Improve the capital investment decision-making process

A comprehensive workflow methodology and supporting technology framework offer a solid approach to strategically managing assets, before a company invests major resources


In the global process industries, the object of a project’s economic analysis is to identify the most effective investment opportunities and strategies to pursue well in advance of actually making an investment. The “best” engineering design does not necessarily ensure that a company will achieve the desired return on investment capital or achieve the targeted rate of return on invested capital.

Accomplishing a comprehensive investment decision means blurring the lines between the traditional engineering disciplines of process, mechanical and cost. Effective investment decision-making requires a workflow in which all engineering disciplines work fluidly and in harmony to make the various facets related to a project investment transparent to the organization. In this way, investment criteria may be openly and thoroughly vetted by the organization, ensuring that these investments will achieve the greatest return for the company and its shareholders.

Traditional vs. new paradigm. The object of economic analysis is to identify the most effective opportunities, threats and strategies for investment. Rapidly reviewing investment criteria for the capital-intensive process industries is no simple feat. Yet speed is crucial to take advantage of market opportunities when they exist. Traditional approaches to this process require a workflow in which all disciplines of the organization. A clearly defined workflow spanning all of the engineering disciplines is required to achieve a truly optimal investment decision.

The decision flow and options-analysis stages described below represent a new approach that we anticipate most organizations will evolve towards in the years to come.

Best process selection. The new approach for best process selection involves defining the proper process technology required to manufacture the desired product slate. Early in the conceptual design stage, engineering functions including process, mechanical and cost engineering must work together to review the chemistry of the process, define conceptually how much the process will cost, how long it will take to build the plant, and define the plant’s operating cost. Finally, at the conceptual stage, these various criteria are summed to determine the investment payback period and rate of return.

Involving all of the engineering and business disciplines in the conceptual design phase is essential to begin the investment decision flow, as more than 80% of the ultimate total installed cost (TIC) is locked up in the conceptual design phase. For verification of this, one needs only to look at the summary sheet for the direct and indirect costs of a project.

The chain of costs indicated by a conceptual design starts with the simple list of process equipment. This implies costs for installation materials and associated construction labor. The chain continues with feed and product storage facilities, utility requirements, site-specific items including racks, utility piping, a control system and power distribution network. The consequences of this chain have induced workflow managers to gain maximum impact on a project investment by focusing on the front end portion of the workflow (FEED = front end engineering design)—that is, during conceptual design. It is therefore imperative that front end engineering disciplines and business managers interact early and often.

Best plant configuration. Evaluating the costs and process trade-offs of flexible plant configuration is an important facet of investment decision-making. With grassroots plants becoming increasingly rare, particularly in the U.S. and Western Europe, plant lifetimes and durations now have sunsets well beyond the 20 years typically appropriated when an asset was first commissioned.
When new capital is spent, plants must be built for maximum flexibility—allowing for future revamps, expansions and potentially even for change-of-service. Plant configurations can be defined as having front end units (FEU) and back end units (BEU). One strategy is to scope each FEU and BEU section at a certain capacity. Then combine the FEU and BEU one or more times to achieve not only scale but also operational flexibility through various configuration strategies. Fig. 1 shows an example.

The new options-analysis method for best plant configuration requires a rigorous analysis and interaction of many engineering and business disciplines in an organization. This analysis should result in defining key project quantities, costs, TICs, schedule, and the resulting internal rate of return (IRR) and net present value (NPV) for each configuration option. Only then is the best configuration decision made in a transparent and easily understood fashion.

**Project funding.** Using this technique for project funding involves analyzing the impact that, say, a 10%-variation in TIC would have on the project’s viability. This is essentially a method by which an organization can properly evaluate the risks associated with investment options and prepare appropriate contingency, ensuring there are no surprises during a project.

Fig. 2 lists the key investment selection metrics for a proposed greenfield alternate fuels project of $30 million in TIC. Not surprisingly, the lower cost option represents a shorter payback period. Further, the lower cost project option shows a higher IRR and NPV. Most notably, the NPV/TIC ratio between the two projects is substantial, despite the relatively small perturbation in TICs.

Such results, while self-evident here, should not be taken for granted that they are, in fact, intuitive. Often, such results are non-intuitive, and a simple summary such as that in Fig. 2 provides transparency for rapid and credible decision-making at an early stage.

**Least cost.** Analysis for least cost involves the simultaneous interaction of several engineering disciplines working together to decide how best to handle a single object. Frequently, one discipline’s premises and results may impact another discipline’s starting point.

When faced with alternatives, cross-functional teams involving process, mechanical, safety, maintenance, reliability and cost engineering must review and determine the proper strategy for alternatives such as the sparing strategy for pumps and other rotating equipment. Does one go with a 100% pump with a 100% spare or two 50% pumps with a 50% spare? For heat exchangers, should we go with one shell to contain all of the tube surface area or utilize two shells each with half the total surface? What is the cost advantage of the heat exchanger network utilizing seamless or welded tubes?

For that matter, what about choice of material of construction? Does it make sense to use lower cost A-515 steel for a pressure vessel or is the higher strength and higher cost A-516 steel more appropriate? In each instance, process requirements, design, cost, safety and reliability must be analyzed to define which path to take. The new approach requires the simultaneous input, analysis of results and review by process, mechanical, safety and cost engineers.

**Construction methodology.** Construction methodology will have a significant impact on TICs. Evaluating in detail which sections of a plant should be stick-built and which modules and skid-units should be shop-fabricated will determine the impact on TICs very early in a project lifecycle.

For plants in operation with turnaround a major cost factor, it may well be important to determine the cost of shop-built skid units that would be installed quickly and tied-in rapidly during a planned, short turnaround shutdown. The options-analysis value is in its capability to identify cost-schedule benefits for such circumstances.

**Contract negotiation.** An oft-overlooked aspect of project work is anticipating and preparing for contractor negotiation. For the initial bid on a project, owner operators (O/Os) must be sure that their bidding contractors are providing quotes for exactly what the O/Os are requesting.

Transparency of project requirements is not only a prerequisite when advancing project within an organization. Rather, transparency is critical in ensuring that the bidding process is thoroughly understood by project engineering and procurement contractors (EPCs). Business-to-business transparency ensures that O/Os and EPCs are in line with each other’s expectations, ensuring rapid and accurate turnaround of EPC bids.

Beyond the initial bid, corporations must prepare for change orders that arise during the course of a project. Typical change orders are: modifying to conform to a new P&ID; adding a service road, using gravel, asphalt or concrete; providing a spare pump (or two at 50%); adding a security gate and/or guard house; adding a run of pipe rack and piping; removing existing vessel and foundation; adding a relief valve and pipe run, etc. A project team must quickly determine the impact of change orders on a project, defining if they should revise the design and—depending on the severity of the change order—whether or not to stop forward-motion on the project.

Achieving the optimal business decision means that an O/O

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**Fig. 1.** Evaluate the cost of flexible plant configurations.

**Fig. 2.** Impact of total installed cost (TIC) on key drivers for business decisions.
must prepare for change-order negotiation from a position of strength. The only knowledgeable path forward for an organization is to approach this challenge through a united, interdisciplinary project team using a standard basis for decision-making. Such a team can define the impact on project economics of each aforementioned example of a change order; they can define the impact of asphalt versus gravel for a road, of concrete versus standard security fencing, etc.

From a transparent framework in which all of the major impacts on project economics are known, defined, and shared, the project team can decide how best to negotiate a change order. Additionally, corporate management will be aware of every important aspect of project change early in the change-order process, ensuring proper fiscal oversight and guidance.

**Value of a tiered contractor strategy.** Contractor strategy is also an important aspect to project management and TIC impact. The analysis of contractor tiering and its cost-schedule-economic consequences is key to the project investment workflow. Either a single contractor or several in a tiered responsibility structure can execute a project. An example EPC tiered strategy is defined in Fig. 3.

Whatever arrangement is decided on, identifying the associated costs and delivery schedule is important. To meet production startup, is it necessary to fast track the project or work multiple shifts with overtime? During this approach’s evaluation process, an organization can make informed decisions about workloads by discipline and how to incorporate internal engineering staff for project work. Project teams must define work breakdown structures and areas of assignment for each EPC, and how they will interact as part of the overall project with internal corporate teams.

**Most effective use of investment capital.** Business decisions must be made regarding plant composition and project life cycle. Through a concrete decision-making framework that tracks the entire life cycle of a project, an organization can define the impact on ROI of each of the following:

- TICs, utilities, feedstocks, operation costs
- Products sales in price and volume, and the trade-offs between the two
- Impact of slowdowns due to construction delays, EPC delays or delays incurred by decisions such as change orders.

It is important to quantify these aspects of an investment and create a vector chart that illustrates the quantitative and qualitative impact each of these business criteria have on project ROI (Fig. 4).

**Outlook.** The bottom-line investment answers and detailed supporting data are provided when an organization uses a comprehensive workflow and accompanying business practices. These workflows and business practices must be parsed by decisions aligned with the natural decision flow of a project, instead of by engineering discipline. Achieving this within an organization requires forward-thinking management to oversee the dramatic cultural changes required within an organization to accomplish these tasks.

Additionally, an organization must have staff that is capable of surging their performance, migrating quickly from extant work practices to new workflows. These new workflows must incorporate the best elements of prior practices, such as engineering excellence, for example, yet adopt new concepts and tool sets that enable cross-functional communication and collaboration.

Finally, achieving dramatic efficiency improvements in capital investment decision-making is an operational necessity for companies competing in the process industries. Capital expenditures are continuing to rise, and process industry organizations are under intense pressure to handle this capital intensity with their existing headcount—or with fewer headcount.

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**Fig. 3.** General tiered structure of contractors. The contractor strategy must include work breakdown and area assignments.

**Fig. 4.** An example vector graph describes the ROI influencers.
Learn how you can improve your capital investment decision-making process

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