Best Practices for the Planning and Execution of Turnaround Projects in the Oil and Gas Industry

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# Contents

Executive Summary 3  
Background 4  
Introduction 5  
Best Practices for Planning and Execution of Shutdown, Turnaround and Outages 6  
   1. Scope Management & Project Change Notices (PCNs) 6  
   2. Cost Tracking 7  
   3. Schedule Control 7  
   4. A Successful STO is a Safe STO 8  
   5. Stakeholder Communication 8  
Conclusion 10  
About Coreworx 11  
About the Author 11  
References 12
Executive Summary

Shutdowns, Turnarounds, and Outages (STO) are usually sizable projects executed under strict time constraints with severe financial impacts for project delays. They are also subject to significant potential scope changes that arise from found and extra work during the outage period, and require rapid decision making and approvals that cannot be avoided. This combination often results in the “perfect storm” of circumstances during the outage period, making effective project controls one of the most important elements in successfully executing a shutdown or turnaround project. All too often, traditional project control tools leave turnaround managers ill-equipped to make rapid, yet informed decisions in the midst of the “perfect storm”.

Analysis of industry-accepted best practices, for the planning and execution of STO projects, show that an effective project control solution needs to have a number of distinct functional and integrative capabilities. Specifically, it must have:

- a comprehensive scope management system with an integrated change management process,
- a complete cost capture tool capable of tracking labor, material, and equipment on shift-by-shift basis, as well as
- an integrated budget management system to track incurred costs against budget values and generate accurate daily cost and performance key measures.

All of this information needs to be fully integrated with the project schedule to support resource allocation, scope addition and deletion, scheduling changes, critical path evaluation, and cost overrun projections.

Most STO projects today rely on spreadsheet-based project control tools, developed and operated by veteran project control managers who are in many cases scheduled to retire in the next five years. Excel spreadsheets, though very flexible and powerful, are clearly recognized as uncontrolled, limited in visibility across a team, prone to errors, and difficult to deploy as a standardized tool unless the original author of the spreadsheet also joins the project. As a result, many forward thinking Owner/Operators have recognized that standardization and maturity in their STO project controls competency across their asset base require the development of best practices, supported through integrated project control solutions that address the unique requirements of STO projects.

With the maturity in system integration technologies and best-of-breed industrial project control solutions, Owner/Operators can now expect to rapidly adopt commercial solutions that fully address their STO project control requirements. This is being achieved today through incremental changes within an Owner/Operators’ IT landscape, and avoids the “boil the ocean” approach of the past. With minimal risk and impact to IT, Owner/Operators can rapidly deploy comprehensive and easy-to-use project control capabilities at the plant level, and achieve standardization across the asset base, while at the same time achieving complete visibility to performance metrics across their portfolio of STO projects.
Background

Up until the mid-1990’s, the U.S. had excess refinery capacity, but as of 1995 most US refineries have been running consistently near capacity during the peak-demand periods, at utilization levels of approximately 92%\(^1\). Global energy demand is growing rapidly and is expected to increase 53% by 2035\(^2\). Maintaining the reliability of all plants involved in the oil and gas supply chain requires periodic turnarounds to perform various maintenance tasks that cannot be accomplished while the plant is operational. In addition to the scheduled turnarounds, plants may also be forced into unplanned shutdowns due to various operational and safety incidents. Regardless of the type of plant or the cause of the shutdown, every plant faces immense pressure to maximize their utilization level, and corresponding revenue, and faces significant financial loss associated with even one day that a unit is offline.

The impact of any schedule delay in the completion of a shutdown or turnaround is three fold – the obvious increase in project cost, the lost production, and for public companies, a hit to the stock price as investors become nervous about delays. To better quantify the impact of lost production, consider the value of 100,000-barrels-per-day of lost production for a refinery. The average duration of a turnaround in the Oil & Gas industry ranges from 20-60 days, depending on the type of work that is required\(^3\). With a loss of 2 to 6 million barrels, during a turnaround, the pressure on a turnaround team is extreme. They must take all measures feasible to ensure the project completes on time.

The exceptional circumstances of the STO projects, namely spending a large portion of operational and capital budgets during short periods of intense activities and under strict time constraints, requires highly effective processes to manage the cost and performance of these undertakings. It is not uncommon for Owner/Operators to have a number of plants in their asset base and therefore having to deal with simultaneous turnaround projects each year. Whether working with a portfolio of assets or a single facility, the plant owners, operators, and STO management teams need complete visibility on the progress of activities during a turnaround to make rapid and informed decisions.

The inefficiencies and shortcomings of traditional project control tools for STO projects has motivated leading research institutions, including the Construction Industry Institute (CII) and Construction Owners Association of Alberta (COAA), to establish best practices for the planning and execution of STO projects. This paper summarizes these best practices, along with guidance on how to select and implement a project control solution that will support rapid deployment and standardization of these best practices across an Owner/Operator’s asset base.

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\(^3\)PDRI: Project Definition Rating Index — Industrial Projects, Implementation Resources 113-2, Third Edition, Construction Industry Institute, Austin, TX, 2008
Introduction

Generally, the complexity and the overall difficulty of an STO project increases with an increasing project budget. However, the operational expenditure component of the budget is usually the key factor in determining the overall complexity of the STO project. In general, larger operational expenditures translate to an exponentially larger number of activities and labourers on the site. A 200,000-barrel-per-day refinery may go from normal operations with approximately 500 staff to a turnaround project with a peak of 2,000-2,500 on-site staff. At this scale, traditional spreadsheet-based project control tools struggle to address the requirement to deliver real-time, highly accurate cost and performance metrics to key project stakeholders during STO project execution. While there are many measures of a “successful project”, for the purposes of this paper, the successful execution of an STO project are to:

- Approve, budget, and schedule all work that is executed,
- Accurately understand work progress on a shift-by-shift basis (twice a day) to within +/- 1-2%,
- Understand 90% of incurred costs with no more than a 24 hour delay, reported daily with maximum of a 2 shift lag,
- Accurately forecast cost and schedule variances, utilizing the timely information as listed above, and
- Understand and mitigate risks to personnel, cost and schedule.

The effectiveness of the processes and tools used to manage STO projects are assessed based on their ability to implement industry-accepted best practices. The rest of this paper summarizes the best practices for STO project planning and execution, and the role of project controls tools in implementation and execution of these best practices. These guidelines align with recommendations by the Construction Industry Institute (CII) for Front-End Planning of Renovation and Revamp projects, including CII’s Project Definition Rating Index (PDRI) and the Shutdown Turnaround Alignment Readiness (STAR) tools.

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6Analysis Supporting Front End Planning for Renovation and Revamp Projects, Part 2, Research Report 242-12, Construction Industry Institute, Austin, TX, 2009
8Front End Planning for Renovation and Revamp Projects, Implementation Resources 242-2, First Edition, Construction Industry Institute, Austin, TX, 2009
Best Practices for Planning and Execution of Shutdown, Turnaround, and Outage Projects

1. Scope Management & Project Change Notices (PCNs)

One of the most common causes for STO projects going over time and over budget is ‘scope creep’, driven primarily by multiple conflicting objectives. In order to minimize the risk from scope changes, the scope of an STO project needs to be agreed upon well in advance of the event with a ‘freeze’ date of no later than six months before the execution date. STO projects are scheduled events which take place on a regular basis, usually on a 3 to 5 year interval, and the planning for each turnaround project may start 18 months in advance of the event. From a maintenance manager’s perspective it is critical that the priorities are set correctly and that critical tasks are completed during the turnaround, otherwise O&M budget will be spent in patching and nursing the issues until the next planned turnaround, or may even cause a forced turnaround, which is understandably the worst nightmare of any Owner/Operators.

The scope, which will ultimately be defined in terms of Work Orders with Task Lists, must clearly describe the labor, equipment, material, and permits that are required. The collection of Work Orders and Task Lists will then be used to calculate the STO budget. Detailed Work Orders are developed through planning functions, normally by planners who are familiar with the plant and understand the installed equipment. Workface Planning and detailing of the activities is a complex process in itself and requires multi-disciplinary input from various project stakeholders. It is critical that all sponsors of the Work List come onboard early in the process. These sponsors include key decision makers from Engineering (Capital, Repair, Business Development), Inspections (Asset or Integrity Management), Maintenance, and Operations. Collaboration with the contractor who is responsible for executing the work is also highly recommended at this stage. Getting their input early on helps mitigate risk, and limits dealing with change orders and conflicts during the rapid pace of a turnaround.

Therefore, the scope definition activities and scope management systems need to be supportive of a collaborative environment, and also need to have a Project Change Notice (PCN) system in place to effectively track the changes in scope and their impact on the budget as they arise throughout the planning and execution phases of an STO project. Since these projects are often planned to the ‘activity’ level, changes in ‘activity’ need to reflect the changes in resources, durations, materials, and equipment. Therefore the PCN module needs to be integrated with all other project control features so that it can automatically update all the appropriate functions, thus increasing the efficiencies of the system. Changes to the scope also need to be properly categorized in order to provide better visibility to their cause, including late, found, extra and cancelled work.

In smaller STO projects where the work is primarily executed by internal staff, corporate systems can usually provide the minimum requirements for managing and controlling the scope of the project. However, most STO projects have a significant scope of work being performed by contractors, and this scope and resulting Work Orders are prepared in separate contractor systems. Therefore, the STO project must have one system of record capable of managing the entire scope, and collective PCNs, in order to effectively support planning, scheduling, and budget control functionalities. It also needs to be able to communicate back any changes and updates to the individual contractor systems. Therefore, the tools must be capable of two-way integration with both the Owner/Operator’s ERP systems, and one or more contractor systems.

Work executed ‘under the radar’ will slow progress, misallocate resources, and increase costs without explanations. In other

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words, if isn’t written down it didn’t happen, and how can you control what didn’t happen? Adherence to the scope change process is crucial to managing costs and performance of an STO project.

2. Cost Tracking

STO projects often face reporting against a complicated financial structure. Most plant managers accept the fact that their traditional budgeting systems are not designed to meet the unique requirements of turnarounds. The complication of the cost structure of STO projects starts with the fact that there may be many different cost centers on a given project, each being allocated varying percentages of the overall STO budget. There may also be a number of project scopes being executed, each with its own Authorization for Expenditure (AFE), and in many cases attributed to joint-venture partners.

An effective cost tracking system must be able to accurately track all aspects of field cost capture, including labour, expenses, material and equipment. It needs to be able to track individual cost components based on the shift, skill, and Work Order or Cost Code that they worked on; in some cases there even needs to be varied overtime rates for a given trade. In addition to the timesheets, expenses such as overnight, travel, etc. also need to be tracked on an individual basis. Material quantities and purchase orders also need to be tracked by the system. Finally, the field cost, man-hour and progress control solution needs to be able to track hours booked for various equipment types or even an individual piece of equipment against a Work Order or Cost Code in the system.

There are also a number of indirect costs, such as supervision or certain equipment rentals, which are not associated directly to a Work Order but are incurred to support the project and need to be tracked appropriately. In order to deliver on the expectations of a successful STO project, the cost tracking system needs to be able to capture the incurred costs at the end of the shift and communicate the incurred costs to the main cost and performance control module, where it can be integrated with the schedule, original budget, and the rest of the project planning and execution information and used for supporting the required managerial functionalities including planning and forecasting.

Budget estimates for STO projects are often received with low confidence in their accuracy due to the unique characteristics of these projects. This lack of confidence is due to a combination of factors, including traditionally poor estimates, contracting strategy, significant found and extra work in aging assets, and procurement related schedule delays. Therefore, the scope management, cost capture, schedule control, and budget management functionalities in the project cost and performance management solution need to be highly integrated, such that variances are noted and re-forecasting for the impact of these variances can be automatically generated.

3. Budget Management

Most scheduling software solutions can, and will, level your work to meet your resource availability profiles better than what an experienced planner or scheduler can manually perform. This is a proven method for longer-term capital and maintenance projects, where the rate of change in the scope and the rate of the progress of work are easily managed through existing planning or scheduling software and processes. However, STO projects are very different in the sense that the schedule is very closely tied with the budget. This dependency is mainly due to the extreme financial penalties for delay and sheer volume of activities taking place on any given day. Another unique characteristic of STO projects is that an updated schedule is required on a shift-by-shift basis, thus requiring a closely tied integration between the schedule, cost, and performance capturing functionalities.
In addition to the shortcomings of the traditional scheduling tools in handling the unique characteristics of STO projects, many traditional scheduling processes and techniques are also not applicable to these specialized projects. For example, traditional crashing and mitigation techniques may not work in STO environments, as additional resources do not necessarily mean faster progress! This is due to a number of limiting factors including physical space, number of available permits, material and equipment availability, and resource availability. Another important point is that due to the highly dispersed yet dependent activities taking place on such short time intervals, cancelling work without eliminating resources does not save money, since re-allocation of resources on short notice may not be possible due to all the other limiting factors.

In terms of schedule control, the bottom line is that the schedule needs to be fully integrated with all other aspects of project controls, including cost capture, change control, and budget management in order to support the rapid decision making processes that are required for effective management of cost and performance on STO projects.

4. A Successful STO is a Safe STO

STO projects deal with unique safety challenges due to the large amount of labor and equipment operating on extended shifts and on non-typical activities during very strict schedules. The on-site workforce typically triples during a turnaround project, with a large fraction of workforce being contract labourers who are unfamiliar with the plant and its equipment, which further increases the risk of safety incidents. The conflicting objectives of the vast amount of activities taking place during a short period often result in very hazardous working conditions. As the project progresses, and particularly if it is delayed, labour fatigue also becomes a serious concern. The scope changes can also be a major concern for safety, as the found or extra work is normally not planned to the same level as other work and therefore increases the risk of the overall project. These safety challenges need to be actively monitored, managed, and mitigated in order to reduce the risk to the overall project.

Most organizations have a dedicated Safety Management System (SMS). Safety performance is a Key Performance Index (KPI) and is often expressed in terms of a Total Injury Frequency (TIF) and a Total Recordable Injury Frequency (TRIF). These KPIs are usually measured by the contractor and reported by the area and by the phase of the project.

From a turnaround manager’s perspective, safety is most effectively monitored when KPIs for the entire project workforce are presented, with aggregation of information across contractors, disciplines and areas. Integration of safety information, presented alongside all other project control key performance indicators, provides the turnaround manager the holistic view needed to take appropriate actions to reduce and mitigate the risk to the workforce and to the project.

5. Stakeholder Communication

During an STO project, it is critical to have an accurate estimate of the work progress on a shift-by-shift basis. Accurate knowledge of an STO project’s progress supports a number of management level decision making processes when considering resource allocation, scope addition and deletion, scheduling changes, critical path evaluations, and cost overrun projections. This information can also be used to communicate with other stakeholders on the project, particularly
where the work may be funded through many AFEs and joint-venture partners. When managed with an integrated project controls solution, these progress performance values can be analyzed at the project, sub-project, AFE, or area level. Also, trends can be identified and analyzed by comparing progress performance snapshots and baselines throughout the project. The overall project performance information can then be used to communicate the various performance parameters of the project to the management team and also to communicate applicable information such as forecasted start-up timing to the customers.

More sophisticated project control solutions even enable the management of a portfolio of projects by rolling up the KPI and progress performance information from various projects into one centralized portfolio dashboard. This functionality can be very useful for the management teams of Owner/Operators with more than one plant, a common scenario in the industry.
Conclusion

STO projects require mature cost and performance management tools that can rapidly be deployed and fully integrated with the Owner/Operator’s existing IT landscape. Without an end-of-life strategy for spreadsheet-based project control tools, Owner/Operators will struggle to achieve wide-spread adoption of industry-accepted best practices.

During an STO project, decisions require timely and accurate summary of a vast amount of information. This data needs to be tracked, reported, and integrated on a shift-by-shift basis in order to provide full visibility to turnaround managers who must make rapid and informed decisions. This spans information across all project control elements — scope, cost, schedule, and safety.

Industry-accepted best practices confirm that planning and execution of STO projects must have an effective project controls solution that provides an integrated platform for cost and performance management. Owner/Operators should expect a solution that is able to:

- Manage the scope and facilitate and control the scope change process,
- Accurately track all aspects of incurred costs, including labor, expenses, material, and equipment, against appropriate Work Orders or Cost Codes, and on a shift-by-shift basis,
- Control the project budget and track the changes to the budget as a result of scope changes or schedule variances,
- Integrate with the project schedule to support planning and forecasting functionalities for both cost and schedule of the project, and
- Integrate safety related information with other project KPIs at the project and portfolio level to provide better visibility for control and mitigation of project risks.

Owner/Operators understand that they can no longer maintain the status quo for tools, and that project execution will continue to get more complex as an asset ages, with the incident rate of found work likely to increase. Today, they can completely avoid the traditional IT approach of first “boiling the ocean”, and instead achieve significant improvement in their project control tools with minimal changes to your technology environment. The reality is that the most effective approach is to adopt a robust commercial project controls solution that can leverage and fully integrate with an existing IT landscape. This is now possible because of maturity in systems integration technology and commercial project controls solutions specialized in industrial projects. These solutions will increase the return on existing investments by Owner/Operators in ERP, maintenance management, and scheduling systems. Attaining best-in-class project control capabilities for your STO projects has never been easier.
About Coreworx

Coreworx Inc. provides integrated project information and cost control solutions for projects in the oil & gas, power and mining sectors. The Coreworx solution is a proven web-based enterprise software system that enables engineering and construction contractors and owner/operators to automate best practices, mitigate business risks and improve performance to budget throughout the entire project lifecycle. Coreworx services a portfolio of projects valued at over $500 billion across more than 50 countries, on more than 500 projects with nearly 70,000 users. Coreworx has offices in Kitchener, Calgary, Houston, Perth (Australia), and Aberdeen (UK).

Coreworx brings over 27 years of experience in the Cost and Performance Management of projects around the world through an integrated cost and performance management system designed to manage all types of field development, engineering, and construction projects including major capital projects, turnaround projects, and operation, maintenance, and services projects. Specifically, the major functionalities of Coreworx Cost and Performance Management Solution include:

- Full integration across business units providing sub-project, project and portfolio level visibility through standard reports and integrated dashboards,
- Sophisticated estimating, budget management, change management, and budget forecasting capabilities for efficient project management,
- Comprehensive cost capture and management of work orders, timesheets, resources, purchasing, equipment, material, and labour, and
- Total cost management for actual, incurred, and accrued costs.

Coreworx enables you to maximize your investment in your existing ERP and Scheduling tools with the best in class cost and performance management tool! Coreworx Cost and Performance Management has been deployed and integrated with leading ERP and scheduling tools, including but not limited to: SAP, Oracle E-business Suite, IBM Maximo, Primavera P6, and Microsoft Project.

About the Author

Arash Shahi is a Senior Product Manager with Coreworx, responsible for the Cost and Performance Management product line. He is an experienced Civil Engineer and completed his Ph.D. in Project Management at the University of Waterloo, a world-renowned institution for its engineering research. Arash has over 15 publications and has presented his work in the field of automated project controls and project management at various Canadian and international conferences. He is an active member of the Construction Industry Institute, serving currently as a research team member on Portfolio Level Project Management. Arash works with Owners, Operators, Service Providers and EPCs to align his product line to industry requirements and best practices for cost and performance management in the execution of shutdowns, turnarounds, outages and major capital projects.
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