# CONSTRUCTION VALUE MANAGEMENT REVISITED: THE DESIGNER'S ROLE

**Thomson, D.S. and Austin, S.A.**

*Department of Civil and Building Engineering, Loughborough University, Loughborough, Leics., LE11 3TU*

## ABSTRACT

Value management is well established in construction. The method provides a structured, documentable consideration of project stakeholders to ensure that projects are required, framed to satisfy values and sufficiently supported by all stakeholders to ensure successful completion. A variety of construction-specific value management methods exist and many UK design management contractors offer the practice to clients as a structured method of considering the role of each project in adding value to clients' business activities.

Value management in construction has grown from the manufacturing sector, but historical review suggests it was extrapolated verbatim, with limited revision for construction application. The soundness of this foundation is examined. The paper reviews the extent to which designers are currently provided with mechanisms to consider stakeholder values during the project stages when most design output is produced. Integral Value Engineering is proposed to continuously relate ongoing design activity to the project values current at the time of each design task's completion.

The paper describes a toolbox of value-adding tools that provide project designers with methods of structuring design activity to relate technical design solutions to stakeholder values. Development of the toolbox as a web-based resource is reviewed, and its supporting role confirmed by validation exercises. The paper concludes by establishing the need for all designers in the supply chain to be provided with methods of structuring their problem solving processes to address value delivery, and the suitability of the value-adding toolbox to them. Future work must develop means of actively maintaining a shared understanding of values throughout project progression, providing a framework and objective for ongoing design activity.

## KEYWORDS:
Design Management; Problem Solving; Integral Value Engineering; Value Adding Tools; Value Management

# 1. INTRODUCTION

## 1.1 Research Background

The construction industry is experienced in sharing understanding of project objectives between front-end teams and stakeholders. This understanding informs project formatting, allowing key physical and performance characteristics to be defined with sufficient stakeholder buy-in for projects to progress (Simister and Green, 1997). A variety of value engineering and value management practices structure this activity. Many UK-based design management contractors use these to document how their sketch and scheme designs provide value for money to their clients. These practices consider value to be provided when the client's (who project stakeholders may represent) objectives are satisfied.

This consideration of value does not tend to be extended into detailed design and later project stages. This is despite most design output being produced during these stages, representing the greatest opportunity to demonstrate value for money to clients. Integral Value Engineering (IVE) has been proposed previously (Austin and Thomson, 1999) to address value within ongoing project design activities. The practice has been developed by the Integrated Collaborative Design (ICD) research project, a collaboration of Loughborough University, AMEC Capital Projects – Construction and eleven supply organisations, supported by the EPSRC and DETR through the IDAC Link programme.

This paper describes the key business and project provisions required by integral value engineering and outlines its basic mechanisms. Research tools used to establish the premise of IVE are also discussed.

## 1.2 Origins of Value Engineering

Value engineering (VE) originated in the manufacturing sector. In response to materials shortages, Lawrence D. Miles and the General Electric Company developed value engineering during the late 1940's and early 1950's (Fowler, 1990). The technique examined the function performed by product parts, informing the identification of alternatives capable of performing the same function. VE is characterised by this systematic, function-based examination of product parts (Zimmerman and Hart, 1982).

When mass production emerged, VE optimised product designs by improving their effectiveness. This was achieved by directly linking the functions required by customers to their corresponding product parts, demonstrating their value-adding role (Crum, 1971). This approach simplistically considered product value to be derived from the cost and complexity of product manufacture. Mass producers used VE to increase their value by simplifying products to reduce manufacturing costs and increase profit margins. Conversely, consumers got better value through the lower prices resulting from this product simplification.

With the arrival of custom and agile manufacturing VE evolved to consider customer expectations as values. Statements of objectives were still systematically reviewed and sometimes abstracted into functional definitions to determine which are needed as opposed to wanted. This allowed the removal of the cost of unnecessary characteristics. VE changed from retrospectively reviewing existing designs to assisting new design development in response to identified needs.

The construction industry first used VE in the 1960’s to understand client requirements at the outset of a project. Methods to identify functional requirements were adopted verbatim from manufacturing. As the growth of VE in construction continued through the 1980’s and 90’s, the term value management (VM) emerged to represent examination of the relationship of the project to the business processes its output must support. Client values began to be addressed directly, without necessarily using function analysis to understand functional requirements. Instead, verbose statements of requirements were reviewed to determine which are needed, and must be provided, and which are merely wanted, and may be removed to reduce unnecessary cost.

The term value management also emerged in response to the geographical spread of VE principles (Kelly and Male, 1993). For these reasons, the term ‘value management’ became associated with the consideration of value in the European construction industry, where VM was adopted after VE had first been used in the North American and Japanese construction industries. A critical review of required functions remains the foundation of VM in construction, irrespective of the term used to describe it. Some established VM processes are prescriptive and fixed, while others vary their approach in response to individual circumstances.

## 1.3 Current Construction Practice

The construction industry experience of using VE and VM to structure early project formatting is based on their use of workshops to achieve group buy-in to key decisions. Whilst there are a variety of terms and methods, Male et. al. (1998) have shown that the core principles remain constant. Terminology variations are associated with the context and the prior knowledge of their users. More recently, a European Standard and associated Vocabulary have been produced (British Standard Institute, 1997; 2000) to provide a common basis for future practice development.

Construction VM practices were reviewed during the research study, including the timing of their application to projects (Figure 1). VM is usually implemented as a series of workshops, applied at key project development stages. These workshops create convenient forums for making shared decisions regarding project format and progression. In addition to the timing of its application, VM can also be characterised by the scope of the problem it addresses.

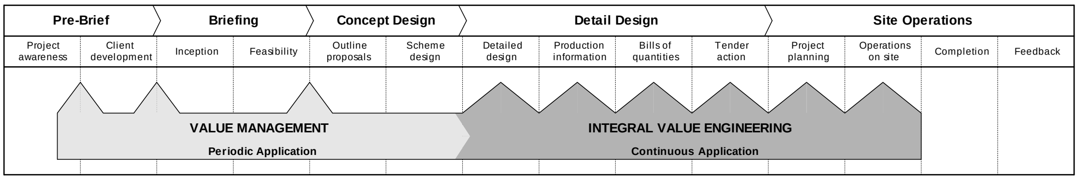


**FIGURE 1: Relationship of Integral Value Engineering and Value Management**

We question current VM practices that aim to define construction values for entire projects. In addition to mapping project characteristics to client values, a basic benefit of VM is the ability to facilitate the making of key decisions by the project client and stakeholders. However, as projects progress, the client and stakeholder involvement changes from making strategic decisions to routine, operational project decisions. Their role is typically reduced to agreeing the design decisions of their professional project team. The relevance of VM to involve stakeholders in *all* design decisions therefore diminishes with project progression.

The restriction of VM to early project stages arises because it addresses construction projects as single, complex problems (Kaufman, 1992). When developing design solutions to such complex problems, it is widely recognised that key decisions must be made sufficiently early in problem solving to avoid the cost of their implementation exceeding their benefit (most often a cost reduction). In the case of VM, this cut-off point occurs at the end of concept design, limiting opportunities to consider value during the later project stages when most design is undertaken. The term 'value engineering' sometimes represents the focused examination of design solutions during later project stages. However, these reviews tend to be instigated by budget overruns. In this context, VE is a euphemism for de-specifying or de-scoping (i.e. cost cutting). Integral value engineering (IVE) provides an alternative means to address value in design management and considers individual design tasks as problems. This overcomes the restriction of opportunity for change faced by value management. Opportunities are created to revise emerging solutions during all project stages where design is undertaken to improve their response to project values. Austin et. al. (1999) have shown that as many as 600 design tasks may be undertaken with a high degree of concurrency in a typical building project. Viewed collectively, IVE practice therefore appears as the continuous stream of value consideration illustrated in Figure 1.

## 2. THE INTEGRAL VALUE ENGINEERING APPROACH

The discussion above has established the benefits of viewing individual design tasks as individual problems. Once adopted by their design organisation, the tools and techniques of IVE will support individual designers in their consideration of the relationship of their design solutions to project values in addition to their technical objectives. When implemented by all IVE designers within an organisation, the audit trail of the value-adding role of design decisions requested by clients will be created.

### 2.1 Using Collaborative Problem Solving to Consider Value

To determine how design problem solving can be structured, a variety of problem solving processes were compared to develop a generic method. This assessment is illustrated in Figure 2.

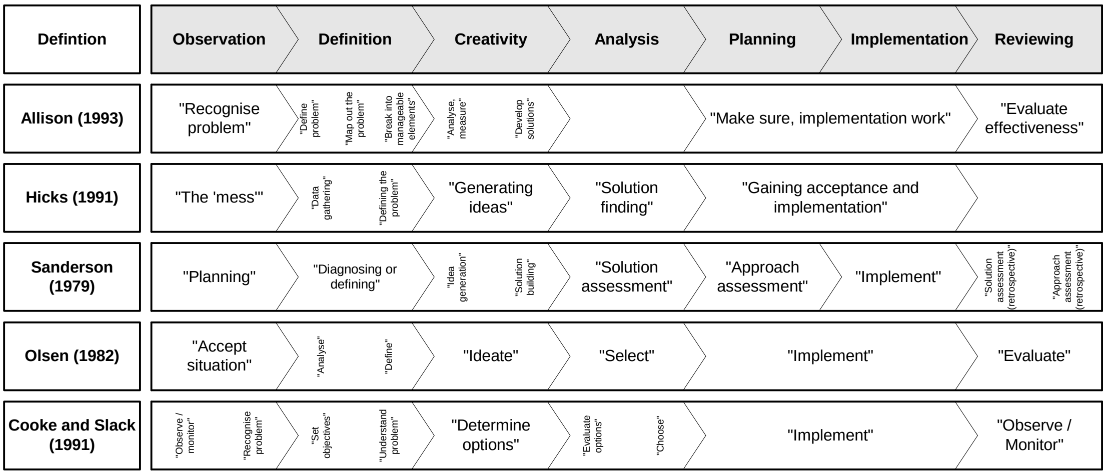


**FIGURE 2: Comparison of Typical Problem Solving Processes**

The Job Plan is the central process of many VM methods (for examples see Kaufman, ibid.; SAVE International, 1997). The generic job plan definition in Figure 3 has been derived from them. It became apparent that these methods are a value-specific implementation of a problem solving process. This observation reinforced the problem solving approach of integral value engineering used to relate design solutions to project values.

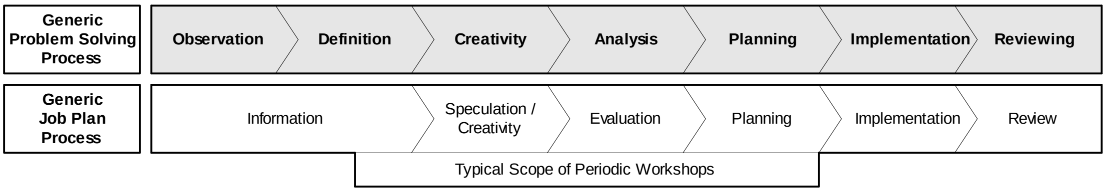


**FIGURE 3: Generic Job Plan Stages**

Integral value engineering (IVE) contributes to the creation of the collaborative working environments in which value-adding design solutions can be developed most effectively. This practice forms a core element of integrated collaborative design (ICD), contributing an enabling mechanism to the collaboration of supply chain members to share design expertise. ICD has developed a variety of practices to aid organisations' creation of long-term, collaborative business relationships and short-term project environments suited to collaborative problem solving. This collaboration is supported by value-adding tools and the value-adding toolbox, which, in turn, supports IVE.

## 2.2 Establishing a Culture of Problem Solving

For IVE to be effective, its principles must be ingrained in organisation culture. In a supply chain context, this can be established with strategic partners to develop the collaborative working environments in which specialised supplier expertise can be introduced into design solutions. Other parts of the ICD project have addressed these supply chain management issues.

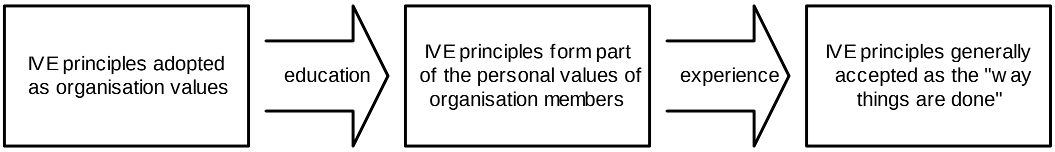


**FIGURE 4: Steps in Establishing a Culture of Integral Value Engineering**

A culture of considering value in design must be established by sustained management action to ingrain IVE principles into working practices. If well managed, cultural evolution can follow the effective pattern established by Schein (1985), and illustrated in Figure 4.

This culture must adopt the principle of managing design tasks as problems, defined as difficulties that must be overcome (Hawkins, 1986). This problem solving culture must use the problem solving processes to create forums:

1. in which individual designers can structure their development of technical design solutions using existing methods while also relating these solutions to the values that frame the project; and
2. for collaboration with other members of their organisations and with other organisations, such as suppliers.

### 2.3 Establishing Value-Adding Design Rigour

To provide the value-adding design rigour increasingly requested by industry clients, the development of value-adding design cultures within organisations should be concerned with establishing the relationship between technical design solutions and relevant project values. This will create the audit trails required to demonstrate value for money to clients.

IVE is applied to design processes by applying value-adding tools to support the problem appropriate to the design task at hand. Documenting use of the tools can provide evidence of the role of the technical design solution in providing value to the project. These can be reviewed and summarised retrospectively in response to client requests for demonstration of design value.

## 3. INTEGRAL VALUE ENGINEERING MECHANISMS

Assuming that an organisation has successfully established an internal culture of collaborative problem solving, two key mechanisms should be adopted to support IVE. These are value-adding tools and the value-adding toolbox used to disseminate them within their organisation.

### 3.1 The Value-Adding Tools

A value-adding tool is a problem solving technique that can help establish the ability of an emerging technical design to satisfy relevant project values. To complete a single design task in accordance with the principles of IVE, the designer assembles appropriate value-adding tools into a problem solving process. Technical design activity progresses within that process. As the problem solving process progresses, relevant value-adding tools are used to understand the role of the emerging design solution in satisfying relevant project values. As discussed above, this is documented to provide the audit trail required by client to demonstrate value for money.

A portfolio of value-adding tools have been selected from three main sources:

1. established value management and value engineering methodologies;
2. problem solving techniques used in general management disciplines; and
3. product development techniques used in the manufacturing sector.

Two types of value-adding tool were identified: those from the established VM or VE practices in construction and manufacturing; and a second set that support problem solving in general. The tools were also selected to suit their application by an individual designer, collaborating where appropriate with other members of their organisation and any specialised supplier or sub-contractors.

The initial portfolio of value-adding tools was validated through a series of workshops held with designers including civil engineers, structural engineers, architects and mechanical services engineers. The designers were visited at their place of work, individually or in small groups. Using either the design problem they were considering at the time they were visited or one that they frequently face, a problem solving process was assembled from value-adding tools to create a framework in which the technical solution could be developed when relating it to project values. Case studies were developed to illustrate the interaction of the technical design process with the value-adding tools. In total, 7 engineers were visited, yielding 5 case studies of tool use.

The designers were not aware of the origins of each proposed value-adding tool. Eighteen tools sourced from established value management practice were confirmed and eleven general problem-solving tools were found effective in this new role. However, each organisation must determine which value-adding tools are suited to their manner of working and the type of design work they perform when establishing their IVE practice.

### 3.2 The Value-Adding Toolbox

Once an organisation has compiled its value-adding tool portfolio and has established an internal culture of collaborative value-conscious design, it must make its tools available to its designs. This is achieved using a value-adding toolbox.

The purpose of the value-adding toolbox is to provide designs with:

1. the tools;
2. strategies for selecting appropriate tools; and
3. a selection of examples, proformas and software tools to support their application.

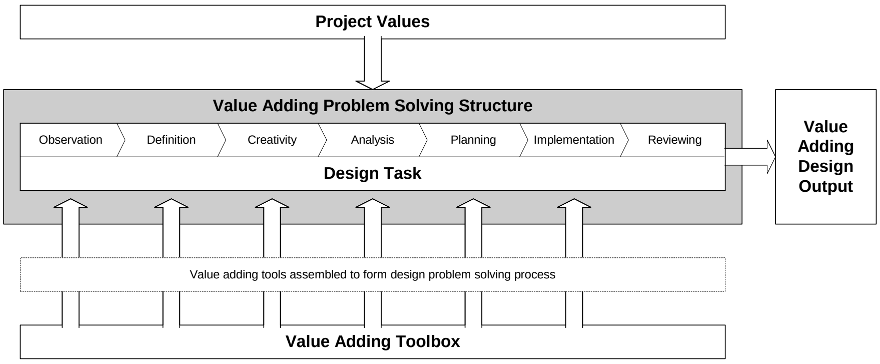


**FIGURE 5: The Creation of Problem Solving Frameworks to Progress Design**

Figure 5 illustrates the role of the value-adding toolbox in providing a source of value-adding tools for use by designers to structure their design problem solving to meet the project values.

The toolbox was created initially in paper form. It was then developed as a web-based tool, an approach with a number of significant advantages. Electronic provision on a corporate Intranet improves access and aids maintenance. By storing all information in one location, revisions can be easily implemented and immediate made available to designers. Such an electronic resource can also be shared among supply chain members where long-term, collaborative business relationships exist. The electronic form also facilitates the inter-linking of tools, connection to supporting templates and software and lets designers explore suitable tool combinations.

## 4. CONCLUSIONS

Integral value engineering can provide construction organisations with the opportunities to rigorously consider value as they solve design problems. It is also a response to the requests of industry clients to demonstrate how projects provide value for money. Audit trails that map the relationship of individual design solutions to project values will, provide documented evidence of value for money. IVE is a systematic, rigorous approach that extends established value management and value engineering practices beyond the conception stages of projects.

The use of value-adding tools, and an associated value-adding toolbox to disseminate them within an organisation, has been validated by case studies with design engineers. The key mechanisms of integral value engineering have been found effective and useful to commercial organisations. The opportunity to deploy these resources electronically has been identified, and its role in enabling their sharing among supply chain partners established.

Having provided a method of relating design task problem solving to project values, a complementary method must be developed to relate the designers' understanding of these values throughout project progression. In particular, it should provide a response to the fact that the framing values of the client and stakeholders can change as their understanding of their needs improves as a consequence of project progression.

## 5. REFERENCES


Allison, M. (1993) *The Problem Buster's Guide*, Gower, Aldershot, UK.

Austin, S., Baldwin, A., Li, B. & Waskett, P. (1999) "Analytical Design Planning Technique: A model of the detailed building design process", *Design Studies*, 20, pp. 279-296.

Austin, S., Thomson, D.S. (1999) "Integral Value Engineering in Design", *Proceedings of Cobra 1999, RICS Construction and Building Research Conference, 1-2 September*, School of Construction and Property Management, University of Salford, UK.

British Standard Institute (1997) *Value Management, Value Analysis, Functional Analysis Vocabulary, Part 1. Value Analysis and Functional Analysis (BS EN 1325-1)*, British Standard Institute, London.

British Standard Institute (2000) *Value Management (BS EN 12973)*, British Standard Institute, London.

Cooke, S., Slack, N. (1991) *Making Management Decisions (2nd Ed.)*, Prentice Hall, New York.

Crum, L. W. (1971) *Value Engineering: The Organised Search for Value*, Longman, London.

Dell'Isola, A. (1997). Value Engineering: Practical Applications for Design, Construction, Maintenance and Operations. Kingston, MA, RS Means.

Fowler, T. C. (1990) *Value Analysis in Design*, Van Nostrand Rienhold, New York.

Hawkins, J.M. (Ed.) (1986) *The Oxford Reference Dictionary*, Clarendon Press, Oxford, p.662.

Hicks, M. J. (1991) *Problem Solving in Business and Management: Hard Soft and Creative Approaches*, International Thomson Business Press, London.

Kaufman, J. J. (1992) "Value Management: A Methodology, Not a Tool.", *Value World*, 15(1), pp. 13-17.

Kelly, J., Male, S. (1993) *Value Management in Design and Construction*, E&FN Spon, London.

Male, S., J. Kelly, et al. (1998) *The Value Management Benchmark: Research Results of an International Benchmarking Study*, Thomas Telford, London.

Olsen, S. A. (Ed.) (1982) *Group Planning and Problem-Solving Methods in Engineering Management*, John Wiley and Sons, New York.

Sanderson, M. (1979) *Successful Problem Management*, Wiley-Interscience, New York.

SAVE International (1997) *Value Methodology Standard*, SAVE International, Northbrook, LI, USA.

Schein, E. H. (1985) *Organizational Culture and Leadership: A Dynamic View*, Jossey-Bass Publishers, San Francisco.

Simister, S. J., Green, S. D. (1997) "Recurring Themes in Value Management Practice.", *Engineering, Construction and Architectural Management*, 4(2), pp. 113-125.

The Institution of Civil Engineers (1996) *Creating Value in Engineering: ICE Design and Practice Guide*, Thomas Telford, London.

Zimmerman, L. W., Hart, G.D. (1982) *Value Engineering: A Practical Approach for Owners, Designers and Contractors*, Van Nostrand Reinhold, New York.