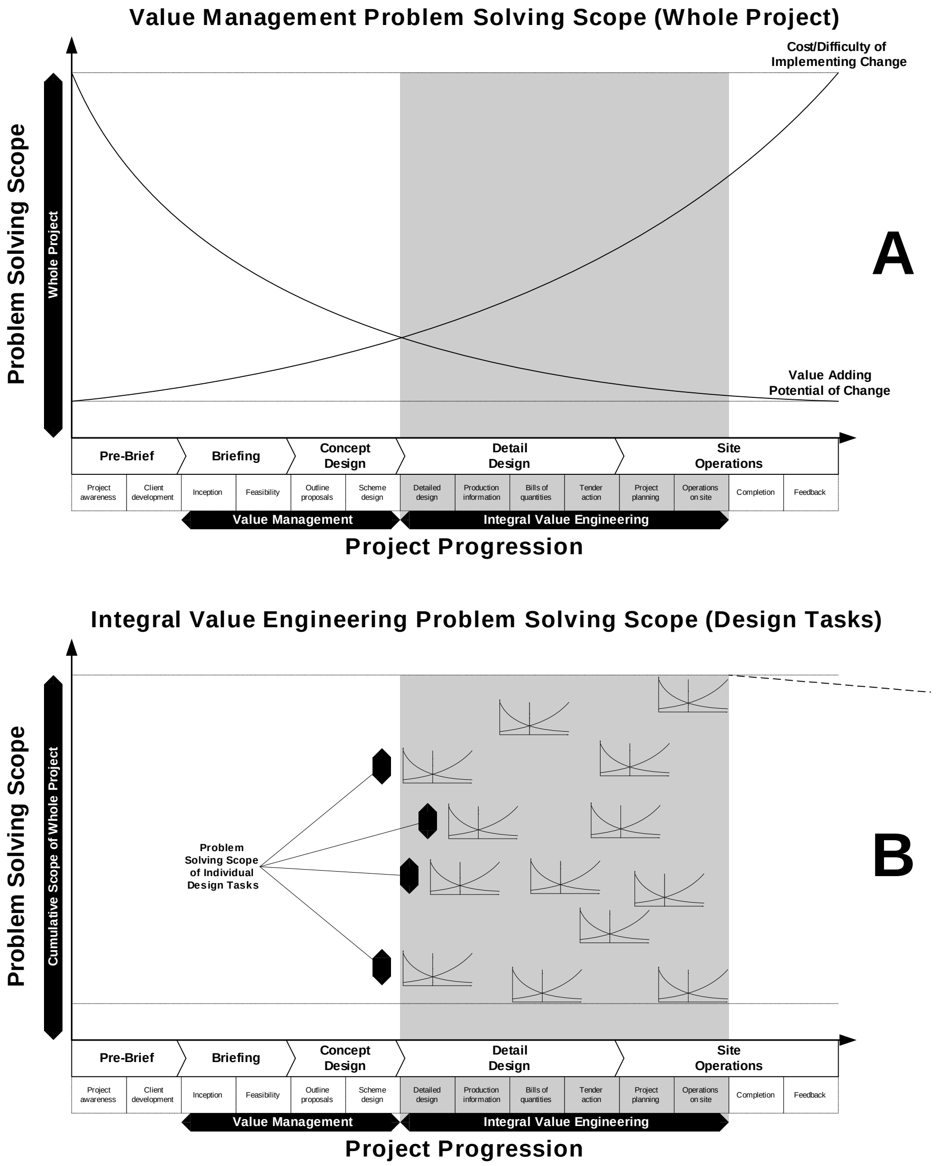

FIGURE 2: Variation of Design Problem Scope within Project Progress

Viewed collectively, the application of problem-solving frameworks to individual design tasks continuously address value throughout detailed design development (Figure 3).

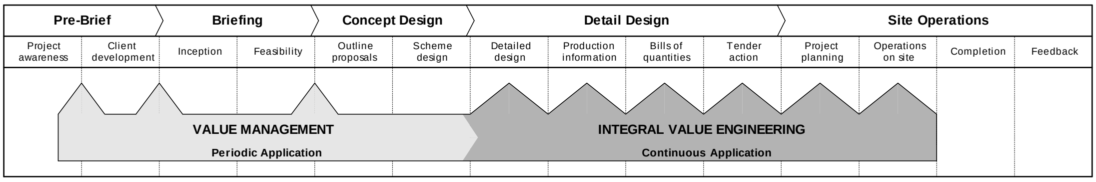

FIGURE 3: Value Management and Integral Value Engineering in Project Scope

We have examined whether a problem solving process will aid the consideration of value when developing technical design solutions. The Job Plan, which is commonly used to structure value management processes (see SAVE International, 1997; British Standard Institute, 2000 for examples), is itself a specialised problem solving process: a series of workshop forums establish the buy-in of clients and stakeholders into an emerging project solution while satisfying project value objectives. In effect, the Job Plan already confirms that a problem solving process is an appropriate mechanism to establish the ability of a design solution to provide value. This research has also investigated whether designers can use problem solving frameworks to develop and document technical design solutions and their relationships to project values. The latter would facilitate the audit of value-adding contributions to the project.

3. VALUE-ADDING MECHANISMS TO SUPPORT IVE

This section describes the use of a problem solving process by designers to manage the delivery of value from individual design tasks, using integral value engineering.

3.1 THE VALUE-ADDING TOOLS

Value-adding tools are assembled to form problem solving frameworks in which individual design tasks can progress. Each tool provides a means of performing the tasks typically undertaken within a given stage of a problem solving process. They help designers consider whether an emerging technical solution is likely to satisfy the relevant project values.

We initially assembled a range of tools that could be used by designers to expose the relationship between their design solutions and project values by drawing from existing value management, value engineering and problem-solving practices in a variety of industries. An initial set of 38 tools was documented in a standard formal comprising a description of: its purpose; a summary of its function; a pictorial representation of its procedure (where appropriate); its typical applications; its advantages and disadvantages; and links to related tools. Later review reduced the size of this tool set.

By documenting the outcome of tool use, an audit trail of the role of each design solution in adding value to the project will be created. This will provide a response to the growing demand of industry clients for documented evidence of the role played by the construction projects they procure in providing value to their businesses.

3.2 THE VALUE-ADDING TOOLBOX

Designers start the problem solving processes by selecting a tool from a central repository (Figure 4). This resource must be maintained by their organisation to contain the tool descriptions, examples and supporting proformas and software. The management of this resource can also provide competitive advantage to an organisation as it influences the ability of designers to relate their technical design solutions to project values.

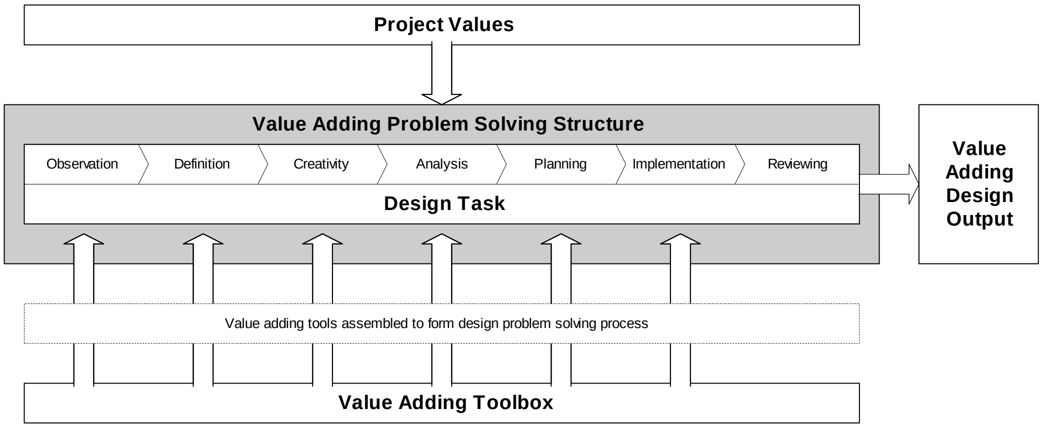

FIGURE 4: Value-Adding Problem Solving Frameworks

Such a value-adding toolbox must be available to all designers and be actively maintained if it is to disseminate current knowledge and value-adding lessons learned within an organisation. The value-adding toolbox can also guide designers' selection of tools suited to their problem solving requirements. Five selection methods were developed, using:

1. the stage of project progression in which the design task is considered;
2. the stage of the problem solving process for which a tool is required;
3. characteristics of the design task to which the tool will be applied;
4. key words or phrases in tool descriptions; or
5. an index of all tools in the toolbox.

The value-adding toolbox is suited to electronic dissemination using the Internet or the Intranet of a single organisation or a supply network. This will speed access and provides a simple means of ensuring that designers always have access to their organisation's current tool portfolio. The ICD project has validated this approach by converting a paper-based prototype to an active, web-based resource. An electronic medium also encourages exploration by designers using standard web technologies, which can help them identify suitable value-adding tools.

3.3 TESTING THE VALUE-ADDING MECHANISMS

The principle, format and dissemination mechanism of the value-adding toolbox was tested by case studies of its application by a representative sample of the design disciplines commonly involved in construction projects. This exercise sought to validate their application of problem-solving and to help understand the role of design task solutions in adding value to projects.

Each tool has already been shown to be effective and widely used in its originating industry. Therefore, the purpose of this validation exercise was to determine the ability of these tools, to improve designers' understanding of the relationship of their emerging design solutions to relevant project values. To achieve this, a series of workshops were held with a representative selection of designers, sourced from a large multi-disciplinary design management contractor. These engineers were selected from a broad spectrum of design disciplines, providing a sample of the attitudes towards integral value engineering that may be encountered in practice.

Validation workshops were held with designers either individually or in pairs. Prior to the validation exercises, the designers attended a workshop to familiarise them with IVE principles, including the role of value adding tools and the value-adding toolbox. Each designer was visited at his or her place of work and asked to consider how integral value engineering could be applied to the design task they were working on at the time of the visit. They were guided through the process of tool selection and problem solving process formation although no influence was exerted regarding tool selection or their application. This process produced five case studies of design problem solving using IVE principles.

Designers' ability to add value to a project through their design solutions was improved in all cases. This was established by the retrospective review of the problem-solving process assembled from value adding tools and the resulting documented output of those tools. In all cases, the completing engineer determined that the value adding tools had provided him or her with greater insight into the requirements of their client (or client representatives) and the ability of their technical design solution to satisfy them than would have arisen had the problem been solving using established methods along. They considered the exercise of assembling a problem-solving process to be beneficial due to its ability to provide them with this additional insight and to justify their chosen technical solution. However the benefit to a whole construction project or organisation could not be addressed in these case studies and a broader validation exercise is required.

3.4 COLLABORATING TO DESIGN IN VALUE

Supply chain management initiatives create long-term business relationships between organisations that repeatedly work with each other. These long-term relationships create opportunities to develop and use business resources collaboratively (Porter, 1985). The value-adding toolbox is an example of a business resource suited to this collaborative development. By sharing a single toolbox, the value-adding tools in it will provide a common basis for collaboration between members of different organisations.

Where individual design tasks are complex and require the specialised input of a number of individuals and organisations, this approach will be particularly advantageous. A variety of tools within the initial tool portfolio help create and manage the forums required for the group-based working to promote collaboration. Whilst workshops within established value management practices gather buy-in, these IVE workshops will gather expertise.

4. CONCLUSION

Integral value engineering will provide a means of extending the consideration of value during construction projects into those stages where the greatest quantity of design information is produced. It adopts an explicit problem solving approach, building on certain aspects of established value management practice during project conception, and extending them to later stages of design.

The consideration of project values has been found to be sufficiently applicable to all stages of design activity. Furthermore, audit trails of the value-adding role of technical design solutions can be provided during all project stages. Value-adding tools, sourced from a value-adding toolbox, have been found to be helpful in guiding the development of technical design solutions. The opportunity to collaboratively develop these business resources with supply network partners has been identified and the benefits of electronically disseminating them within that network established.

There is a need to extend the validation of integral value engineering principles to whole projects and organisations and to test its ability to document value-adding design trails that can demonstrate value to clients. This would allow a measurement of the extent to which project satisfies the values of its procuring clients, allowing corrective action to be taken if found necessary during project progression.

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6. ACKNOWLEDGEMENTS

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