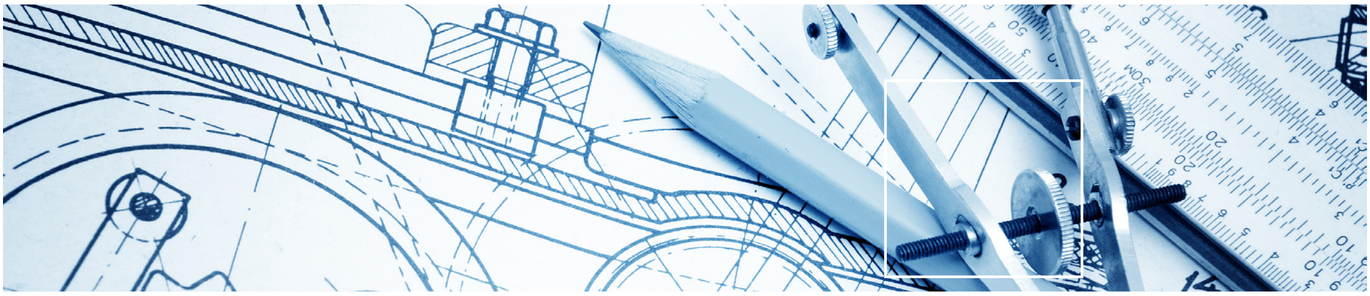
Arthur D Little

Viewpoint

Value engineering of capital projects

Is your business optimizing value over the entire asset lifecycle, from the start?



Large capital projects are often not delivered at the lowest possible cost, nor do they deliver maximum value at any given cost. Systematically identifying opportunities for cost reduction, whilst ensuring they do not have an adverse effect on functionality is what every executive involved in capital projects wants, knowing that innovative ideas have been incorporated along the way. Value engineering of large capital projects typically delivers cost savings of at least 10% vs. previous projects or initial concept designs, and also presents opportunities for value enhancement through additional functionality. So how can companies benefit from applying this technique so often used in product engineering? This Arthur D. Little viewpoint explores the question and describes the key activities needed to drive substantial value benefits over the asset lifecycle, through value engineering in capital projects.

Risk aversion, a lack of capabilities to evaluate opportunities systematically, and an emphasis on capital cost rather than lifetime costs can all hinder capital projects from being fully optimized

Whilst companies are increasingly under pressure to deliver capital projects on time and under budget, large capital projects are not always fully optimized. Why is this the case? Three reasons can provide an answer to this question:

1. Organizations tend to stick with what they know, and resist change. Hence, tried and trusted materials, technologies and suppliers are often favored over alternatives that may be cheaper, deliver better quality, or increase revenue. The design standards of large capital projects are commonly based on prior similar projects, without carefully considering completely different technologies that may have sprung up in the meantime. The risk of the unknown is often seen to outweigh the potential benefits of innovating, so that resources are often not allocated, to the identification and evaluation of such opportunities.
2. Cost saving efforts are typically focused on capital costs, whereas operations and maintenance costs can often be the bigger cost factors over the lifetime of an asset, and can even account for 60-70% of the total lifetime costs savings realized.
3. Most importantly, companies often lack the capabilities and knowledge required to optimize their investments. Systematically assessing the potential impact of cost reduction initiatives on functionality, and identifying opportunities that maximize functionality is crucial. Many companies lose out on substantial value benefits because they do not maximize the value to be generated at the lowest lifetime cost, whilst ensuring the desired outputs are not negatively impacted. A relatively low return on capital employed is one of the most transparent indicators that a large gap exists and that significant benefits could be delivered through value engineering.

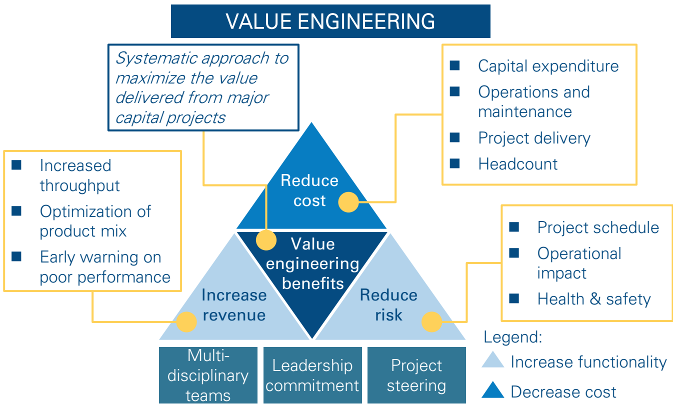
Value engineering typically delivers at least 10% in lifetime cost savings, without compromising the quality of outputs or asset functionality

Value engineering can address this gap and provide a clear answer on how to reap substantial value and optimize capital projects. Value is maximized through:

- Lifetime cost savings, typically of at least 10%. The relative contribution of CAPEX and OPEX savings to the total savings will vary depending on the nature of the project.
- Increased functionality, delivered through revenue enhancement and/or risk reduction (as highlighted in Figure 1).

So how does value engineering generate significant benefits that other approaches do not deliver?

Figure 1. Benefits of value engineering



Source: Arthur D. Little

Value engineering is based on innovative, out of the box thinking, the assessment of all relevant costs, and a systematic opportunity identification process conducted by a multi-disciplinary team

Value engineering differs from standard cost reduction methodologies in a number of ways, which allows this approach to generate far bigger benefits:

1. Value engineering is underpinned by thinking in terms of functionality. A function is defined as what the asset should produce; whether that is, for example, a manufactured product or power to railway infrastructure. When defining an asset's functions, the inputs (e.g. systems, components, or raw materials) that are to be used are irrelevant, aside from ensuring the function is performed safely, and complies with necessary standards. The focus is set on the output, rather than on the process and the input. Emphasis is thus shifted away from incremental changes to the existing design, to a step change approach assessing the different methods and technologies that could be employed to deliver the required outputs. Creativity, innovativeness and out of the box thinking are stimulated.
2. Value engineering accounts for both CAPEX and OPEX. As OPEX can be the most significant cost factor over an extended lifetime, it is critical that the analysis covers OPEX accurately.
3. The value engineering process involves conducting workshops with a multi-disciplinary team of experts in all relevant areas, including for example engineering, project management, product and process, cost estimation and procurement. Opportunities that may often be considered as too risky can be properly assessed by the team and evaluated against the firm's risk appetite, rather than be rejected before they have been fully considered.
4. The value engineering concept allows for a clear segmentation of opportunities into two categories: cost saving versus functionality enhancement, and therefore provides a structured framework for opportunity identification.

We have developed a step-by-step approach to value engineering that helps our clients fully optimize their capital projects

Arthur D. Little's approach, which comprises seven steps, is aimed at ensuring that our clients gain the maximum benefits from applying the value engineering concept.

1. Assess project goals, background and develop cost baseline

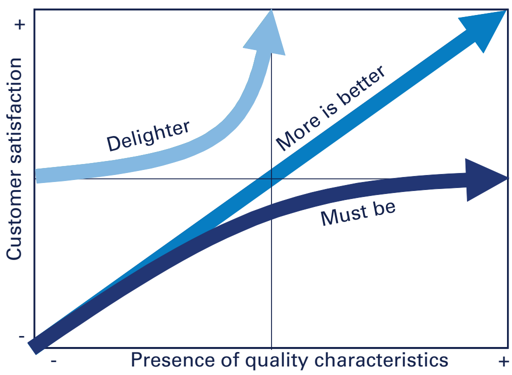
The first phase is aimed at clearly defining the scope of value engineering, obtaining an understanding of previous, similar capital projects and developing the cost baseline for the project's scope of work. It is critical that the cost baseline be developed with the highest cost granularity possible. Costs should include both the cost of delivering the capital project and the operations and maintenance costs over the lifetime of the asset.

2. Identify the asset's functions; assess the cost of each function and its contribution to the asset's output

The second phase identifies the functions to be performed by the asset and evaluates their cost and impact. Each function is analyzed in detail and segmented into sub-functions. Up to 50-100 sub-functions can be identified for each main function. Once all functions and sub-functions are identified, they are mapped against the cost baseline developed in Phase 1 to assess which costs contribute to which function, in the so called cube analysis.

Functions are further segmented into "must be", "more is better" and "delighter" functions, as defined in the Kano matrix below.

Figure 2. Kano matrix to categorize performance needs



This segmentation reflects the relationship between the value or customer satisfaction created by each function versus the function's output and costs. While increasing the output of a "more is better" function will lead to increased value creation, increasing the output of a "must be" function will lead to increased value only up to a point. Beyond this point, maximizing the function's output leads to no additional value and thus incurs unnecessary costs.

As a simple example, in producing a cup of coffee in a coffee shop, the degree of cleanliness of the cup would be a "must be" or "basic need" function, as at some point further cleaning (sterilizing) will not add further value to the customer, so doing that simply adds unnecessary cost. However, the quality of the coffee itself is a "more is better" or "performance" function, in that the higher the quality, the higher the price that customers are willing to pay, up to a certain extent.

Functions defined predominantly as "must be" functions should be considered for cost reduction primarily. On the other hand, "more is better" functions should be seen as opportunities to enhance functionality through increased revenue and/or decreased risk. These functions will very often require a trade-off between cost and value, to be further evaluated during the following steps of the process.

Upon completion of this process, the functions with the highest cost can be identified and prioritized for further analysis. It is not unusual that about 20% of the functions drive 80% of the cost, thereby highlighting clear areas of priority.

3. Brainstorm on value maximization

In Phase 3, the aim is to develop a long-list of potential opportunities. Brainstorming sessions involving a multi-disciplinary panel of experts are key to identify opportunities for optimizing each prioritized function. It is important for the "rules of the game" in these sessions to be clearly defined, for example, to emphasize to participants that all ideas are valid and encouraged in a workshop "safe zone".

Opportunities identified in the brainstorming sessions could include using a completely different technology or asset set-up, different materials, new energy efficiency techniques, or alternative suppliers. A key point here is to consider bigger, "system level" changes as well as more detailed and specific changes that can be found in ancillary equipment specifications and the like.

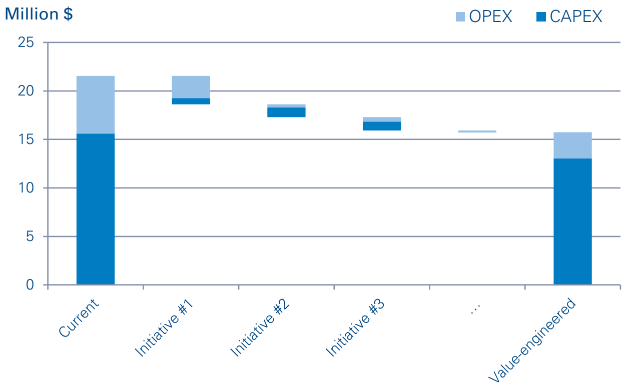
4. Assess risk levels

Identified opportunities are then filtered based on their level of risk and on the risk appetite of the project owner. Opportunities deemed too risky are removed. For example, using a cheaper construction material can result in cost savings, but the increased risk of corrosion would need to be carefully assessed. Risk assessment must be comprehensive and informed: both risk likelihood and impact should be accounted for. This approach is critical when assessing high risk, high impact opportunities in particular.

5. Evaluate the value of opportunities

Retained opportunities are then assessed based on their Net Present Value (NPV). The NPV is computed for each opportunity by measuring its impact on the asset's CAPEX and lifetime OPEX, and by assessing its cost and time of implementation. Potential suppliers and other sources are typically contacted for verification on financial estimates or technical applicability as part of this process. Past experience shows that lifetime cost savings of at least 10% and of up to 30-40% can be achieved. The chart below illustrates a value engineering project that led to 30% of lifetime cost savings, 60% of which are OPEX savings over the lifetime of the asset.

Figure 3. Lifetime cost reduction through value engineering



6. Develop action plans

Once the NPV has been assessed for all opportunities, these opportunities are prioritized and an implementation roadmap is developed. Quick wins are usually implemented first. It is also critical to ensure that opportunities with a long lead time can be fully implemented in time.

7. Leveraging value engineering: roll-out

Three steps are required to roll out and internalize value engineering across the organization (see Figure 4 below). The first step is to implement the results of the value engineering initiative along the implementation plan, prioritizing more urgent capital projects in the case of numerous similar projects. Following this pilot, the second step is to review how the client's current strategy, processes and organization structure and capabilities foster/hinder value engineering through undertaking gap analysis against best practice.

Fit for purpose solutions to leverage and internalize value engineering are developed from this analysis as a third step. It is crucial for governance mechanisms, roles and responsibilities to be clearly defined. A project management office could be set up in the interim to ensure successful roll-out. Corporate communication plans should be drafted and training programmes for selected staff to develop in-house capabilities rolled out.

For those organizations with multiple assets of the same type, the opportunity is also there to leverage value engineering across their portfolio, so as to multiply the benefits of the investment.

Figure 4. Leveraging value engineering

Source: Arthur D. Little

Value engineering is widely applicable across industries, typically undertaken at the design stage

Following the analysis and description of value engineering and Arthur D. Little's approach, one may ask in which industries and at which project stages the concept can be applied.

The answer is simple: value engineering is applicable to all industries that require significant capital investments. This includes the Travel and Transportation, Telecommunication, Chemicals, Manufacturing, Oil & Gas, Automotive, Healthcare and Utilities industries for example. It is most relevant for companies considering to invest in large scale capital projects of above $5m CAPEX and lifetime OPEX costs or in multiple major assets of the same kind, whether to set up new or replace old assets.

As just one example, carbon composites have long been identified as a major opportunity for asset lifetime cost reduction. In the last 10 years, commercial aviation has embraced this, to the extent that the new Airbus A380 structure is 25% carbon composite, and the Boeing 787 is more than 50%, resulting in a 20% efficiency improvement.

Benefits to be gained from value engineering are typically maximized if the initiative is conducted at the concept study or FEED phase, in order to avoid large sunk costs of investments already made and allow maximum flexibility in technology and design choices.

The appropriate use of the value engineering methodology can save companies significant amounts of money, whilst also allowing for opportunities to increase revenue and/or reduce risk. Value engineering provides a highly viable and effective method for optimizing major capital projects and respond to the ever increasing pressure of driving substantial value benefits and delivering maximum efficiency.

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Arthur D. Little

Arthur D. Little has been at the forefront of innovation since 1886. We are an acknowledged thought leader in linking strategy, innovation and transformation in technology-intensive and converging industries. We navigate our clients through changing business ecosystems to uncover new growth opportunities. We enable our clients to build innovation capabilities and transform their organization.

Our consultants have strong practical industry experience combined with excellent knowledge of key trends and dynamics. Arthur D. Little is present in the most important business centers around the world. We are proud to serve most of the Fortune 1000 companies, in addition to other leading firms and public sector organizations.

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