Operational Readiness: Bridging the Gap Between Construction and Operations for New Capital Assets

This document will explore the factors that determine the level of lifecycle costs and emerging operational readiness best practices that can dramatically reduce risk and improve ramp-up, operational performance and long-term O&M costs of new assets.

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Introduction

Despite the global economic slowdown, several factors are conspiring to spark a spate of new capital construction. These factors include: demand for various commodities (e.g., oil, gas and other natural resources); new discoveries along with new extraction and processing technologies for these commodities (e.g., oil deposits in deep water ocean and shale gas deposits in the U.S.); high commodity prices enabling more costly production technologies (e.g., oil sands); and the current cheap cost of capital. Deloitte, in a recent whitepaper about the mining industry in Africa, suggests that countries and companies in Africa and worldwide "continue a push toward significant industrialization and infrastructure renewal."1 As industrial organizations today tackle the challenges of deciding when to build new capacity, they tend to be driven by carefully formulated business cases. Compelling business cases often lead to sizeable capital expansion projects justified by the anticipated growth in revenue and profits that eventually will be garnered. Do these anticipated benefits materialize? Unfortunately, the reality is they typically fall short of expectations for many reasons and risks span the gamut of variables, including political, economic, market, financial, organizational and operational. Arguably, operational risks are, at the same time, one of the largest and one of the most controllable risks and, ironically, one of the most mismanaged.

It traditionally has been the case that significant leakage of anticipated project value occurs during the turn-over/commissioning and ramp-up periods of the new asset lifecycle. Case studies have measured this leakage to be as much as 30% of the value that was anticipated during the early stages of the total lifecycle.2 The early stages consume the first three to five years and include the engineering, design, construction, commissioning and ramp-up phases. The ramp-up phase is usually the first year after commissioning—often a painful period of unstable operations, with significant lost revenue and profit opportunities due to unexpected and extended downtime.

Of equal and often greater significance, the actual operations and maintenance costs (O&M) of the assets during the longest portion of the total asset lifecycle—the operate/maintain stage (often 30 years or more)—typically are 1% to 2% higher (conservatively speaking) than the expected total lifecycle costs assumed in the initial business case—and this does not include the operability value destroyed because of poor design choices, unprepared operators and maintainers, antiquated maintenance strategies and a lack of necessary documentation. Choices made during the early design and construction phases set in place the long-term operating performance, as well as the long-term operations and maintenance costs for the more than 30-year life of the asset. Poor choices can doom the organization into incurring unnecessary lifecycle costs, reaching into the hundreds of millions of dollars for some large projects.

This whitepaper will explore the factors that determine the level of lifecycle costs, as well as the emerging operational readiness best practices that can dramatically reduce risk and improve ramp-up, operational performance and long-term O&M costs with relatively modest investment up front.

Value Leakage

Let's first explore the value leakage in the early ramp-up stage of a typical capital project (up to 30% of anticipated early benefits). For clarity, the ramp-up stage of the new asset lifecycle is the period spanning the construction/commissioning phase and the first year of the operate/maintain phase, as illustrated in Figure 1.

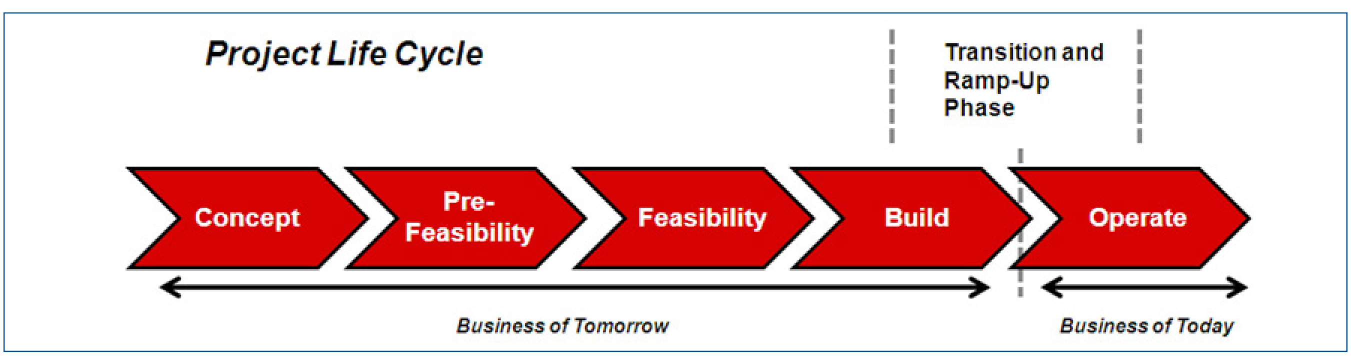

Figure 1 — *Ramp-up phase of new asset lifecycle (Source: Deloitte, 2012).*

In the cited Deloitte whitepaper, the authors try to quantify and categorize the typical value leakage occurring in the construction and ramp-up phases. See Figure 2 for Deloitte's graphical depiction of the value destruction in typical capital projects.

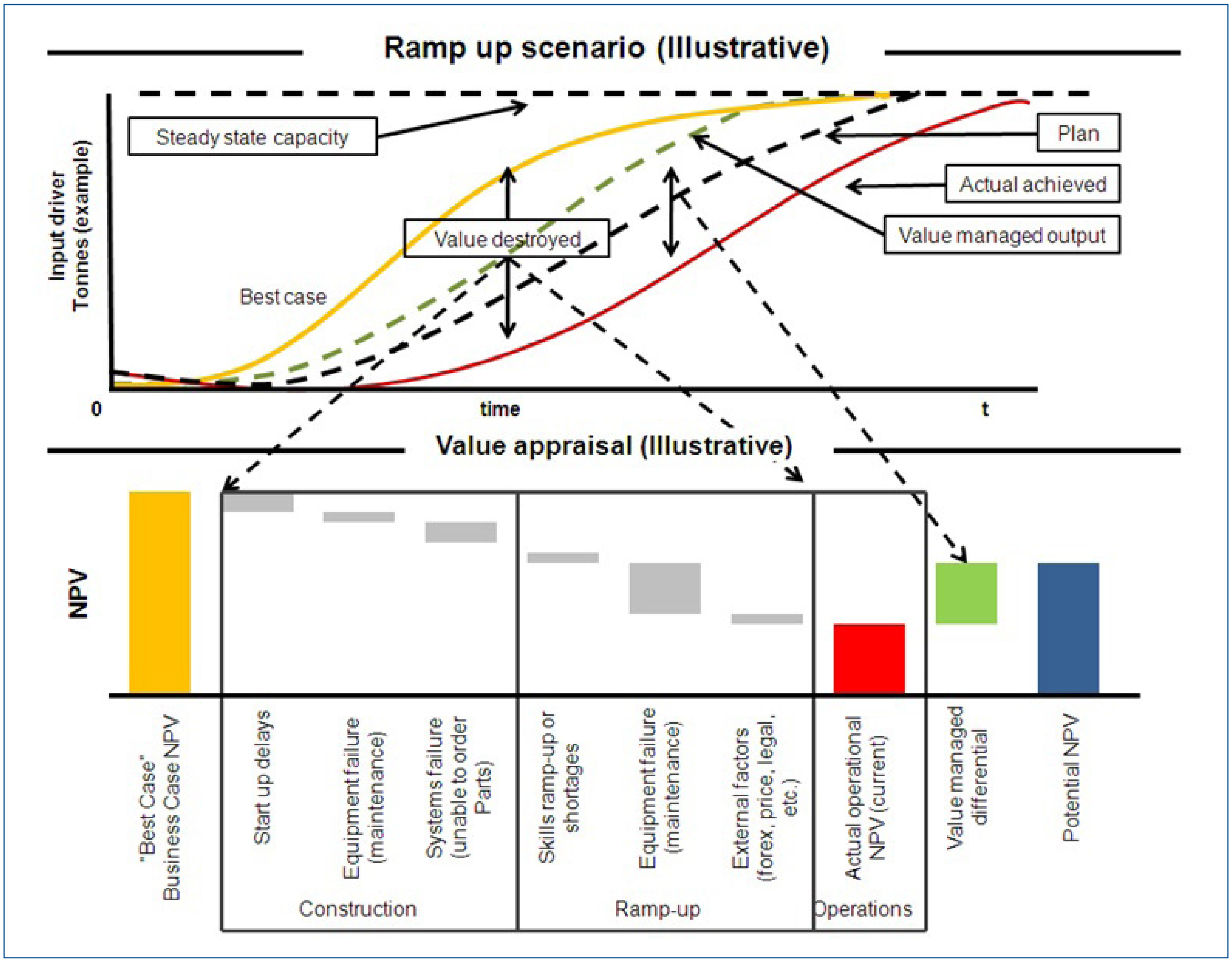

Figure 2 — *New capital project value destruction (Source: Deloitte, 2012).*

The chart in Figure 2 starts with a "best case" business case (considered theoretical and not often used in the project justification) and then whittles away at that business case with major categories of value destruction, including start-up delays, equipment failures (occurring both during construction as well as during the first year of operation), systems failures, skill deficiencies and external factors. Keep in mind this chart only deals with short-term value losses; it does not address the impact of early decisions on long-term operations and maintenance. We'll look at that in a moment.

This chart actually rings quite true for experienced professionals in the industrial community. In your experience, how familiar are the following conditions?

- The new plant has been "tossed over the fence" to the operations and maintenance organizations from the capital construction people.
- The operations and maintenance people were not given the opportunity to contribute to the design or equipment selections.
- The plant is being commissioned later than scheduled because of construction delays, and now the company is pressuring operations to make up the lost time.
- The project came in over budget and at the end of the construction phase, options to facilitate maintenance and reliability (e.g., instrument packages) were sacrificed in favor of saved time and cost.
- Voluminous operations and maintenance documentation is delivered coincident with commissioning in the disparate formats that the engineering and procurement contractor firm, construction contractors and equipment suppliers elected to use (usually inconsistent and not readily transferable into the enterprise asset management (EAM) system).
- Some of the equipment selections were based on the value of lowest initial cost and not on the basis of total lifecycle cost or reliability/maintainability.
- No consideration was given to make and model of already installed assets, resulting in no standardization, a need for overstocking of spare parts, and a requirement for operations and maintenance to become familiar with every brand and model under the sun.
- Abundant spare parts have been procured and delivered, usually at great capital cost, in anticipation of the frequent equipment failures that likely will occur given the operations and maintenance organizations' unfamiliarity and lack of experience with the new equipment.
- The EAM system has not been loaded with asset and spare parts master data or maintenance procedures representing the new assets.
- Original equipment manufacturer (OEM) maintenance recommendations are contained only in the OEM hardcopy manuals and are largely time-based preventive maintenance with heavy reliance on parts replacements and little use of predictive maintenance or condition-monitoring technologies.
- Little was done to perform acceptance testing (e.g., predictive maintenance baselines) and ensure proper installation and readiness for mission prior to releasing the contractor(s), leaving the operations and maintenance organizations to fix the mistakes of the contractor(s).
- The first year of operations is very stressful, with significant unexpected downtime due to the operators and maintainers trying to learn the new plant on the fly, not having had time to prepare, train and be ready for the operations phase.

This list can go on and on, but the point is hopefully made. Please remember, the chart in Figure 2 addresses only the ramp-up period opportunities. Potential avoidable long-term costs related to the total lifecycle cost over the majority of the lifecycle is additional.

As mentioned earlier, actual total operating costs during the longest portion of the total asset lifecycle—the operate/maintain stage—typically are 1% to 2% higher than the expected total lifecycle costs assumed in the initial business case, and remember, this does not include the operability value destroyed. In addition, on the basis of overall equipment effectiveness benchmarks reported by Aberdeen and others, top maintenance reliability performers can conservatively expect 10% more production throughout their assets' lifecycles than mid-tier performers.3 The increase in production and reduced costs all add up to a lot of money.

Why Does This Status Quo Continue?

It is a fair question to ask. With hundreds of millions of dollars to be saved, why is this a common practice? The answer is largely cultural; this is not the way we do things. In industries where a change in practices could bring about the greatest benefits, there are strict divisions between construction and operating responsibilities that reach conflicting objectives. This is also reflected in the division between financial management of capital expenditures (CAPEX) and operating expenditures (OPEX). To put it mildly, there is a gap that new assets have to cross as they become operational from construction and CAPEX to operations and OPEX.

The gap reflects the earnest and best intentions of both the engineering and operations organizations. The typical goal of the engineering and design groups is to complete the project on time and on budget, and they work diligently to prevent the introduction of additional requirements. When operations takes possession of the assets, it, in turn, focuses on attaining production targets and hitting operational efficiency metrics. Typically, neither side includes budget for the development of asset data or maintenance strategies. For the engineering group to build the necessary information, it would need additional engineering services. The operations group often falls victim to the fallacy that the staff needed to maintain the assets will just have to build the plans as they go. There are no provisions for additional staff or contractor expense to build the needed information after the handover. As a consequence, information sets developed during the project's engineering, construction and commissioning phases are not properly translated into operational information, and critical aspects of the assets' histories are lost forever.

In recent years, very thin project margins (reportedly as low as single digit) for engineering and procurement contractors (EPCs) have further exacerbated the situation. Where one might reasonably expect EPCs to differentiate their offerings by including structured asset data and detailed maintenance strategies, such options, EPCs argue, only further erode margins.

The systems used by engineering and operations also add complexity to the exchange of information. Engineering design systems are largely document oriented. They produce and manage isometric drawings, piping and instrumentation diagrams (P&IDs), mechanical data sheets, and a host of other drawings and documents. In contrast, EAM systems are highly structured and largely dependent on data populated in database fields. Different in nature, engineering data needs thoughtful transfer into EAM systems to maintain consistency and ensure the integrity of data relationships. The challenge of moving data from unstructured, document-based systems that are built from contributions of many different EPCs to a single, structured, database-backed system is significant but not insurmountable.

Underlying these challenges is a failure on the part of the corporation that will own and run the assets to include the whole asset lifecycle in their management of data standards. In several cases, companies have built data standards into their EAM system. The reporting functionality of top tier EAMs—such as MAXIMO and SAP—benefit from data standards for asset hierarchies, classifications, characteristics and domain values. Indeed, companies that have put these standards in place are generally in the group that continues to show improvement in asset management performance. Nevertheless, in very few cases have these standards been translated into handover requirements that EPCs must include in their project bids. This generally reflects the lack of an entity with the authority to span from engineering into operations and maintenance. It follows that without a requirement for the foundational data, the maintenance strategies are also overlooked.

The typical status quo will continue without investment in and attention to operational readiness during the early design and construction phases of the project.

Mitigating Strategies

As mentioned earlier, there is ample published proof that a well-designed risk mitigation program will easily reduce total long-term lifecycle costs by 1% to 2% (conservatively speaking, and again, this does not include avoided operability risks and CAPEX benefits), streamline start-up and ramp-up activities, and enhance early operational performance. Robust programs address myriad risks by capturing asset data; developing failure-mode-based maintenance strategies; creating condition baselines; charging the work management system with all relevant asset, spare parts and maintenance strategy data; and finally training and preparing the operations and maintenance workforce—all during the engineering and construction phases of a project.

Figure 3 is an example of the business areas addressed by a comprehensive operational readiness program.

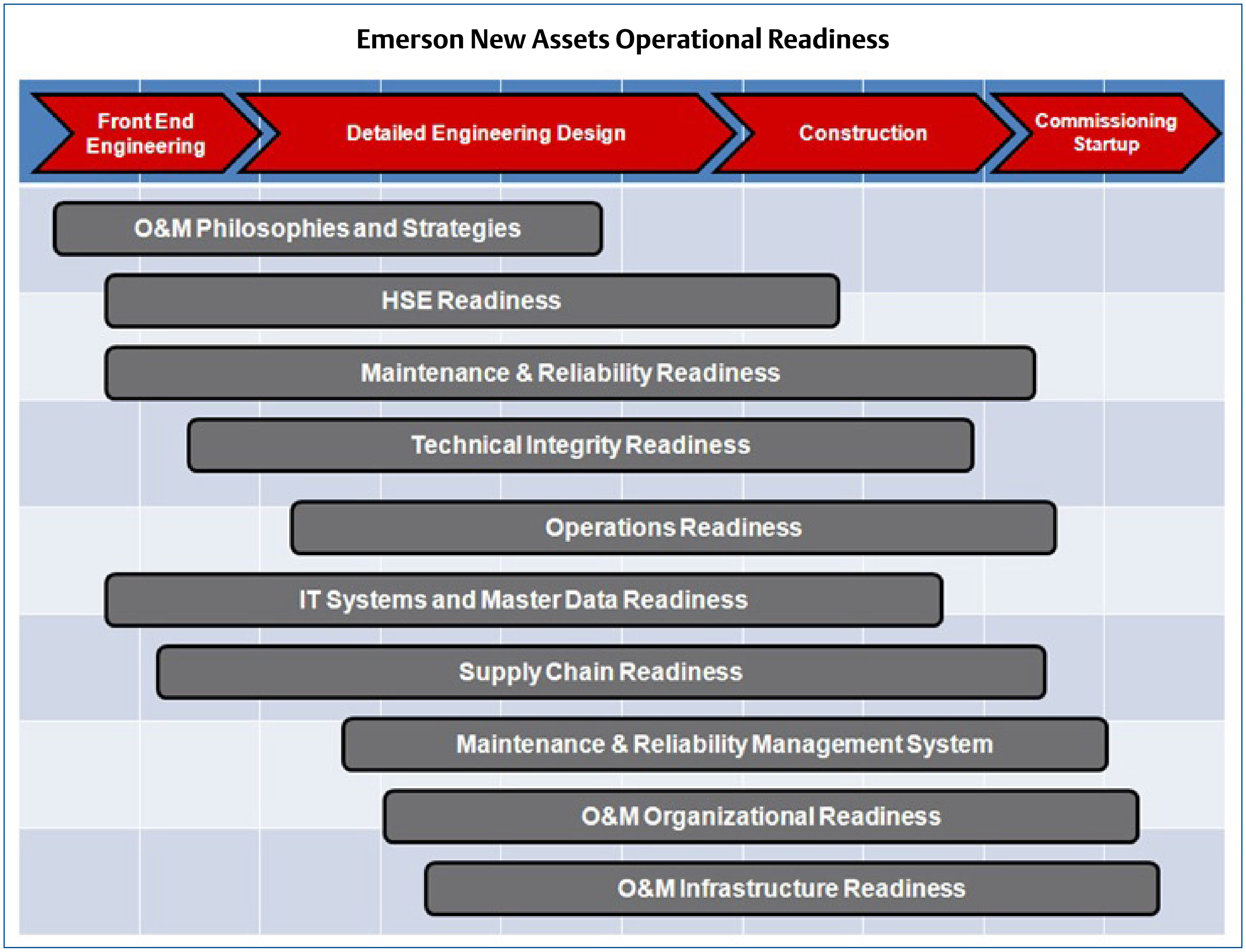

Figure 3 — *Comprehensive Operational Readiness Plan.*

Each major category shown in Figure 3 represents a detailed and comprehensive set of activities, each almost a sub-project in itself. The threads of the operational readiness plan illustrated in Figure 3 are detailed in Whitepaper Capital Projects Operational Readiness and Business Risks. While it is a lot of work to carefully develop and execute a comprehensive operational readiness program, remember the short- and long-term benefits far outweigh the costs.

In addition to a clear plan consisting of the categories outlined in Figure 3, the effectiveness and efficiency of the new asset program can be greatly enhanced by these supporting standards: guidelines, reference documentation and formal requirements. For example, master data standards provide the detail needed to develop handover requirements for the EPCs during the initial bid process. Later in the project, these standards support consistent implementation of maintenance strategies. Maintenance strategy standards, organized according to the equipment types defined in the master data standards, significantly reduce the engineering effort required to analyze and build the maintenance program. A comprehensive review of the standards needed and the supporting development process is detailed in Whitepaper Maintenance Program Development for New Assets.

"The Early Bird Catches the Worm"

There is ample proof and little argument today that organizations that deploy best reliability-based maintenance practices to existing operational assets produce significantly more asset availability at lower costs. Where making a profit is important, such organizations have a dramatic bottom-line impact and enhance their competitive footing. Numerous articles have been written detailing the mechanics of such programs and the successes of companies that have employed them. We argue (and empirical evidence supports) that developing such a program, that is bringing new assets into these reliability-based maintenance programs early in an asset's lifecycle, is more cost effective than developing a program at any other time, and, as we've presented, can drive significant value both in the short and long term.

Think of best reliability-based maintenance practices as a risk-mitigation program designed to anticipate and mitigate potential problems that are likely to negatively impact total project value once operation begins. Such programs prepare the organization that will be responsible for the operation and maintenance of the new assets during design and construction. With the right preparation, the organization will be more ready to assume the operations duty than has historically been the case. The term "operational readiness" is rooted in this principle.

Figure 4 illustrates the increasing cost of risk mitigation as a new capital project progresses through its lifecycle stages.

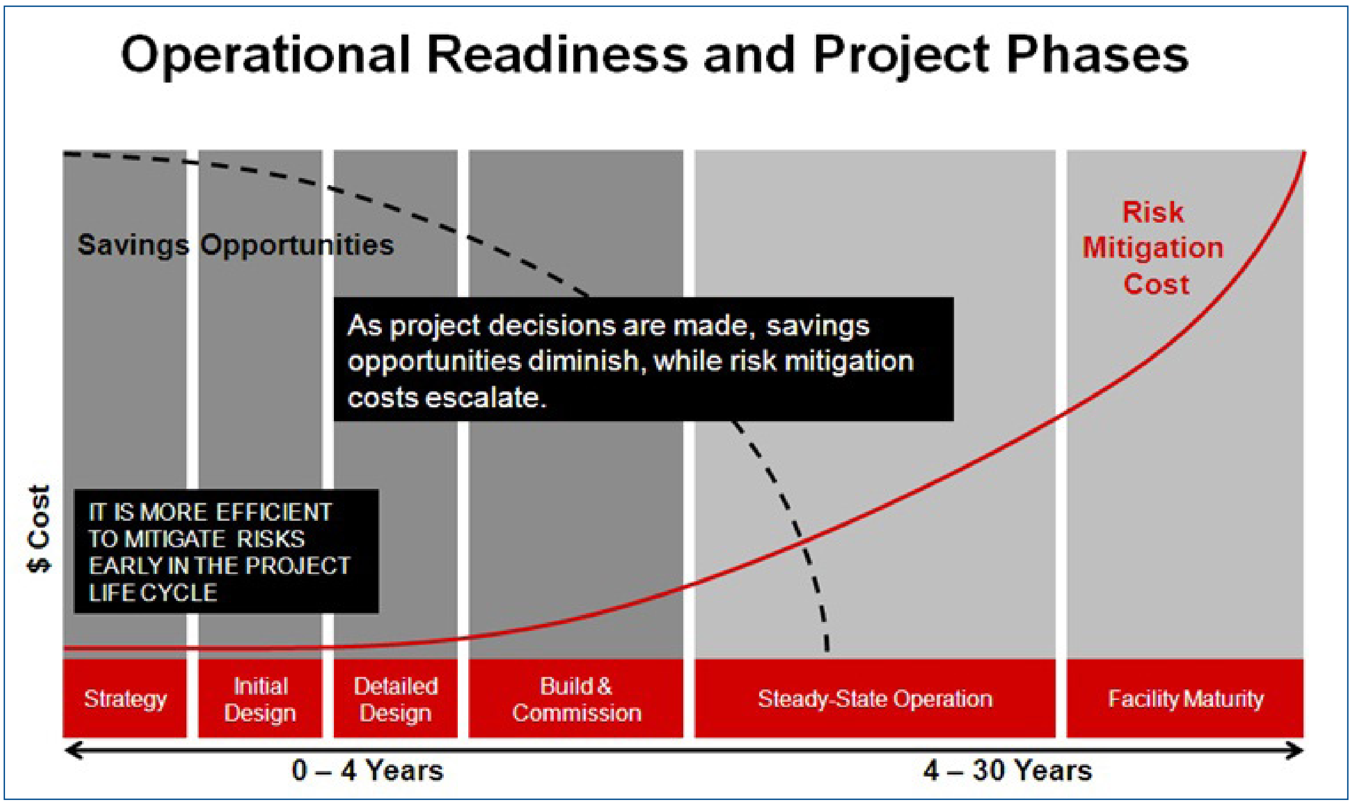

Figure 4 — *Theoretical risk mitigation costs vs. lifecycle phases.*

Note in Figure 4 the sharply increasing cost of risk mitigation as a project progresses. It is significantly cheaper to address risk mitigation at the earliest stages of the asset lifecycle.

Interestingly, as Figure 5 shows, the vast majority of the total lifecycle cost of new assets may already be irreversibly incurred prior to new plant commissioning. The ability to influence the total lifecycle cost of new assets by 1% to 2% (conservatively speaking) is lost once the assets are commissioned.

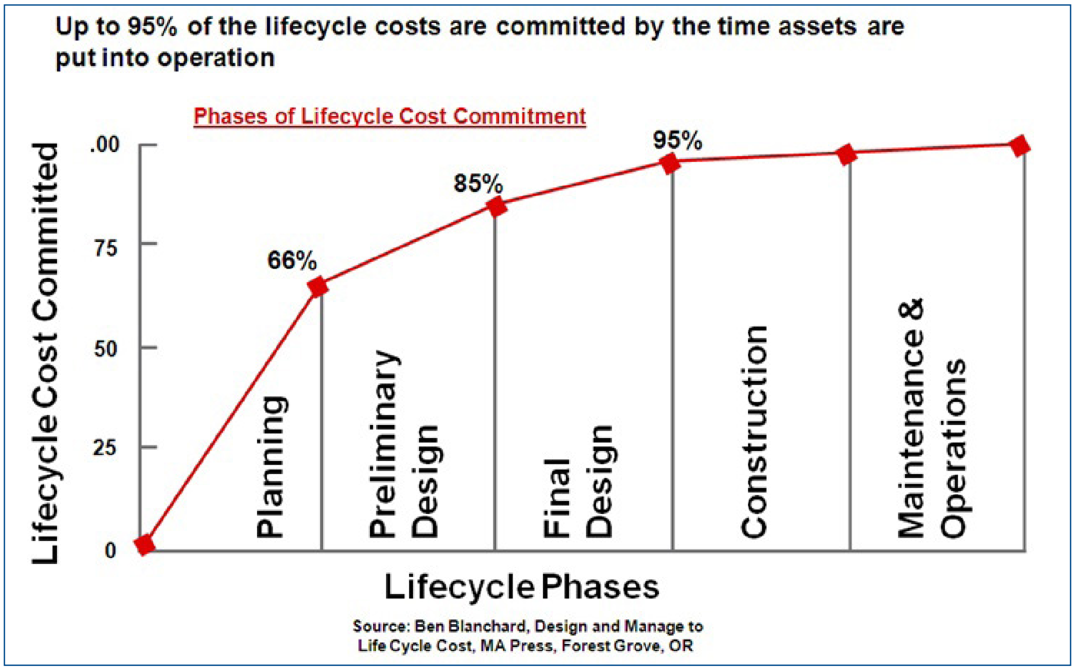

Figure 4 — *Phases of lifecycle cost commitment (Source: Ben Blanchard: Design and Manage to Lifecycle Cost; MA Press)*

Incorporating the reliability point of view as an equal partner at the earliest stages of the new asset lifecycle will add costs to the capital expenditure (estimated to be 2% to 3% of total project cost), but will drive benefits far in excess of those costs—both immediately upon commissioning and over the long haul.

As we have demonstrated, the business benefits of bridging the gap between construction and operations are substantial. They are realized from several areas and have the potential of reducing the overall project budget. Within the design and construction phase, the development of asset data and maintenance strategies can be both applied to the reduction of initial capital spare parts costs. Rather than accepting the equipment manufacturer's recommendations on spares stocking, optimal stock levels can be established that more than offset the data and strategy development costs. Furthermore, an organized approach can avoid spare parts duplications and foster interchangeability with benefits to the investment in capital spares and the inventory account. The application of predictive technology for the development of baselines prior to acceptance has the added benefit of identifying installation defects, which saves repair costs (and downtime) from affecting operating expenses. Emerson has proven these two benefits, offsetting the upfront operational readiness investments for several clients.

In addition to cost-savings benefits, development of asset data and maintenance strategies during the capital phase of the asset lifecycle also makes good financial sense. Since the asset data and maintenance strategies provide a benefit to the company throughout the lifecycle, they should be capitalized and amortized across the life of the asset. Incurring the expense to build the program prior to the operating phase of the asset lifecycle allows the operating budget to be built on an assumption of steady-state operation and based on budgeting benchmarks for similar assets. Paying for these efforts as operating expenses can impact margins, overstate operational costs and affect business performance. Remember, thinking that these foundational programs will be built over time is a flawed assumption. As countless examples across numerous companies show, the program is never really built and assets are allowed to degrade into less than top quartile status, a difficult condition from which to recover.

Conclusion

Reliability-based maintenance organizations create significant value, and the organizations that implement programs early in the lifecycle enjoy the greatest benefits. The costs of the program are typically in the range of 2% to 3% of overall project costs. Confirming Deloitte's findings, companies like Shell Oil have observed that these costs are typically recouped quickly in increased asset reliability, improved safety, lower modification costs, and especially, in reduced operating and capital expenses associated with turnarounds.4 Extending asset data and maintenance standards into the design phase and establishing strict reliability-based turnover and commissioning standards will undoubtedly encounter cultural and political challenges, but the business benefits are significant enough to warrant the level of executive sponsorship needed to overcome such barriers. Companies like Chevron are establishing executive sponsorship of this philosophy, where a higher authority bridges the gap between engineering/construction and operations—insisting that data standards and reliability-based maintenance strategies be part of the capital project deliverables, prohibiting projects from being declared complete without these programs, and disallowing engineering/construction decisions that will be detrimental to the long-term operating and maintenance phases of the asset lifecycle.

A successful operational readiness program—including a data and maintenance strategy program for new assets—depends on a set of detailed corporate standards and well organized workflows. Success with large capital projects further depends on software systems used for managing the vast number of documents and for validating data from documents against the standards. Fortunately, many organizations already have the software platforms and parts of the standards needed. As awareness of the business case, tabulated in Table 1, increases and early adopters establish further proof, more organizations will be seeking to put all these pieces together and take on the early incremental costs in favor of the long-term, game-changing benefits.

Lifecycle Phase	Ramp Up	Operate
Cost Category	2 % to 3 % of Project Cost	NA
Benefit Category	30% Project NPV Improvement	1 % to 2 % reduction in lifecycle costs 10 % greater production potential across the asset's lifespan

Table 1 — *Summary of Business Case Elements.*

It is high time we relegate these antiquated practices to the ash heap of history, and for serious and well-informed companies, there are ample financial and practical reasons to do so.

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