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Maximizing Engineering Value

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**Prepared by
Construction Industry Institute
Maximizing Engineering Value Research Team**

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Executive Summary

The value that engineering contributes to capital projects is rarely maximized for a wide variety of reasons. The engineering phase can be rushed; the design team can be under-resourced; owner's requirements can be unclear; technology can change rapidly; organizational structures can be constraining; or project objective priorities can be unclear, to name a few. In today's project environment, maximizing engineering value requires that many different issues, opportunities, and challenges be identified and confronted early in the project planning process.

Responding to these opportunities and challenges, CII established the Maximizing Engineering Value Research Team to examine various strategies through which project value from engineering can be maximized. Applying rigorous search, analysis, and evaluation processes, the research team ultimately identified 64 engineering strategies for maximizing value to capital projects.

To better understand each of the 64 strategies, the research team further examined each strategy from many perspectives:

- Purpose and objective
- Motive for implementation
- Impact on 11 common project value objectives, including tradeoffs
- Influence of timing on the effectiveness of implementation
- Project characteristics and circumstances for which impact is leveraged
- Frequency of implementation
- Ease of implementation
- Fundamental or mandatory vs. optional implementation
- Linkage with other project phases
- Role in overcoming common barriers to maximizing engineering value
- References for further information.

Much of this information has been organized into one of the research team's publications, *Engineering Strategy Catalog* (CII Implementation Resource 245-2, Tool 2), yet additional questions remain. For example, from such a large listing, how can a project team select those strategies most beneficial to a project? Also, how can such strategies be effectively implemented within a project context – and integrated with design effectiveness efforts? Answers to these questions may be found in the *Maximizing Engineering Value & Design Effectiveness Toolkit* (IR245-2).

When well planned and executed, engineering value can be significantly enhanced on capital projects. The *Toolkit* is intended to be a comprehensive and easy-to-use resource that project teams can use to maximize engineering value. This publication summarizes the process applied by the research team, highlights key findings from the research, and introduces and reviews elements of the *Toolkit*.

Introduction

Need, Purpose, and Objectives

Owners, architects/engineers, and contractors in both the private and public project environments devote much effort to delivering and operating successful projects. Unfortunately, the industry's track record is not perfect. In fact, history provides many examples of projects that have not succeeded to the extent desired.

Projects fail as a result of many causes. In many instances, critical aspects of engineering and design are either poorly executed or overlooked altogether. In some projects, the consequences are severe. Many such failures result in excessive costs to correct deficiencies, delay project completion delays, unexpectedly high operating costs, or in a few cases, even loss of life. In other cases, engineering and design efforts succeed in meeting stated objectives, but maximum value is still not achieved because targeted performance objectives are set too low. In any case, special efforts are needed to help maximize engineering value.

CII formed the Maximizing Engineering Value Research Team (RT 245) in recognition of the need to complement existing CII research and recent findings on design effectiveness, which were published by the Design Effectiveness Research Team (RT 233). In essence, the question was: Beyond design effectiveness, what is maximizing engineering value about? RT 245 set out to find the answer to that question.

The primary purpose of this research was to clarify and raise the industry's awareness of the broad range of issues and drivers that influence how engineering value on capital projects can be optimized. The hypothesis for this research was as follows:

The value from engineering work scope and approach can be maximized by being responsive to the unique challenges and opportunities of a project.

The intended audience for this research includes all project management professionals, particularly those involved in the management or leadership of engineering activities.

Specific objectives accomplished during this research include:

- Developing an inventory and descriptive catalog of engineering strategies that are beneficial in achieving project value objectives.
- Expanding an implementation model for design effectiveness to include ways to maximize engineering value.
- Identifying and assessing barriers to engineering value and determining how engineering can proactively respond.
- Developing implementation tools to help project teams maximize engineering value.

Research Scope Limitations

For the purpose of this study, “engineering” is defined in a broad sense, encompassing front-end engineering design (FEED), detailed design, procurement, and technical support of project feasibility analysis, planning, fabrication, field construction, and commissioning/startup.

The scope of this research is limited to how engineering organizations, within either owner or contractor organizations, can contribute to maximizing project value.

Except for the case study that is focused on the Standard Plant Design engineering strategy, the emphasis of this research is on awareness of high-value engineering strategies and their selection rather than on detailed, tactical implementation guidance.

Overview of Research Methodology

Figure 1 illustrates the process followed by the research team. A mix of methodologies was used:

- Based on a literature review and team discussions of recent industry challenges and developments and through a highly

iterative process, the research team developed and refined an inventory of engineering strategies.

- Building on the recent work of CII's Design Effectiveness Research Team (RT 233), RT 245 further developed an implementation model for maximizing engineering value (i.e., a work process), a characterization of engineering strategies, and the Strategy Selection Tool (software).
- RT 245 conducted an industry survey to assess barriers to maximizing engineering value (again expanding on the work of RT 233).
- A case study was conducted in order to characterize a success story with macro-level project design standardization.
- The team validated through industry application the Strategy Selection Tool.

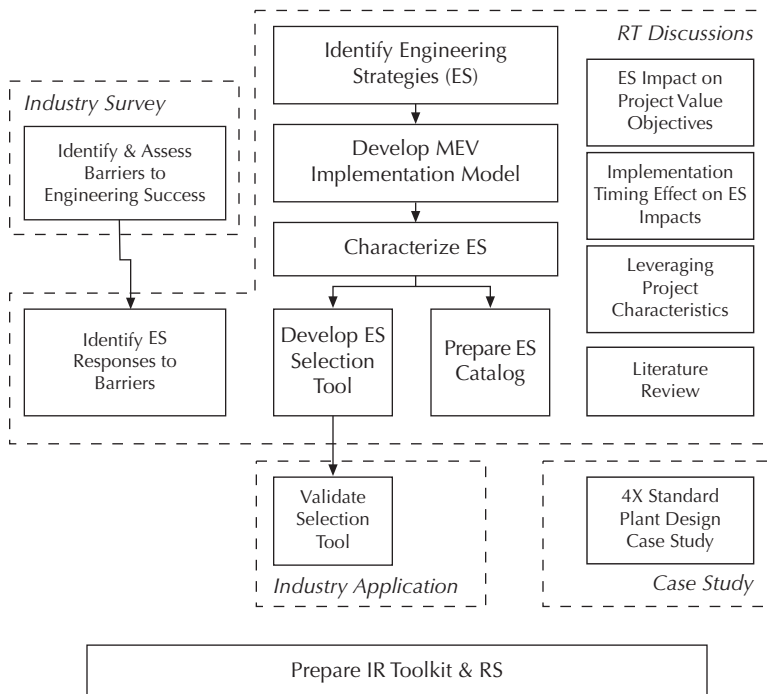


Figure 1. Research Methodology

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Key Findings

Fundamental vs. Optional Engineering Strategies

Sixteen of the 64 engineering strategies, in the judgment of RT 245, are of a fundamental nature and should be implemented on most if not all projects. These fundamental strategies (all with A prefix designations) are listed in Table 1.

Table 1. Fundamental Engineering Strategies

A Fundamental Engineering Strategies	
A 1	Design Progress Monitoring
A 2	Quantity-Based Design Productivity Tracking
A 3	Design Quantity Takeoffs
A 4	Appropriate Allocation of Design-Related Risks & Rewards
A 5	Automated RFI Tracking
A 6	Standard Process for Design Delivery
A 7	Design Quality Mgmt./QA/QC
A 8	Project Team Internal Alignment Assistance
A 9	Change Management Protocol Assistance
A 10	3D CAD
A 11	Cost Escalation Tracking
A 12	Design for Operational Safety
A 13	Design for Construction Safety
A 14	Integration of Lessons-Learned into Design
A 15	Technology Tracking & Selection
A 16	Risk-Based Design

Thus, in order to maximize engineering value, these strategies should be vigorously pursued.

Table 2 reviews the remaining 48 Optional Engineering Strategies, which are presented in six different groupings (and designated with B–G prefixes):

- B. Alternative design delivery strategies
- C. Assistance to owner services
- D. Management of design interfaces
- E. Strategic design decisions
- F. Design approaches
- G. Opportunity capture/Design for X

Strategies Responsive to Engineering Value Barriers

The research team conducted an industry survey to gain a better understanding of the frequency and severity of barriers to engineering value. The 10 most severe and frequent barriers to engineering value and associated preventive engineering strategies are presented in Table 3 (see pp. 8–9).

As discussed later in the Implementation Model, owner and contractor project managers should assess the presence of these barriers in advance and, working with engineering managers, should appropriately and effectively implement one or more of the engineering strategies identified.