Lessons Learned from Recent, Large and Complex Construction Projects: A Compilation of Case Studies

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Abstract

This paper and presentation take a prospective and retrospective look at conditions and issues that give rise to claims, disputes and litigation associated with large and complex projects. The emphasis is on planning and progress-related features, issues and ways of working. While complex, the issues associated with project disputes and claims (avoidance, preparation and resolution) are linked by common planning/development and resolution features. Dealing with these common issues has two views (or perspectives) and hence two opportunities for (or paths to) success (or failure). Understanding the conditions that lead to (or avoid) claims can be helpful in successful project planning. Understanding these same issues from a retrospective view can help establish cause and effect. The content is based on lessons learned over the past five to six years in actual project environments. All case study situations and topics are based on actual situations and circumstances. The issues are real and the cause and effect relationships are fact-based.

Topics and Issues addressed (in this paper and the associated presentation) include: Single Asset Owners, Owner-Furnished Equipment, Managing Critical Work (Critical Path Visibility and Parallel Critical Paths), Managing Non-Critical Work and Labor Disruption.

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Single Asset Owners

Introduction

Revenue generating facilities (e.g. power plants, chemical process facilities) are sometimes owned by a standalone entity. The design, engineering, procurement, construction, commissioning, startup and turnover of these plants and facilities can be particularly challenging for both owners and contractors. The planning, scheduling and execution of these requires attention to some unique and compelling factors.

Owners are financed using project financing that is typically derived from financial analyses focused on return on investment, cash flows and other time-related concepts. In these situations, the owner's balance sheet is limited and cash availability is the key. Further, these project management teams are formed from contract personnel with little or no infrastructure. Implementation tools for simple concepts such as project control processes, technical specifications or standards, and interface procedures may not exist.

The project management teams (owner) may consist of contract personnel. While individually competent and skilled, the "ad hoc" nature of such an organization is more characterized by individual skill sets and less by owner-oriented project management processes and infrastructure. Further, this sort of owner has no track record or reputation in the marketplace. This creates additional risk for the contractor.

Another compelling factor is the nature of financing and/or ownership. Projects that have public ownership tend to be particularly difficult for enlightened management if (and when) significant unplanned disruptive events emerge.

Finally, these owners seem unusually averse to implementing changes that are to the contractor's benefit (equitably). Both money and time are issues with these project financed owners.

Consequently, unique project planning and control challenges exist.

A key characteristic relates to "staying power" in the face of significant disruptions to the planned execution. Significant disruptions alter the financial projections and cash flows that underlie the financing and project basis. Events that result in longer term (say 6-12 months) challenge the asset or balance sheet of these owners.

Case Studies

Examples of long term delays include serious design issues and major construction defects.

In one such case, a construction defect gave rise to a long term (3-6 months) delay. As the contractor responsibly proceeded with remediation actions the extended schedule created pressure on the owner's balance sheet (cash position). The delay was aggravated and extended by a force majeure event which further impacted the owner's staying power. Ultimately, the facility was liquidated through a bankruptcy proceeding. It is not apparent that any of the primary parties avoided serious and negative financial impacts.

In another such case, process issues (likely attributable to both the owner and the contractor) led to a prolonged commissioning and startup period/duration. Of course, during this extended duration, the owner's cash position was eroded over time. As above, the outcome was liquidation through bankruptcy.

In both cases mentioned above, another influence presented itself. Both facilities relied upon a common commodity as feedstock and the output of the facility was to be a commodity. In both cases, the feedstock and the finished product experienced negative marketplace changes during the (disrupted) engineering and construction period. Further, operating costs were problematic due to energy costs. These negative marketplace factors degraded the deteriorating project financial projects and, therefore, financing options. While hedges and other risk management techniques mitigated the impacts, the size and complexity of the delays were too much for the tolerance level of these owners.

Conclusions / Lessons Learned

The message and the conclusions in this regard is that unique and sometimes unorthodox planning and scheduling ways of working are necessary. These conclusions include:

- Clear interface specifications – the parties must clearly differentiate responsibilities regarding facility performance and scope of work. Owner involvement needs clear definition.
- Clear and definitive change provisions – the parties need to document how the contract price and performance period (duration) is to be administered. Further, timely resolution of differences is a necessity.
- Schedule maintenance – schedule development and updates are crucial in these time-sensitive projects.
- Contingency replanning – a process for replanning and restructuring the contract should be in place or the contractor and owner should have a set of contingency plans.

Owner Furnished Equipment

Introduction

Owner furnished equipment (OFE), also known by other terms such as "free issue" presents unique planning and scheduling challenges. The idea is that another party to the contract (hopefully) orders and supplies equipment, material (even services, such as utilities or scaffolding) to the contractor. The notion is that the contractor receives the equipment, goods or services and then erects, installs or otherwise uses these items.

The motivation for this type of arrangement can be one or more of several seemingly logical concepts. Equipment with long lead times for fabrication and delivery may be ordered in advance of placing a contract for the equipment erection or installation. Another motivation relates to cost savings. Some believe ordering equipment and commodities (bulk materials) can be done by a general contractor or owner and thereby save a markup by a

subcontractor. In these cases, an interface is created between the ordering/procurement entity and the execution (engineering, erection, installation, fabrication, etc.) entity. The creation of this interface becomes the issue.

The obvious challenge here is to plan and manage around the interface with the supplying (or contract specified) party. These interfaces serve to amplify any issues (delivery, quality, design) that emerge.

Large field erected and/or integrated equipment is a common example. Done for reasons related to long lead time delivery, these pieces of equipment tend to be on or near the project's execution critical path. Ordered by an owner, expediting (monitoring and assessing progress) can be a challenge that some owners are not equipped to address. Accurate forecasting of fabrication and delivery is essential for erection contractor planning and scheduling. As issues arise, some owners are not equipped to detect these variations to plan (assuming there is a plan). Further, some react by obscuring variations with the expectations that other unrelated issues will result in delays that will mitigate or negate the impact of the equipment variation.

Case Studies

In one case, the owner preordered a large piece of field erected and integrated equipment. As delays emerged and (later) were detected by the owner, the contract delivery obligation to the erection contractor became a problem. The action was to ship equipment in pieces, not assembled as anticipated by the erection contractor. This shifting of work from the factory to the field (and from the fabricator to the erection contractor) created a planning and scheduling issue. The problem was further aggravated by the remote location of the job site and the failure of the owner to disclose this action (in this case, inaction). Finally, fabrication defects were not detected in the shop (no shop erection) and the corrective work was transferred to the field. This added work aggravated the impacted schedule.

In another case, the owner was obliged to supply a key utility. This utility was essential (and planned) for use in construction. As the contract date for this utility came and passed, the owner refused to supply mitigation measures and forecast dates for the supply of this service. This lack of information prevented action by the contractor to mitigate the owner's issue.

In yet another case, a general contractor ordered commodity materials for installation by specialty subcontractors. Untimely delivery of the commodities caused delays and disruptions to the subcontractor work. While the subcontractors in question did not have suitable project control procedures to detect and show "cause and effect," the subcontract operated at a loss and claim resolution was required. This resolution was frustrated by the lack of effective project controls covering this key interface.

Conclusions / Lessons Learned

The message and the conclusions regarding owner furnished equipment (free issue material) is that unique and aggressive planning and scheduling ways of working are necessary. These conclusions include:

- Clear interface specifications – the parties must clearly differentiate responsibilities regarding facility performance and scope of work. Owner involvement needs clear definition.
- Clear and definitive change provisions – the parties need to document how the contract price and performance period (duration) is to be administered. Further, timely resolution of differences is a necessity.
- Schedule maintenance – schedule development and updates are crucial in these time-sensitive projects.
- Contingency replanning – a process for replanning and restructuring the contract should be in place or the contractor and owner should have a set of contingency plans.

As-Planned Schedule / Accepted Programme

Introduction

A Critical Path Management (CPM) plan and schedule is one of the most fundamental managerial tools used in professional project management. It reflects (hopefully) the intention of the lead or prime contractor regarding project execution. Further, it reflects (again, hopefully) the intentions of all key stakeholders, including the owner.

Ideally, this meeting of the managerial minds can be achieved and documented through a schedule approval process. Again ideally, the detailed schedule would be developed in a timely fashion and submitted to the owner. Once revisions and improvements have been achieved, the owner would approve this tool. Once approved, this baseline schedule would form the as-planned schedule (or accepted programme, as termed in United Kingdom).

An issue arises when the contractor fails to submit a suitable schedule and/or the owner refuses to approve a suitable submission.

Cases

In one case, the contractor submitted a proposed CPM schedule; however it did not conform to the contract time provisions and requirements. The owner (rightfully, by most standards) refused to issue an approval. The parties then proceeded without resolution of this key baseline matter. Ultimately, when time-related disputes arose, the contractor was unable to demonstrate a cause and effect relationship under the contract provisions. This unfortunate situation precluded the contractor from prevailing on an otherwise legitimate claim against the owner.

In another case, the contractor prepared and submitted a (seemingly) legitimate schedule in a timely manner. The owner replied with some comments and requests; but failed to take action regarding approval or disapproval. The parties proceeded to use (essentially) the submitted schedule and updates for managerial purposes including replanning and resolution of issues. This platform provided the contractor a tool for use in preparing time-related claims.

Conclusions / Lessons Learned

The message and the conclusions regarding schedule submission and approval is summarized in the following recommendations:

- Contracts should contain clear requirements and process provisions that address schedule preparation and approval
- Contractors (regardless of contract provisions to this effect) need to prepare thoughtful and complete schedules with the intent being to gain a meeting of the minds through approval action by the owner.
- Owners should insist on and review the initial schedule submissions and ensure ultimately the parties converge on a clear position regarding the as-planned schedule.
- Lacking approval action by the owner, contractors should act to legitimize their intended as-planned, baseline schedule. Actions that tend to legitimize the intended (and submitted) schedule include: use for managerial purposes, use as a basis for updates and submit the updates, include updates in the periodic progress reports, and use the most current update for actions such as change requests and dispute resolution.

Managing Critical Work

Introduction

Critical Path Visibility

One of the most fundamental tools for a project manager and her / his team is the CPM schedule. Further, clear visibility and utilization of this Key Performance Indicator (KPI) is essential to successful ongoing management.

In baseball, there is a cute and very old gimmick called the “hidden ball trick.” The idea is to conceal the ball in your glove in order to trick a base runner into taking a lead (haphazardly) off a base. The trick is then completed by tagging the unsuspecting runner with the ball (concealed in your glove hand).

During the prolonged duration (longer than the longest baseball game) of a lump sum turnkey or engineering, procurement and construction (EPC) contract, there is a tendency to hide the critical path. This tendency (unlike a trick) can occur during:

- Design/Engineering

- Procurement of bulk materials
- Fabrication (typically piping)
- Construction/Erection (first 60-75%).

The notion is that, during the above phases of work, planners and schedulers tend to think in terms of bulk progress (not to be confused with bulk materials). For example, engineering can be planned and progressed through isometric drawings without regard to the priority for individual deliverables (drawings). During procurement, valves and fittings are purchased and expedited without regard to criticality of the underlying piping system. In fabrication, metrics can be chosen that emphasize numbers (or count) of spools without regard to urgency. Finally, during early construction, progress emphasis is often by area and bulk material (e.g. tons of steel), not key systems (e.g. critical power, specific piping systems). The result is a loss of visibility and loss of emphasis on management of the critical path work.

In one case involving a refinery retrofit, the construction was to occur in the Los Angeles basin. Air quality issues and related permitting, caused planning to include fabrication of modules at a remote location. Largely piping (some electrical and instrumentation), this required that piping materials be procured and delivered to the fabrication yard. Procurement strategies called for piping from one vendor, valves and fittings from another. The material was then to be shipped to a fabricator for spool fabrication. Isometrics (or equivalent) were needed to support spool fabrication. The plan continued, once the spools were complete, they would be shipped to the modularization yard, integrated with other spools, steel, hangers and the rest. The modularization yard was thousands of miles from Los Angeles.

In this refinery case, the "devil was in the details." Piping design managed by drawing count, purchasing managed by bulk items ordered, expediting was being managed in a similar (bulk) manner, and the scenario went on in a similar manner. All the pieces had to arrive at the fabrication yard in a synchronized manner to support erection of the modules. Once fabricated, the modules were shipped several thousand miles to the site.

The project schedule was developed using bulk progress in all of these activities, without the logic and detail to determine status and prognosis at the fabrication yard. Of course, once the details and logic were added to the schedule, it was obvious that the fabricated modules could not be completed as required to support construction during the refinery shutdown. Faced with this dilemma, what was the initial answer? "Ship the fittings to the site for installation in the field." Likely, the air quality people would not have been sympathetic to this solution to defective planning.

In another case, a process plant was being designed and constructed under a Lump Sum Turnkey (LSTK) execution strategy and contract. The schedule duration was several years and the underlying work (by the contractor) included design and engineering, procurement, construction and erection, commissioning, startup and turnover. Within these phases and the related activities, detailed logic and progress was inserted into the baseline schedule and periodic updates. Since the contractor was operating under an LSTK arrangement and was experienced in these facilities, the contractor knew the intended startup sequence.

Unfortunately, the plan and schedule used bulk progress for design / engineering, bulk procurement / expediting and early construction (by area). Consequently, the systems startup approach was obscured until later in construction when the transition to a startup (system logic based) schedule format was implemented. As a consequence, the management team lost the use of a key managerial tool, critical path progress based on a systems perspective.

Parallel Critical Paths

On long duration, complex projects, parallel critical paths can be encountered. While truly parallel critical paths are unlikely, the variances in duration, logic and other factors, can give the appearance or effect of such a situation. This is not necessarily a problem when the work on these (near) parallel critical paths is the responsibility of the same party.

When multiple parties have responsibilities on differing parallel critical paths, the issue become problematic. For example, if the owner controls one critical path (a permit, for example) and the contractor controls work on the other critical path (for example, site construction restrained by the permit, but otherwise critical). In this case, a delay by

one party on their critical path will impact the other party. However, a delay by the other party at approximately the same time may well create a concurrent delay situation.

Case

In one case, a LSTK contractor was reliant on the owner to supply a key utility to support continuation of site work. Both parties experienced delays independent of the other parties' work. The contractor provided schedule updates detailing the forecasted date requirement for the owner utility. However, the owner refused to provide any forecast for the resolution of the owner's delay in providing this key utility. Instead, the owner took the position that the owner-furnished utility would be available when actually needed by the contractor (contractor delay resolved). The matter was further complicated by the fact that the owner obligation was a date certain in the contract.

Ultimately, the contractor was ready (contractor delay having been resolved) prior to the owner. The owner proceeded to use certain administrative barriers and processes to prolong the contractor readiness. Retrospective analyses and record review revealed that the owner delay had preceded the start of the contractor delay and was resolved later than the contractor. Resolution of this issue was greatly complicated by the owner's actions and/or inactions during the delay period.

Conclusions / Lessons Learned

In the situations discussed above, several conclusions and/or lessons learned emerge:

- Regarding establishing the as-planned schedule, seek a meeting of the minds between the contractor and the owner through an approval process. Lacking approval, use the intended schedule for manager purposes, periodic updates, managerial reporting and as a basis for changed work evaluation.
- Regarding potential concurrent delays, both parties need to be aggressive in seeking status and forecast information from the other party. Further, the practice of "pacing" during concurrent situations is problematic and lead to liabilities during possible dispute resolution proceedings (this last matter is not discussed in this paper due to limitations on the allowable length of the paper).

Managing Non-Critical Path Work and Labor Disruption

Introduction

The challenge associated with managing non-critical path work is common to virtually all LSTK projects. In addition to the normal issues associated with bulk progress, actions or inactions by the owner can add considerable complexity to this challenge. Owner delays can be masked among the myriad of activities that are the responsibility of other (than the owner) stakeholders. Even when detected or disclosed, these variances to plan are often dismissed as simply consuming available float. Hence, the owner (or other stakeholder) may rationalize as having no impact. Of course, the reality is that these sorts of departures may (or may not) add risk or disruption to the project execution. The managerial challenge becomes detection, assessment and quantification, should it be appropriate to compensate the contractor for the impacts.

Cases

In one such case, the owner had an obligation to provide various utilities to support the construction plan and schedule. While these requirements were contract requirements (dates certain), the owner was materially late with the actual dates. When pressed, the owner took the position that the contractor was not truly ready for the utility and that the impacts of the delays merely served to consume float.

The contractor provided a retrospective "S" curve analysis to demonstrate the impact (time) and a retrospective measured mile analysis to demonstrate related disruption. While the analyses demonstrated cause and effect, the lack of timeliness coupled with notice requirements degraded the effectiveness of the underlying position. These analyses were used to advance a negotiated settlement.

Conclusions / Lessons Learned

Schedule risk and labor disruption can be suitable recognized and demonstrated through the use of analyses such as "S" curves and measured mile. Since timeliness and notice are compelling issues, the contemporaneous project reports and managerial action must be sufficiently robust to achieve detection and quantification of these problematic variances.

Conclusions

Many of the challenges in the planning and management of large and complex project with long duration execution periods are unique. However, most are common to other engineering, procurement, construction and/or startup projects. The lessons learned in the larger projects can be applied to management situations encountered by many project management teams.

The individual conclusions and lessons learned that are listed above have been extracted from actual experience with larger and more complex projects. They are the author's assessment of reasonable approaches to the underlying issues. This should not be confused or interpreted as the only approach or even the best approach to the issue as presented. Perhaps the value is in the statement of the issue and the dilemma that is created. Best of luck in your future project management ventures.

Bibliography

America, M. C. (2005). *Change Order Productivity Overtime* . Rockville: Mechanical Contractors Association of America .

Callahan T, M. (2009). *Construction Change Order Claims Second Edition.* Frederick: Aspen Publishers.

Davison, P. R., & John, M. (2009). *Evaluating Contract Claims Second Edition* . Ames : Wiley-Blackwell.

Institue, P. M. (2007). *The Practice Standard for Scheduling* . Atlanta : Project Management Institue .

Institute, P. M. (2005). *Practice Standard for Earned Value Management* . Newton Square : Project Mangement Institute .

Institute, P. M. (2006). *Practice Standard for Work Breakdown Structures Second Edition* . Atlanta: Project Mangement Institute .

Law, S. o. (2002). *The Society of Construction Law Delay and Disruption Protocol* . Oxforshire : Society of Construction Law .

McDonald Jr, D. F., & Zack Jr, J. G. (2004). *Estimating Lost Labor Productivity in Construction Claims* . Morgan Town : AACE.

Pickavance, K. (2005). *Delay and Disruption in Contruction Contracts Thrid Edition* . London : LLP.

Schwartzkopf, W. (2004). *Calculating Lost Labor Productivity in Construction Claims: Second Edition.* Frederick: Aspen Publishers.

Wickwire, J. M., Driscoll, T. J., Hurlbolt, S. B., & Grof, M. J. (2010). *Contruction Scheduling: Preparation, Liability, and Claims Third Edition* . Frederick: Aspen Publishers.