Scheduling Challenges in the Industrial Construction Sector

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Agenda

- Scheduling Practices and Project Success
- Schedule Specifications and Schedule Planning
  - Rolling Wave
  - Traditional – Integrated or Stand Alone
- Managing Multiple Schedules and Schedule Distribution
- Schedule Checking
- Update Cycle and Capturing Impacts
- Cool Reports ~

Scheduling Practices and Project Success

- Dr. Andrew F. Griffith, PE
  - Independent Project Analysis, Inc. based study
    - 494 completed major industrial capital projects (72% from North America, 58% petro-chemical)
    - Projects authorized from 1993 to 2003 (Median Q3 2000)
    - Average cost of $24M, median $4.3M, range $100k to $934M
    - 59 different owner organizations~

Scheduling Practices and Project Success

- Methodology:
  - IPA project data collected at project authorization and project completion
  - Measures of project success:
    - Cost
      - Cost Index - Cost performance relative to the industry benchmark for comparable projects
      - Cost growth relative to the estimated cost at the time of project execution
    - Time
      - Schedule Index - Execution schedule relative to the industry benchmark for comparable projects
      - Schedule slip relative to the planned project finish date set at the time of authorization~

Scheduling Practices and Project Success

- Project Definition Rating – 494 Projects:
  - No schedule – 3% (15 projects)
  - Milestone schedule – 55% (272 projects)
  - CPM Network schedule – 29% (143 projects)
  - CPM Network with resource loading – 13% (64 projects)~

Scheduling Practices and Project Success

Outcome Metric	Resource Loaded CPM	CPM	Milestone
Absolute Cost Index	0.95	0.98	1.03
Absolute Schedule Performance	0.91	0.97	1.04
Percent Cost Growth	-1%	2%	5%
Absolute Schedule Performance	0.91	0.97	1.04
Percent Schedule Slip	2%	19%	25%

Cost & Schedule Comparable to Similar Projects

Cost & Schedule Baseline Comparison

CPM, Resource Loaded and Core Team Reviews

Outcome Metric	Projects that did Core Team reviews	Projects that did not do Core Team reviews
Percent Cost Growth	0%	11%

Scheduling Practices and Project Success

- Summary of Dr. Griffith's findings:
  - Fully Integrated schedule
  - Use Critical Path Method (CPM)
  - Resource load the schedule
  - Early detailed review of the schedule by the core project team
- This is the starting point!
  - Add Risk Analysis, Buffers, Analysis, What If's~

Scheduling Practices and Project Success

- Projects with the highest level of schedule definition at authorization had on average:
  - 8% lower cost
  - 13% faster schedules
- They were more predictable:
  - 6% less cost growth
  - 23% less schedule slip~

Schedule Specifications
Owners vs. Prime Contractors

- Owners: You get what you ask for
  - Review current schedule specification requirements P3 vs. P6
  - Ability to withhold progress payment
- Primes: Most Prime Contractors do some form of scheduling and believe they are doing enough
  - Cost more to develop and maintain (full vs. part-time scheduler)
  - Misconceptions - Loose control of the schedule
  - Size of the project – 40 M+ ~

Common Specifications

- Project Schedule Structure
  - Contractual Milestones
  - Clear Complete Scope of Work
  - WBS
    - Easily understood
    - Supports the major phases of the project
    - Supports the major components of the project
  - Coding
    - Phase
    - Area & Sub-Area (physical or administrative area)
    - Equipment #
    - Responsibility
    - Discipline
  - Activity ID structure
  - Calendars~

Common Specifications

- Standards/ Definitions /Conventions
  - Activities
    - Criteria (scope, duration)
    - Descriptions: Location, Verb, Noun
    - Understandable when taken out of context
    - Links and Open Ends - CPM
  - Resources
    - Major disciplines (electricians, welders, ironworkers…)
    - Major Equipment
    - Major Quantities~

Common Specifications

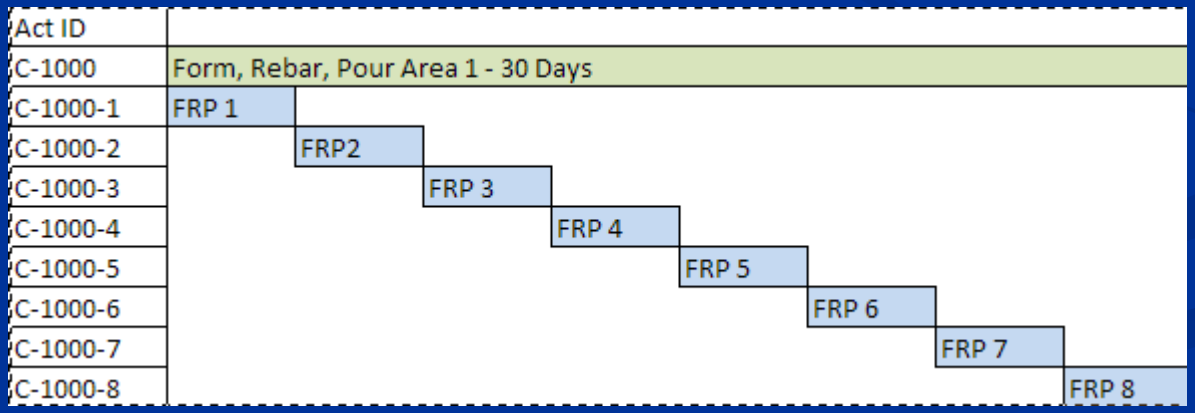
- Standards/ Definitions /Conventions
  - Numbering scheme and format for:
    - Filters
    - Layouts
    - Reports
  - Conventions for Adding Activities
  - Master Project / Subproject Process
  - Updating Cycle / Process
  - Updating Requirements
  - Reports - Provides appropriate information for each entity – Owner, Engineer/Architect, Contractor, Subcontractor
- ** Email / CC Owner all subcontractor schedule correspondence
- **Owner attend subcontractor meetings ~

Schedule Planning

- How are we going to manage the project and schedule
  - Type of Schedules
    - Rolling Wave
    - Traditional - Consistent Level of Detail
      - Integrated
      - Individual – Stand Alone~

Rolling Wave

- Schedule Development Rolling Wave
  - Initially High level of Detail then add additional activities prior to start
  - Original duration does not increase
  - Original Activity becomes a Level of Effort and tracks duration to baseline plan.
  - Project Duration or Engineering Considerations~



Integrated Schedules

- Master Project/Subproject structure
  - Time and cost savings
    - Dates are synchronized between schedules
    - Information updated one time only
    - Concurrent updating of schedules
  - Ability to link between projects
    - Schedules stay synchronized even when checked out
    - Links between projects are maintained at the master schedule level
    - Activity coding dictionaries, layouts, and filters are synchronized
  - Ability to "check out and check in" a project to individual companies for their updating.
    - Ability to do schedule comparisons both at the master project and sub project levels~

Integrated Schedules

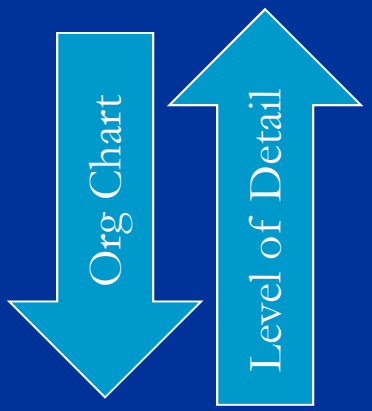
- Master Project/Subproject structure
  - Subprojects are useable during the month without effecting the master schedule.
    - 3 week look ahead
    - "what if" analysis
  - Subprojects can be transmitted as legal documents
  - Security
    - Each entity has access to only their subproject.
    - Subprojects do not have access to activities in the master other than viewing linked activities.
    - Data dictionary structure is controlled at the master level~

Management of Multiple Schedules

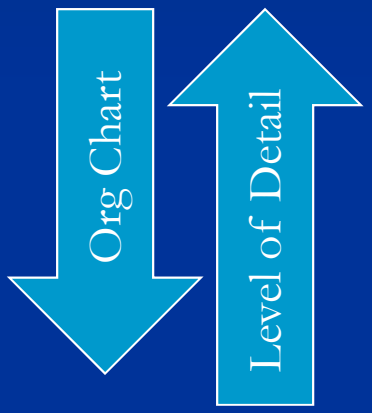
- Multiple Schedules with multiple levels of details
- Multiple schedulers with different skill levels.
- Mega Projects – Multiple departments with multiple schedules
  - Planning, Field, Quantity Tracking, Pay Apps, Design/Engineers, Monthly Reporting Narratives~

Management of Multiple Schedules

- Owner
  - Summary Bars and Milestones
- Prime Contractor
  - Full Scope of Work
    - 5 to 20 day activities
    - One activity per responsibility party/Subcontractor
    - One activity per area / sub-area or equipment # ~



Management of Multiple Schedules



- Sub-contractor
  - Subcontractor's Scope of Work
  - Relative Milestones or concurrent impacting activities
  - Crew tracking and man hours
  - Mini windows of access before next trade

Owner	PRP Concrete Areas 1-10					
Contractor	FRP 1			FRP 2		
Subcontractor	Form 1	Rebar 1	Pour 1	Form 2	Rebar 2	Pour 2

  - Change Order Preparation
- Associate Activities by ACT ID~

Schedules Distribution

- Electronic data distribution
  - Give out an electronic vs. paper schedule vs. no distribution
  - Monthly vs. weekly master schedule distribution
    - Monthly – dates change over time.
  - Export considerations
    - P6 versions
    - MS Project
    - Excel
    - Adobe Reader ~

Common Scheduling Problems

- Mechanically Correct
  - Level of Detail
  - Open Ends
  - Critical Path
  - Proper Links / Tie Offs
  - Coding vs. WBS
  - Minimum coding – Phase, Area, Equipment #, Sub-area, Responsibility ~

Common Scheduling Problems

- Mechanically Correct
  - P6 Settings
  - Resource loaded – Quantities, Man-hours, Costs
  - Calendar Start / Finish Hours
  - Data Date start Hour
  - AS / AF Hour
  - Constraints Start / Finish Hour
  - Duration not in whole days ~

Not Allowed Schedule Changes

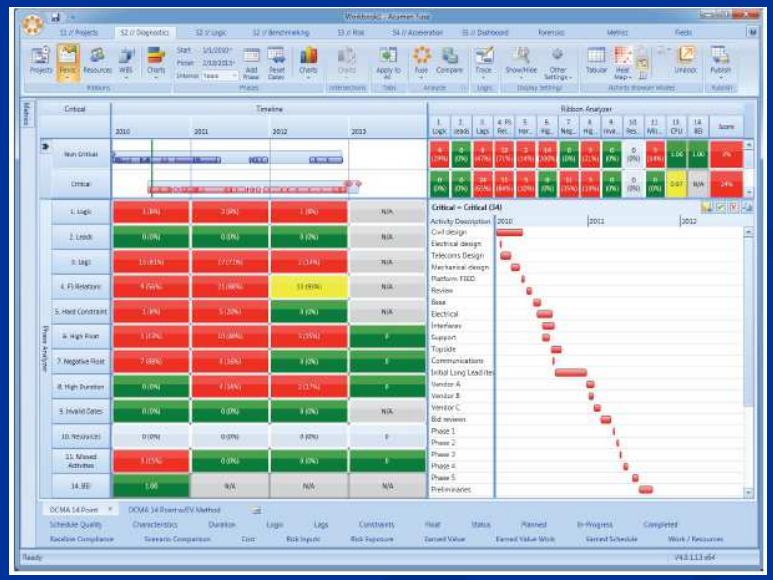
- Schedule changes –
- Activity ID
- Activity Description
- Responsibility reassignment
- Deleting and adding activities~

Schedule Integrity - Mechanically Correct

- QA steps
  - Configure software options
  - Close open ends
  - Remove Mandatory and Start/Finish On constraints
  - Justify every constraint used
  - Verify contractual Milestones / Dates are entered
  - Balance resource loading to the estimate
  - Review Float
    - Low Float
    - High Float
  - “Test” the schedule~

Schedule Software Checkers

- Primavera
  - P6 built-in checker (F9 Report)
  - Claim digger – Schedule Comparison
  - Primavera Risk Analysis
- SA Pro / Enterprise
- Acumen Fuse~



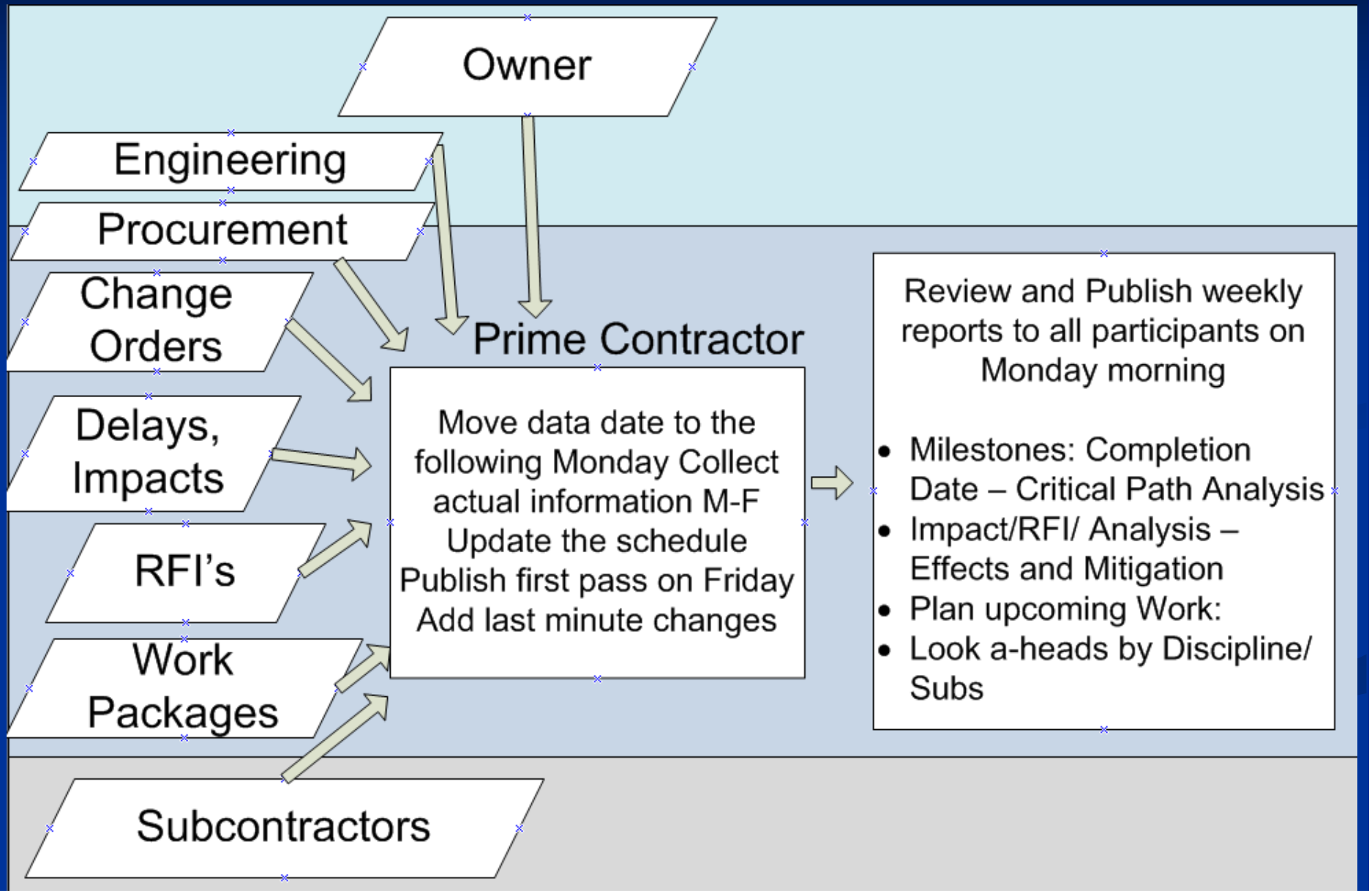
Schedule Software Checkers

	SA Pro / Enterprises	Primavera P6	Primavera Claim Digger	Deltek Acument Fuse	Primavera Risk Analysis
Cost	$1,900.00	$2,750 + $605 yrly maint.	Free with P6	$5,000 + $1100 yr maint+ S470 tax	$9,500 + $2,090 yr. maint.
Schedule Comparisons	x		x		
Task view		x		x	x
Softeware it Analyses	P6, MSP	P6		P6, MSP, Excel	P6, MSP
Constraints	x	x		x	x
Open-ended tasks (Does not include ignored links)	x	x		x	x
Out of sequence updates ("broken logic")	x	x		x	x
Lags longer than 100 units	x			x	x
Negative lags ("leads")	x			x	x
Positive lags on Finish-to-Start links	x			x	x
Start-to-Finish links	x			x	x
Lags between tasks with different calendars	x			x	x
Links to / from summary tasks					x
Duration uncertainty distribution shape 2	x			x	x

Update Cycle

- Execution – Following the Plan
- Forecasting vs. Historical
- Completion of activities – Rolling wave ~

Weekly Information Flow



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Schedule Impact Form

Date: _____

Company: _____

Project: _____

Impact Number: _____ → **Schedule Activity ID:** _____

Impact Start Date: _____ → **Impact End Date:** _____

Impact Description: _____

_____

Impact Type: (check one)

- o Excusable, Non–compensable
  - o Force Majeure (severe weather)
  - o Unexpected Subsurface conditions
- o Excusable, Compensable
  - o Design Error
  - o RFI's
- o Non–excusable, Non–compensable
  - o Subcontractor Performance
  - o Contractor Performance

Impact Cause: (check all that apply) Section Break (Continuous)

- o Act of God
- o Unknown Conditions
- o Design Omission
- o Design Error
- o RFI Process
- o Late RFI Answer
- o Estimate Omission
- o Scope Change
- o Late Submittal
- o Late Submittal Approval
- o Late Material or Subcontract Order
- o Late Material Delivery
- o Late Subcontractor Mobilization
- o Field Install Interference
- o Schedule Logic Error

Impact Responsibility: (check all that apply)

- o Owner
- o Contractor
- o Subcontractor (name: _____)
- o Other: (name: _____)

Consequence of Impact: (attach additional pages, copies of RFI's or pictures, etc…)

_____

_____

_____

Schedule Activity (s) Directly Impacted: (list Activity IDs) _____

_____

Delays & Impacts

- Types of Impacts :
  - EC - Excusable, Compensable ^
    - Generally receive Time and $
    - Examples - Design Error, RFI's, Owner requested change
  - ENC - Excusable, Non–compensable
    - Generally receive Time
    - Examples - Force Majeure (severe weather), Unexpected Subsurface conditions
  - NENC - Non–excusable, Non–compensable ^
    - No Compensation
    - Examples - Subcontractor Performance, Contractor Performance ~

Delays & Impacts

- Additional Coding - used to show changes from the baseline schedule during the project
  - IMPT – Impact Type
    - EC - Excusable, Compensable
    - ENC - Excusable, Non–compensable
    - NENC - Non–excusable, Non–compensable
  - IMPN – Impact Number
    - 001 – Increase Scope of Work
    - 002 – Activity Duration Extended by Contractor ~

Delays & Impacts

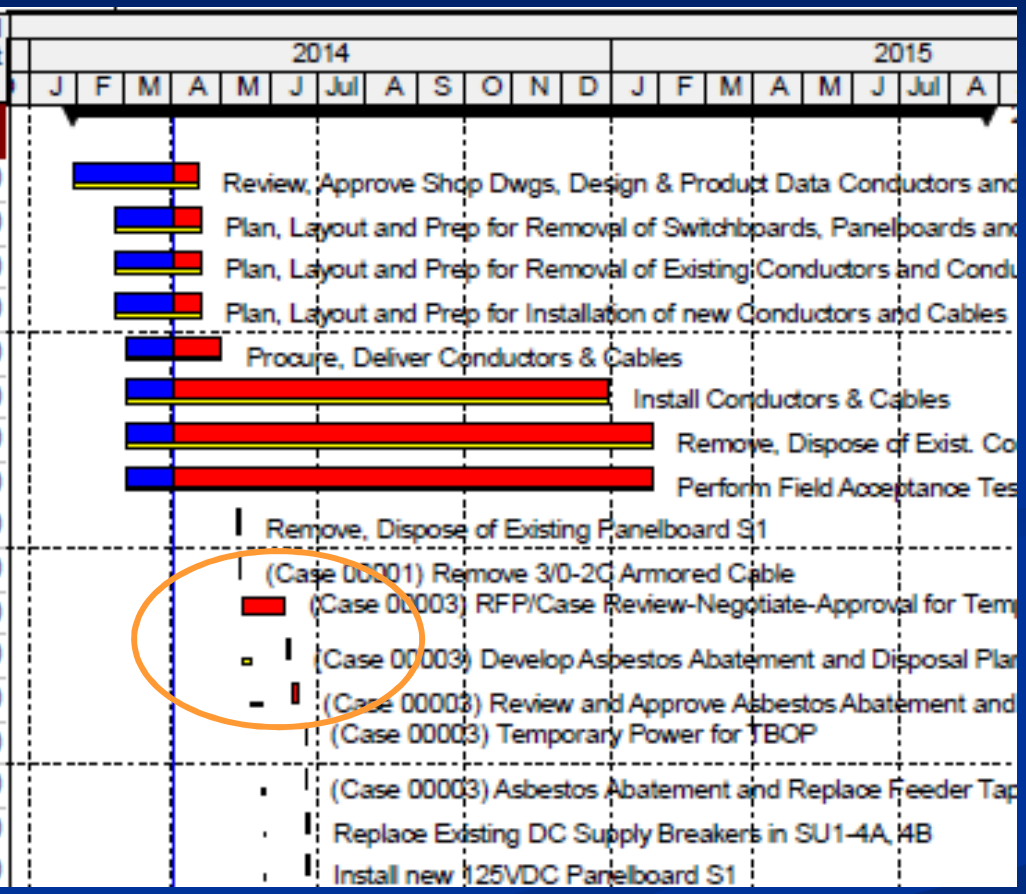
- Delays / Impacts evaluated against the current plan (contemporaneous schedule) and/or baseline
- Document, Illustrate, Analyze the impact/delay to the schedule immediately
- Get acknowledgement of the delay from all parties immediately
- Set a recovery plan. Recover immediately.
  - Additional work hours/days
  - Additional resources
  - Additional time (date extension) ~

Uncontrollable Delays

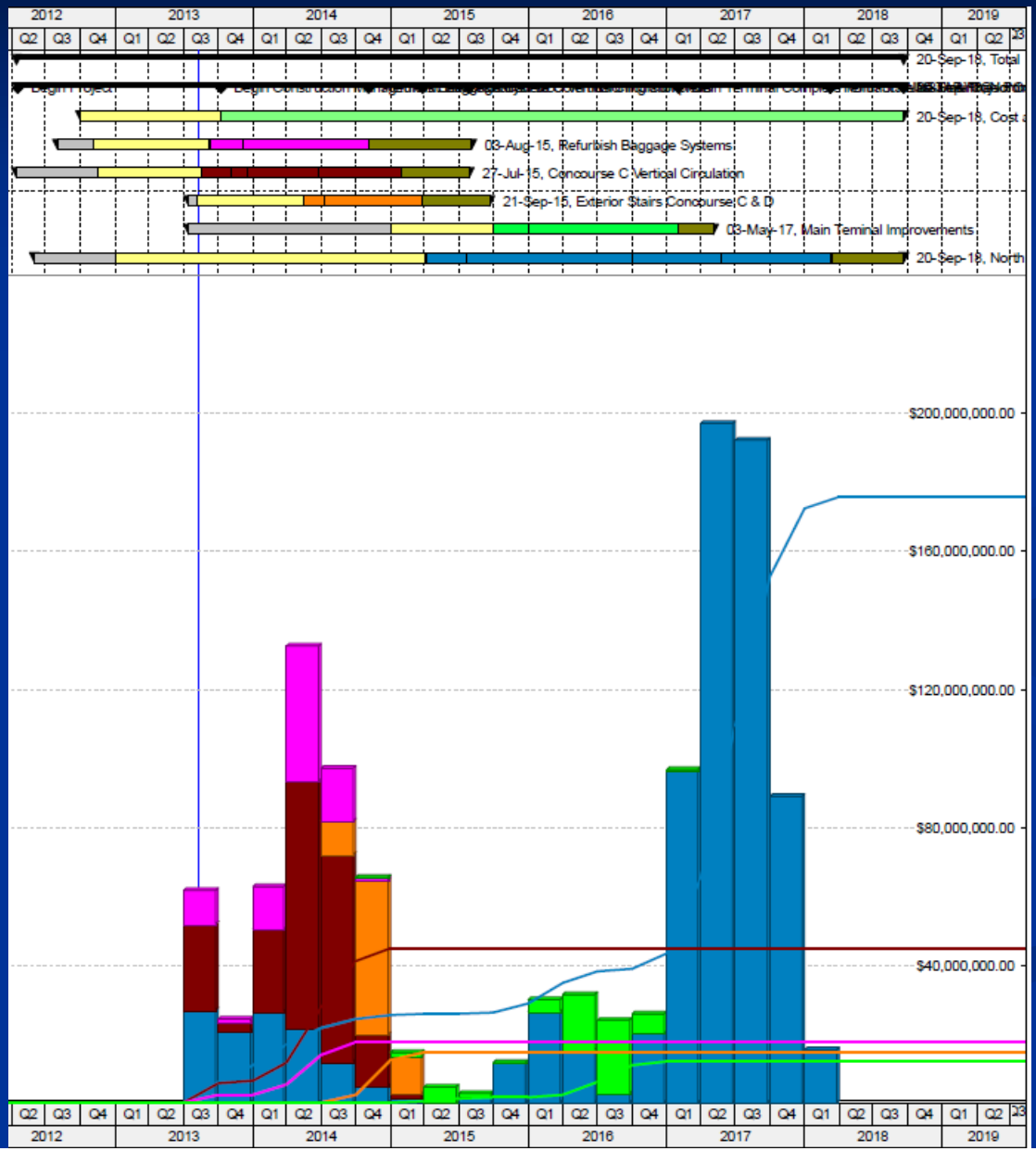
- Delays are addressed in the schedule after the impact has been identified
  - Impact can affect work in progress or work in the future
  - Add the impact to the schedule
  - Add the “consequence” activity or extend the duration of the in progress activity
  - Add logic
  - Illustrate the impact ~

P6 Variance Reports

Start	Finish	Mar 2014 Start	Mar 2014 Finish	Total Float
28-Jan-14 A	16-Apr-14	28-Jan-14	16-Apr-14	-147.0
24-Feb-14 A	17-Apr-14	24-Feb-14	17-Apr-14	-82.0
24-Feb-14 A	17-Apr-14	24-Feb-14	17-Apr-14	-82.0
24-Feb-14 A	17-Apr-14	24-Feb-14	17-Apr-14	-82.0
03-Mar-14 A	01-May-14	03-Mar-14	01-May-14	-147.0
03-Mar-14 A	30-Dec-14	03-Mar-14	30-Dec-14	-82.0
03-Mar-14 A	26-Jan-15	03-Mar-14	26-Jan-15	-82.0
03-Mar-14 A	26-Jan-15	03-Mar-14	26-Jan-15	-82.0
13-May-14	13-May-14	13-May-14	13-May-14	-82.0
14-May-14	14-May-14	14-May-14	14-May-14	-82.0
15-May-14	10-Jun-14			-82.0
11-Jun-14	12-Jun-14	15-May-14	19-May-14	-82.0
16-Jun-14	19-Jun-14	20-May-14	27-May-14	-82.0
23-Jun-14	23-Jun-14			-82.0
23-Jun-14	24-Jun-14	28-May-14	28-May-14	-82.0
24-Jun-14	25-Jun-14	29-May-14	29-May-14	-82.0
24-Jun-14	25-Jun-14	29-May-14	29-May-14	-82.0

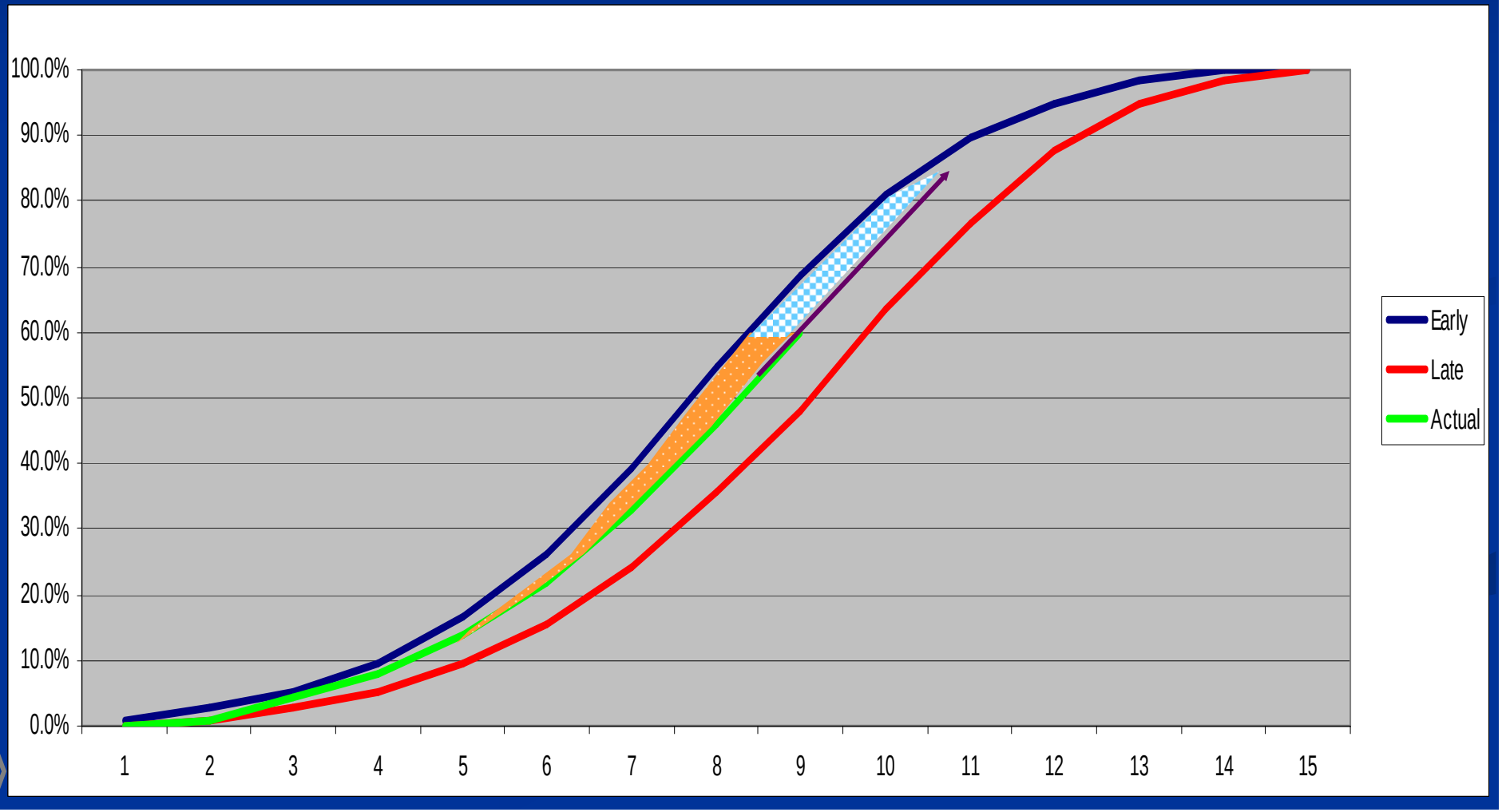


Resource Evaluation

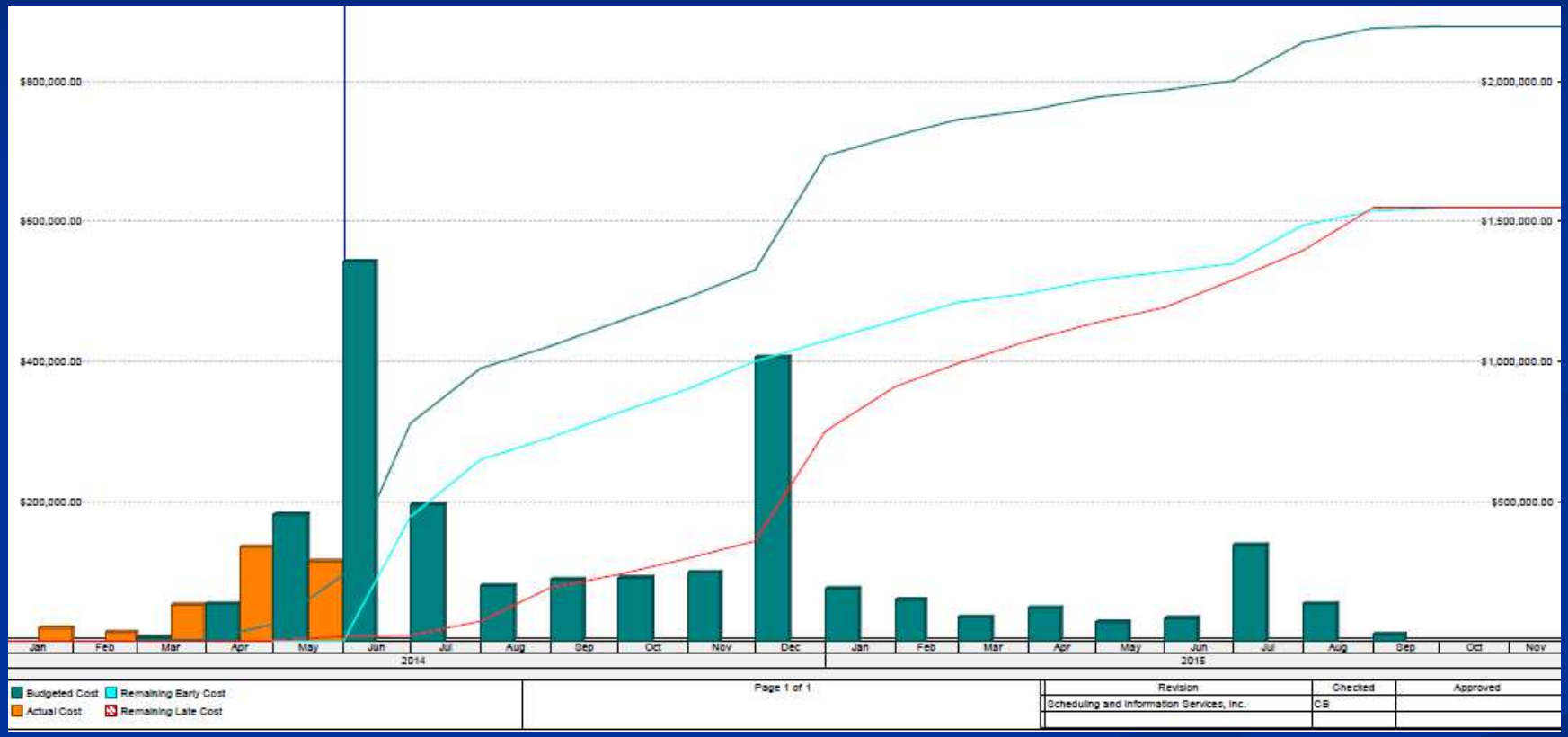


Performance Monitoring

S Curves



P6 Curve



Budgeted Cost

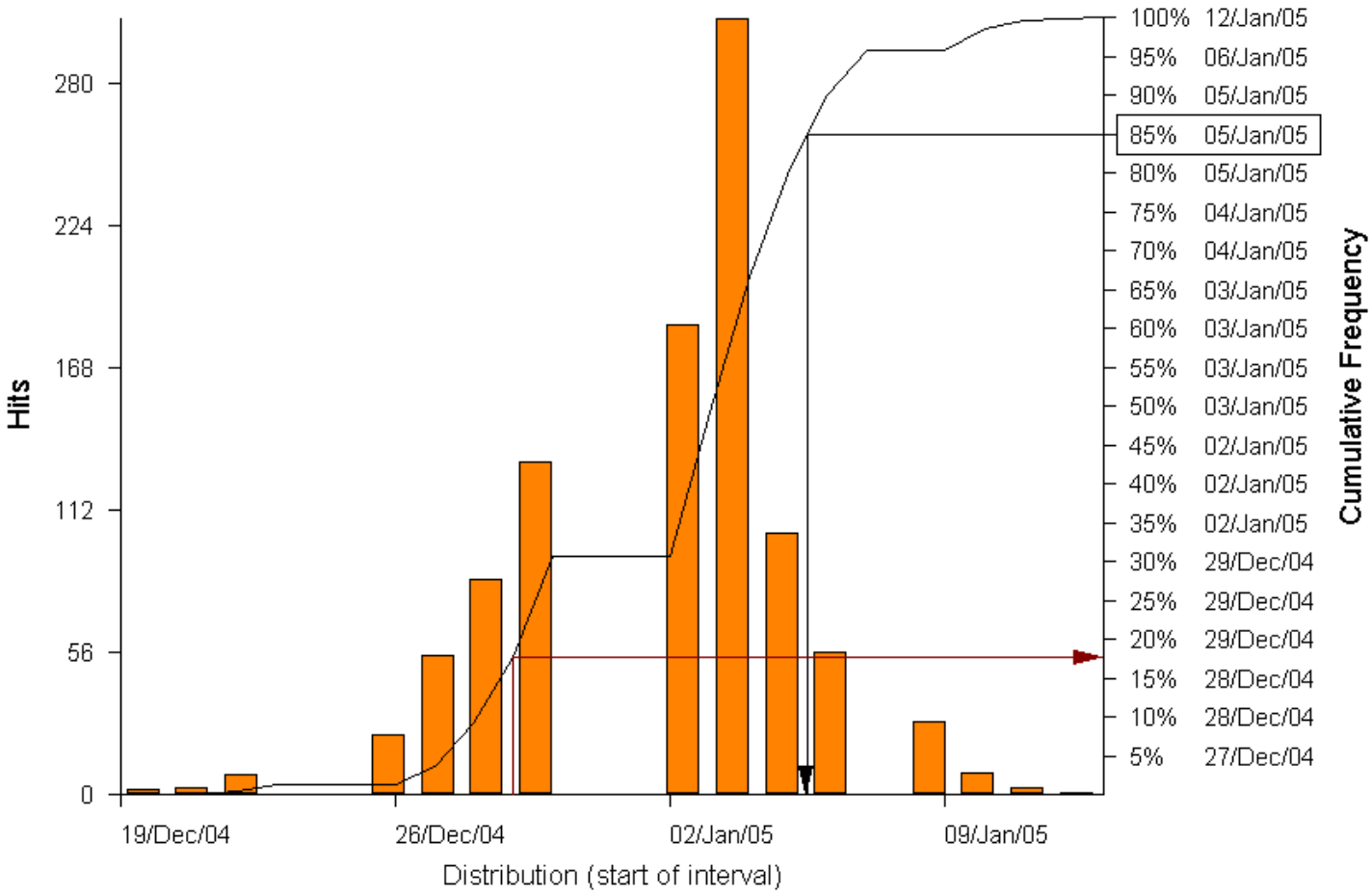
Remaining Early Cost

Actual Cost

Remaining Late Cost

Finish Date Analysis

Entire Plan : Finish Date



Analysis

Simulation:	Latin Hypercube
Iterations:	1000

Convergence

Plan Finish Date:
Converged in 200 iterations
(variation < 1% over 100 iterations)
Total Plan Cost:
Converged in 200 iterations
(variation < 1% over 100 iterations)

Statistics

Minimum:	19/Dec/04
Maximum:	12/Jan/05
Mean:	01/Jan/05
Max Hits:	306
Std Deviation:	3.730

Selected Confidence 85%:	05/Jan/05
Deterministic Finish:	28/Dec/04
Probability	18%

The End

Scheduling Techniques to Optimize Execution
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References

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