Turnarounds have a distinctive character of their own and cannot be managed as if they were just another sort of ‘Engineering, Procurement and Construction’ (EPC) project; a ‘turnaround-specific’ methodology of management is needed. Drawing on the philosophy of the Project Management Institute’s Guide to the Project Management Body of Knowledge (PMBOK®) the author reviews the special problems presented by process plant turnarounds and also their particular management needs.

Abstract

Applying PMBOK to Shutdowns, Turnarounds and Outages

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A TURNAROUND-SPECIFIC MANAGEMENT METHODOLOGY

The discipline of project management enjoys different states of maturity across different industries, the construction industry probably enjoying the greatest maturity in this field while the software development/IT industry is probably enjoying the greatest growth in maturity at this time. In the process industries the maturity of the project management discipline as regards turnarounds is still very poor, stagnant at best.

There appears to be little if any development of, or dialogue about, the discipline within the field. Turnaround failures (budgets blown by millions of dollars, target dates missed by days) are still as prevalent as ever. The same mistakes are being repeated over and over. The main problem is that turnaround managers continue to treat turnarounds as if they were ‘Engineering, Procurement and Construction’ (EPC) civil projects and hence apply an EPC-centric project management methodology.

One of the greatest challenges to turnaround managers is realising that turnarounds are different from EPC projects. They have their own unique characteristics and demands. They require a specialised project management methodology. This document is intended to spark a dialogue for developing a turnaround-specific management methodology.

Background

The Project Management Institute (PMI) has published A Guide to the Project Management Body of Knowledge (PMBOK®) which identifies and describes the subset of the project management discipline that is applicable to most projects most of the time. It

FOREWORD

Shutdowns, turnarounds and outages

All the major process industries (refining, petrochemicals, power generation, pulp and paper, etc.) have their own nomenclature for maintenance projects. For the purposes of this document, ‘turnaround’ is intended to encompass all types of industrial projects for existing process plants including –

- Inspection and testing
- Shutdowns
- Emergency outages
- De-bottlenecking projects
- Revamps
- Catalyst regeneration, etc.

i.e. all those instances when an operating plant must be shut down until the work is completed and then restarted, thus ‘turning around’ the unit or plant. In this paper ‘turnaround’ is also intended to refer to the entire span from pre-turnaround preparations, to shutdown, to execution and finally to start-up.
provides a loose guideline for structuring a project management methodology, and describes its primary purpose as being – ‘...to identify and describe that subset of the PMBOK that is generally accepted. ‘Generally accepted’ means that the knowledge and practices described are applicable to most projects most of the time, and that there is widespread consensus about their value and usefulness. ‘Generally accepted’ does not mean that the knowledge and practices described are or should be applied uniformly on all projects; the project management team is always responsible for determining what is appropriate for any given project.’

It is up to turnaround managers to evaluate the applicability to turnarounds of their specific project management methodology. Many turnaround managers do not have a formal background in project management and have never studied the PMBOK. As a result, there has been little discussion in professional circles of the proper application of the PMBOK to a turnaround-specific management methodology.

Most turnaround managers employ an EPC-centric project management approach to turnarounds. In order to analyse the applicability of this approach, we first need to understand the important differences between turnarounds and EPC projects. Then we shall have the proper basis for evaluating a turnaround-centric project management methodology in accordance with the PMBOK.

**Important differences between turnarounds and EPC projects**

There are significant differences between turnarounds and EPC projects (see Table 1), which are worth exploring.

Because the scope is only partially known when execution begins, turnarounds demand much stricter scope management controls. A constantly changing scope (and schedule) means that the baseline schedule is a useless measuring stick. As it is the entire basis for measuring and tracking EPC project performance, it is clear that a different paradigm is required for turnarounds.

A changing schedule and changing manpower requirements make resource levelling, a popular tool for EPC projects, counter-productive for turnarounds. This issue is explored in greater depth in the Resource Levelling Vs. Critical Mass white paper which can be found on our website (www.interplansystems.com/html-docs/resource-leveling-critical-mass.html).

The compressed work basis for executing turnarounds means that all team members have less time to analyse and react to changing priorities. Problems that go unchecked can significantly affect the likelihood of reaching time and budget goals. As a consequence, there is a much greater need to use the schedule to drive the project execution (whereas it is sometimes used mostly as a contractual tool in EPC projects). It is critical for all schedule and progress information to be highly visible, timely, comprehensive and accurate.

With these distinctions in mind, we can now explore the tenets of the PMBOK and start working towards a turnaround-specific project management methodology.

Table 1. EPC projects vs. turnarounds

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>TURNAROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Usually well-defined scope, from: a. drawings b. specifications c. contracts d. permits, memos, etc.</td>
<td>1. Usually loosely defined scope, from: a. past turnaround experience b. inspection reports c. operations requests d. historical estimates</td>
</tr>
<tr>
<td>2. Scope is static. Few changes occur during execution.</td>
<td>2. Scope is dynamic. Many changes occur as inspections are made.</td>
</tr>
<tr>
<td>3. Can be planned and scheduled well in advance of the project.</td>
<td>3. Planning and scheduling cannot be finalized until the scope is approved, generally near the shutdown date.</td>
</tr>
<tr>
<td>4. Projects are organized around cost codes/commodities.</td>
<td>4. Turnarounds are work order based.</td>
</tr>
<tr>
<td>5. Generally do not require safety permits to perform work.</td>
<td>5. Turnaround work requires extensive permitting every shift.</td>
</tr>
<tr>
<td>6. Manpower staffing requirements usually do not change.</td>
<td>6. Manpower staffing requirements change during execution due to scope fluctuations.</td>
</tr>
<tr>
<td>7. Project schedules can be updated weekly or monthly.</td>
<td>7. Turnaround schedules must be updated every shift, daily.</td>
</tr>
<tr>
<td>8. Projects measure time in days, weeks and months.</td>
<td>8. Turnarounds measure time in hours or shifts.</td>
</tr>
<tr>
<td>9. Project scope is usually all mandatory.</td>
<td>9. Turnaround scope is flexible. Usually a large percentage of work can be postponed to a later window of opportunity if necessary.</td>
</tr>
<tr>
<td>10. Project schedules are uncompressed. Schedule acceleration can be used to correct slippages in the critical path.</td>
<td>10. Turnaround schedules are compressed. There may be little or no opportunity to correct the critical path by accelerating the schedule.</td>
</tr>
</tbody>
</table>
PROJECT SCOPE MANAGEMENT
One of the greatest challenges in a turnaround is scope management. This is true for virtually all phases of scope management as outlined by the PMBOK, viz. Scope Planning, Scope Definition, Scope Verification and Scope Change Control.

Scope planning, definition and verification
Unlike EPC projects – which usually have a well defined scope established with long lead times before the project execution phase – it is common for turnaround scopes to be changing up to the last minute before project execution. There are several factors contributing to this –

- Market conditions (plant profitability) can cause variability in considerations for the budget (requiring scope adjustments), window (squeezing or relaxing the time frame available for executing the project) and start date (which may affect the decisions on what scope to include, the ability to plan the work, or material availability).
- Planning input is usually derived with input from Operations, Inspection, Safety, etc., and Operations may continue to identify potential scope for the turnaround until the last minute.
- The availability of specialised tools, materials, equipment and/or resources may affect decisions on how to approach portions of the scope (i.e. plans may need adjusting to accommodate a different method or scenario to accomplish the same goal).

One result of this is that turnaround budgets are rarely based upon a complete, detailed plan. They are often based upon conceptual estimates, extrapolations of past turnarounds, or on incomplete planned scopes that are compensated with a large allowance for contingencies, and it is therefore necessary to review the cost estimate for the final approved scope and make sure it is covered by the approved budget or authorisation for expenditure (AFE). If not, either the scope should be culled where possible (or failure to meet the budget will be pre-determined) or the budget should be adjusted to reflect the plan (not always politically viable).

Scope change control
In a turnaround, the scope will change - sometimes dramatically. As equipment is opened, cleaned and inspected the extent of required repairs can be determined, planned, costed and either approved or tabled for a future window of opportunity. Every add-on to the schedule should be processed with a defined procedure for evaluation/approval. An additional challenge is presented in companies where the existing culture allows operators to direct work crews (or get supervisors to direct work crews) to perform work that for one reason or another was not included in the approved project scope. The only solution is to change the culture to respect the defined procedure for add-on approval. Operators and supervisors or superintendents must buy in to the add-on approval procedure and field hands must be directed to work only on approved scope as directed by their supervisors. Where this is not possible (or there is a ‘work in progress’) it is imperative to at least document and account for these unapproved jobs, where performed, so that progress tracking (earned value) may give a meaningful impression of the productivity of the field work.

Operators and supervisors or superintendents must buy in to the add-on approval procedure and field hands must be directed to work only on approved scope as directed by their supervisors.

Management needs to exercise care when evaluating add-on repair scope, in order to ensure that existing resources, productivity and time can accommodate the work (where the repair scope is not operationally critical or safety critical). Management can end up in a position of balancing the impact of add-on repair work against the culling of original scope where resources become constrained on work that is non-
critical (from both a time and operational or safety point of view).

It is desirable to classify scheduled or progressed activities according to two main criteria, viz.

(a) • Approved Scope
   • Unapproved Scope
   • Cancelled Scope

and (b) • Original Scope
   • Add-On Scope

PROJECT TIME MANAGEMENT
One of the most obvious signs of the low maturity in turnaround project management is the state of the planning and scheduling that is intended to form the foundation of the management process. A successful turnaround management methodology must set a high standard for the planning and scheduling to be successful.

Scheduling
It is of paramount importance to understand that – unlike EPC projects where a baseline schedule is often used as a firm contractual commitment – a turnaround schedule should be considered a guideline tool to drive the execution of the work. This understanding is fundamental to developing a successful turnaround management methodology.

Turnaround managers have a lot of discretion with regard to scope management in schedules. While there will be portions of the scope aside from the critical path work that must be executed within the instant project, a significant portion of the scope may usually be postponed to future turnarounds or maintenance opportunities. As priorities shift, depending upon the scope of add-on repair work and resource constraints, managers need a turnaround schedule that offers flexibility in managing the non-critical work.

Baseline schedules (other than for critical and near-critical paths) are meaningless for turnarounds once they start. For turnarounds, it is expected that as inspections are performed, a changing scope (and therefore priorities for constrained resources or non-time-critical work) and often poor schedule compliance (due to unavoidable circumstances) will force the schedule for non-time-critical work to change from update to update.

Activity definition
The planning of activities that are overly broad in scope is one of the biggest obstacles to using a schedule for any meaningful purpose. They –

• are difficult to estimate with confidence,
• can mask details that the planner neglected to consider,
• preclude a detailed critical path analysis where more detail may allow refinements in the logic,
• detract from the accuracy of progress estimation (estimating % complete is more difficult).

Because of the compressed nature of turnarounds, there is a very small window available for recording and processing information on progress in order to generate updated schedules for the next shift. The greater the detail in the activity definition, the less thinking or guesswork is involved in assigning progress to the defined tasks.

Activities must be clearly defined, and should be measurable. This means anyone should be able to determine whether a particular activity (as defined) is in progress, or completed. Activities must be defined every time there is a break or change in work content, or changes in the work crew.
Because of the dynamic nature of turnarounds it can be counter-productive to employ soft logic and resource levelling schemas that smooth the schedule. Both techniques are designed to produce a static plan for execution that is not practical for turnarounds. Soft logic will necessitate constant time-consuming changes and updates to maintain a meaningful schedule once deviations from the schedule occur (and this is expected in a turnaround). Resource levelling schemas that alter a hard logic schedule will introduce multiple problems within a turnaround context. (See the white paper Resource Levelling or Critical Mass? on our website: www.interplansystems.com/html-docs/resource-leveling-critical-mass.html).

It is instead preferable to maintain a schedule for critical and near-critical path analysis and to allow field supervision discretion in directing their crews on non-time-critical work according to changing priorities and circumstances. At every update turnaround managers should monitor progress trends, productivity/earned value and scheduled resource requirements, to ensure that sufficient time and resources are available to complete the non-time-critical work within the span of the critical path.

At the end of a turnaround, the final scope of the execution usually encompasses several categories of work, viz.

- known scope (planned or estimated)
- anticipated repairs (may or may not have been planned or estimated)
- unanticipated repairs (not planned or estimated)
- unauthorised work (not planned or estimated)
- cancelled work (planned or estimated but culled during execution).

So, prior to execution, the turnaround manager may have a set budget covering known scope, anticipated repairs and some contingency allowance to cater for possible remaining items. Because most indirect costs (though not necessarily material costs) are keyed off the direct labour costs, the key to successful cost control in a turnaround is execution control (keeping resources productive) and scope management (balancing add-ons against non-critical work).

**Earned value management**

In most cases, it is very difficult to obtain a meaningful earned value analysis in a turnaround. There are several problems that conspire to frustrate the system:

- The process for capturing and approving actual hours usually lags behind the progress updates by at least one shift, if not two or three.
- The application of the correct work order and cost code number on timesheets is poor
- Unauthorised work is charged to existing work orders and cost codes but not captured for planning and estimating.

Where earned value analysis is conducted, it may be most meaningful to compare numbers analysed by resource type instead of by work order or cost code. In this fashion, managers may have some measure of the productivity of the resource relative to the schedule.
PROJECT QUALITY MANAGEMENT

According to the PMBOK, project quality management entails several aspects, viz. –

• quality planning,
• quality assurance,
• quality control.

Of these, quality assurance and quality control are usually well defined (and in some cases, government regulated) for safety concerns in turnarounds. Quality planning, on the other hand, is an issue that is usually poorly addressed. It is recommended that organisations employ a system for capturing and improving plans and estimates for recurring jobs from turnaround to turnaround. This entails benchmarking during execution and a follow up review post-execution to update the system. Too often, the follow up review never occurs and it is left to chance that the planner will remember necessary details the next time a turnaround involving the same unit is planned.

In many cases where the preparation time for planning a turnaround is compressed or inadequate there is a better than average chance that turnaround plans based upon templates (or historical plans) will suffer from cut and paste syndrome and not receive due consideration for customising to the instant situation. The best solution for mitigating these problems is to use a planning system like eTaskMaker®.

PROJECT HUMAN RESOURCE MANAGEMENT

Most turnarounds involve managing a large contract work force to execute the project. The dynamics of organisational planning and staffing are usually well understood. The industry is mature enough for project roles and responsibilities to be well defined. There is a mature support industry of specialised and general contractors to supply the necessary human resources.

Probably the greatest challenge that turnarounds present in comparison with EPC projects is the management of the human resource. This is true at a macro (overall staffing levels) and micro (delegation of work to labour pools) level.

Most turnarounds staffing levels can be represented with a bell curve. Staffing levels for specialised skills are increased slowly as units are blinded and vessels opened. Staffing levels are reduced as repairs are completed near the end of the turnaround. Managers should analyse staffing levels versus schedule requirements frequently (in some cases daily) to ensure that sufficient manpower is available to complete the bulk of non-time-critical work within the span of the critical path while also demobilising excess manpower to control costs.

It is critical to the successful execution of a turnaround for field supervisors and superintendents to foster a co-operative teamwork spirit with regards to managing the existing labour pool. Where supervisors and superintendents are held accountable for meeting individual schedule and progress goals, competition for (and hoarding of) skilled labour can occur and jeopardise the project success. Supervisors and superintendents should bear equal responsibility for meeting the overall schedule and progress goals.

PROJECT COMMUNICATIONS MANAGEMENT

One of the single most important aspects of successful turnaround management is communication. Because of the compressed time frame, there is less time available to everyone in the turnaround team to overcome the problems caused by poor communication.

Communications planning

Many turnaround organisations do not have a communications plan outlining team members’ information needs, delivery schedule and distribution system. Ad hoc reporting does not provide the necessary foundation for maintaining high visibility of the project to all stakeholders. A proper communications plan should include –
Information distribution

Since turnarounds are so dynamic, information needs to be updated every shift if visibility and control are to be maintained. In order to help field supervision stay on top of changing schedule priorities, it is recommended that complete schedule updates be initiated just before the end of every shift so that they may be disseminated to the field at the start of the next shift. Without this, the schedule will quickly become meaningless as a tool for managing and driving the project scope and execution. Stakeholders in turnarounds are always pressed for time. It is recommended that all disseminated information conform to standard report formats, familiarity with which will enable team members to read and digest the information quickly and will minimise the potential for misinterpretations.

Performance reporting

A turnaround project should not be analysed in the same manner as an EPC project. Their dynamics and characteristics are different. Baseline schedules that drive EPC project analysis are relatively meaningless for turnarounds after the first couple of shifts.

Turnarounds require specialised metrics for analysis, e.g.–

- **Summary progress attainment curves for measuring, tracking and trending against earned progress.**
- **Critical mass**

(see our website – [www.interplansystems.com/turnaround-project-management-primer/critical-mass.html](http://www.interplansystems.com/turnaround-project-management-primer/critical-mass.html)).

**PROJECT RISK MANAGEMENT**

Turnarounds usually entail a high degree of risk. Because the scope of work is only partially known, managers must prepare for the possibility that the effort to clean or repair equipment may exceed estimates and expectations when the equipment is opened and inspected for the first time.

*It is recommended that risk analysis be considered for critical and near-critical path work in the schedule because such work carries the greatest likelihood of affecting timely completion.*

In general, it is not practical to attempt to model all potential risks within the project schedule. There are virtually infinite possibilities for required repairs on the more complicated pieces of plant equipment like compressors, heaters/furnaces, towers, etc.

It is recommended that risk analysis be considered for critical and near-critical path work in the schedule because such work carries the greatest likelihood of affecting timely completion. Managers must balance the cost of maintaining any specialised parts or materials for identified risks against the cost of a possible schedule delay should such parts or materials need to be procured at the last minute.

**CONCLUSION**

Turnarounds are very challenging and dynamic high performance projects. They have many unique characteristics that differentiate them from other types of projects. The EPC-centric approach to project management does not work very well for managing turnarounds.

It is hoped that this paper may prompt the reader to consider employing a turnaround-specific methodology for managing turnarounds. Considering the stakes involved, it is high time that industry adopted a more mature approach to this task.