Best Scheduling Practices

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Outline

• **Background**

• Definitive Project Schedule
  – Comprehensive
  – Based on sound scheduling techniques
  – Resource-loaded
  – Used as a control tool
  – Applied to all contract types

• Conclusions and Recommendations
What Practices Really Matter?

• The quality and completeness of the Front-End Loading (FEL) prior to the start of execution

• Integration of the project team around:
  – The business purpose of the project
  – Team roles and responsibilities

• The timely and effective use of Value Improving Practices
Front-End Loading Measurement

**Site Factors**
- Equipment layout
- Soils data
- Environmental requirements
- Health & Safety requirements

**Engineering Definition**
- Engineering tasks
  - Detailed scope
  - Feedstock/product properties
  - Program Definition
  - Space Planning
  - Adjacencies
- PFDs
- H&MBs
- P&IDs
- One-line elec. diagrams
- Major equipment specs
- Cost estimate
- Participation/buy-in of:
  - Operations
  - Maintenance
  - Business

**Project Execution Plan**
- Contracting strategy
  - Who
  - How
- Team participants & roles
- Integrated schedule
  - Critical path items
  - Identification of shutdowns for tie-ins
  - Overtime requirements
- Plans
  - Commissioning
  - Validation
  - Startup
  - Operation
  - Manpower
  - Quality assurance
- Cost/schedule controls

**FEL**
Schedule Definition Is a Key PEP Element

- Provides a framework for planning the project
- Identifies critical activities, relationships, and constraints
- Functions as a communication tool
- Provides a tool for controlling the project
- Provides the platform for integrating cost and schedule estimates
- Pulls different PEP elements into a single model
Cost Index Analysis

Schedule Definition Drives Cost Performance

- Resource-Loaded
- CPM Schedule
- Milestone
- No Schedule

Average Cost Index

pr < 0.00
Other Project Outcomes

• Schedule definition at authorization is also correlated with other key project outcomes:
  – Execution schedule performance
  – Cost growth
  – Schedule slip
  – Construction productivity

• Relationships are independent of other key project drivers.

• Relationships hold for both large and small projects.
If Project Scheduling Is So Important ...  
*Why Such Slow Improvement?*

Year of Authorization

- **Not Used**
- **Factored**
- **Preliminary**
- **Definitive**

Industry average PEP definition at authorization  
(Controlling for project size)
New Data Collection Elements

• Started collecting electronic schedule files in June 2000:
  – Pacesetter and prospective project evaluations
  – MS Project®, Primavera P3®, Primavera SureTrak®

• Introduced new workbook questions in 2001:
  – Provide additional data to support schedule definition rating
  – Data are collected as part of every project interview
Cut to the Chase:  
*What Does a Well-Defined Schedule Look Like?*

Results are based on combination of sources and analysis techniques:

- Evaluation of individual schedules
- Statistical analysis of data
- Discussions with project teams
- Application of fundamental scheduling practices and theory
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Definitive Project Schedule: Comprehensive

A project schedule should cover the entire project scope and life-cycle and include sufficient detail to reflect the project’s execution plan.
Integrated Schedules

• Integrates all project phases into a single master schedule:
  – Definition, detailed engineering, procurement, construction, shutdown/turnaround, and commissioning and startup

• Only 40 percent of project schedules include all applicable project phases:
  – Many are missing FEL, shutdown/turnaround, or commissioning and startup
Integrated Schedules
Correlated With Cost Performance

pr < 0.05
Level of Detail

- Each phase should be detailed enough to show specific activities and transitions
- Specific elements to consider include:
  - Project definition activities and system requirements
  - Specific engineering design activities and milestones
  - Activities regarding major equipment purchases
  - Design packages issued to construction
  - Construction activities, milestones, and interfaces
  - Turnover of specific systems, commissioning and startup activities
Classic Approach
*Schedule and Cost Developed Around WBS*

- Project Scope
- WBS
- Project Schedule
- Project Cost Estimate
- Project Controls During Execution
Reflects Planned Approach

- Authorization process
- Contracting approach
- Design and construction packages
- Plans for work calendar, shift work, and overtime
- Turnaround/shutdown coordination
- Turnover sequence
- Commissioning and startup plan
Scheduling Turnover Sequence
*Reduces Risk of Serious Overrun*

- Included Turnover Sequence in Schedule: 10%
- Did Not Include Turnover Sequence in Schedule: 40%

$pr < 0.06$
Reviewed With Core Project Team

• Schedules should be reviewed with core project team to support buy-in to the plan.

• Review also provides a check for accuracy and feasibility.

• 25 percent of schedules are not reviewed by the team.
  – Lack of review is correlated with higher cost growth.

• This review provides an easy opportunity to improve the schedule.
Definitive Project Schedule: 
\textit{Based on Sound Scheduling Techniques}

Project schedule should be based on the application of modern scheduling techniques.
Industry Practices

• Only 55 percent of schedules are based on CPM:
  – Activity dates and project duration based on network calculation
  – Clear critical path

• Remainder are high-level milestone schedules using a loose network of activities.

• Almost 8 percent of projects are authorized with no schedule of any type.
Activity Float

• Activity float is used to identify the critical path and near-critical paths:
  – Excessive float indicates logic errors
  – Excessive float also indicates lack of analysis to ensure schedule activity dates match plans

• Many schedules include high levels of activity float:
  – Teams are simply managing to early dates
  – Reduces usefulness of CPM technique
  – Major problem when fighting contractor claims
Network Design

• Tie all activities together into a complete network.

• Limit use of activity constraints
  – Excessive use of constraints results in logic errors.
  – Source of problems as the schedule is updated with actual progress.

• Specify multiple work calendars to model planned workweek and amount of overtime and shift work.
Definitive Project Schedule: 
*Resource Loaded*

Critical project resources are loaded into the schedule using appropriate units of measure.
Why Resource Load Schedules?

• Basically, you do not know if the planned approach, schedule, and cost are feasible until you evaluate a resource-loaded schedule

• Resource-loading helps to validate approach
  – Ensures alignment between cost estimate and schedule
  – Enables evaluation of peak labor
  – Provides model for resource leveling
  – Focuses team on the critical resources
  – Aids in portfolio management
Resource Loading

Correlated With Cost Performance

Cost Index

pr < 0.01

+1 Std.
Mean
-1 Std.

Resource Loaded

Not Resource Loaded
Resource Loading

…and With Schedule Performance

Mean

pr < 0.06
Resource Loading Approach

• Focus on the key resources that drive project cost and schedule:
  – Which resources represent the highest costs, may be in short supply, may experience congestion, need active management during execution?

• Load labor resources to the discipline or craft level.

• Load project budget to generate accurate cash flow.
Definitive Project Schedule: 
*Used as a Control Tool*

The project schedule should be continuously updated and maintained as a control tool throughout the project life.
Industry Practice

• IPA’s Project Control Index measures the level of project controls applied to projects:
  – Active owner project controls, physical progressing, and frequent reports are drivers of success.

• Most schedules are abandoned at some point during the execution phase:
  – Project teams cannot conduct variance analyses without updated schedules.
  – No historical data are available for use on future projects.
  – Schedule history will be missing in event of claims.
Definitive Project Schedule: 
*Applied to All Contract Types*

- “My project is lump-sum EPC. I don’t need to do a schedule, it is the contractor’s responsibility.”
  - Lump-sum EPC projects typically have less well-defined schedules at authorization.

- Previous IPA research shows:
  - Lump-sum EPC projects typically have higher costs.
  - Outcomes are extremely sensitive to levels of definition.
Why Bother for EPC Lump-Sum?

- Shifting risk to the contractor does not compensate for the lack of definition at authorization.
- EPC contractor typically does not manage all phases.
- Many of these lump-sum projects also include other scope elements that must be integrated efficiently.
- Provides cross check with the cost estimate.
- Facilitates constructability reviews.
- Provides a tool to check the validity of the contractor’s schedule.
Cost Index Analysis

Schedule Definition for Lump-Sum EPC

Cost Index

-1 Std. Mean +1 Std.

pr < 0.00

Resource Loaded CPM Schedule Milestone Schedule
So What Is Reasonable?

Develop a master project schedule independent of the contractor in support of authorization.

• Reflect level of data used to build cost estimate.

• Resource load with most critical resources onto summary bars.

• Focus on transitions from FEL to execution and turnover from execution to commissioning and startup.

• Build in key deliverables and interfaces required by owner.
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Conclusions

So what does a well-defined project schedule look like?

• Comprehensive

• Based on a sound application of network scheduling techniques

• Resource loaded with critical resources

• Applied to all project types and contracting formats

• Used as a tool for project controls and historical record
Cost Index Analysis

*Great vs. the Rest*

![Cost Index Analysis Diagram](image)

- Cost Index
- Integrated, CPM, Resource-Loaded, Turnover Sequence, Team Review
- Missing One or More

+1 Std.
Mean
-1 Std.

pr < 0.02
Benefits of Investing the Effort

• Only 6 percent of recently completed projects met all five criteria.

• However, data show a significant difference in cost performance for these few projects.

• Data also show directional improvement for other outcomes:
  – Schedule slip
  – Cost growth
Recommendations

• Actively drive the planning process and ensure the participation of key team members.

• Build planning and scheduling core competency within your organizations.

• Use the project schedule for:
  – Planning and communicating during FEL
  – Project control during execution
  – Recording historical data for future projects

• Don’t do it just to get the “score” from IPA!