ABSTRACT
The economic basis for capital projects is generally focused on perceived economic benefit versus first cost – the cost to design, construct and fully implement the project. Part of that plan is the design life of the project. Initial budgets are frequently established based on historical data that has been adjusted for inflation. But none of those data may be specific to the actual project. Funding commitments are generally made at that point in the process and it becomes very difficult to increase the initial budget once it is established. One of the major problems with this approach is that it does not consider the economics of maintaining the viability of the project over its entire life cycle.

This presentation puts forth the argument that a life-cycle approach is a better way to plan and implement a capital project. A life-cycle approach incorporates maintenance costs, downtime, lost production and other economic factors into the initial project. It provides an opportunity to consider the benefits of using materials, methods and processes which may be more expensive on a first cost basis but have significant benefits over the economic life of the project.

Where technically applicable, titanium would significantly benefit from a life-cycle approach to capital projects.

INTRODUCTION
The definition of a capital project is one that is designed to be economically viable for a number of years. The duration of economic viability is an important factor in the design and construction of the project, yet that has not been as important a consideration as the cost to design, construct and start up a project, which is generally described as the “first cost.” While first cost is the easier and simpler means to make project decisions, it fails to take into account many ongoing factors, which will impact the economic life of the project.

DISCUSSION
Decisions based on first cost fail to recognize critical elements such as modifications required to correct deficiencies in the original design, maintenance requirements, viability of materials-of-construction over the economic life of the project, and in the case of production processes, the length of production runs, loss of production and profits due to scheduled and non-scheduled maintenance outages. Project management is generally rewarded on the basis of meeting three objectives, completing the project within the scheduled time frame and doing that within the allocated budget and meeting safety goals.

EXAMPLES
A project designed and constructed on a first cost basis. The production unit was completed in March of a certain year and brought online the following month. Within 90 days of startup, a number of deficiencies were discovered in materials-of-construction, instrumentation and controls.
While the control software could be corrected or upgraded without disrupting production, changing control elements and materials-of-construction required downtime and resulted in lost production.

Take the case of repowering a 600 MW generating station, which was a complex project. The coal fired boilers were replaced with combined effect gas turbines and the station was changed from a base loaded power generator to a topping plant, which was to be brought on line and shut down based on the need for electricity. The project included a change in the source of makeup water for the cooling towers. The plant was no longer permitted to use river water and the cost of potable water was prohibitive, so they negotiated with the municipal sewage authority to use secondary municipal wastewater from the sewage plant across the river. This required post filtration and sanitization at the power station. That water once cycled up in the cooling system was very corrosive to carbon steel. For the first system, concrete lined pipes were used for the circulating water. The second system was designed with fiberglass and polyethylene pipes. 317SS with 4.0% molybdenum was specified for the turbine condenser tubes due to the level of biomass in the cooling water. The winning bid from a condenser manufacturer specified 316 SS with 3.5% molybdenum, which was accepted by procurement without any technical review, but with a performance guarantee. Apparently neither procurement nor the vendor was aware that the condenser would also be used as a dump condenser to condense live steam while the plant would be taken offline quickly.

Within a few months of startup and several instances of using the condenser to dump live steam, they began to experience tube leaks. That was at the beginning of the summer. They could not afford to take the condenser out of service, but did have to de-rate the plant by 30% (from 600 MW to 420 MW), purchasing the difference off the grid for the rest of the summer. It turned out that the vendor used 316 SS with 3.05% Mo. It took a two-month outage to retube the condenser and vendor was required to use titanium.

These are but two examples of problems resulting from dependence on only on first cost analysis for capital projects.

LIFE CYCLE

Considering the entire economically viable life of a project is a more effective method of planning a capital project. So it is necessary to first determine how many years the project needs to remain viable rather than using a historically accepted life cycle. Historically, some facilities are designed for 20, 25 or 40 years. 40 years may seem like a long time, but the 607,000 bridges in the USA have an average age of 42 years with 11% of them structurally deficient. The newest oil refinery in the USA was built in 1977 and the oldest one in 1898. The average age is over 50. Most, if not all, have been upgraded with new processes over the years. At the same time, most oil and gas pipelines have been in operations for more than 50 years and many water pipelines exceed 80 years of operation. So the viable life spans of those projects significantly exceed even 40 years.

The interstate highway system dates back to President Eisenhower in the late 50’s. While construction of interstate highways ceased in the late 90’s, some of those original roads are still in use. How long do they function adequately before requiring major repair? And how long do those
reparations take? It seems that both are functions of the amount of traffic and the climate at that location.

Piers have unique life-cycle issues related to their specific environments. Are they located in sweet river water, brackish water or seawater? Are they subject to significant tidal effects? Are they proactively maintained or does maintenance occur after the fact?

So what is the viable economic life of a new project? If it is an infrastructure project – a bridge, tunnel, pipeline, pier or office building, road, etc. there are plenty of historical examples of such structures to reference. If the project is a production facility, there are other determining factors. Will the facility be designed to produce only a specific product? If so, how many years will that product be viable in the marketplace? What is the probability of a more cost-efficient production facility being brought online by a competitor? What is the probability that demand for the product will dwindle (supply exceed demand)? When might that happen? If the project is designed to be modifiable to produce other products, how many years will it remain economically viable?

The longer the economic life, the greater the opportunity will be to utilize methods and materials, which may be more costly on a first cost basis but more economical on a life-cycle basis. For example, a structure, which will be in operation five years may be constructed of carbon steel and then coated to inhibit corrosion, while the same one with an anticipated life of 40 may require sandblasting and recoating every 5 or 6 years. The latter may be significantly more costly over the project life than one constructed of a corrosion resistant metal or alloy. Another alternative would be to utilize one of the new advanced coating technologies which are repairable.

Other factors to consider include cost of planned downtime, production losses, unabsorbed overhead, equipment replacement, maintenance labor (including contractors), etc.

A good example of documenting maintenance requirements during the entire life-cycle is the documentation in a new car maintenance manual. Every routine maintenance action, whether it is changing oil or inspecting something, is well documented by both mileage and calendar month.

So, how is life-cycle planning applied to capital projects? Start with estimating the economic life of the project. Then do a preliminary evaluation using the first cost method. Follow that by analyzing alternatives that would be more economical over the project life. Finally, validate the results using a net present value (NPV) analysis. Another name for an NPV analysis is a discounted cash flow, which, in essence, determines the amount of money that would have to be invested today in order to fund the entire project – the first cost, plus all life-cycle costs such as repairs, partial replacements and maintenance throughout the project’s economically viable life. Estimate those costs in today’s dollars then apply generally accepted inflation factors on a year-by-year basis. Apply straight line depreciation across the entire project life. Finally, using those year-by-year totals, discount them by the cost of money over the period.

Life-cycle analysis can be done on a “what-if” basis, by considering one decision at a time in order to come up with an optimum solution.
So, why go to all this trouble? Because it puts the benefits into the language that corporate and government decision makers use when making economic decisions. Whether selling a service, a product or both, make your presentations in both economic and technical terms. Remember, if you are making your presentation to a specifier, a buyer or an influencer, she or he will have to carry your message to the decision maker in the language that is most meaningful to him or her.

CONCLUSION

This paper is strictly an overview of the benefits of using a Life-Cycle Costing to capital projects. Tomorrow Barry Benator will present an excellent workshop on the subject. He will present the tools that will help you fully utilize this valuable sales tool. I encourage you to participate in it.