

**Engineers Cost Less Early than Attorneys Later.  
Project Management in the Nuclear Sector  
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**Abstract**

Engineers cost less early than attorneys do later. This premise sounds simple, but many projects fail, or are perceived as poorly managed, because proper cost estimates were not developed early in the project. Fixed-price contracts are not properly estimated because the project manager wants the project to be approved and wants to keep the budget down. Then, halfway through the project, the actual durations of the activities are realized and as the costs go up, the project is considered a failure.

At the Robinson Nuclear Plant, owned by Progress Energy, the project manager contracted with a design firm and then used a time and materials contract with the installer to assist designing the main transformer replacement, including the transformer fabrication, installation, heavy hauling, fire suppression, and fire wall design and installation, prior to receiving a cost estimate for the installation.

**Scope Definition**

According to the *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*—Fourth Edition (Project Management Institute [PMI], 2008): “Defining and managing the project scope influences the project’s overall success” (p. ). Clearly defining the scope up front and gaining accurate estimates of the cost and budget schedule is essential to overall project success. However, many groups attempt to develop the cost and schedule on their own. While the quality may be achieved, the project may

**Sydney Opera House**

The Sydney Opera House is a multi-venue performing arts center in Sydney, Australia. The structure was conceived and largely built by Danish architect Jørn Utzon, who in 2003, received the Pritzker Prize, architecture's highest honor. The citation stated:

There is no doubt that the Sydney Opera House is his masterpiece. It is one of the great iconic buildings of the 20th century, an image of great beauty that has become known throughout the world – a symbol for not only a city, but a whole country and continent. (“Sydney Opera House,” 2009)

The Opera House was made a UNESCO World Heritage Site on 28 June 2007. The Opera House is one of the world’s most distinctive 20th century buildings, and one of the most famous performing arts centers in the world. However, the original cost estimate in 1957 was US\$7 Million and the original completion date set by the government was 26 January 1963.

The Opera House was formally completed in 1973 at a cost of US\$102 million. Was the project a failure? How did the cost grow from US\$7M to over US\$100M? The project fell victim to a politically low-balled construction budget, which eventually resulted in a cost overrun of 1,400%.

For the first stage of the project, Utzon worked very successfully with the rest of the design team and the client, but as the project progressed, the Australian government officials insisted on progressive revisions. They also did not fully appreciate the costs or work involved in design and construction. Tensions between the client and the design team grew further when an *early start* to construction was demanded despite an incomplete design. This resulted in a continuing series of delays and setbacks while various technical engineering issues were being refined. The building was unique, and the problems with the design issues and costs increases were exacerbated by commencement of work before the completion of the final plans.

After the election of Robert Askin as Premier of New South Wales in 1965, the relationship between client, architect, engineers, and contractors became increasingly tense. Askin had been a vocal critic of the project prior to gaining office. Differences ensued. One of the first was that Utzon believed the clients should receive information on all aspects of the design and construction through his practice, while the clients wanted a system (notably drawn in sketch form by Davis Hughes, where architect, contractors, and engineers each reported to the client directly and separately). This had great implications for procurement methods and cost control, with Utzon wishing to negotiate contracts with chosen suppliers (such as Ralph Symonds for the plywood interiors), and the New South Wales government insisting contracts were put up for bid. Sound like a familiar scenario? Enduring quality is remembered, where schedule overruns and added costs are forgotten.

## **The Chunnel**

The Channel Tunnel, also known as the Chunnel, is a 50.5-kilometre (31.4 miles) undersea rail tunnel linking England with France beneath the English Channel (“Channel Tunnel,” 2009). The tunnel carries high-speed Eurostar passenger trains, Eurotunnel roll-on/roll-off vehicle transport, and international rail freight trains.

In 1802, French mining engineer Albert Mathieu put forward a proposal to tunnel under the English Channel with illumination from oil lamps, horse drawn coaches, and an artificial island mid-Channel for changing horses.

The eventual successful project began construction in 1988 and opened in 1994. The project came in 80% over its predicted budget. Both the freight and passenger traffic forecasts that led to the construction of the tunnel were largely and universally overestimated. Although the captured share of Channel crossings (competing with air and sea) was forecast correctly, high competition and reduced tariffs led to low revenue.

In 2008, Eurostar carried 9,113,371 passengers in cross-Channel Tunnel traffic, a 10% increase over the previous year.

## **Cost Overrun**

Several studies have been conducted on this crucial topic of project cost overruns. According to the studies, both construction and IT projects often fail to be completed on time and on budget. One of the studies of cost overrun found that 90 out of 100 projects had overruns; overruns of 40% to 100% are very common. The worst part is that the pattern has not changed for the past 100 years. In 2004, one study stated that the average IT project cost overrun was 43% percent and 71 percent% of IT projects were over budget and not completed on schedule.

## **Scope Management**

At Progress Energy, scope management is considered integral to development of the project plan, which establishes the deliverables and associated requirements. Scope management begins in the project initiation phase where project scope is first defined, at a level specific enough to produce an order of magnitude work breakdown structure (WBS) and schedule. During project planning, the scope is further defined to a level detailed enough to support development of the scope, cost, and schedule baselines. During the design segment of the execution phase, the scope of work to complete the project is further detailed and refined to its final state. Scope management concludes at project closure with confirmation of project scope delivery and acceptance.

## **Project Evaluation and Authorization Process**

Progress Energy uses a project authorization (PA) process to document the project scope, schedule, benefits, objectives, and costs in a standard format so that an adequate business case can be established prior to the commitment of significant resources. A PA is required separately for the planning phase and the execution phase and authorization must be obtained before work can begin. Authorization for each phase may span more than one calendar year.

## Business Analysis Package

A business analysis package (BAP) is developed for every non-routine project that has costs greater than US\$5 million. The BAP is a communications tool that provides management enough information to make an informed decision. The package is expected to be understandable, free of excess jargon with clear recommendations and supporting arguments. The BAP standard is short and concise. Funding requirements by year are required.

## Transformer Installation Scope

The scope of my project includes purchasing four main step-up transformers (three plus one spare) valued at nearly US\$12 million, purchasing one auxiliary transformer, replacing the transformer, and installing the a new fire protection system and a new fire barrier system. The installation must be completed in 22 days during a refueling outage at a nuclear power plant.

## Engineers Early

When I conducted a Benchmark visit to another nuclear utility to observe their transformer installation project, the project manager advised me, “Get your installers in early.”

I listened and followed this advice. We contracted with the company that manufactured the transformers using a time and materials contract to get their installation crew to come to our facility and participate in the 30% design review. During this design review, we identified several critical design changes:

- One of the transformers would not fit in the current configuration and we had to seek guidance from the manufacturing facility on how to modify the transformer, while preserving the warranty.
- The fire protection system proposed by the engineer’s designer was not “buildable” by the fire protection installer. Note: we actually contracted with the fire protection installer to complete the design.
- The rocks in the containment pit need to be removed to evaluate the volume of the containment pit to hold the water and oil should a transformer fail and to validate the integrity of the containment pit.

We conducted a value engineer review to evaluate the options and determined that the scope was achievable in the 22-day outage window, but only by working 24 hours a day. We also conducted some bottom up cost estimating, using industry resources for labor rates and equipment rentals to attempt to forecast a more precise range of the installation costs and thus, better defining the budget numbers. Project managers must always consider the project authorization timeline, budget approval timeline, and the time to complete the design and then, the competitive bid process.

By engaging engineers early in the process, we were better able to predict the costs of the project and gain project authorization before the contract award. Additionally, by engaging engineers early, we were able to define the scope, deliverables, acceptance testing criteria, and expectation more clearly in the bid process. We all know the better scope definition, the fewer contract amendments, and potential litigations from contract disputes.

The lesson to be learned, when you are responsible for implementing a new project that your company has not done before, contract with technical experts to help develop your scope, schedule, cost estimate, and begin to identify risks early in the process.

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