Target Costing

Compliant facilities, delivered at the lowest possible cost, minimize the risk of failure and maximize the return on investment

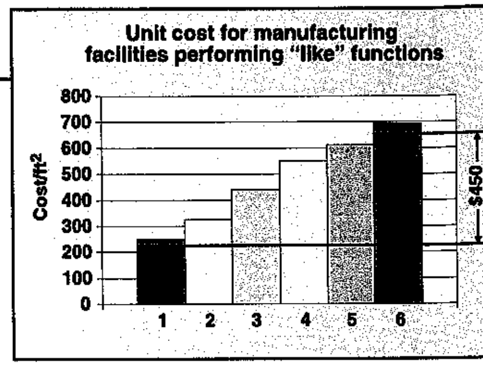

FIGURE 1. The cost variance for a high-purity manufacturing facility can be as much as \$450/ft² to make the same type of product with no discernible difference in the quality of the end product

Christopher R. DiPaolo
ProTecs

Free trade agreements, global manufacturing standards and the Internet have made it possible for companies to do business in countries they would not have considered 20 years ago. Open, is a world of opportunity, but for processors of pharmaceuticals, semiconductors and other materials that must meet high standards of product purity and performance, the competition is stiffer than ever as compliance with industry standards and government regulations forces companies large and small to play by the same rules.

To better flex their muscles in the marketplace and pump up research and development, giant drugmakers are dismantling inhouse manufacturing operations, and moving production to places like China, India, Puerto Rico and Ireland, where they can take advantage of cheap land, low-cost labor, tax incentives or other perks. So, too are the nimble neophytes in emerging fields such as biopharmaceuticals and nanotechnology; these R&D startups are outsourcing production, foregoing the prohibitive cost of owning and operating manufacturing facilities.

Prerequisite for the manufacture of novel products that may spend years in development pipeline are technologically advanced manufacturing facilities. To maintain cash flow — especially if there is no revenue base — these types of facilities must be delivered at the lowest possible cost.

However, many companies, particularly those in throes of startup and scaleup, are inexperienced or unfamiliar with the nuances of specifying high-technology manufacturing facilities and cannot approach these projects using the traditional methods to meet their requirements. Target costing is a methodology designed to minimize the risk and maximize the return on investment for the delivery of high-technology facilities.

Own versus outsource

Vertically integrated and extremely secretive, the giant drugmakers and electronics companies have shown a distinct preference of campus-like properties that are large enough to contain most of their operations, including corporate offices, R&D laboratories and production plants. Staff engineers and managers infinitely knowledgeable about the company's products are usually onsite and available around the clock to keep operations running smoothly.

The primary business of most commercial realtors and developers is the development of flexible office, retail and warehouse space in buildings that, at most, are zoned for light industrial use. The most-complex utility system in such facilities is usually an in-rack fire suppression or emergency power backup system. With the growing demand for contract-manufacturing services, these developers are wandering into unfamiliar territory. The complexity involved in locating and leasing space for a manufacturing operation that may involve the delivery and use of toxic gases, hazardous-materials storage and containment, as well as systems for air scrubbing, water purification and wastewater neutralization is beyond the skill of most development companies.

Consider, for example, the developer of a partially occupied 100,000-ft² building that wants to lease 20,000 ft² of the space to a pharmaceutical contract manufacturer. Such an arrangement could pose serious health and safety risks for the building's office tenants. Conversely, the proximity of the contract manufacturer to an operation that, for example, generates a high level of dust, may expose its own operations to a higher risk of contamination.

As tenants, contract manufacturers and R&D startups want facilities that perform at the highest levels of purity, with tight control tolerance and compliance, but are constructed at the lowest possible cost. Providing the flexibility for expansion and some aesthetic elements to attract the desired workforce only adds to project cost and make it that much more difficult to bring the project in on budget. Initial capital deferment is imperative to stay competitive and preserve cash, and thus slow down the burn rate.

The conventional rules of thumb for construction costs and lease terms are being set aside in favor of new ones. Established architectural and engineering service firms, and construction contractors are forming new divisions or subcontracting specialized firms that are experienced in assessing the needs and delivering complex, compliant facilities.

To attract and keep tenants, developers are sweetening incentives, offering, for example, higher tenant improvement allowances. A tenant improvement (TI) allowance is the dollar/ft² given to the tenant for capital improvements for the property. It is built into overall lease costs to rent the space over specific number of years; for example, a potential tenant may need to rent 20,000 ft². The landlord may give a \$50/ft² TI allowance or \$1 million.

This is somewhat of a risky proposition for some developers, especially when tenants may have not have a revenue stream, as in the case of an R&D startup, or companies with promising drugs or novel products that have not yet been proven or approved. If the company's funding runs out in the interim, it may have to file for bankruptcy or shut down, leaving the landlord with a costly facility for which it must find another tenant to recoup its initial investment.

For these and other reasons, it is important for landlords to proceed prudently in accommodating highly specialized or customized technologies that are not easily transferred to future tenants. It is important for all parties involved in

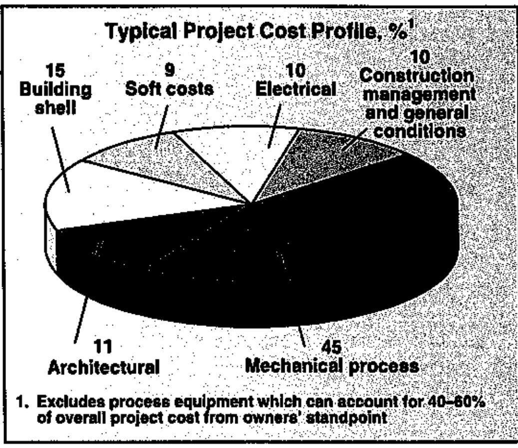

FIGURE 2. Soft costs include design and engineering, and commissioning, which can vary based on the complexity of the systems installed, documentation and testing

a project to understand all of the initial project parameters and overall project costs. An increasingly accepted method to assure that expectations of project performance, compliance and costs will be met is to design and build facilities to a pre-determined project budget. This method is called "Target costing."

Target costing

Target costing is a program-management methodology that focuses on design and engineering efforts to deliver capital projects to meet a specific budget. For this methodology to work effectively, clients must forthcoming, and identify and divulge any project budget constraints at the start of the program. If not, they run the risks of designing and engineering facility they cannot afford, and lose valuable time and money associated with reengineering, value engineering and rebidding the project to align the project scope with financial objectives. Clients with reasonable project budgets can achieve process performance, compliance, time-to-market and financial objectives for their capital projects based on the approach and key decisions made during the planning and programming phases.

However, there is no standard method for designing and completing a project. As shown in Figure 1, for example, the cost variance among various high-technology companies within the same sector performing "like" functioning manufacturing operations to produce a similar type product can be as much as $450/ft^2$. Consider a 10,000-ft^2 production facility, in which one company spent $4.5 million more than another company to make the same type of product; there is no discernible difference in the quality of the end products from the two facilities. To understand the differences in facility costs, consider why actual cost variances occur.

- ***Large companies versus small companies***. There is a different mentality in approaching a project from the perspective of a large company with established revenues and a risk-adverse culture versus a small company with limited resources and no established culture and their use of entrepreneurial approaches to solving difficult facility issues. Spending more money does not necessarily guarantee a better quality product. The assurance that a facility and its process will deliver a perfect product each and every time without risk of failure is not an investment any company can afford
- ***Facility size***. A critical factor affecting project unit costs ($\$/ft^2$) is the overall size of the project, otherwise known as economy of scale. There is a fixed cost to operating all businesses, including a construction project. As the project grows in size, the fixed costs become a smaller component of the overall cost while the exact opposite is true for smaller projects
- ***Risk tolerance***. A company that has an operation running from 8:00 a.m. to 5:00 p.m., five days a week versus a company with 24-hour operations, 7 days week will have very different approaches to designing their respective facilities. The 24/7 facility will purchase equipment with higher specification requirements with redundant equipment/ systems to ensure uptime. Also, the amount and type of automation, and control systems required in the 24/7 facility will be more robust and extensive. There is substantial cost associated with reducing operational risks, and there are financial and philosophical decisions customized to each company
- ***Process known versus unknown***. As discussed previously, it is critically important to design from the process backward to limit cost. If the scope of the project cannot be fully defined at the beginning of the project, or the process and process equipment are not determined, then the project approach will require more flexibility in the design of critical systems to allow for worst-case scenarios. If product capacity requirements are unknown at time of programming and planning, then the company may need to oversize critical systems to provide the flexibility for future growth and capacity expansion. While implementing future needs in the current scope of work may increases the initial capital project cost, it results in fewer interruptions to current operations and decreases costs at time of expansion
- ***First cost versus operating cost***. The company must make a decision based on an analysis of the return on investment (ROI) and, based on overall project budget, system performance-criteria choices made during the development of the basis of design. If a company has a business horizon of 3–5 years for its technology, then the decision is easier than that for a company with a 10-year horizon. An example of this type of decisionmaking is whether to use individual outdoor direct expansion (DX) air-cooled conditioning units for all areas, or, to use an indoor central water-cooled chiller system with outdoor cooling towers to provide the same quality air to all spaces. The difference is the operating cost associated with each of these two approaches. The DX approach uses twice the electrical power of the water-cooled solution. The cost to furnish and install the water-cooled system is about 1.5 times that of the DX system.
- ***Contract facility versus producing products inhouse***. The approach to designing a contract facility is different from that used by a company that makes its own products. A contract facility has client influences that impact costs such as: facility flexibility to handle multiple products with different capacities, design aesthetics to attract and impress prospective customers, documented proof that the facility performs to client requirements, ensures product integrity throughout processing and protects against cross contamination from other products.

While an owner's philosophical approaches to a facility affect costs, there are other reasons for large cost differences between facilities with "like" operations. Consider, for example, the cost impacts of different approaches to individual building components. To understand why certain building components have a greater impact on cost variances than others, look at the typical project cost distribution for high-technology facilities, shown in Figure 2. The distribution profile shows the break down of costs for designing, constructing and commissioning the required facility in-

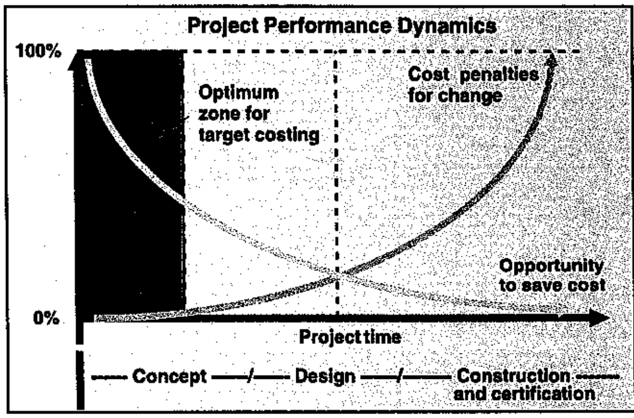

FIGURE 3. The best opportunity to impact project costs is at the beginning of master planning and conceptual development. As the project progresses, this ability diminishes

Project Consequences of Upfront Decisions

Issue	Capital cost/SF	Operating cost
Flexibility — future expansion	↑	↑
Value engineering	↓	↑
Energy efficient systems	↑	↓
Size of facility/economy of scale — large	↓	↑
Low risk tolerance — large company profile	↑	↑
Process undefined /worst-case scenario assumptions	↑	↑
Intensive code and regulatory compliance	↑	↑
Extent of automation and control	↑	↓

FIGURE 4. Decisions made in the early phases of a project will dictate the viability of the project, and have longterm effects on operations and the cost of ownership

frastructure to support a particular process (+/-5%, depending on the type of process industry sector). It should be noted that Figure 2 excludes process equipment, which can account for 40–60% of the overall project cost from the owners' standpoint. Using the aforementioned distribution profile, examine the following categories in detail:

Building shell. Defined as the outer envelope that houses the internal operations — slab, structure, exterior walls and roof, along with limited utility systems required by code — the project cost of this component can vary considerably due to the type of building facade, structural integrity, location, height, utility infrastructure requirements and attractive architectural features. This component's project cost can vary from $0–90/ft^2. The zero cost assumes the developer owns the building and leases to a high-technology tenant, as previously discussed.

Architectural systems. The choices of architectural finishes that achieve a smooth, cleanable surface without compromising the products are too numerous to describe. Key cost drivers are the type of walls, floors and ceilings selected for the facility, which can have a total possible cost variance of $80/ft^2, depending on the material selected and the labor required for installation. These selections are also based on the cleanliness classification levels outlined for the facility, and the allowances given for net-to-gross footage allocations. For example, some of the questions that should be asked are: Do room finishes assure or add to product quality? Is a room with walls made of honey-combed metal cleanroom panels likely to produce better products than epoxy-painted drywall? While companies that use more-expensive finishes will incur a higher capital-investment cost than those that employ a lower-cost strategy, the function or purpose of the facility can be identical.

Mechanical and process systems. Typically, the largest component of the overall project cost, and, in turn, the single largest cause of project cost variances, mechanical and process systems are critical to product quality and plant capacity. An improperly designed air or water system, can easily lead to product failures. The combinations of equipment and system choices are too numerous to quantify. However, the philosophical approach of designing from the "process backward" is crucial to the selection of mechanical and process systems.

- The mechanical systems design approach can cause an overall cost variance of $165/ft^2 with regard to: exhaust and makeup air systems, room air classifications, redundancy of critical systems, energy-efficient systems versus lowest first-cost systems, number of control zones, type of ductwork and insulation, terminal high-efficiency particulate air (HEPA) filters versus central HEPA in heating, ventilation and air-conditioning (HVAC) units, central plant systems versus a localized systems that supports each area, specification of larger-size equipment in anticipation of future buildout, control criteria for temperature, humidity specifications, central building automation control versus localized control with monitoring capability
- The process systems design approach can cause an overall cost variance of $155/ft^2 with regard to: process cooling and heating systems, high-purity water systems, bulk- and specialty-gas purity requirements, chemical distribution and collection systems, waste treatment systems, process vacuum systems, scrubber technology, extent of process automation, isolation technology, clean-in-place systems versus manual cleaning, clean steam systems, safety alarms and detection devices

Electrical systems. The electrical cost component is the most consistent and predictable component of project costs. Electrical requirements are largely regulated by national codes, which lead to consistent approaches in designing these systems. Cost variances occur because of requirements for emergency power, uninteruptible power supply, redundant substation service with a static switch, lighting, lightning protection/grounding, power voltages and means of distribution and security. There can be an overall cost variance of $45/ft^2 for electrical systems.

Soft costs. Included in this cost are fees for professional services, such as general conditions-construction management, design, engineering and commissioning

- General condition-construction management for a project represents the costs associated with managing all construction activities by a general contractor or construction management firm. It also includes costs for a temporary office, equipment and utilities for all related construction-management personnel. This cost can vary from 5–10% of the overall project cost, based on duration of the project, phasing strategy, project complexity, weather conditions and utilization of overtime for expediting project.

  The construction management fee can vary from 1–5 % based on the projects' risk profile, the form of contract being lump-sum versus time and material contract and if liquidated-consequential damages clauses are included in the contract terms (risk-reward)
- Design and engineering is a small component of the overall project cost. Professional fees on a project can vary from 5–10% of the facility cost due to: project methodology of design-build versus design-bid-build, project goals that must comply with a certain standard of purity or cleanliness, a large effort is required to define the process, or it is a first-of-its-kind technology versus a proven one. While de-

sign and engineering is a relatively small variance, it is important to recognize that poor engineering, or inadequate project planning will have significant impact on product quality and project cost overruns, and will increase the length of time it takes to complete the project

- Commissioning is the effort required toward the end of construction to prove that all critical and non-critical systems are installed and perform to specifications, as determined by the initial design and engineering documentation and criteria. This component is equivalent to 1–2% of the overall project cost. Variance is a function of the complexity of the system, having proper documentation outlined and requested at the time of bidding to vendors and subcontractors, the amount of factory acceptance testing versus field testing, and the timing of completion of construction.

Process backwardsTechnology continues to advance at an exponential rate and, by doing so, enhances the quality of life all over the world. To enable this continued growth, it is imperative that every company that has a viable technology be given the best possible opportunity to advance it. To assure that strategic goals are achieved, knowledgeable and experienced service professionals and project-delivery specialists must work closely with developers and advanced technology companies at the outset of the project to clearly define and identify project parameters. The greatest opportunity to impact project costs is at the beginning, during master planning and conceptual development. As the project progresses, this ability diminishes, as shown in Figure 3.

The consequences of the decisions made in the early phases of the project will dictate the viability of the project from a financial perspective and also have longterm effects on operations and cost of ownership, as shown in Figure 4.

The most effective way to assure project success is to design the facility from the process backward and establish a target cost for the project. Then, manage all efforts that will result in a facility that performs to the required process specifications, conforms to code and regulatory requirements and meets the initially desired strategic and financial objectives. ■

Edited by Deborah Hairston

Author

Christopher R. DiPaolo is president of ProTecs (8 Tower Bridge, Suite 760, 161 Washington St., Conshohocken, PA 19428; Phone: 877-941-1001; Email: cdipaolo@protecsinc.com; Web: www.protecsinc.com), a provider of turnkey design-build services for the life science and electronics industries. DiPaolo, who manages all phases of a project from design concept to tool hook-up and qualification, founded ProTecs in 2006. He has more than 15 years of experience coordinating and managing over $200 million of design-build projects for clients such as Uniroyal Optoelectronics LLC, Emcore Corp., Anadigics, Inc., and Sterling Semiconductor. DiPaolo, who holds B.S. degrees in architectural engineering and civil engineering from Drexel University (Philadelphia, PA), is a member of the Semiconductor Equipment and Material International (SEMI) and the Design Build Institute of America (DBIA).